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The mission of the IJISPM – International Journal of Information Systems and Project Management – is the dissemination of new scientific knowledge on information systems management and project management, encouraging further progress in theory and practice.

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International Journal of Information Systems and Project Management (IJISPM)
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EDITORIAL

It is our great pleasure to bring you the second number of the 13th volume of IJISPM. In this issue, readers will find important contributions on e-logistics, GDPR, IT project success, IT strategic alignement, and cloud-based project management.

Beyond the line and hook: Identifying primary e-logistics technology adoption factors in the fishing industry

Bradley Bucky Khumalo, Shaun Pather

In the current era, e-logistics technologies have become commonplace in businesses to enhance supply chain and associated data analytics efficiencies. However, while contributing significantly to the GDPs in many countries, the fishing industry has been slow at adopting new technologies. Many slow adopters in this industry continue to use outdated data collection methods, thereby resulting in less-than-optimal data-driven decision-making. While prior research has examined the role of emerging technologies in the industry, there has been limited research to date to understand adoption issues. Our study therefore investigates factors that influence the adoption of e-logistics technologies in the fishing industry, using the Western Cape province in South Africa as the study site. The research investigated these factors using the Security-Technology-Organisation-Environment-Diffusion-of-Innovation framework. Qualitative data was collected via semi-structured interviews. The findings provide a rich insight into several adoption factors that demonstrate an interplay of technological innovations, organisational dynamics, and the environment within the industry. The findings were synthesized into an e-logistics technology adoption model. This paper enriches the existing literature on technology adoption, contributing insights for fishing industry stakeholders, and lays the foundation for informed decision-making in the realm of e-logistics integration.

Factors related to GDPR compliance promises in privacy policies: A machine learning and NLP approach

Abdel-Jaouad Aberkane, Seppe vanden Broucke, Geert Poels

This paper employs Machine Learning (ML) and Natural Language Processing (NLP) techniques to examine the relationship between organizational factors, such as company size and headquarters location, of data processing entities and their GDPR compliance promises as disclosed in privacy policies. Our methodology comprises three main stages, each representing a key contribution. Firstly, we developed five NLP-based classification models with precision scores of at least 0.908 to assess different GDPR compliance promises in privacy policies. Secondly, we have collected a data set of 8,614 organizations in the European Union containing organizational information and the GDPR compliance promises derived from the organization's privacy policy. Lastly, we have analyzed the organizational factors correlating to these GDPR compliance promises. The findings reveal, among other things, that small or medium-sized enterprises negatively correlate with the disclosure of two GDPR privacy policy core requirements. Moreover, as a headquarters location, Denmark performs best regarding positively correlating with disclosing GDPR privacy policy core requirements, whereas Spain, Italy, and Slovenia negatively correlate with multiple requirements. This study contributes to the novel field of GDPR compliance, offering valuable insights for policymakers and practitioners to enhance data protection practices and mitigate non-compliance risks.

Perceptual mapping of the association between IT project success and factors promoting strategic alignment

Marcus Vinícius Medeiros de Araújo, Jairo Simião Dornelas, Rodrigo Barbosa da Silva

The present research aimed at investigating the existence of associations between the factors promoting the strategic alignment of Information Technology (IT) and the success of IT projects. IT projects carried out in a public company in the Brazilian electricity sector from 2015 to 2018 were taken as the locus of the study. The research had a descriptive nature, used the quantitative method and a survey with 144 respondents from the company's business and IT areas. The key findings indicate that the success of IT projects depends on both the social dynamics between IT and business teams, as well as the intellectual/strategic alignment of IT plans,

resources and priorities with the overall business objectives. This research contributes by providing insights into the aspects of strategic alignment and their influence on project success. It offers practical guidance for organizations in managing IT projects and aligning them with business objectives. While the study focuses on a specific Brazilian public company, further research is needed to validate the findings across different industries and contexts. Overall, this research enhances our understanding of the relationship between strategic alignment, IT project success, and provides a foundation for future studies in this area.

A framework of critical success factors of cloud-based project management software adoption

L. I. Assalaarachchi, M. P. P. Liyanage, C. Hewagamage

Project Management (PM) software is an enabler of project success and is now being offered as a cloud-based software with the advancement of cloud computing. This research was conducted to explore the critical success factors affecting the adoption of cloud-based PM software. Semi-structured interviews were carried out with Information Technology (IT) professionals following the qualitative approach. Through thematic analysis, four themes were identified as areas considered when adopting cloud-based PM software: technological, organizational, environmental, and vendor-specific factors. Relative advantage, ease of use, compatibility, and reliability were categorized as the technological factors. Organization size, the technological readiness of the organization, employee willingness, top management support, and change management process were identified under organizational factors. Competitors' adoption, industry trends, and dedicated internet connectivity were identified under environmental factors. Additionally, features such as maintenance and service support from the vendor, popularity of the brand name, and availability of free trials emerged as vendor-specific factors.

We would like to take this opportunity to express our gratitude to the distinguished members of the Editorial Board, for their commitment and for sharing their knowledge and experience in supporting the IJISPM.

Finally, we would like to express our gratitude to all the authors who submitted their work for their insightful visions and valuable contributions.

We hope that you, the readers, find the International Journal of Information Systems and Project Management an interesting and valuable source of information for your continued work.

The Editor-in-Chief,

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RESEARCH ARTICLE

Beyond the line and hook: Identifying primary e-logistics technology adoption factors in the fishing industry

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Abstract

In the current era, e-logistics technologies have become commonplace in businesses to enhance supply chain and associated data analytics efficiencies. However, while contributing significantly to the GDPs in many countries, the fishing industry has been slow at adopting new technologies. Many slow adopters in this industry continue to use outdated data collection methods, thereby resulting in less-than-optimal data-driven decision-making. While prior research has examined the role of emerging technologies in the industry, there has been limited research to date to understand adoption issues. Our study therefore investigates factors that influence the adoption of e-logistics technologies in the fishing industry, using the Western Cape province in South Africa as the study site. The research investigated these factors using the Security-Technology-Organisation-Environment-Diffusion-of-Innovation framework. Qualitative data was collected via semi-structured interviews. The findings provide a rich insight into several adoption factors that demonstrate an interplay of technological innovations, organisational dynamics, and the environment within the industry. The findings were synthesized into an e-logistics technology adoption model. This paper enriches the existing literature on technology adoption, contributing insights for fishing industry stakeholders, and lays the foundation for informed decision-making in the realm of e-logistics integration.

Keywords

diffusion of innovation; e-logistics; fishing industry; supply chain management; technology adoption; technology-organisation-environment.

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1 Introduction

Organisations in several industries have adopted various tools, approaches, and associated technologies in their quest to implement systems to support both improved performance and the monitoring of growth (Schnegg & Möller, 2022). These systems leverage data as a core input. This proliferation and abundance of data, driven largely by the pervasiveness of inter-networks, has brought the realization of the importance of developing analytical capabilities and embracing data analytics as a business driver. Data analytics is the science of analysing raw data to draw conclusions and involves the process of inspecting, cleansing, transforming, and modelling data and applying algorithms to draw insights from the data, including identifying previously unknown patterns (Elgendy & Elragal, 2014; Frankenfield, 2020). Central to data analytics are e-logistics systems that capture data through the entire supply chain, integrating stakeholders and their activities, thus enabling complete data chains. Consequently, these systems engender an environment conducive to holistic data analysis approaches within organisations.

While the potential benefits of e-logistics systems are recognised, some industries remain slow to adopt. In addition, factors that drive or impede the implementation of such technologies within specific industries and regional contexts remain less explored. One such sector is the fishing industry, where opportunities for digitising remain significant. For many fisheries, fish stocks have continued to deplete, while a growing human global population has resulted in increased fish product demand (FAO, 2020). The Covid-19 pandemic crisis further accelerated this, where there were numerous supply chain shocks, lifestyle and supply chain reconfigurations, ongoing environmental concerns, and continued fisheries stock depletion (FAO, 2020). In response, many fishing authorities have implemented regulations to protect and preserve marine life, implemented fishing quotas, and applied fisheries science to improve the industry's sustainability. While acknowledging progress, the fishing industry has not fully exploited opportunities presented by modern software systems and has been adopting data management systems at a slow pace (Girard & Du Payrat, 2017; Merrifield et al., 2019). The industry has not embraced data-centred strategies to enable opportunities for process improvements, efficiency increases, revenue growth, and overall business sustainability (Siefkin, 2018). However, while prior research has examined the role of emerging technologies in the fishing industry, there have been limited studies to date to understand adoption issues.

Given the foregoing, this paper reports on an investigation into the multifaceted interplay of factors that affect the adoption and integration of e-logistics solutions in the daily operations of fishing organisations. This research was conducted amongst fishing organisations operating within the Western Cape province in South Africa, a region representing a well-established fishing sector. The primary question investigated is: "*What are the primary factors influencing the adoption of e-logistics technology in Western Cape fishing organisations?*". The technologies considered are those with the potential to improve data analytics by digitising some or all aspects of the fishing supply chain and providing safe, timely, and reliable data collection, movement, storage, access, sharing and analytics as needed in fisheries management.

In the next section, we present a literature review, encompassing an overview of fishing supply chains and the role of e-logistics technologies. We further discuss the extant literature in relation to adoption research before describing how prior research and research gaps informed our research model and investigation. In Section 3, we summarise our methodology for data collection and analysis and discuss our findings in Section 4. Finally, we present the e-Logistics Technology Adoption model in Section 5 and provide a conclusion, limitations and opportunities for future research in Section 6.

2 Literature review

2.1 Supply chain management and the use of data in the fishing industry

Supply Chain Management (SCM) concerns the integration of activities within and between organisations, incorporating the organisation's logistics capability, structures, and enabling technologies (Abuzaid et al., 2023; Wagner & Sweeney, 2010). In the fishing industry, SCM considers the different actors who maintain and manage fishing vessel fleets, provide

operational technologies, manage fishing activities, data collection, transformations, and analysis, and those who make, regulate, and enforce fishing laws accordingly in an effort to provide fish products in a sustainable manner (Barkai & Lallemand, 2014; FishSA, 2019).

In South Africa, the Western Cape is a business hub with notable presence of fishing organisations ranging from artisanal small-scale fishers to large-scale commercial fisheries. The province has 11 of the proclaimed 13 national fishing harbours, which contribute 5% to the province's Gross Domestic Product (GDP) and contributes over 70% of the national industry income and over 70% of the industry employment (FAO, 2018). Therefore, the Western Cape fishing industry served as an ideal delineation for this study.

2.2 The suite of e-logistics technologies to support fisheries SCM

Cloud-computing dependent technologies like mobile technology, remote-sensing and other Internet of Things (IoT) sensors, distributed computing, and storage capabilities are opening new integrations opportunities into agri-food systems, including fisheries, laying down a foundation for an agricultural revolution (Gray et al., 2018). E-logistics, which refers to the integration of digital tools and data-driven processes into SCM, heralds a transformation in navigating fishing organisations complex operations. It entails applying the latest information technologies to support logistics management (Dȩbkowska, 2017). In the fishing industry, Merrifield et al. (2019) note that at least three fishing industry-enabling technology advances have allowed a transition from paper-based systems to digital ones in a cost-effective manner. These include mobile, cloud and mapping on the internet. Bradley et al. (2019) classify enabling technologies as electronic monitoring, reporting, and mobile computing technologies. Other complementary technologies include traceability technologies like blockchain, fish-finding technologies, smart-weighing systems, drones and other machine learning tools or capabilities like artificial intelligence (Bradley et al., 2019; Girard & Du Payrat, 2017). These identified technologies could potentially improve management and decision-making through context, situation, and location awareness (Kamilaris et al., 2017). Furthermore, cloud-computing as an enabler of all these technologies provides affordable, efficient, volume-unlimited data storage (IBM, 2022a). The development of these technologies continues to play a vital role in reaching sustainable fishery resource management and the adoption thereof becomes imperative to understand towards better management of the uncertain realities of fishing operations (Fujii et al., 2017).

2.3 e-Logistics technology adoption in the fishing industry

While there are several new technologies and systems to support data analytics and associated business intelligence and data governance initiatives, Diaz (2020) notes that the adoption and implementation of these technologies, in fisheries, are still lacking. Furthermore, in the developing world, including South Africa, a discrepancy exists between the inherent characteristics of fisheries and the data systems utilized to delineate them (Mills et al., 2011). It thus follows, that organisations ought to manage their digital supply chain and enhance information flows (Wang & Pettit, 2016). e-Logistics technologies provide an opportunity for this improved data management (Rose, 2021). Managing fisheries sustainably in an era of uncertainty and climate change requires modernised fisheries data systems from the source of the data through the data chain to the end-user of the data (Merrifield et al., 2019). There thus have been calls for the adoption and implementation of e-logistics which would improve data analytics and overall fishing operations outcomes.

2.3.1 Drivers of technology adoption

In a study on aquaculture technology adoption among smallholder fish farmers in Kenya, Obiero et al. (2019) developed a framework categorizing themes like Farmer Characteristics, Technology Characteristics, External Environment, Economic Characteristics, and Advisory and Extension Support into intrinsic, intervening, and decision-making variables. The framework was modified from Kumar et al. (2018) and Meijer et al. (2015). The authors *(ibid.)* identified education, household size, advisory services and farm-specific characteristics as influencing the decision to adopt aquaculture

technologies. Notably, their findings align with several other studies including Okello et al. (2020), Fadeyi et al. (2022), and Mesere & Worth (2022) in that perceived usefulness and perceived ease of use are primary factors of technology adoption.

Adewale Isaac et al. (2020), in their study in Ondo State, Nigeria, found that profit, education, household size, experience, fish price, cooperative society and perceived cost of equipment were the main factors influencing the adoption of improved fish processing technologies. The study employed a questionnaire on fishing technologies used and classified these into traditional and improved fishing technologies. By this classification, the study discerned the factors driving the adoption of improved fish processing technologies.

Isaacs et al. (2022), considering a transition from vulnerability to viability of small-scale fishers in South Africa suggest an understanding of various supply chain dynamics including power, ownership, demographics of fishers, fisher communities and technology as influencing the adoption and use of fishing technologies. The authors *(ibid.)* emphasise the importance of understanding the current state-of-affairs in tandem with the intricate interplay of these factors from various perspectives to promote sustainable fisheries practices. As one of the primary contributions, their research highlights technology's role towards equitable outcomes in fishing and a need to investigate this as an adoption factor. Furthermore, e-logistics enable data to be collected once and used many times, sometimes in real-time (Barton et al., 2011; Merrifield et al., 2019). This single version of the truth enables timely, accurate, and objective analyses facilitating fisheries' transition from vulnerability to viability.

2.3.2 Barriers to technology adoption

In understanding drivers of adoption, barriers ought to be considered too (Murphy et al., 2022). A study in South India by Giné & Klonner (2005) found that asset poverty or a lack of financial capital inhibits the ability to adopt fishing technologies. The study, conducted in a rural community estimated the impact of poverty on adoption of technology and recommends the adoption of relevant policy in such contexts. The authors conclude that a lack of wealth is a key predictor for delayed adoption.

Furthermore, this research acknowledges that fishers want to improve their fishing effort. In this end, therefore, there is a need to understand fishers' consideration of conservation in their activities. Murphy Jr. et al. (2022) found that there is a need to marry profitability with environmental sustainability and identified a lack of knowledge in this understanding as being a barrier to the adoption of technologies geared towards sustainability. The authors *(ibid.)* conclude their paper by recommending an all-stakeholder collaboration in the implementation of fishing technologies.

Considering these findings, both drivers and barriers to adoption were considered and are discussed in this paper. While humans decipher and operationalize data, technologies serve as the generators of this data (Fujita et al., 2018). Technology is a complement to human activities, and it is people who identify and decide on the most suitable technology and act on the purchase, use and discarding thereof. Our paper acknowledges that e-logistics technologies awareness may lead to adoption and use and provides a lens into lived experiences of fishers.

2.4 Framework for the study

Following on the literature review the research gaps that were identified include a lack of industry context-specific studies, as well as a limited consideration of the role of socio-economic factors in relation to the adoption of technologies. Secondly, there appears to be a dearth of studies which provide guidance for the development of data-driven policy in the fishing industry. Lastly we identified a need to demonstrate the interplay of traditional practices and other adoption barriers that are unique to the geographical context of the industry given that technology adoption is not a one-size-fits-all endeavour (Jokonya et al., 2014).

As such, the extant literature was considered in developing our research framework. Previous studies and frameworks considered were both at individual and organization level. Theories primarily used in the individual technology adoption studies included the Technology Acceptance Model (TAM) by Davis (1989), the Theory of Planned Behaviour (TPB) by Ajzen (1991), the Theory of Reasonable Action (TRA) by Fishbein & Ajzen (1975) and the Unified theory of acceptance and use of technology (UTAUT) by Venkatesh, et al. (2003). The organisational focus of the study, that proposes limited volitional control in decision-making in organisations thus necessitated a consideration of other frameworks that would better capture the research question dynamics both within organisations and externally.

2.4.1 The technology-Organisation-Environment framework (TOE)

The Technology-Organisation-Environment framework (TOE) served as a foundational framework for the study. The TOE brings into perspective the human and non-human actors of a supply chain, categorising the factors of technology adoption into the *technological*, *organisational,* and *environmental constructs* (Awa et al., 2016; Tornatzky & Fleischer, 1990). It is an integrative and holistic framework (Ramdani et al., 2013). The *organisation* factors are descriptive, considering the nature, resources and managerial structure of the business and the *environment* construct considers external factors like external support, government regulation, and competitors (Hoang et al., 2021; Liu, 2019). The TOE framework displays its strength in industry and size friendliness as evidenced by numerous information systems research studies carried out and is useful in the investigation of a wide range of innovations and contexts (Awa et al., 2016). Furthermore, it has been broadly supported in empirical work and remains among the most prominent and utilized theories of organisational technology adoption since its development (Agrawal, 2015).

2.4.2 The Diffusion of Innovation framework (DOI)

The diffusion of innovation framework (DOI) served to complement the TOE as it is broad-based and provides a complementary technology perspective to the TOE by design (Qasem et al., 2020; Rogers, 1962). The five perceptual characteristics of innovation provide good structure to the investigation of the technological influences identified in the TOE. These are: *relative advantage*, *compatibility, complexity, trialability* and *observability* and are defined in Table 1. Innovativeness, in this regard is related to specific independent variables, namely, individual characteristics, internal organizational structural and external characteristics (Oliveira & Martins, 2011). It integrates three components: adopter characteristics, characteristics of innovation and the innovation-decision process (Taherdoost, 2018) and was developed in considering and synthesising over 508 innovation diffusion studies to explain both the adoption and acceptance of an innovation (Liu, 2019). The DOI posits that an innovation, which is an idea, practice or object perceived to be new, undergoes a process of communication to members within a social system, over time (Chui-Yu et al., 2017; Rogers, 1962). The framework assumes that individuals have different degrees of willingness to adopt technology and classifies them into five categories from most likely and willing to adopt to least willing to adopt categories of adopters, namely, innovators, early adopters, early majority, late majority, and laggards, respectively (Rogers, 1995). In playing a complementary role to the TOE, Taherdoost (2018) found that the DOI was one of the most common complements in research relating to Information Management. Furthermore, various studies incorporated the TOE and DOI frameworks in combination including Kumar et al. (2018), Hiran & Henten (2020), Lai et al. (2018), and Sabu et al. (2018).

2.4.3 Security as a construct

Investigating blockchain adoption factors, Mthimkhulu & Jokonya (2022) found that security within the logistics supply chain was an important influence on adoption. Similarly, other studies found that, among other factors, data security was a barrier to technology adoption, especially with cloud-centred technologies (Awa et al., 2016; Maroufkhani et al., 2020; Park & Kim, 2021; Salleh & Janczewski, 2016). In this research, security is predicated on the three fundamental principles of data security: the CIA triad of confidentiality, integrity, and availability (Brooks, 2022; Murphy et al., 2022). Data security covers numerous aspects, including security access, resource optimisation and analytics trust (Haufe et al., 2016).

Furthermore, the construct was investigated in terms of privacy, hacking, spoofing, deception, and encryption (Girard & Du Payrat, 2017). Given its criticality, data security was integral to our investigative framework. We considered concerns relating to safeguarding intellectual property rights, protecting sensitive information like fishing location and other catch-related data and discussed issues relating to data ownership, stewardship, accountability and responsibility.

2.4.4 An integrated framework: Sec-TOE-DOI framework

Integrating the model into a Security-TOE-DOI (Sec-TOE-DOI) model facilitates a nuanced examination of the multifaceted influences driving or hindering the adoption of e-logistics technologies in the fishing industry, ultimately paving the way for more informed decision-making and strategic interventions. In this manner, therefore, security and the persuasion stage characteristics of the DOI were merged with the technology construct of the TOE. The resulting framework is depicted in Figure 1, highlighting the interactions of constructs and concepts investigated. The adoption of this framework enabled both small and large corporations to be investigated. This informed our survey instrument design.

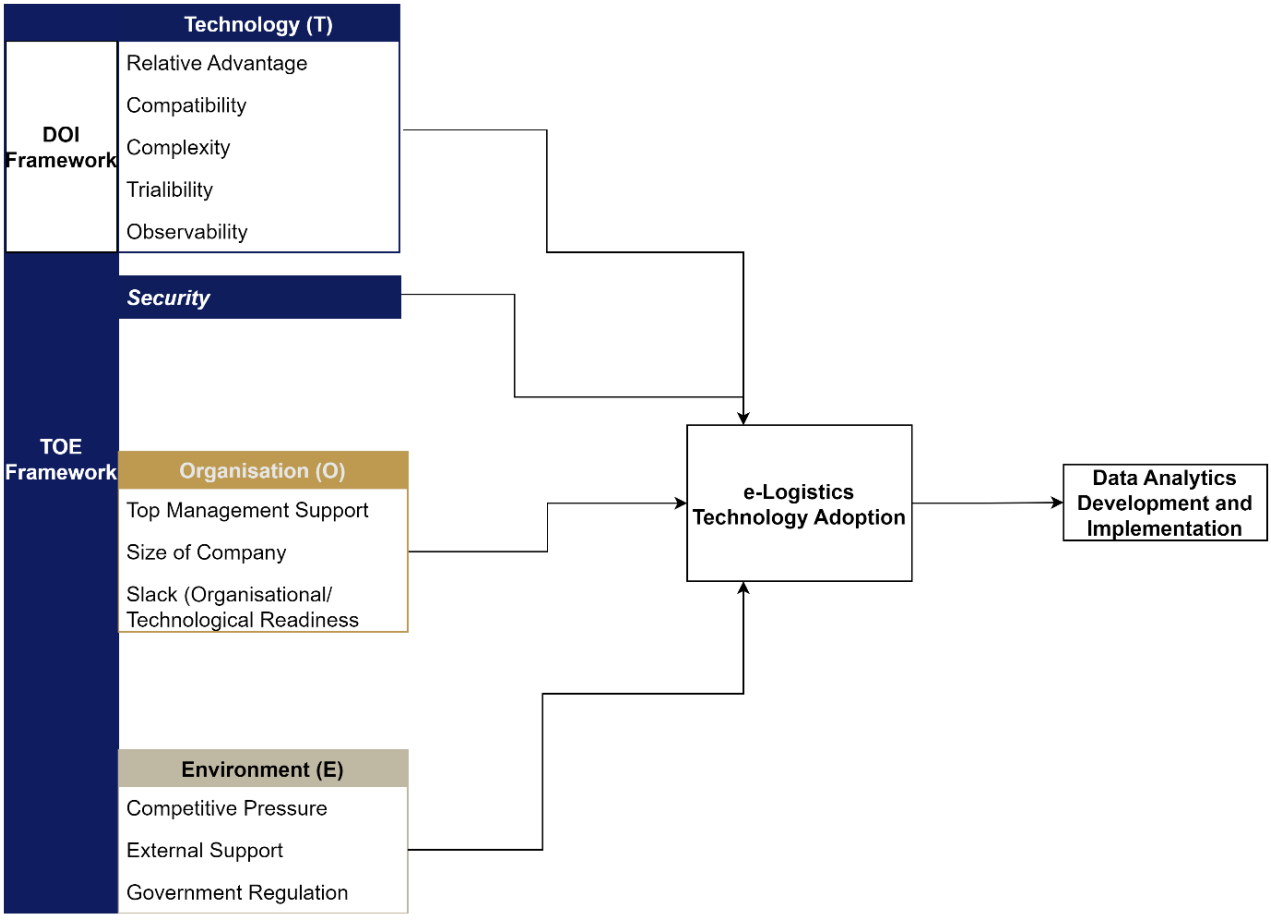

Fig. 1. Sec-TOE-DOI framework to investigate e-logistics technology adoption

Figure 1 as a framework, enabled the development of qualitative surveys to capture the importance of each of the constructs and concepts defined. Table 1 defines the constructs and concepts as used within the Sec-TOE-DOI.

Table 1. Sec-TOE-DOI Concepts definitions

Construct	Concept	Definition	Source
Technology *(consideration of both the internal and external aspects of technology)*	Relative advantage	The degree to which an innovation is perceived to be better than the preceding idea.	(Kumar et al., 2018; Liu, 2019)
	Compatibility	The degree to which an innovation is consistent with existing business processes, practices, and values.	(Rogers, 1995)
	Trialability	The degree to which an innovation can be experimented with.	(Rogers, 1995)
	Complexity	The degree to which an innovation is difficult to use.	(Rogers, 1995)
	Observability	The degree to which the results of an innovation are visible to others.	(Rogers, 1995)
	Security	This considers data security in terms of access, confidentiality, privacy, IP protection and data ownership. It includes measures taken for business continuity.	(Bertino, 2016; Lopez, 2013)
Organisation *(descriptive factors considering nature, resources, and managerial structure)*	Top management support	The degree to which managers comprehend and accept the capabilities of the new technology system, including providing a vision, support, and/or commitment to the technology.	(Maroufkhani et al., 2020)
	Size of the company	The firm's size in terms of employee numbers, revenue, and relative size in the Western Cape fishing industry.	
	Slack	The fishing organizations' readiness to invest in new technologies, technical expertise, and information Technology (IT) capability, including IT infrastructure, and the availability of personnel with the relevant skills.	(Maroufkhani et al., 2020)
	Absorptive capacity	The organisation's ability to recognise the value of new information, assimilate, and apply it towards a commercial end.	(Cohen & Levinthal, 1990)
Environment *(consideration of external factors)*	Competitive pressure	Influences from the external environment, including customers, suppliers, and competitors.	(Maroufkhani et al., 2020)
	External support	Support from vendors and/or other third parties to encourage firms to innovate and adopt an innovation.	(Maroufkhani et al., 2020)
	Government regulation	Rules and policies that either inhibit or encourage the adoption of certain technologies, including technology standards.	(Tornatzky & Fleischer, 1990)

The definitions as found in literature were contextualised and analysed within the context of the fishing industry.

3 Methodology

3.1 Research design

To address the research question, the interpretivism paradigm was adopted. Interpretivism supposes that reality is subjective and based on individual experiences (Ryan, 2018). We adopted an explorative and qualitative design approach. This was ideal, as little is available regarding the Western Cape fishing industry. The objective was thus to listen to research participants to build an understanding of what is heard (Potter, 2015). Semi-structured interviews were used to investigate the adoption factors that were conceptualised in the Sec-TOE-DOI structured framework. The qualitative research captured the nuanced insights from interviewed stakeholders within fishing organisations.

3.2 Unit of analysis

Fishing organisations in the Western Cape comprised the unit of analysis. Individual respondents represented organisational perspectives and behaviours that influence the decision to adopt specific e-logistics technologies, responding from various perspectives of technical, financial/procurement involvement, managerial control, and operational knowledge.

3.3 Data sources, sampling strategies and techniques

To identify prospective interview respondents, purposive sampling was applied. The companies were identified using the Fishing Industry Handbooks, 45th (George Warman Publications, 2017) and 46th (George Warman Publications, 2018) editions. Interview participation requests were sent to ninety fishing companies (both large commercial-scale and small-scale). Of the ninety organisations, 20% (18) consented to participating in the research. The eighteen respondents allowed for in-depth interviews that in turn allowed for analysis and the development of the Western Cape's fishing industry's e-logistics adoption framework. Table 2 presents a summary of the participants.

While a significant portion of our respondents hailed from fishing operations companies, we deliberately ensured a diverse representation of stakeholders to broaden perspectives. The respondents were drawn from various business units and multiple roles and were in positions to directly influence the adoption of e-logistics technology or had already participated in operations using such technologies.

Table 2. Research participant summary

Type of Company	Definition	Type of Role	No. of People	% of people
Fishing Association **(4 | 22.2%)**	A group of organisations of a specific fishery, pursuing a joint purpose.	Executive Management, Operations	2	11.1%
		Fisheries Management Consultant	2	11.1%
Fishing Consultancy **(3 | 16.7%)**	A consultancy firm in environmental sustainability and fishing consulting.	Executive Management - Operations	2	11.1%
		Fisheries Management Analyst	1	5.6%
Fishing Operations Company **(7 | 38.9%)**	A company that owns, manages or operates fishing vessels.	Executive Management, Operations	3	16.7%
		Fisher/ 2nd Mate	1	5.6%
		Fisher/ Skipper/ Owner	2	11.1%

Type of Company	Definition	Type of Role	No. of People	% of people
		Fisheries Management Consultant	1	5.6%
Fishing Technology Company **(4 | 22.2%)**	Organisations providing and/or developing fishing technologies used by fishers.	Business Development Manager - Fisheries	1	5.6%
		Developer and Analyst	2	11.1%
		Executive Management - Operations	1	5.6%
Total Respondents			**18**	**100%**

3.4 Data analysis

Figure 2 provides an example of the logic applied during the analysis phase of the research.

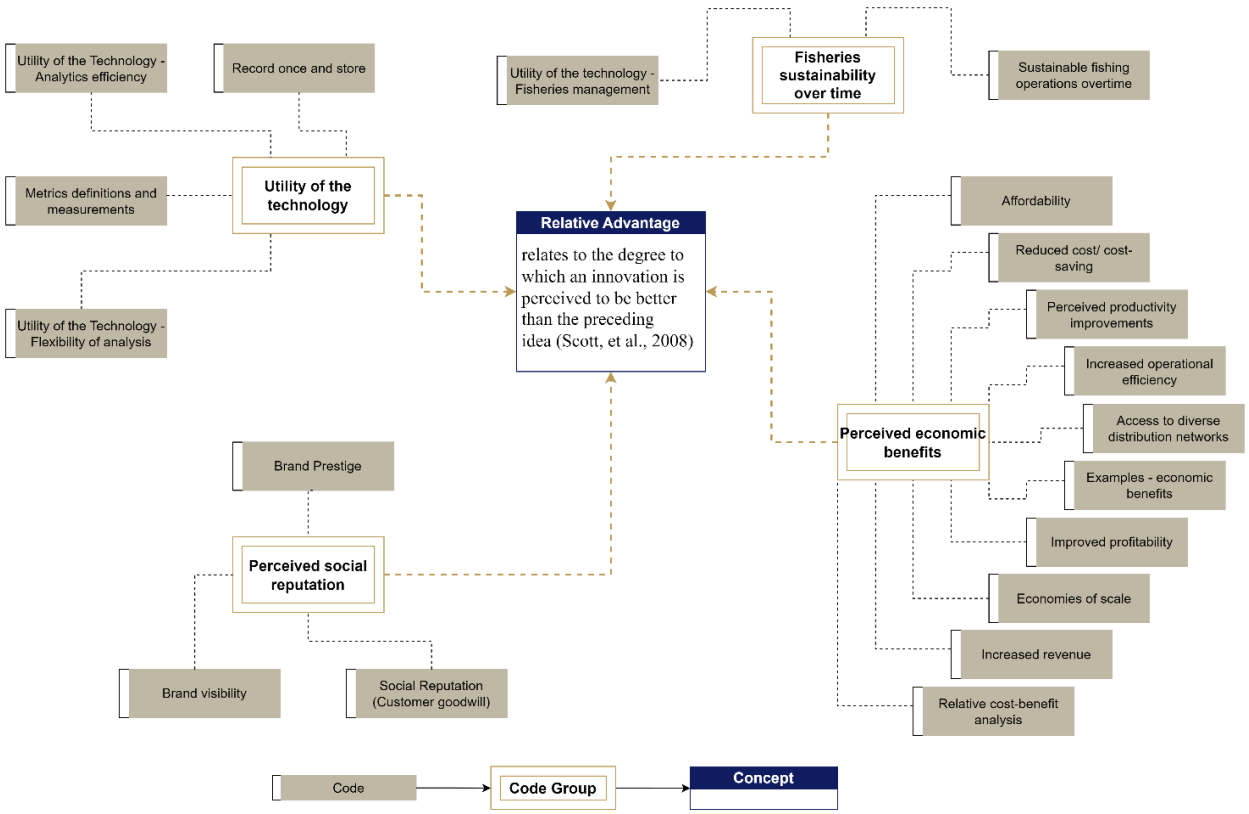

Fig. 2. An example of coding during qualitative analysis

Once the interview consent had been received, both physical and online interview sessions were organised over a 3-month period. The interviews were recorded, transcribed, and the data collected and cleaned up to ensure that inputs were coherent. Data validation, editing and masking techniques were applied to ensure that no self-identifiable analyses would be provided, and that information would not be misinterpreted or misrepresented. During the interviews, memos were added, highlighting frequently occurring thoughts. Soon after the interview, some time was taken to; listen to the

recordings, transcribe the interview, re-consider frequently highlighted thoughts, and add any other insight as was relevant. In analysing this data, coding units were identified, and data were classified within these units. A combination of deductive coding based on the framework, augmented with inductive coding to make provision for that which was not apparent from the framework was used. Deductive coding refers to a top-down approach where codes are developed from an already-developed framework or codebook (Saldana, 2015). Inductive coding refers to a ground-up approach where codes are developed from the data (Saldana, 2015). The codes applied to interviews were grouped into code groups, then further into concepts. The concepts then informed the constructs as identified in the Sec-TOE-DOI framework.

The logical flow of codes to the code group to the concept (theme) and finally upward to the construct from the model enabled informed analyses of factors, including their interplay across all stakeholders.

4 Findings

The respondents were 50% female (9) and 50% male (9). In terms of the respondents' companies, 22.2% (4) were from Fishing Associations, while 16.7% (3) were from Consultancies. Additionally, 38.9% (7) were from Fishing Operations companies and the remainder of 22.2% (4) were from Fishing Technology companies. At least 50% of respondents had over 10 years of tenure in their organisation and at least 61% had over 10 years of experience in the fishing industry. The experience and knowledge of the interviewees in relation to the fishing industry and technology use trends informed us of the objectivity and depth of the respondents' qualitative feedback as further discussed in the sections that follow.

Table 3. Respondents' fishing industry experience

Years of Experience	Under 1 Year		1-2 Years		3-5 Years		6-10 Years		Over 10 Years	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Current Company	1	6%	4	22%	2	11%	2	11%	9	5%
Fishing Industry	0	0%	3	17%	1	6%	3	17%	11	61%

The findings show that while the constructs: Technology, Organisation, and Environment influence technology adoption in the sector, specific concepts within these constructs drove this adoption.

4.1 Technology construct

Concepts of relative advantage and compatibility were found to be primary adoption-influencing factors. Within the relative advantage concept, respondents emphasized the utility of the technology, the perceived economic and social benefits, and overall fisheries sustainability. One fishing operations executive captured this succinctly, by stating:

> *"I hate doing things twice and that's what the digital world stops us from doing. My policy was to have data, keep data on our servers and have the flexibility to analyse it whenever we wanted to do so."*

This finding is consistent with other technology adoption research in other industries that found that perceived usefulness is an adoption-driving factor. Hubert et al. (2019) found that perceived usefulness and a technology's utility increased trust in smart home technologies and, therefore, the likelihood of adopting the technology. Similarly, Thevaranjan and Samantha (2022) found relative advantage as an influencing factor in e-commerce while Baptista & Oliveira (2015), using the UTAUT model, found performance expectancy, a construct assessing the utility of a technology as significant in the decision to adopt mobile banking.

The respondents further emphasised the importance of differentiating between systems and process compatibilities. Systems compatibility refers to technological compatibilities while process compatibilities refer to the technology fitting into the organisations' operations, e.g., software for compliance purposes. In both instances, compatibility was identified as influencing technology adoption, with process compatibility being more emphasised.

> *"You need something fit-for-purpose for your business. It's not a one-size-fits-all. People who get into operations tweak the operations."*

Fishing organisations tend to be willing to adapt operations to technology and vice versa, to reach internal efficiencies. A different executive noted:

> *"The fishing environment is very harsh. The weather elements sometimes determine what technology may be out at sea and what technologies may not be out... As a rule, fishermen must focus on fishing and not any other role. Technology must therefore complement the fishers' efficiency."*

Concepts of complexity, observability and trialability were not seen to primarily influence e-logistics technology adoption. Respondents noted that all new technology requires familiarity and thus may initially seem complex. Additionally, while one may observe success in other organisations, using certain technologies, in fishing, organisations tended to look inward, to seek internal efficiency optimisation as opposed to observing other organisations and imitating their winning formulae. Dynamics relating to differing operations from one organisation to the next diminish the value of observability as a factor. A different fishing executive noted:

> *"You may have a way your operational structure is and that influences what technology you use. One rarely looks next door. You can understand the competitor but it's generally about your operations."*

Respondents emphasised that fishing is a specialised industry requiring partnerships between technology developers and other fishing stakeholders, and that the partnership cannot begin at trialing the software but must be a continual exercise from conceptualising the idea to the final delivery of the specialised solution. As Nwaiwu et al. (2020) advocate, all-stakeholder involvement is imperative to build the needed trust and the adoption of technologies thereof.

4.2 Organisation construct

In moving to the organisation construct, one of the interview respondents acknowledged this factor by discussing the human resources dynamics, stating:

> *"The fishing career was previously not a desired one. It was simply a question of the choice of employer and not the choice of employment. Significant changes are being made to make the industry more attractive."*

In this end, therefore, top management support was identified as primarily influencing human capital to adopt technology. Management's ability to impose policy, their ability to assess and assume risk, and their influence on absorptive capacity both in terms of capital and financial resources make them a pivotal centre of technology adoption. In literature, likewise, Chandra and Kumar (2018) assert that positive attitudes of top management have tended to positively influence technology adoption at organisational level.

Absorptive capacity and slack were considered as one construct with respondents identifying the availability of uncommitted resources (human and financial), inherent fishermen's biases, and the knowledge and experience with technologies as primary adoption factors. As a factor of adoption, this implied both a positive and negative influence. The research found that the experience of human actors in the industry, especially fishers, was a primary contributor to the

adoption or rejection of e-logistics technologies. Fishers tend to be conservative in nature and prefer to stick to proven ways of working. One of the respondents noted:

> *"Usually, a younger crowd tends to be more receptive to technology than people who are set in doing things how they do them."*

New technologies thus may not be readily accepted as they may challenge this notion. Additionally, fishers tend to include, as part of their expertise, their knowledge of fishing grounds and techniques. E-logistics pose a threat to this specialisation, by moving the fishing grounds expertise and knowledge from the fisher to the technology. This, various fishers, especially small-scale fishers, mentioned as being a threat to their economic livelihood.

Another find from this analysis was that contrary to previous studies highlighting formal education as a key adoption-influencer, in the Western Cape fishing industry, it was the awareness and familiarity with available technologies that drove adoption, rather than formal education levels. A fisherman, describing some of his fishing mates stated:

> *"There are a lot of fishermen out there that don't even have smartphones, though they're still working with old cell phones. Guys are working with texts instead of WhatsApp and so you can kind of understand that there are people that are old school that do not want to change."*

As such, fishers in the industry may have varied formal education qualifications yet possess skills and knowledge much harder to quantify. There is an opportunity for technology developers to develop solutions with some educational material to accompany their technologies. This finding also supports Ghobakhloo et al. (2012), who identified a lack of knowledge, complexity of technology and unfamiliarity as barriers to technology adoption, these, needing consideration in all technology adoption endeavours. This barrier, the authors *(ibid.)* note, leads to a cultural distrust of technology, an alluded to reality in our research.

Concluding their interview, a female fishing consultant captured the absorptive capacity and slack concept's importance by stating:

> *"As a concluding remark, the most important factor is will. Everyone must be willing. Will is a fundamental influence and there are many examples when discussions stalled because of unwilling parties."*

Cultural biases, a lack of knowledge, a lack of resources and other organisational realities could hinder technology adoption, yet a willingness to overcome these challenges is a fundamental influencer to adopt modern e-logistics technologies. As the popular adage goes, "where there's a will, there's a way".

The size of the fishing organisation did not feature as a primary adoption factor. Different organisations employ different technologies with varying degrees of complexity. These technologies range from basic weather forecasting tools to electronic logbooks, onshore data analytics solutions and other paper-to-digital innovations. Larger companies tend to focus on leveraging economies of scale to increase fish production, while smaller companies prioritize affordability, opting for technologies that align with their specific operations.

4.3 Environment construct

In terms of the environment construct, competitive pressure, a modern driver of economic development, was not considered a primary adoption-influencing factor. While business ought to remain competitive for business continuity, fishing organisations tend to optimize internal operations to remain competitive.

A fishing operations' executive with engineering expertise noted:

> *"I applied fishermen's knowledge together with engineering knowledge and some technical knowledge and this has given our company a competitive edge by reducing the cost of developing our services and increasing the efficiency and reliability of our vessels across the board. We are perceived positively by our customers."*

The inward efficiency focus ensures business continuity and sustainability. However, external environment support was found to be a primary adoption-influencing factor. In particular, codes relating to partnerships, confidence and trust building, continual consultation and feedback, social partnerships and availability of industry skills and vendor support featured significantly during interviews, and these were identified as influencing technology adoption. A fishing consultant noted:

> *"You've to trust this or you've done this wrong and it's more about them (fishers) getting their confidence in it, which they will then pass on to other people."*

This trust was emphasized as the foundation to partnerships in solutions development, unseating a need for software trialing and other traditional "get-to-know" activities. These partnerships, in turn, provide the ability to lower barriers to technology adoption. As fishers' development input is considered, trust is built. As trust is built, usage of the solution and the needed feedback thereof are more likely to be provided, further continuing the cycle of development and use of e-logistics technology solutions. People do what they do and technology complements what people do.

As found in the research, governments tend to have the power to impose and enforce fishing licenses and laws. By virtue of this reality, all respondents considered government regulation as a primary adoption-influencing factor. However, further analysis revealed that many organisations using e-logistics technologies had not done so by direct government influence. Of note, in South Africa, many fisheries are required to provide paper logbooks in specified document structures, thus diminishing the returns on digital data capture and reporting automation. A fishing association executive thus added a caveat to government regulation influence stating:

> *"Yes, I think it's a primary factor because these processes are integrated, yet government systems are outdated. There is no incentive for the industry to provide electronic data because they simply can't use it at present. They (government) still want the notebooks, you know?"*

An organisation thus may adopt e-logistics technologies but still need to provide paper logbooks to the government authority to fulfil regulatory requirements. For these organisations, internal dynamics drive adoption, yet if the government were to force digital inputs, the adoption of these technologies would then be driven both internally and externally.

Government regulation may negatively impact adoption if they hinder or dis-incentivise e-logistics technology use. In South Africa, respondents highlighted that fishing licenses and quota management regulation are sometimes unpredictable, hindering significant capital investments. Regulation may increase risk and diminish e-logistics technologies return on investment. A recommendation in this light is for the government to reconsider legislation and remove outdated clauses and or improve them. This augments both Marciniak (2010) and Bolosha et al. (2023) who found that removing the uncertainties in business continuity and removing outdated legislation may incentivise businesses to adopt new e-logistics technologies, especially from small-scale fishermen's perspective.

Government's human resources skills play a critical role in that, if there is a misalignment between government human resources e-logistics technology use with the other fishing industry personnel, there may not be an incentive for the fishing organisations to digitise operations as the government would still require traditional reporting outputs. In this end, a recommendation was raised, that government legislation ought to follow a standards-based approach which, when defined

by a fishing consultancy executive referred to legislation that provided strategic and sometimes operational guidelines yet not stifling innovation. The executive suggests an approach to legislation where fishers, scientists, government, technology providers and fish product consumers develop fishing standards that inform operations and encourage e-logistics technologies. This finding and impact was alluded to by Bolosha et al. (2023) and Smidt & Jokonya (2022), who emphasised the need for farmer-centred/ stakeholder-centred participation in innovation and collaboration when developing policy with particular consideration of small-scale farmers in South Africa.

An additional realisation was the government's role in influencing technology adoption on organisations within the DOI's spectrum of organisations' propensities to adopt new technologies. Government regulation and incentives are most relevant where industry-wide technology adoption is needed. It is most necessary for laggards while as one moves away from the laggards to innovators, the need for such regulation and incentives becomes less necessary. This presents an opportunity for government-driven digitisation initiatives.

4.4 Security

The security construct was analyzed from a data security, quality, and governance perspective, then from an ethical and business sustainability and continuity perspective.

4.4.1 Data security, quality, and governance

The security construct was analyzed in terms of the security, quality, and governance throughout the data life cycle from fish retrieval and data capture offshore to integration and analysis, storage and archiving at the shore. E-logistics technologies ought to reliably showcase an ability to prevent data loss, theft, and manipulation, prevent hacking, and ensure and protect data ownership, data confidentiality and controlled data access. As Haufe et al. (2016) notes, securing sensitive organisational data has become increasingly vital to organisations. Technologies that provide clarity on ownership and risks associated with adoption are more likely to be favored.

Furthermore, data integrity was mentioned within the security concept. While data security emphasises the protection of digital information from unauthorised access, corruption and theft, *data integrity* informs part of the data security concept and emphasises the consistency and trustworthiness of the data, complementing data quality in terms of accuracy, timeliness and completeness (IBM, 2022b; Monczka et al., 2009). These technologies ought to provide data as and when needed within the shortest time possible.

While nothing may be completely secure, reflecting some level of security measures within an e-logistics technology improves the possibility of the technology being adopted. This finding was in line with Monczka et al. (2009) and Nwaiwu et al. (2020) who found that many technology adoption studies show the importance of security and trust as factors that could either directly influence behavioural intentions or indirectly influence other independent variables, such as perceived usefulness and ultimately lead to a positive influence on behavioural intentions.

4.4.2 Ethics and business continuity

In the South African context, ethical challenges were raised as influencing technology adoption. How technology displays fairness and acts as a complement to personnel within the fishing organisation and government may influence whether the e-logistics technology will be adopted. This relates to the ethics surrounding fishing technologies, their development, use, partnerships, and overall contributions to society. In discussing the philosophy of their market-available technology, a fishing technology executive noted:

> *"The idea is to build collective action, build a movement, build a brand of small-scale fishers, providing premium quality, ethically sourced, fully traceable, socially just fishing package."*

The executive continues to note:

> *"It is not just about competitive advantage but about fairness as well. It's about moving small-scale fishers from informal marginalised spaces to a state of social entrepreneurship."*

As Diaz (2020) found, community partnerships are a necessary foundation for encouraging technology adoption. Technologies that have this ethical bias are more likely to be adopted.

Furthermore, the question of automation, artificial intelligence and implications for employment ensued, i.e., will the adoption of e-logistics technologies result in significant job losses and loss of income for many personnel and thus families? South Africa's Gini Coefficient (gap between the rich and poor) measured at 0.65 in 2015 (Leibbrandt & Díaz Pabón, 2021). Unemployment rates have persistently remained high, at 34.5% as of 2022 (Stats SA, 2022). As such, employment opportunities and losses influence decisions relating to technology adoption. E-logistics technologies that may result in perceived unsustainable job losses are less preferred to those that support increased efficiency, yet re-skilling and growing employment prospects due to organisations and industry growth and restructuring. An environmental consultant noted:

> *"In South Africa, one question to ask is: How many workers am I going to lose? What is my employee turnover? Employment is a hot topic in South Africa. We have a really high unemployment rate. The rise in technology, specifically within the operational fishing sector is not always viewed in a positive light as it can be seen as a method or process to reduce staff numbers and replace workers."*

As such, e-logistics technologies adoption in South Africa ought to consider more socially-just distributive outcomes as noted by Jokonya et al. (2014). At the same time, isolated political sentiments were shared. The major premise presented in this light highlighted that affirmative action amongst other laws in the country had enabled some groups of people yet disabled other groups of people. This, in turn, disincentivised investment into longer-term capital-intensive e-logistics technologies by some groups. One fishing operations executive, who mentioned that he started fishing at a tender age and carried over his father's legacy notes:

> *"We have animosity in society, black trying to rid of whites and vice-versa, through whatever means and for whatever reasons."*

The sentiment was shared to suggest that, in addressing societal realities, business predictability and continuity has suffered leading to reduced investments including in e-logistics technologies that would have otherwise grown the fishing industry. In this end therefore, e-logistics technologies ought to enable, as far as possible, organisational sustainability requirements. At the same time, government regulation ought to complement the efforts by pursuing social justice ends for all groups of fishers to enable and develop further, the South African fishing industry.

5 e-Logistics technology adoption model

These findings were synthesized into the e-Logistics technology adoption model presented in Figure 4. The adoption model harnesses the factors identified as the primary e-logistics technology adoption factors. Within the **technology** construct of the Sec-TOE-DOI, concepts of *relative advantage* and *compatibility* were found to be primary adoption factors. *Complexity, trialability,* and *observability* were not considered as primary adoption factors. Within the **organisation** construct, *top management* and the s*lack and absorptive capacity* concepts were found to be primary factors of adoption, while the *size of the organisation* did not feature. *Competitive pressure* was not considered a primary adoption factor among the **external environment** concepts, while e*xternal support* and g*overnment regulation* were considered as primary factors both in encouraging adoption and in becoming barriers to adoption. Furthermore, **security** was emphasized as pertinent to the adoption endeavor. This is presented in Figure 3.

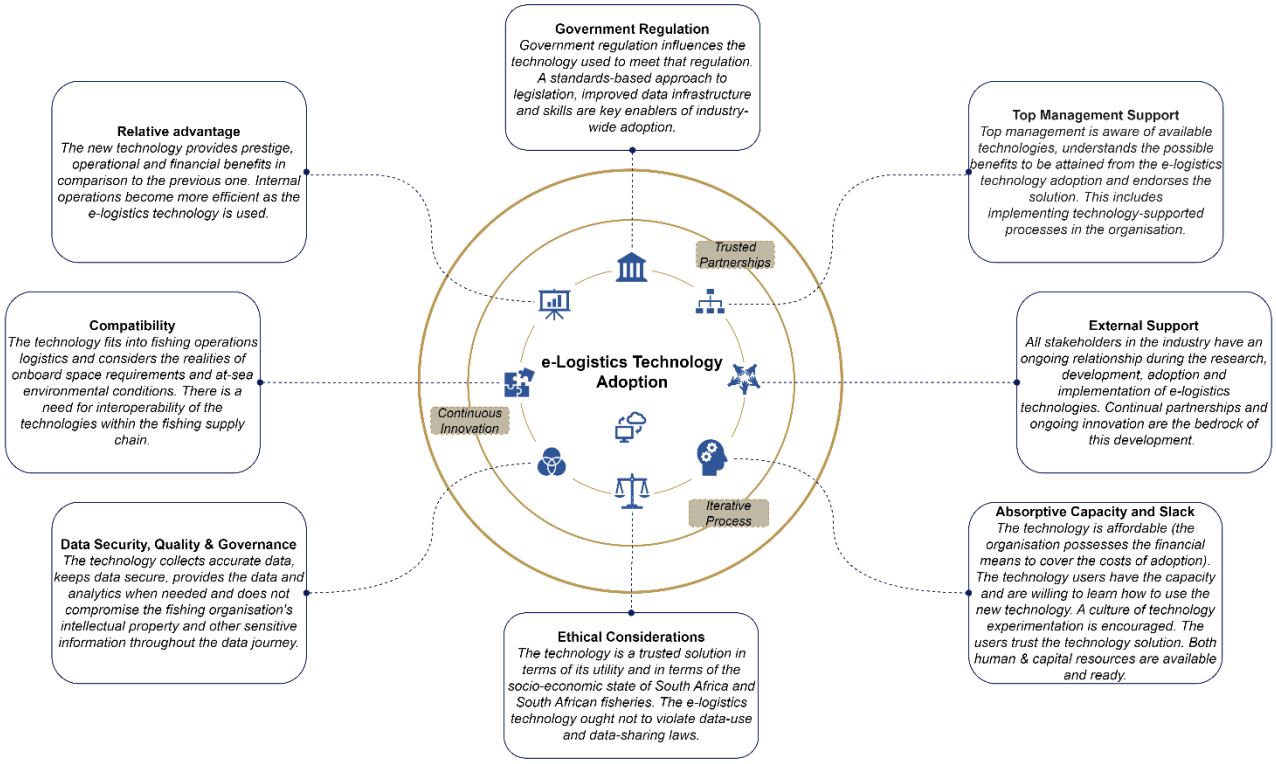

Fig. 3. e-Logistics technology adoption model

The findings may be summarized as:

- ***Relative advantage:*** Technologies that offer increased prestige, operational and financial benefits are likely to be adopted. Internal efficiency is a primary driver of fishing operations and e-logistics technologies that drive this are more likely to be adopted.
- ***Compatibility:*** E-logistics technologies must consider and adapt to fishing operations realities of vessel space, availability of power, and at-sea environment conditions. Additionally, these technologies ought to enable interoperability of technologies within the supply chain.
- ***Top management support:*** Effective top management tends to champion innovation, driving technology adoption with an understanding of the benefits and assuming risks associated with the use thereof. Furthermore, top management controls the financial capital and has the power to adjust business operations in line with available e-logistics. Technologies that have this top management buy-in are more likely to be adopted than those not favored.
- ***Slack and Absorptive capacity:*** E-logistics technology adoption depends on the organisations' human, technical and financial capacity. Organisations that have a culture of innovation or experimentation are likely to adopt e-logistics technologies. Furthermore, there must be a willingness (capacity to learn, trust and use technology) and availability of financial resources for investment in technology (affordability). Technologies that show these values are more likely to be adopted, necessitating partnerships between stakeholders to build such a foundation.
- ***External support:*** To improve adoption prospects, all industry stakeholders ought to work as a unit, building continual relationships throughout the adopted e-logistics technology life cycle and the data chain. It is insufficient to introduce technologies for trials and train individuals on use without partnerships at the solution development level.

- ***Government regulation:*** As a primary adoption-influencer in the South African context, the government has powers to incentivize activities and impose compliance. Regulations thus ought to play this role, building controls (standards) without imposing technologies and stifling innovation. Governments may further improve their infrastructure to match modern technology trends and align both the infrastructure and technical skills with industry, improving opportunities for e-logistics technologies adoption with a limited punitive push industry-wide.
- ***Security:*** Improved data security, integrity, quality, and governance, ethical considerations, and business security, and, therefore, certainty, are primary adoption factors. E-logistics technologies that enhance trust in the solution while appealing to socially acceptable norms and providing the necessary security are more likely to be adopted.

Our study recognises the intertwined web of stakeholders and activities in the fishing industry and acknowledges that the identified primary adoption factors operate within an interdependent environment, where each element enables the other or is better served as part of a whole. The identified factors are valid within an ecosystem of stakeholder partnerships and innovation. Furthermore, in South Africa, ethical development and policy considerations are significant influencers in technology choices, aligning with the nation's efforts to address historical disparities. While perceptions play a role in technology adoption decisions, policy amplifies their influence.

6 Conclusion

By meticulously untangling the intricate web of influencing factors of adoption, this research enriches the existing literature on technology adoption, contributing insights for fishing industry stakeholders, and lays the foundation for informed decision-making in the realm of e-logistics integration. Through this exploration, we aspire to not only enhance the academic discourse on technology adoption but also foster meaningful advancements in the sustainable growth of the fishing sector. The study thus seeks to establish a bedrock in informed decision-making in the e-logistics technology adoption body of knowledge.

The findings align harmoniously with the United Nations Sustainable Development Goals (SDGs): notably SDG9, which pertains to the advancement of industry, innovation, and infrastructure, SDG12 which encourages responsible consumption and production and SDG14 with the goal of considering life below water by encouraging sustainable fishing. The study promotes inclusive innovation, sustainable fishing, and efficient data analytics. Adopting e-logistics technologies may be a catalyst for solving global fishing crises (Ortiz, 2019).

It is acknowledged that the limitation of the study is that it was conducted in a single fishing region. This presents opportunities for future research in that future studies may proceed to validate the findings across the wider fishing population, including statistical analyses of the identified factors across regions for generalizability. Future research may additionally include the factors' influence by type of organisation to build stakeholder awareness across the industry. Furthermore, research could include investigations into fishery-specific technologies as deep-sea fishing may prove more sophisticated compared to small-scale fishing and thus requiring different sets of technologies to build efficiencies. This could include longitudinal studies to understand the impact of the ongoing interventions towards sustainable fishing.

Finally, the study provided insight into the factors that underpin the adoption of e-logistics technology among Western Cape fishing organisations. The paper conceptualised a unique Sec-TOE-DOI framework by drawing on the extant body of knowledge. Based on the data collected, the framework was refined into an e-Logistics technology adoption model. The findings emphasize a resounding truth: the bedrock of success lies in fostering robust and unwavering partnerships among all stakeholders. Beyond the identification of influential factors, it is the strength and trust within these alliances that steer the course. Consequently, the study offers valuable insights into potential interventions for the industry, grounded in the conclusions derived from the empirical findings. It is essential to acknowledge that the world of technology is one of perpetual evolution. The journey of adoption and utilization is not a finite destination but a continual iteration. It is a journey in which adaptation is not just a choice but a necessity.

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Appendix A. Research Instrument

Construct	Concept	Objective	Question
Technology	Relative Advantage	**Non-Adopted Company** a) To assess whether a non-adopted is actually considering Relative Advantage as part of their potential adoption. **Tech-Adopted Company** a) To assess the extent to which Relative Advantage influenced the decision to adopt.	**Non-Adopted Company** a) How important is your position in the industry? b) If a technology will give you an advantage (prestige, economic, productivity) - will that on its own convince you to buy? **Tech-Adopted Company** a) When you adopted the e-logistics did you consider how it would place you at an advantage in the industry, in terms of prestige or economic or productivity? b) To what extent did this industry advantage feature in your decision to procure the technology?
	Security	**Non-Adopted Company** a) To assess the degree to which security, data security and governance may influence the decision to adopt a technology. **Tech-Adopted Company** a) To assess the degree to which security, data security and governance influence technology adoption decisions.	**Non-Adopted Company** a) In your organisation, does an understanding and assurance of data security in a technology primarily drive the decision of whether the new tech will be adopted or not? **Tech-Adopted Company** a) As you were deciding on whether or not to adopt new e-logistics technologies, to what extent was the concept of security (data protection, governance, and security) a major driver of the decided outcome?
	Compatibility	**Non-Adopted Company** a) To assess the relevance of specific e-logistics technologies (e.g. e-logs, GPS, iEMR etc.) in relation to business processes and systems. b) To assess the extent to which compatibility of new e-logistics technologies to business processes and systems influences the decision to adopt. **Tech-Adopted Company** a) To assess the extent to which compatibility of adopted technology with previous processes influenced the decision to adopt.	**Non-Adopted Company** a) How important is compatibility between business processes/ available business systems and the new e-logistics technology? b) Would you consider this compatibility as a primary driver of the decision to adopt a new technology? **Tech-Adopted Company** To what degree what the compatibility of the new technology to your business systems and processes a priority decision-maker in adopting e-logistics technologies.
	Complexity	**Non-Adopted Company** a) To assess the degree to which perception and or knowledge of ease of use of available	**Non-Adopted Company** a) To what extent does the complexity or the simplicity (ease) of use of a technology influence your decision to adopt a technology?

Construct	Concept	Objective	Question
		technology on its own, by company personnel changes the decision to adopt.	b) Regardless of other known benefits of a technology, would complexity alone influence your decision to adopt/ not adopt the technology?
		Tech-Adopted Company a) To assess the degree to which ease of use or perception of ease of use of adopted technology within the company influenced the decision to adopt.	**Tech-Adopted Company** a) To what extent was the perceived complexity of the technology (or simplicity), the primary driver of the decision to adopt e-logistics technologies?
	Trialability	**Non-Adopted Company** a) To assess whether trialability is an important factor for the company in making the decision to adopt an e-logistics technology and to what degree this is so.	**Non-Adopted Company** a) In your decision to adopt a technology, does the ability to easily implement incremental milestones and or stop the technology altogether influence whether you adopt the technology or not?
		Tech-Adopted Company a) To assess whether the adopted technology was easily piloted and whether that ability/ inability was a factor in the decision to adopt.	**Tech-Adopted Company** a) To what degree was the possibility of easily piloting or trialling the software the key driver of the decision to adopt the said technology?
	Observability	**Non-Adopted Company** a) To assess the extent to which observed benefits of technology experienced by other companies influence the decision to adopt.	**Non-Adopted Company** a) Does the organisation benchmark any technology likely to be adopted against seen benefits from other companies b) If yes, does the observed success in one company automatically imply a decision to adopt the technology?
		Tech-Adopted Company a) To assess whether the adopted technology decision was influenced by observed benefits in other companies.	**Tech-Adopted Company** a) To what extent would you consider the observed results in another company of using a new e-logistics technology a primary influence in the adoption of the technology? b) If no organisation were observed, then would you say the idea of seeing positive results from a technology in another company can be a key driver of the decision to adopt a technology?
Organisation	**Top Management Support**	**Non-Adopted Company** a) To assess top management's awareness of technology and the degree to which they influence the decision to adopt.	**Non-Adopted Company** a) To what degree do you consider top management's endorsement and support of a technology as being a primary driver to adopt a technology?
		Tech-Adopted Company a) To assess the degree to which top management awareness	**Tech-Adopted Company** a) To what extent did you find the role of top management and their support in deciding

Construct	Concept	Objective	Question
		and support of adopted technology influenced the decision to adopt.	the new e-logistics technology to adopt? Was this a primary feature?
	Size	**Non-Adopted Company** a) To assess the extent to which organisation size (employee count and size of operations) affects the decision to adopt a technology. **Tech-Adopted Company** a) To assess the degree to which the size of the company and the size of the operations influenced e-logistics technology adoption in the past.	**Non-Adopted Company** a) To what extent is the size of your organisation influencing the decision of whether to adopt e-logistics technologies for data analytics or not? Please consider size in terms of employee numbers, the size of your operations, annual revenue, and industry market share. **Tech-Adopted Company** a) To what extent was the size of your organisation a major driver of the decision of whether to adopt e-logistics technologies for data analytics or not? Please consider size in terms of employee numbers, the size of your operations, annual revenue, and industry market share.
	Slack (Absorptive Capacity)	**Non-Adopted Company** a) To assess the extent to which availability of funds, people, people skills, and information technology infrastructure (uncommitted resources) influence the decision to adopt e-logistics technologies. **Tech-Adopted Company** a) To evaluate whether the availability of uncommitted resources influenced the decision to adopt, on its own.	**Non-Adopted Company** a) To what extent within the organisation does the education of the people, the availability of IT resources and availability of funds influence a decision of whether to adopt a technology? b) Would you consider the availability of these factors as a major driver in your decision to adopt and would these alone make you decide on adopting a new e-logistics technology? **Tech-Adopted Company** a) To what extent within the organisation did the education of the people including fishermen, the availability of IT resources and availability of funds influence the decision of whether to adopt a technology? b) Would you consider these factors as a major driver in your decision to adopt a new technology and would you say these alone could have been the sole/ primary drivers of your technology adoption decision?
Environment	Competitive Pressure	**Non-Adopted Company** a) To understand and assess the extent to which competitors have an influence in informing the company's e-logistics technologies adoption.	**Non-Adopted Company** a) The decision to adopt any technology is driven primarily by that the industry is extremely competitive and the technology may give a competitive edge. Some competitors are already using this technology. To what extent is this

Construct	Concept	Objective	Question
		b) To assess the extent to which industry competition intensity (push and pull factors) influences the decision to adopt.	statement true in your experience and to what extent does this reality influence your decision to adopt an e-logistics technology?
		Tech-Adopted Company a) To assess the extent to which competitors influenced the decision to adopt e-logistics technologies. b) To assess whether competition intensity, in the fishing industry influenced the decision to adopt.	**Tech-Adopted Company** a) The decision to adopt any technology is driven primarily by that the industry is extremely competitive and the technology may give a competitive edge. Some competitors are already using this technology. To what extent was this statement true in your experience and to what extent did that reality influence your decision to adopt the e-logistics technologies in use?
	External Support	**Non-Adopted Company** a) To assess the extent to which third parties, vendors or software providers influence the adoption of e-logistics technologies within the business.	**Non-Adopted Company** a) To what extent do you consider external support from software vendors and other service providers being a primary influencing factor for whether to adopt a technology?
		Tech-Adopted Company a) To assess the extent to which third parties, vendors or software providers influenced the adoption of e-logistics technologies within the business.	**Tech-Adopted Company** a) With regards your adopted e-logistics technologies, to what degree were availability of software vendors and support thereof a major driver in making your decision?
	Government Regulation	**Non-Adopted Company** a) To evaluate the influence that government regulation and laws have in the decision to adopt different e-logistics technologies.	**Non-Adopted Company** a) In South Africa, some fisheries are regulated by the government. Do government legislature and laws feature in your determination of what technologies to consider for your data analytics? - And to what extent would you say this is a factor in your decision to adopt an e-logistics technology?
		Tech-Adopted Company a) To assess the extent to which government regulation and legislation influenced e-logistics technology adoption.	**Tech-Adopted Company** a) In South Africa, some fisheries are regulated by the government. Do government legislature and laws feature in your determination of what technologies to consider for your data analytics? - And to what extent would you say this was a factor in your decision to adopt an e-logistics technology?

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RESEARCH ARTICLE

Factors related to GDPR compliance promises in privacy policies: A machine learning and NLP approach

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Abstract
This paper employs Machine Learning (ML) and Natural Language Processing (NLP) techniques to examine the relationship between organizational factors, such as company size and headquarters location, of data processing entities and their GDPR compliance promises as disclosed in privacy policies. Our methodology comprises three main stages, each representing a key contribution. Firstly, we developed five NLP-based classification models with precision scores of at least 0.908 to assess different GDPR compliance promises in privacy policies. Secondly, we have collected a data set of 8,614 organizations in the European Union containing organizational information and the GDPR compliance promises derived from the organization's privacy policy. Lastly, we have analyzed the organizational factors correlating to these GDPR compliance promises. The findings reveal, among other things, that small or medium-sized enterprises negatively correlate with the disclosure of two GDPR privacy policy core requirements. Moreover, as a headquarters location, Denmark performs best regarding positively correlating with disclosing GDPR privacy policy core requirements, whereas Spain, Italy, and Slovenia negatively correlate with multiple requirements. This study contributes to the novel field of GDPR compliance, offering valuable insights for policymakers and practitioners to enhance data protection practices and mitigate non-compliance risks.

Keywords
general data protection regulation; privacy; privacy policy; natural language processing; machine learning.

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1. Introduction

The landscape of data protection has experienced notable changes since 2016—the year in which the European Union (EU) decreed the General Data Protection Regulation (GDPR)—as data processing entities processing data of EU data subjects were obliged to meet the requirements of the GDPR (Tikkinen-Piri et al., 2018). This transformation stimulated a wide range of responses, ranging across the exploration of innovative solutions like blockchain for GDPR-aligned data repositories (Al-Abdullah et al., 2020), investigating how information security frameworks can assist in implementing GDPR in the banking industry (Serrado et al., 2020), to data processing organizations reevaluating and enhancing their privacy policies (Amos et al., 2021). The latter resulted in increased length and content of the privacy policies, including the disclosure of GDPR-relevant requirements (Linden et al., 2020). This development is also reflected by the use of GDPR terminology in privacy policies, demonstrating the imprint of the GDPR on online privacy (Degeling et al., 2019; Strzelecki & Rizun, 2020).

Privacy policies act as a conduit for the data processing practices of the corresponding organizations and are, therefore, the essential source of information for the user to learn what happens to user data (Reidenberg et al., 2015) and whether it is treated in line with the regulations of the GDPR. To ensure the latter, organizations with an online presence added new privacy policies to their website, leading to an uprising in transparency on the web. In some European countries, for example, 15.7% of websites added new privacy policies close to May 25, 2018—the date of entry into force of the GDPR—whereas over 70% of websites updated their existing privacy policies (Degeling et al., 2019).

However, the surge in transparency was not accompanied by a similar rise, content-wise: only a modest portion (32%) of privacy policies examined post-GDPR fully meet its mandates (Rahat et al., 2022). A preliminary study by Contissa et al. (2018) even suggests that none of the analyzed privacy policies were fully compliant. This non-compliance issue can be related to several organizational factors, e.g., size and resources (Texeira, 2019; Freitas & Da Silva, 2018), sector, and geographical location (Zaeem & Barber, 2021). However, to our knowledge, no study analyzes the underlying organizational factors related to GDPR compliance as mentioned in the corresponding privacy policies. Building on previous research (Aberkane et al., 2022), this article aims to fill that gap by analyzing data processing entities' organizational factors to identify factors related to GDPR compliance promises in privacy policies.

Since privacy policies are typically articulated in textual form, this study aims to leverage their inherent linguistic nature effectively. Consequently, we employ a Natural Language Processing (NLP) based Machine Learning (ML) approach—ideally suited to dissect and understand these text-rich documents—to identify the aforementioned organizational factors related to GDPR compliance promises. Our research question (RQ) reads as follows: "What organizational factors are associated with the disclosure of GDPR compliance promises in the privacy policies of data processing entities?" Our contributions include 1) developing high-precision NLP-based classification models to evaluate GDPR compliance promises in privacy policies, 2) a comprehensive dataset of 8,614 EU organizations, including organizational information and GDPR compliance promises, and 3) an analysis of organizational factors that correlate with GDPR compliance promises.

This article starts in Section 2 by presenting relevant background information about the GDPR and the considered GDPR privacy policy core requirements. Section 3 follows this by discussing related works in the field. The adopted research methodology is then described in Section 4. Section 5 focuses on the developed classification models, followed by the data collection in Section 6. Section 7 presents the analysis of this work, leading to the discussion in Section 8. The article culminates in Section 9 with a conclusion of our research. Finally, we close by detailing the limitations of our work in Section 10, setting the stage for potential future research.

2. Background

This section provides an overview of the GDPR, the role of privacy policies in disclosing organizations' data processing practices, and the core GDPR privacy policy requirements considered in this article.

2.1. GDPR compliance & privacy policies

The most relevant parts of the GDPR to this study are the regulations focusing on privacy disclosure and how these relate to privacy policies. In particular, we depart from Article 12, where the GDPR states that the controller—the person or entity that determines the purposes and means of the processing of personal data—should take appropriate measures to provide any information related to the processing of personal data, to the data subject in question in a "concise, transparent, intelligible and easily accessible form, using clear and plain language" (GDPR, 2016). In general, a privacy policy does precisely this. It discloses the data processing practices of the data processing entity (Karjoth & Schunter, 2002). For this reason, we consider privacy policies as the base for studying and analyzing the GDPR compliance promises of data processing entities.

2.2. GDPR privacy policy core requirements

This research does not consider all possible GDPR compliance promises organizations make in their privacy policies. Instead, we scope our analysis to five core GDPR privacy policy requirements, considered generic and easily identifiable (Müller et al., 2019). This approach expands upon our previous study, which focused exclusively on the requirement of Purpose (Aberkane et al., 2022). The five core requirements included in this analysis are listed in Table 1.

Table 1. Five GDPR privacy policy core requirements (Müller et al., 2019)

GDPR Requirement	Description	GDPR reference
Data Protection Officer	Notice of the contact details of the data protection officer, where applicable	Art. 13: §1b
Purpose	Notice of the purposes of the processing for which the personal data are intended	Art. 13: §1c
Acquired Data	Notice that personal data is, or is not, collected, and/or which data is collected	Art. 12, Art. 14: §1d
Data Sharing	Notice of 3rd parties that can or cannot access a user's personal data	Art. 13: §1e, §1f
Rights	Notice of the user's right rectification and erasure	Art. 13: §2b

A data processing entity must appoint a Data Protection Officer (DPO) if the core data processing activities involve processing sensitive personal data on a large scale (GDPR, 2016). Even if no legal obligation exists, designating a DPO or an equivalent role to lead the data processing activities in good channels and ensure compliance is recommended. Furthermore, among the information that has to be provided where personal data are collected from the data subject is Purpose. This comprises the purposes of the processing for which the personal data are intended and the legal basis for processing. Next, regarding Acquired Data, the data processing entity should give notice of the categories of personal data concerned. Also, it should be disclosed whether the data will be shared with third parties—in line with the requirement of Data Sharing. Lastly, the data processing entity must communicate the existence of the user's Rights, which are limited to the right to rectification and erasure in this study.

2.3. Context of the study

In setting the context for our study, it is crucial to understand the potential causes, complexities, and implications associated with GDPR non-compliance, as these directly influence the GDPR compliance commitments stated in privacy policies. For example, small and medium-sized enterprises may struggle with resource constraints, complicating the implementation of GDPR's technical and organizational requirements (Freitas & Da Silva, 2018; Kapoor et al., 2018). Moreover, publicly listed companies face their own set of challenges concerning GDPR compliance. These companies operate in the public eye, with their operational activities and financial statements subject to public scrutiny (Ghonyan, 2017). As a result, GDPR non-compliance for such companies can have significant repercussions, including potential reputational damage (Ford, 2023).

GDPR compliance can also vary between countries and may be influenced by numerous factors, such as the country's regulatory environment and digital proficiency. Germany, for example, has demonstrated a longstanding commitment to regulating personal data processing, which is evident in its robust data privacy framework (Riccardi, 1983; Zell, 2014). This dedication is further evidenced by Germany's imposition of more fines than any other EU Member State during the initial year of GDPR enforcement (Barrett, 2020). The same is true for Sweden (Bygrave, 1998), potentially contributing to improved compliance practices today. However, a recent study argues that despite its historical precedent, Sweden still needs to meet GDPR standards (Herlin-Karnell, 2020), highlighting the ongoing complexities even for countries with established data protection histories. Additionally, the interpretation of the GDPR may vary between countries due to (subtle) language differences in its translations (Dexe et al., 2022), adding another layer of complexity to compliance efforts.

Furthermore, it is worth considering that the level of digital proficiency within a country—e.g., as per the European Commission's Digital Economy and Society Index (2022a)—can potentially impact its capacity to adhere to the GDPR effectively. Denmark, for instance, stands out as a digital front-runner in the EU and globally (European Commission, 2022b). Nevertheless, even with this seemingly favorable environment, interpretation of the GDPR remains a complex task (Motzfeldt & Næsborg-Andersen, 2022).

Moreover, the approach of countries can change over time. A noteworthy illustration of this is the Spanish Data Protection Agency, which appears to have adopted a stricter stance following the initial two years of GDPR enforcement (Levis & Fischer, 2021). This is suggested by the substantial number of fines imposed in Spain, which currently stands at 872 (CMS Law, 2024). In contrast, Eastern European countries have generally imposed fewer fines than their Western European counterparts (Daigle & Khan, 2020). For example, Slovenia, which only recently implemented the Data Protection Act aligning with the GDPR (Frantar & Gajšek, 2023; Vrabec, 2020), has yet to impose fines (CMS Law, 2024). However, it should be noted that the fines mentioned are only those that have been publicly disclosed, which means the actual numbers may differ.

3. Related work

GDPR-related research questions have been increasingly addressed with NLP techniques (Aberkane et al., 2021). This trend, however, does not include—to our knowledge—research conducted on identifying organizational factors using NLP and ML. In what follows, we briefly overview two adjacent research streams involving NLP and ML: privacy policy readability and the evaluation of privacy policy completeness, identified using the backward snowballing approach (Wohlin, 2014).

3.1. Privacy policy readability

Several authors have addressed the readability of privacy policies in light of the GDPR. For example, Tesfay et al. (2018) outline the most relevant parts of the privacy policy using ML, employing PrivacyGuide, a privacy policy summarizing tool, classifying privacy policy content into eleven privacy aspects. Influenced by the GDPR, the authors aim to support Internet

users by simplifying the readability of privacy policies. Similarly, Zaeem et al. (2020) present PrivacyCheck v2. This ML-based tool automatically summarizes privacy policies by answering key questions, including questions that cover the essential concerns addressed by the GDPR. The tool aims to educate users on how their personal data is used on the Internet and how to select companies that attach more value to data protection.

3.2. Evaluating privacy policy completeness

The majority of identified relevant literature focuses on evaluating privacy policy completeness in light of the GDPR. For instance, Liepina et al. (2019) designed a methodology for annotating post-GDPR privacy policies to identify and assess compliance with the GDPR using legal analysis, ML, and NLP—aiming to aid consumers with, among other things, understanding their rights and obligations as per the GDPR. More recently, Amaral et al. (2019) proposed AI-based automation for the completeness checking of privacy policies according to the GDPR—evaluated using 234 privacy policies from the fund industry—achieving precision and recall of 92.9% and 89.8%, respectively. Furthermore, using ML and rule-based analysis, Liu et al. (2021) propose an approach to analyze privacy policy contents and identify violations against Article 13 of the GDPR. Besides completeness, the authors also touch upon readability by implementing the approach in AutoCompliance, a web-based tool that reduces the user reading time by 55%. Along the same lines, El Hamdani et al. (2021) use rule-based approaches combined with ML to develop methods to automate compliance checking of privacy policies. In particular, the authors build a two-module system to verify the GDPR compliance of privacy policies, focusing mainly on the completeness of privacy policies. The first module extracts data practices, while the second module checks these extracted data practices on, among other things, the presence of mandatory information according to the GDPR. Lastly, Müller et al. (2019) introduce a data set of annotated privacy policies based on five GDPR privacy policy core requirements containing 18,397 natural sentences. The authors then proceed to design classifiers and evaluate the state of GDPR compliance "in the wild" by crawling privacy policies from actual companies. The results show that at least 76% of the privacy policies do not comply with at least one of the considered GDPR requirements.

3.3. Research gap

In sum, contrary to previous literature, this study aims to not only investigate whether core requirements of the GDPR are disclosed in the privacy policy—thus slightly overlapping with the completeness research stream—but also aims to map the organizational factors that correlate with this disclosure. Expanding on previous research, this study identifies organizational factors (e.g., location, size, and sector) correlating with GDPR compliance, considering 8,614 data processing entities' privacy policies.

4. Methodology

This section describes the three-staged research methodology of this study.

4.1. Stage 1: training classification models

The starting point is developing a supervised ML-based NLP pipeline to build five classifiers to assess whether privacy policies disclose the five GDPR privacy policy core requirements. This expands on our prior work, which developed a classifier for only one requirement. The data set for training the models was acquired from (Müller et al., 2019) containing 250 anonymized privacy policies comprising over 18,300 natural sentences, each labeled according to the GDPR privacy policy core requirements of Table 1. This stage resulted in five different classification models—trained using Python's Scikit-Learn library (Pedregosa et al., 2011)—each focusing on one of the requirements. Section 5 further elaborates on developing and evaluating the developed classification models.

4.2. Stage 2: data gathering & classification

The second stage focused on collecting a fruitful data set for analysis due to the absence of organizational information related to the privacy policies in the data set utilized in the previous stage. Moreover, the data had been anonymized, precluding the possibility of identifying the company that authored each privacy policy and collecting its relevant organizational data. Thus, utilizing Bureau van Dijk's Orbis database, we gathered data from 168,824 Europe-based companies (Bureau van Dijk, 2021). Following this, we scraped—if possible—the publicly accessible privacy policies of each company, resulting in 10,090 policies (see Section 6 for details). Subsequently, these policies were analyzed using five classification models to determine the disclosure of the five GDPR core requirements. The classification results were then combined with the organizational data of the related company into one data set. Finally, this combined data set was filtered from irrelevant data in anticipation of the final analysis of stage three, resulting in a data set containing the organizational data and classification results of 8,614 companies.

4.3. Stage 3: analysis

The data set constructed in Stage 2 was analyzed to assess to what extent the organizational factors are associated with the disclosure of the five GDPR privacy policy core requirements. This analysis used a separate logistic regression model, utilizing Python's Statsmodels library (Seabold, 2010). The results are presented in Section 7.

5. Classification

The data set for training our models, collected and annotated by Müller et al. (2019), includes 18,397 sentences from 250 privacy policies. The authors amassed the data by scraping the privacy policies followed by manual annotation according to the following five GDPR privacy policy core requirements: DPO, Purpose, Acquired Data, Data Sharing, and Rights. Table 2 presents statistics related to each GDPR class (interchangeably used with GDPR privacy policy core requirements in the remaining sections), showing the sentence counts per class and the average sentence counts per policy.

A sentence is considered to comply with the DPO privacy policy core requirement if "the Data Protection Officer or an equivalent authority is named, or contact details of a similar authority are provided" (Müller et al., 2019). The Purpose requirement is met if the processing purposes are disclosed. The Acquired Data requirement is fulfilled when the collected data is specified. The Data Sharing requirement is satisfied by disclosing information about personal data sharing. Lastly, the authors of the data set limited the scope of the Rights requirement to two GDPR instances: the right to be forgotten and the right to rectification.

Table 2. Data set statistics

GDPR Class	Number of sentences in corpus	Average number of sentences per privacy policy
Data Protection Officer	414	2
Purpose	980	4
Acquired Data	565	3
Data Sharing	830	4
Rights	251	2

5.1. Training the model

This section covers the six steps involved in training and evaluating the classification model, as depicted in Fig. 1.

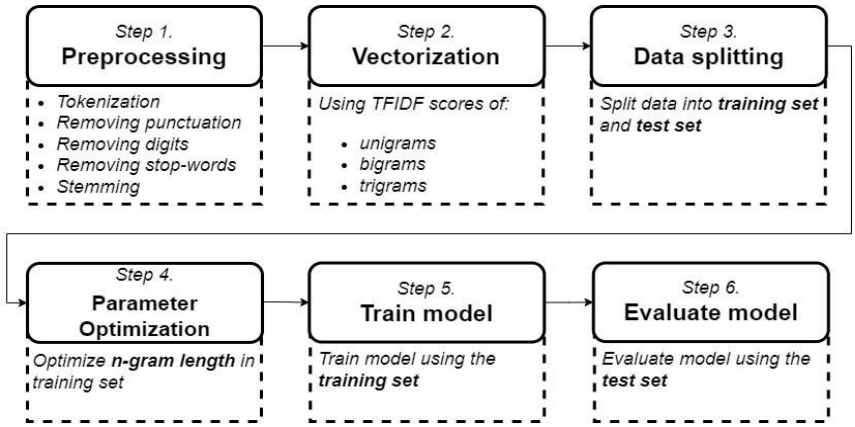


Fig. 1. Process of training and evaluating the classification models

Step 1. First, the corpus was led through a traditional NLP pipeline. This preprocessing process consisted of tokenization, punctuation removal, digit removal, and stemming.

Step 2. Subsequently, vectorization of the sentences took place based on the Term Frequency-Inverse Document Frequency (TFIDF) (Robertson, 2004). In particular, as features for our classification model, we utilized the TFIDF scores of different modes of n-grams (i.e., sequences of tokens of length n): unigrams, bigrams, and trigrams.

Step 3. The data was then divided into training and test sets, increasing the test set size from 0.1 (in our preliminary study) to 0.2. Furthermore, as shown in Table 2, the data set is imbalanced. In fact, over 83% of the sentences are not labeled with one of the five GDPR privacy policy core requirements. To address this imbalance, we conducted a stratified split of the data—for each of the five GDPR privacy policy core requirements (i.e., GDPR classes)—into a training and test set, followed by an oversampling of the training set. The stratified split maintained the ratio between positive and negative sentences, while the oversampling increased the representation of the minority class (i.e., the class of interest).

Step 4. Parameter optimization was performed based on the Area Under the Receiver Operating Characteristic Curve (ROC AUC) using 5-fold cross-validation. The aim was to identify the classification model and parameter settings (mainly focusing on the n-gram length) that yield the most promising results. This resulted in settling on logistic regression, an established and appropriate technique for the addressed problem, i.e., a supervised binary classification problem.

Step 5. This step comprised training the classification models using the optimized n-gram configuration. However, the addressed problem can also be interpreted as a multi-label problem, as the labels are not mutually exclusive. Because of the latter, we opted to address each class individually for simplicity regarding the issue of class imbalance, resulting in five different binary classification problems. Hence, we trained five logistic regression models utilizing the scikit-learn library—configured with the optimized parameters—on the prepared data set.

Step 6. The evaluation of the classification models took place using the test set. The performance of the five classification models is presented in Table 3. We utilized one of the most often used performance metrics for binary classification: the ROC AUC score (Sokolova & Lapalme, 2009). The ROC AUC score represents a measure of the ability of a classifier to distinguish between classes. It corresponds with the probability that the model will score a randomly chosen positive instance higher than a random negative one. A score of 1 corresponds with a perfect model, and 0.5 corresponds with a random model.

Table 3. Initial sentence classification performance

GDPR Class	ROC AUC score
Data Protection Officer	0.965
Purpose	0.848
Acquired Data	0.856
Data Sharing	0.921
Rights	0.950

5.2. Calibration of precision

Given that the models predict at a sentence level, we need to address the following question: *When does a privacy policy meet the GDPR privacy policy core requirement at issue?* Is the mere presence of one positively classified sentence enough to consider the whole privacy policy as disclosing the requirement in question? We decided to raise the certainty of our predictions by addressing the following question: *What number of positive sentences are needed to classify, with a desired level of confidence, a new privacy policy as disclosing the requirement at issue?* We used the inverse cumulative distribution function of the binomial distribution to set a threshold of the minimum positive sentences required to meet a given confidence level. This step is necessary since our classification models work at the sentence level rather than the document level due to the data set used to train the models. This data set consists of labeled sentences extracted from privacy policies without insight into the structure of the original documents (i.e., privacy policies).

We use a contingency table consisting of true positive (TP), false positive (FP), true negative (TN), and false negative (FN) values based on a data set comprising, in total, $\mathrm{E} = \mathrm{TP} + \mathrm{FP} + \mathrm{TN} + \mathrm{FN}$ elements. Note that these values were derived using an optimized cut-off point based on the F1-Score to rectify the bias that permeated the classification model due to oversampling. In this context, $\hat{P}$ describes the elements predicted as positive, meaning $\hat{P} = TP + FP$. The probability that a positively predicted element is a true positive can then be described as $P(y = 1|\hat{y} = 1) = \frac{TP}{\hat{P}}$. Using a binomial distribution, the probability that exactly k elements from $\hat{P}$ are true positives can be calculated as follows:

$$P(|TP| = k) = \binom{\hat{P}}{k} P(y = 1|\hat{y} = 1)^k \big(1 - P(y = 1|\hat{y} = 1)\big)^{\hat{P}-k} = \binom{\hat{P}}{k} P_{TP}^k P_{FP}^{\hat{P}-k} \quad (1)$$

It follows that the cumulative distribution function is equal to the following:

$$P(|TP| \leq k) = \sum_{i=0}^{k} \binom{\hat{P}}{i} P_{TP}^k P_{FP}^{\hat{P}-i} \quad (2)$$

We focus on the probability that the number of TP exceeds a given value. Therefore, we consider the inverse cumulative distribution:

$$P(|TP| > k) = 1 - P(|TP| \leq k) = 1 - \sum_{i=0}^{k} \binom{\hat{P}}{i} P_{TP}^k P_{FP}^{\hat{P}-i} \quad (3)$$

We now find the highest value of k (i.e., k') that keeps the inverse cumulative distribution above a given probability Z:

$$k' = argmax_{k \in [0,|TP|]} P(|TP| > k) \geq Z \quad (4)$$

Given a new set of elements (e.g., sentences in a privacy policy) with $\mathrm{E_n}$ elements of which $\widehat{\mathrm{P_n}}$ are predicted as positive by the model. We consider the document to be positive if the threshold, $\mathrm{Q} = \frac{\mathrm{k'}}{\mathrm{E}}$ is met, i.e., $\frac{\widehat{\mathrm{P}}}{\mathrm{E_n}} \geq \mathrm{Q}$. Table 4 presents the calibrated thresholds for all GDPR classes, combined with the respective precision.

Table 4. Document classification performance

GDPR Class	Threshold Q	Precision per document
Data Protection Officer	0.016	0.908
Purpose	0.028	0.908
Acquired Data	0.016	0.928
Data Sharing	0.030	0.912
Rights	0.009	0.941

5.3. Example

Consider the DPO class, for example, where the threshold Q has been calibrated using a test set size of 3,680 ($\mathrm{E_{test}}$), while the desired probability (i.e., Z) was set at 90%. The calibration result shows that for a given new set of elements (e.g., sentences of a privacy policy), the following threshold $\frac{\widehat{\mathrm{P}}}{\mathrm{E_n}} \geq 0.016$ must be met to achieve a precision of at least 0.908. Given a privacy policy comprising 100 sentences (i.e., $\mathrm{E_n} = 100$), we arrive at the following equation:

$$\frac{\widehat{\mathrm{P}}}{100} \geq 0.016 \quad (5)$$

Then, to classify the privacy policy—with a precision of at least 0.908—we require $\widehat{\mathrm{P}} \geq 1.6$. Since we speak in terms of sentences and not sentence fragments, we round the value of required positively predicted sentences ($\widehat{\mathrm{P}}$) up to 2. In sum, to classify a privacy policy containing 100 sentences as meeting the DPO requirement, at least two of its sentences must be predicted into the GDPR class of DPO.

5.4. Tools

The classification models were developed and evaluated in *Python 3.8.5*. The preprocessing and vectorization (using TFIDF (Robertson, 2004)) steps were conducted using Python's *Natural Language Toolkit (NLTK)* (Bird et al., 2009) library. The tokens were stemmed using *PorterStemmer*. The splitting of the data, parameter optimization, training, and model evaluation was managed by Python's *Scikit-Learn library* (Pedregosa et al., 2011). The oversampling of the imbalanced (training) data was performed using *imbalanced-learn's RandomOverSampler* technique (Lemaître et al., 2017).

6. Data collection

The data collection process consists of two stages: collecting organizational data from Orbis and scraping the privacy policies of the corresponding organizations. We will delve into the details of these stages in what follows.

6.1. Collecting organizational data

We used the Orbis database (Bureau van Dijk, 2021) to collect organizational data from organizations the GDPR applies to. From this database, we collected a random sample of organizational data of 168,824 companies located in the EU, including the following organizational details: the **company name**, **quoted** (describing whether the company was publicly listed), the **country ISO code** indicating the location of the company, **NACE code** depicting the business activity of the company (i.e., sector), the **last available year** of the data, the **operating revenue** based on the last available year, the **number of employees**, and the **size classification** of the organization.

However, not all organizational factors were included in our final set of factors considered for analysis (Table 5). The **company name** was used to crawl the web and scrape the related privacy policy, but it was omitted afterward. Similarly, **the last available year** was only used to sift the data and keep only the data applicable to the GDPR, i.e., data published or updated after the enactment of the GDPR in 2018. Also, we shifted from Orbis' categorization of size, i.e., *small companies*, *medium-sized companies*, *large companies*, and *very large companies*). For the sake of simplicity, *small companies*, *medium-sized companies* were united under the umbrella of "small and medium-sized enterprises", whereas *large companies*, and *very large companies*) were combined into "large enterprises." The latter, i.e., "large enterprises," is defined, according to Orbis, by at least one of the following three criteria: (1) an operating revenue equal to, or more than, 10 million euros, (2) owning total assets equal to, or more than, 20 million euro, and (3) having 150 employees or more. If a company does not meet these conditions, it is categorized under "small and medium-sized enterprises."

Table 5. The final set of organizational factors considered for analysis

Name	Description
Country ISO code	*ISO 3166-1 alpha-2: two-letter country code.*
NACE Rev. 2 code (level 1)	*Classification of 21 business activities, e.g., "agriculture, forestry, and fishing."*
Number of employees	*Number of employees as reported in the last available year.*
Operating revenue	*Operating revenue as reported in the last available year.*
Quoted	*Boolean value indicating whether the company is listed or not.*
Size classification	*Boolean value describing the company's size (i.e., small and medium-sized or large enterprise).*

6.2. Scraping privacy policies

After collecting a sample of organizational data of 168,824 companies located in the EU, we aimed to gather the related privacy policies of the organizations. To do so, we devised a web-scraping algorithm in Python—using the *urllib*, *google-search* (Vilas, 2020), *Newspaper* (Ou-Yang, 2013), and NLTK libraries—identifying and collecting the relevant privacy policies resulting from querying *Google Search*. The privacy policies were collected over 20 days in September 2021. The web scraper followed the following steps:

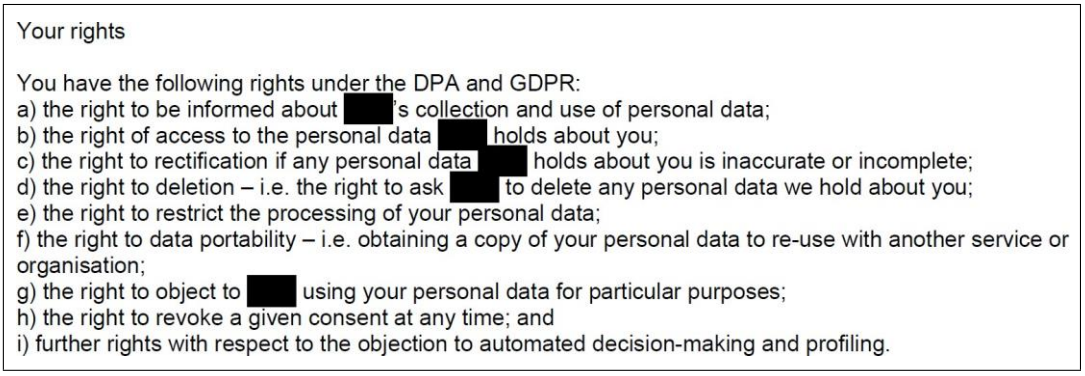
Step 1. Query Google Search with the company name and attempt to identify in the first three results whether (parts of) the company name is present in the Uniform Resource Locator (URL) and, more specifically, in the network location part (netloc) of the URL, according to the general structure of a URL: scheme://netloc/path;parameters?query#fragment.

Step 2. If the netloc included (parts of) the company name, the URL was saved for the next step. If not, the URL was skipped, and the following URL from the Google Search results was considered, with a maximum of three attempts. Finally, the company at issue was omitted from the data set if there was no positive result.

Step 3. Using the relevant netloc, we devised the following Google query to search the specific website of the affiliated organization for a privacy policy: "site:" + <netloc> + " privacy policy".

Step 4. Next, three attempts were made to scrape the relevant privacy policy. The URLs that resulted from the query were examined. If the term "privacy" or "policy" was present in the URL, the text on the corresponding page was scraped *if* the text was written in English *and* longer than ten sentences. The latter requirement was set in place to avoid irrelevant pages. If these requirements were not met, the next URL in line was examined. This process was repeated up to three times.

We were able to scrape 10,090 privacy policies with this process. Fig. 2 shows the disclosure of GDPR compliance promises in one of the scraped privacy policies. These privacy policies were then classified into the five GDPR privacy policy core requirements using the classification models of Section 5. Next, the classification results were tied with the related organizational data from the initial Orbis data set. Finally, this combined data set was sifted from irrelevant data, i.e., data published or updated before the enactment of the GDPR in 2018, resulting in a data set containing organizational data of 8,614 companies, including the corresponding classification results.


Your rights

You have the following rights under the DPA and GDPR:
a) the right to be informed about [redacted]'s collection and use of personal data;
b) the right of access to the personal data [redacted] holds about you;
c) the right to rectification if any personal data [redacted] holds about you is inaccurate or incomplete;
d) the right to deletion – i.e. the right to ask [redacted] to delete any personal data we hold about you;
e) the right to restrict the processing of your personal data;
f) the right to data portability – i.e. obtaining a copy of your personal data to re-use with another service or organisation;
g) the right to object to [redacted] using your personal data for particular purposes;
h) the right to revoke a given consent at any time; and
i) further rights with respect to the objection to automated decision-making and profiling.

Fig. 2. Screenshot of GDPR compliance promises disclosed in one of the scraped privacy policies

7. Analysis

In this section, we detail how the collected data set—containing the organizational factors and GDPR compliance promises of 8,614 organizations—is prepared and then analyzed to identify the organizational factors associated with the GDPR privacy policy core requirements disclosed in each organization's privacy policy. The organizational factors considered for analysis were already outlined in Table 5. The full output of the analysis is made available at https://aberkane.github.io/GDPR-privacy-policies/.

7.1. Training the model

Step 1. The data types of the predictors (i.e., organizational factors) and the target values (i.e., the GDPR privacy policy core requirements) were transformed into a categorical and numerical representation.

Step 2. The categorical data was encoded, whereas the numerical data was scaled.

Step 3. The data was split into a training set and a test set.

Step 4. Parameter optimization was performed by tuning the logistic regression parameters to maximize accuracy using the training set, and then evaluating performance with the test set. Accuracy describes the fraction of correct predictions over the total number of predictions: $accuracy = \frac{TP+TN}{TP+TN+FP+FN}$. The outcome of the parameter optimization is presented in Table 6, including regularization, alpha (i.e., the weight multiplying the regularization penalty term), and the resulting accuracy.

Step 5. The model was retrained on the entire data using the optimized parameters, applying a significance level of 0.05. The results are presented in the remainder of this section.

Table 6. Optimized parameters and corresponding accuracy for Statsmodels' logistic regression

Name	Regularization	Alpha	Accuracy
Data Protection Officer	L1	8.101	0.636
Purpose	L1	0.001	0.867
Acquired Data	L1	5.501	0.829
Data Sharing	L1	9.701	0.752
Rights	L1	0.001	0.771

7.2. Results

Table 7 summarizes the significant predictors and their coefficients associated with the GDPR privacy policy core requirement of **DPO**, which includes providing the contact information for the DPO or equivalent. The results show that being quoted positively correlates with the GDPR requirement of DPO, i.e., a publicly listed company is less prone to communicate the contact details of the DPO—where applicable—than an organization that is not listed. Furthermore, the location of the company headquarters also plays a role, with companies located in Italy having a lower probability of disclosing information regarding the DPO. In contrast, companies in Belgium, Germany, Denmark, France, Ireland, and Sweden are likelier to disclose information about the DPO.

Table 7. Significant predictors and corresponding coefficients for target value DPO

Predictor	P-value	Coefficient
Quoted	1.396142×10^{-4}	0.581482
BE (Country ISO code)	7.610162×10^{-3}	0.337784
DE (Country ISO code)	3.292703×10^{-3}	0.242856
DK (Country ISO code)	1.363752×10^{-3}	0.611399
FR (Country ISO code)	9.424592×10^{-4}	0.285202
IE (Country ISO code)	3.915174×10^{-2}	0.290846
IT (Country ISO code)	8.796016×10^{-12}	−0.522975
SE (Country ISO code)	1.176022×10^{-3}	0.352673

Table 8 presents the significant predictors and their respective coefficients in relation to the GDPR privacy policy core requirement of **Purpose**, i.e., the disclosure of the purposes of the processing. Similar to the previous GDPR requirement of DPO, the results show that being quoted positively correlates with Purpose. Furthermore, the results reveal a positive

correlation between Purpose and Greece as headquarters locations of data processing entities. On the contrary, Slovenia negatively correlates with the Purpose requirement. Similarly, centering on the classification of business activities, "agriculture, forestry and fishing" and "public administration and defense; compulsory social security" negatively correlate with complying with the Purpose-criterion. Finally, relating to the size classification, the "small and medium-sized enterprises" predictor also shows a negative correlation with disclosing the purposes of the processing.

Table 8. Significant predictors and corresponding coefficients for target value Purpose

Predictor	P-value	Coefficient
Quoted	0.031873	0.576 070
GR (Country ISO code)	0.011031	1.031 066
SI (Country ISO code)	0.016175	–0.904 906
Agriculture, forestry and fishing (NACE Rev. 2 code)	0.004734	–1.046 389
Public administration and defense; compulsory social security (NACE Rev. 2 code)	0.040562	–1.388 573
Small and medium-sized enterprises (Size classification)	0.001417	–0.219 327

Next, Table 9 shows the corresponding statistically significant predictors and coefficients related to the GDPR privacy policy core requirement of **Acquired Data**: communicating whether (and which) personal data is or is not collected. The results show that only four predictors are significant predictors, all of which negatively correlate with the Acquired Data requirement. Notably, the negative correlation of the *quoted* predictor shows that publicly listed companies are less likely to comply with the Acquired Data requirement, diverting from the trend between *quoted* and the previous two GDPR requirements: DPO and Purpose. Similarly, companies headquartered in Spain, Italy, and Poland negatively correlate with the Acquired Data requirement.

Table 9. Significant predictors and corresponding coefficients for target value Acquired Data

Predictor	P-value	Coefficient
Quoted	5.280495×10^{-16}	–1.185473
ES (Country ISO code)	3.542255×10^{-20}	–0.993589
IT (Country ISO code)	1.110738×10^{-9}	–0.606650
PL (Country ISO code)	2.841021×10^{-4}	–0.532567

In the context of the GDPR privacy policy core requirement of **Data Sharing**, Table 10 presents significant predictors and their associated coefficients. The findings suggest that being quoted negatively correlates with compliance with the Data Sharing requirement, which is consistent with the previous GDPR requirement of Purpose. The results further indicate that four significant predictors in the *country ISO code* category positively correlate with the Data Sharing target value, specifically Denmark, Ireland, the Netherlands, and Sweden. Conversely, Spain shows a negative correlation with the Data Sharing target value. Finally, being categorized as a small or medium-sized enterprise negatively correlates with the Data Sharing requirement.

Table 10. Significant predictors and corresponding coefficients for target value Data Sharing

Predictor	P-value	Coefficient
Quoted	2.566122×10^{-14}	−1.065388
DK (Country ISO code)	2.015918×10^{-2}	0.510705
ES (Country ISO code)	3.572360×10^{-4}	−0.336990
IE (Country ISO code)	4.081384×10^{-3}	0.496183
NL (Country ISO code)	7.944794×10^{-4}	0.527240
SE (Country ISO code)	4.717011×10^{-2}	0.236954
Small and medium-sized enterprises (Size classification)	-4.825884×10^{-4}	−0.186945

Finally, table 11 illustrates the findings concerning the GDPR's **Rights** privacy policy core requirement, which mandates the specification of the user's right to rectification and erasure. Consistent with all GDPR privacy policy core requirements analyzed, being quoted emerged as a significant predictor of the target value. Specifically, the *quoted* predictor positively correlated with the Rights requirement. Additionally, companies headquartered in Germany and Denmark positively correlated with the Rights requirement, whereas Croatia and Slovenia exhibited a negative correlation.

Table 11. Significant predictors and corresponding coefficients for target value Rights

Predictor	P-value	Coefficient
Quoted	0.000186	0.709050
DE (Country ISO code)	0.001392	0.592737
DK (Country ISO code)	0.014106	0.692819
HR (Country ISO code)	0.020157	−0.625037
SI (Country ISO code)	0.017338	−0.792389

8. Discussion

This section discusses the notable results of the analysis, as presented in the previous section. In general, we focus on the predictors that show a significant correlation with two or more target values. It is worth noting that, except for the *quoted* predictor, the results did not show ambiguity, as no predictor had both a positive and negative correlation with the GDPR privacy policy core requirements.

First, the results show that being a publicly listed company—which corresponds to the **quoted** predictor—correlates with all five considered GDPR privacy policy core requirements. DPO, Purpose, and Rights correlate positively, while Acquired Data and Data Sharing correlate negatively. A publicly listed company usually discloses information where the operational activities and financial statements are public (Ghonyan, 2017), which might increase the need to comply with the GDPR, as non-compliance might lead to reputational damage. Even a small fine can significantly impact the market value (Ford, 2023). Moreover, listed companies typically have more resources since, for example, the organization's net value increases, and the debt-to-equity ratio improves by going public (Ghonyan, 2017). These resources can aid in meeting the requirements of the GDPR, as they allow for carrying out the necessary measures to comply with the GDPR requirements. Therefore, the positive correlations are in agreement with prior studies. However, despite all of the above, results show a negative correlation between a publicly listed company and the disclosure of the nature of personal data collected

(Acquired Data) *and* disclosing whether third parties can or cannot access personal data (Data Sharing), revealing room for improvement.

Centering on **small and medium-sized enterprises**, the results reveal a negative correlation with the GDPR privacy policy core requirements of Purpose and Data Sharing. This result is in line with previous research where the issue of resource poverty regarding small and medium-sized enterprises is pointed out: complying with the requirements of the GDPR may be problematic for small and medium-sized enterprises as they might struggle with taking the required technical and organizational steps towards GDPR compliance (Freitas & Da Silva, 2018; Kapoor et al., 2018) The high cost of non-compliance, including hefty fines, can also pose a significant burden on small and medium-sized enterprises, further exacerbating the difficulties they face in meeting the requirements of the GDPR. The predictor was not found to be significant in the remaining classes.

Regarding organizations' headquarters, the results indicate that **Denmark** positively correlates with the GDPR privacy policy core requirements of DPO, Data Sharing, and Rights, making it the best-performing host country. This favorable performance of Denmark concerning the disclosure of GDPR compliance requirements may be attributed to its achievements in the digital sphere. According to the Digital Economy and Society Index, which presents countries' performance in digitization (European Commission, 2022a), Denmark is "a digital front-runner both in the EU and globally and continues to progress relatively well." Furthermore, Denmark is ranked first in the EU in the connectivity dimension: 95% of households are connected to very-high-capacity networks (European Commission, 2022b). This progress and attitude are reflected in the GDPR measures taken after the looming of the GDPR. Denmark has set up the (already existing) Data Protection Agency to promote awareness of the GDPR and ensure it is followed. The Danish Data Protection Agency also provides guidance and support to companies and individuals so that they can comply with the GDPR.

Its Scandinavian counterpart, **Sweden**, positively correlates with the target values of DPO and Data Sharing. Moreover, like Denmark, Sweden is considered one of the digital front-runners in the EU (European Commission, 2022a). These positive correlations may be attributed to the early adoption of data protection statutes (Bygrave, 1998). Nonetheless, despite this early development, Herlin-Karnell (2020) argues that there is, in fact, a lack of compliance in Sweden due to a "disproportionate reading of the GDPR", mentioning that private actors may purchase a publishing license that exempts them from the GDPR, allowing them to share information about individuals and even earn a profit from this under the banner of freedom of expression. However, to validate the claim indicating that the Swedish reading of the GDPR gives room for actions that may be classified as non-compliance in other EU countries, a thorough investigation is needed into the data processing activities of organizations in Sweden, comparing these activities to the GDPR requirements.

Along the same lines, the results indicate that **Ireland**—which acts as a host for major U.S. digital services providers—positively correlates with the GDPR privacy policy core requirements of DPO and Data Sharing. The country's low corporate tax regime (Gunnigle & McGuire, 2001) and its status as a center for multinational corporations make it an attractive location for companies to establish their European operations. These companies must comply with the GDPR, which might explain the country's high level of compliance. Nevertheless, Daigle and Khan collect some skepticism towards the popularity of Ireland as a headquarters location for the EU operations of major digital services providers, mentioning the concern shared by some EU Member States' Data Protection Authorities about Ireland possibly permitting significant violations of the General Data Protection Regulation (Daigle & Khan, 2020). In 2023, however, the Irish Data Protection Commission (DPC) issued a 1.2 billion euro fine to Meta Platforms Ireland Limited (Meta IE) (EDPB, 2023), challenging the allegations (Francis, 2022).

Another country where the results were optimistic is **Germany**, which is positively associated with the GDPR privacy policy core requirements of DPO and Rights. Germany's commitment to GDPR implementation is demonstrated by the fact that it imposed more fines than any other EU Member State in the first year of enforcement, highlighting its dedication to data privacy regulation (Barrett, 2020). In contrast, almost half of the EU Member States did not issue fines in the first year, many due to a lack of sufficient resources. This decisiveness was to be expected since, even before the advent of the

GDPR, Germany upheld one of the most robust data privacy protection frameworks in the world (Zell, 2014), grounded on, among other acts, the German Federal Data Protection Act of 1977, which protects all forms of personal data on an identified or identifiable natural person, setting a "commendable" precedent in regulating the processing of personal data (Riccardi, 1983). Therefore, it can be argued that Germany's promising results might be linked to its strong commitment to data privacy protection and its pre-existing robust data protection framework.

On the other side of the fence, the results indicate that data processing organizations headquartered in **Spain** are less likely to disclose information regarding Acquired Data and Data Sharing. It might be due to these reasons that the Spanish Data Protection Agency, Agencia Española de Protección de Datos, seems to have taken a more demanding approach after the first two years of GDPR enforcement (Levis & Fischer, 2021). Furthermore, according to the CMS Law GDPR Enforcement Tracker, Spain collected, by far, the most fines since the enforcement of the GDPR (CMS Law, 2024). At the time of writing, the number of fines accumulated to 872, which is more than twice the fines imposed by the second country on the list, Italy, with 377 fines. **Italy**, as a predictor, negatively correlates with the target values DPO and Acquired Data. The Garante per la Protezione dei Dati Personali, i.e., the Italian Data Protection Authority, was slower than most other EU countries in implementing fines against companies following the introduction of the GDPR (Daigle & Khan, 2020). However, beginning in early 2020, it began issuing more severe fines. As a result, and as previously noted, the authority has accumulated a total of 377 fines as of the time of writing. The number of fines imposed by both Spain and Italy seems to agree with the narrative of the results. However, it is important to contextualize these figures. The issuance of a large number of fines does not necessarily indicate an excessive level of non-compliance with the GDPR. Instead, it could indicate the diligent enforcement of the regulation by the authorities. Additionally, it is noteworthy that Italy and Spain have among the largest staffs to support their respective Data Protection Authorities, which may contribute to the high number of fines (Barrett, 2020). This is because they are likely more capable of processing complaints efficiently and enforcing the GDPR than countries with limited resources. On the other hand, authorities with fewer resources might conserve their resources by prioritizing organizations handling sensitive personal data (Presthus & Sønslien, 2021).

Next, **Croatia** demonstrated a negative correlation with one of the requirements: organizations headquartered in Croatia are less likely to disclose information regarding rights in their privacy policies. Its Eastern European counterpart, **Slovenia**, negatively correlates with the requirements of Purpose and Rights. Daigle and Khan (2020) provide insight into the fining of Eastern European countries, thus including Croatia and Slovenia. The authors report that, from May 2018 to March 2020, 11 penalties out of a total of over 100 across the EU exceeded one million euros each, with only one of these 11 fines imposed by an Eastern European country. Furthermore, the authors note that of the 107 fines exceeding 10,000 euros each issued between May 2018 and March 2020, only 24 percent originated in Eastern European countries, possibly indicating a more lenient approach. Focusing on Croatia's fining pattern, we find that out of a total of 29 fines, the vast majority (25) were imposed after 2021 (CMS Law, 2024), indicating a trend towards more stringent GDPR enforcement. In contrast, Slovenia has been slower in complying with GDPR standards. Despite the regulation being instated in the EU in 2018, the Slovenian Parliament only adopted the Data Protection Act (ZVOP-2), a national law implementing the GDPR, on 15 December 2022 (Frantar & Gajšek, 2023; Vrabec, 2020). Currently, no fines have been imposed by the Slovenian Data Protection Authority (CMS Law, 2024). It is worth noting that the fines referenced are based on publicly disclosed data, which may not fully represent the actual figures.

Regarding the industry classification of **NACE**, the results indicate that, among the 21 industries, only two industries showed a significant correlation: "agriculture, forestry and fishing" and "public administration and defense; compulsory social security" negatively correlated with the target value of Purpose. These results imply that the industry classification of data processing entities may not be a reliable predictor of their level of GDPR compliance, as revealed in their privacy policies. The same applies to the predictors of **number of employees** and **operating revenue**, as both predictors demonstrated insignificance.

In conclusion, the findings regarding the predictor of **quoted** lack consistency, as negative and positive correlations were detected. However, the results of this study seem to support the notion that small and medium-sized enterprises face difficulties complying with the GDPR due to limited resources. Additionally, initial observations may suggest a potential relationship between a country's level of maturity in data protection legislation and the disclosure of GDPR privacy policy core requirements by data processing companies headquartered in that country. Finally, previous research suggests that Eastern European Member States may have a distinct approach and attitude toward GDPR compliance compared to their Western counterparts (Daigle & Khan, 2020; Vrabec, 2020). However, validation of these possible causal links requires further research. An overview of all significant correlations—where "+" signifies a positive correlation and "-" signifies a negative correlation—is presented in Table 12.

Table 12. Overview of all significant correlations between the organizational factors and the GDPR privacy policy core requirements

Organizational Factor		GDPR Privacy Policy Core Requirements				
		DPO	Purpose	Acquired Data	Data Sharing	Rights
Country ISO Code	*BE (Belgium)*	+				
	HR (Croatia)					−
	DK (Denmark)	+			+	+
	FR (France)	+				
	DE (Germany)	+				+
	GR (Greece)		+			
	IE (Ireland)	+			+	
	IT (Italy)	−		−		
	NL (The Netherlands)				+	
	PL (Poland)			−		
	SI (Slovenia)		−			−
	SP (Spain)			−	−	
	SE (Sweden)	+			+	
NACE Rev. 2 code	*Agriculture, forestry, and fishing*		−			
	Public administration and defense; compulsory social security		−			
Number of employees						
Operating revenue						
Quoted		+	+	−	−	+
Size	*SME*		−		−	
	LE					

9. Conclusion

In this study, we utilized ML and NLP to address the research question: *"What organizational factors are associated with the disclosure of GDPR compliance promises in the privacy policies of data processing entities?"* The study focused on five GDPR privacy policy core requirements disclosed in privacy policies and examined six organizational factors and their subclasses for their effect on the disclosure of these requirements.

The study made several contributions. Firstly, we developed five NLP-based classification models with precision scores of at least 0.908 to evaluate GDPR compliance promises revealed in privacy policies. This approach offers researchers an innovative method for efficiently and accurately analyzing large volumes of privacy policies, with its calibration step ensuring high precision. Secondly, a data set of 8,614 organizations in the European Union was compiled, comprising organizational information and the GDPR compliance commitments extracted from the privacy policy of each organization. This dataset can serve as a valuable resource for researchers conducting further studies on GDPR compliance and for professionals benchmarking their compliance efforts against a broad range of peers. Lastly, we analyzed the organizational factors that correlated with the disclosure of GDPR compliance promises in privacy policies. These insights can guide future research by helping identify issues and patterns in GDPR compliance across various organizations. Moreover, they can aid professionals in developing targeted approaches to enhance GDPR compliance. For example, our analysis reveals that SMEs are less likely to disclose certain GDPR requirements in their privacy policies, suggesting that these organizations may need additional support. Using this insight, professionals such as policymakers or governmental actors can devise specific training programs or resources tailored to SMEs to enhance their compliance efforts effectively.

Our findings demonstrated that being a small or medium-sized enterprise negatively correlated with disclosing two GDPR privacy policy core requirements. The findings regarding the location of data processing entities revealed 13 significant predictors. Eight countries—Denmark, Germany, Ireland, Belgium, France, Greece, the Netherlands, and Sweden—positively correlated with one or more GDPR privacy policy core requirements without negatively correlating with the remaining requirements. On the other hand, Poland, Croatia, Spain, Italy, and Slovenia negatively correlated with the GDPR privacy policy core requirements. When analyzing the target values, it was observed that the predictors generally tended to correlate positively with DPO and negatively with Purpose and Acquired Data. For Data Sharing and Rights, the number of positive and negative correlations was more balanced.

The study results indicate a potential relationship between a country's level of maturity regarding data protection legislation and the disclosure of GDPR privacy policy core requirements by data processing companies headquartered in that country. Similarly, the results suggest a possible relationship between a country's level of digitization and the disclosure of these core requirements.

This study adds to the growing body of research on GDPR, providing new insights into the challenges of compliance with this regulation. The results were contextualized by aligning them with available literature and statistics. These contributions serve as a foundation for further academic research on the issue of non-compliance. However, the potential of these findings reaches beyond academia, offering a robust basis for professionals.

10. Limitations and future work

This research focuses on five GDPR privacy policy core requirements, although the GDPR encompasses more comprehensive regulations. For instance, in this study, the "Right" requirement is limited to the right to rectification and erasure, whereas the GDPR also includes other rights, such as the right to data portability mentioned in Article 20 (GDPR, 2016). We scoped the research to key GDPR requirements that are easily inferable from privacy policies.

It should be noted that the disclosure of the DPO and Data Sharing privacy policy core requirements is mandated only when relevant. However, we chose to include the DPO requirement as Article 29 Data Protection Working Party encourages

the appointment of a DPO even when not mandated (Data Protection Working Party, 2017). Additionally, given the widespread use of third-party content on websites that might transfer user data, we also considered the Data Sharing requirement (Libert et al., 2018).

Furthermore, as to the object of investigation in this study, i.e., the privacy policy, it is worth noting that a privacy policy does not necessarily reflect the actual data processing activities of the data processing organization in question. Based on Article 12 of the GDPR—which states that data processing entities should take appropriate measures to provide any information related to the processing of personal data to the data subject in question in a "concise, transparent, intelligible and easily accessible form, using clear and plain language" (GDPR, 2016)—this study assumes that privacy policies are generally used for that end. Nevertheless, to identify the actual data processing activities, one should explore them in reality rather than their—possibly distorted—reflection, i.e., privacy policies. Future research should explore these actual data processing practices for a more nuanced understanding of GDPR compliance.

Another limitation is that the collected set of privacy policies is limited to what could be collected through web scraping. For that reason, it might have occurred that privacy policies were not collected because they did not meet the scraper's standard. However, it is worth noting the possibility that organizations' privacy policies were not collected because they did not exist.

Furthermore, this study is limited to privacy policies written in English based on practical grounds related to our NLP approach and to reduce the complexity arising from differing interpretations of the GDPR across various languages (Dexe et al., 2022). This limitation might result in an unrepresentative view of the GDPR compliance promises of data processing companies in the EU, as not all organizations target an English-speaking audience. Consequently, a significant proportion of companies in the EU may be excluded from this analysis. Therefore, future studies should aim to replicate these results by considering privacy policies expressed in local languages to provide a more comprehensive understanding of GDPR compliance across the EU.

Moreover, the GDPR applies to all data processing entities that target EU subjects, irrespective of where the processing occurs. Nevertheless, this research is limited to organizations headquartered in the EU as these organizations must—and are therefore more likely to do so, e.g., to avoid repercussions—comply with the GDPR. This approach resulted in a data set that is highly GDPR-relevant and, therefore, suitable for our analysis.

Lastly, further research is necessary to explore the observations that suggest a potential relationship between a country's level of maturity concerning data protection legislation, its history of privacy legislation, and its level of digitization, with the disclosure of GDPR privacy policy requirements in the privacy policies of companies headquartered in that country. These areas warrant further study to enrich our understanding of GDPR compliance and its many influencing factors.

Supplementary materials

The data set, containing organizational information and GDPR classification (based on the corresponding privacy policy) of 8,614 organizations in the EU, the full output of the analysis, and all scripts regarding preprocessing, scraping, and the analysis, is made available at the following repository: https://aberkane.github.io/GDPR-privacy-policies/.

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RESEARCH ARTICLE

Perceptual mapping of the association between IT project success and factors promoting strategic alignment

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Abstract
The present research aimed at investigating the existence of associations between the factors promoting the strategic alignment of Information Technology (IT) and the success of IT projects. IT projects carried out in a public company in the Brazilian electricity sector from 2015 to 2018 were taken as the locus of the study. The research had a descriptive nature, used the quantitative method and a survey with 144 respondents from the company's business and IT areas. The key findings indicate that the success of IT projects depends on both the social dynamics between IT and business teams, as well as the intellectual/strategic alignment of IT plans, resources and priorities with the overall business objectives. This research contributes by providing insights into the aspects of strategic alignment and their influence on project success. It offers practical guidance for organizations in managing IT projects and aligning them with business objectives. While the study focuses on a specific Brazilian public company, further research is needed to validate the findings across different industries and contexts. Overall, this research enhances our understanding of the relationship between strategic alignment, IT project success, and provides a foundation for future studies in this area.

Keywords
IT strategic alignment; project management; success in IT projects.

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1. Introduction

The intense competition in the markets, intrinsically related to constantly changing socio-technical aspects (Van Grembergen & De Haes, 2009), motivated organizations from the 1990s onwards to replace the back-office role assigned to information technology (IT) with a position closer to strategic decisions, where its ability to promote innovation assumes greater relevance (Weiss & Thorogood, 2011). Hence, the search for the development and implementation of organizational strategies based on technological resources, aimed at establishing competitive advantages, has become an ongoing reality (Turban et al., 2010). For Lorences and Ávila (2013), this aspect provided IT with a transversal insertion in the business environment, permeating various intra- and inter-organizational processes and making decisions related to the use of IT more complex.

Such decisions are made based on existing elements within both the business scope and the scope of IT. Therefore, they involve an elaborate negotiation process that considers desires and availability (Jorfi et al., 2011; Cataldo et al., 2012). These decisions must also align with the priorities defined for executing organizational strategies while bearing in mind the achievement of strategic objectives (Garg & Goyal, 2012; Huang, 2012). This effort is referred to as IT strategic alignment (Kearns & Lederer, 2000; Luftman, 2000). For almost thirty years, the concept of strategic alignment of IT with business has been discussed in academic circles. It refers to the decision-making process where business and IT managers collaborate to determine how technology should be utilized in organizations (Coltman et al., 2015). However, the usual definitions attributed to this concept (Ciborra, 1997; Maes et al., 2000), as well as its applicability in organizations (Johnson, 2011; Simons, 2012), have been intensely questioned.

To understand the dynamics of establishing the strategic alignment of IT, several organizational studies (Luftman et al., 1999; Teo & Ang, 1999; Reich & Benbasat, 2000; Burn & Szeto, 2000; Galas & Ponte, 2006), have been dedicated to identifying both promoting and inhibiting factors that permeate strategic decisions involving both business and IT. Such factors play prominent roles in realizing alignment or complicating its establishment. Additionally, other organizational studies (Weiss & Thorogood, 2011; Chiang & Nunez, 2013), propose an approach to strategic alignment of IT based on IT projects conducted by companies. These studies address the apparent lack of research that considers both internal and external dimensions of organizations.

According to Kearns and Sabherwal (2006), business needs and IT skills converge in IT projects to provide value to the organization. As stated by Hacker and Dolen (2007), when IT projects are successful and achieve their goals, they support the strategic alignment of IT, enabling business objectives. Conversely, when projects are unsuccessful and fail to achieve their objectives, evidence suggests that there are problems associated with the strategic alignment of IT. The failure of IT projects results in significant waste of limited financial and human resources, preventing organizations and the public from realizing intended benefits (Schmidt, 2023). According to Weiss and Thorogood (2011), research on IT project management demonstrates that project success is linked to the involvement of top-level managers and the alignment between business and IT plans developed during the planning phase. These elements were also highlighted by Luftman et al. (1999) as factors promoting the strategic alignment of IT.

The existing literature emphasizes the significance of strategic alignment between IT and business in organizations (Adama et al., 2024). While the concept of IT strategic alignment has been discussed for nearly three decades, there remains a need to study elements that link the promotion of alignment and the success of IT projects. In view of this approach, this work seeks to describe perceptions of business and IT managers regarding elements linked to the strategic alignment of IT and the achievement of objectives intended by IT projects. Specifically, it investigates existing associations between factors promoting IT strategic alignment and the success of IT projects. The locus of this research was a set of IT projects carried out in a public company in the Brazilian electricity sector from 2015 to 2018. Operationalization occurred through a survey of managers from both business areas and IT.

This study offers valuable contributions to both practical and academic literature. It fills a research gap by describing factors that promote strategic alignment between IT and business and how they relate to the success in IT projects. By investigating perceptions of business and IT managers, it provides insight into decision-making processes and their impact on project outcomes. This knowledge can guide organizations in making informed decisions about IT utilization and strategic alignment, improving project success rates. Furthermore, this study enhances understanding of relationships between IT strategic alignment and project outcomes, contributing to the existing body of knowledge in this field. The focus on a specific public company within the Brazilian electricity sector provides real-world insights applicable to similar industrial contexts. Overall, this research has practical implications for organizations and contributes to advancing academic understanding of IT strategic alignment.

This paper is structured as follows: Section 2 presents a brief review of the extant literature on IT strategic alignment and project management. It is followed by a description of the research methodology and data collection procedures in Section 3. The results of data analysis are described in Section 4, and related discussions are presented in Section 5. Finally, conclusions are drawn, and implications for future research are discussed in the last section.

2. Background

2.1. IT Strategic Alignment

Several studies relating IT strategy, organizational strategy, and business objectives inhabited the Information Systems (IS) research agenda during the 1990s and 2000s, with the seminal article by Henderson and Venkatraman (1993) being an initial proposition of a conceptual model for the strategic alignment of IT. It is argued that the strategic alignment of IT promotes superior performance for an organization if the key resources of IT, components of the technological infrastructure, technical skills, managerial skills, and knowledge assets are employed in line with the business strategy while being controlled to ensure the effective management of these resources (Coltman et al., 2015). Thus, strategic alignment between IT and business can be understood as a harmonious relationship established over time between IT resources and business objectives or needs (Luftman, 2000). It is also understood as the degree to which the mission, objectives, and IT planning are adherent to the organization's mission, objectives and strategic planning (Reich & Benbasat, 1996).

Through their contributions, a diverse range of works proposed explanations about strategic alignment of IT, which reveals important concepts (Busanelo et al., 2011). From the article by Henderson and Venkatraman (1993), emerges an understanding regarding levelling, in the strategic scope, of business and IT plans through strategic adjustment is absorbed. Likewise, business and IT structures share efforts regarding functional integration. In turn, Reich and Benbasat (1996) present causes and effects related to strategic alignment of IT, mentioning elements arising from the intellectual (planning methodology and control instruments) and social (actors, decision-making and communication) dimensions of the organization. Despite IT project management achieving high levels of success, only a minority of projects are complete without changes in scope, schedule, or cost (Bilir & Yafez, 2021). This reinforces the importance of IT strategic alignment, considering that smaller differences between implemented IT strategies and formulated IT strategies denote a greater effectiveness of the IT area within fulfilling its planning, promoting a better performance of the business area (Chan et al., 1997). Even so, as project size increases, the success rate decreases (Varajão, 2018), which means that in larger projects this importance is amplified.

Additionally, Teo and King (1997) express a contingency perception whereby relationships between environmental and organizational characteristics are established for different degrees of alignment. Hirschheim and Sabherwal (2001) advocate that organizational performance derives from the organization's ability to maintain the link between business and IT strategies, avoiding deviations from IT's strategic alignment. Otherwise, Palvia et al. (2022) show that IT strategic alignment is one of the mechanisms that mediate the impact of IT governance on performance. Similarly, Chau et al.

(2020) indicates that effective IT governance in proactive organizations positively moderated the relationship between IT strategic alignment and firm performance. In the understanding of Brodbeck and Hoppen (2003), the formulation of business and IT plans occurs mutually, constituting the circular alignment. Kearns and Sabherwal (2006) discuss the idea that the level and understanding of top management about the role of IT, results in better business and IT plans, which, in turn, qualify IT project planning, inhibiting problems in the implementation of these projects. Chao and Chandra (2012) support this perspective, highlighting the influence of top management's IT knowledge on the strategic alignment between business and IT.

Although these propositions show practices that seek to achieve the strategic alignment of IT itself (Weiss et al., 2006; Coltman et al., 2015), other authors point out the difficulties in making the concept applicable to organizational reality, questioning the models and frameworks (Johnson, 2011; Simons, 2012). Additionally, the misalignment between business and IT strategies presents a wide range of risks, including management risk, operational malfunctioning of business processes, information security threats, financial risks, and reputational risks to the organization (Mantey, 2022). In parallel, other contributions focused attention on elements capable of determining different behaviors of the strategic alignment of IT, facilitating its establishment or hindering its occurrence (Reich & Benbasat, 2000; Galas & Ponte, 2006). These works had as a starting point the premise adopted from the perspective of critical success factors (Rockart, 1979), where groups of variables act as promoters or inhibitors of a given phenomenon. Bullen and Rockart (1981) defined the term critical success factor as key areas that are crucial for achieving objectives and goals successfully. Pioneering, Luftman et al. (1999) demonstrated the relationships between a set of 14 factors and their role as promoters of IT strategic alignment. Examples of this set were elements such as the support of top management to the IT area and the involvement of the IT area in the strategic formulation. On the other hand, they also presented a set of 13 factors that acted as inhibitors of IT strategic alignment. Of these, the lack of close relationships between the IT area and the business area and the lack of adequate prioritization of projects stood out.

Although such factors showed a common path to reach IT strategic alignment, other contributions emphasized the reasons that determine the difficulties in implementing it in organizations (Angell & Ilharco, 2004; Santos, 2005). These works argued that there is a tautological character in the definition of the term itself (Maes et al., 2000), with a wide variety of definitions that make it impossible to achieve unity regarding its concept (Brodbeck & Saccol, 2004). Reinforcing the criticisms, Ciborra (1997) argues that the proposed models do not show a measure of IT strategic alignment, making it difficult to measure its effectiveness in the organization. On the other hand, Maes et al. (2000) point out that there are difficulties in understanding the strategic alignment of IT with the business as a stagnant result or a continuous process.

Despite the gaps discussed, other studies discuss the strategic alignment of IT as the result of the efforts made by the organization within the scope of its IT projects, materializing it in its deliveries (Chiang & Nunez, 2013). According to Kearns and Sabherwal (2006) and Weiss and Thorogood (2011), the strategic alignment of IT with the business is influenced by the IT department's services and capabilities within IT projects. It is driven by the organization's technological needs, which are in turn motivated by the objectives outlined in its planning process and the competitive environment.

2.2. Projects Management

By definition, the term project consists of the effort carried out in a certain period of time and spent by a group of individuals, where its result comprises distinguishable elements given its exclusivity in relation to the products of other activities performed (Project Management Institute, 2008a). According to Marques Junior and Plonski (2011), projects seek to promote changes in organizations, while helping to implement business strategies. The adoption of organizational management models based on projects is a reality that permeates several markets around the world (Gray & Larson, 2009). Factors such as the intensified competition in these markets, the increase in the complexity of projects, corporate downsizing and, with it, the promotion of empowerment, have been pressing organizations to apply project management methods and techniques aiming at greater results (Fortune & White, 2006; Rehder & Rotondaro, 2010).

Adams and Barndt (1988) and King and Cleland (1988) were pioneers in highlighting that projects have a life cycle subdivided into four phases: conception, planning, execution and closure. The conception phase is related to the recognition by top management of a strategic need. In turn, the planning phase consists of a set of decisions made by top management that determine whether or not to proceed with the initiative. The execution phase, on the other hand, is characterized by the construction of results based on the use of earmarked resources. Finally, the closing phase comprises the demobilization of resources associated with the project (Pinto & Slevin, 1988).

The occurrence of several initiatives that result in projects is a common fact in organizations, which denotes diversified efforts that occur simultaneously, even promoting the sharing of resources between projects, putting pressure on the execution capacity (Kerzner, 2006). This set of simultaneous initiatives makes up the organization's project portfolio, which is still composed of planned projects whose execution is expected in a future scenario (Davila et al., 2007). Project portfolio management requires the use of specific techniques and procedures that aim to support the decision-making process carried out by top management, in the sense of prioritizing the projects to be executed (Project Management Institute, 2008b), requiring a deep understanding of the elaborated strategies of the present objectives in strategic planning (Jaeger Neto et al., 2013). When an organization prioritizes its projects, it does so according to the relevance of each project to organizational strategies, assigning them an order that gives priority to execution (Castro & Carvalho, 2010). The prioritization process compares projects based on elective criteria pre-established by the organization's top management (Archer & Ghasemzadeh, 1999), with financial criteria being the most common comparing projects with each other (Cooper et al., 1998).

According to Chiang and Nunez (2013), project prioritizations carried out in a wrong or ad hoc manner result in lost investment, underutilization of resources and available execution capacity, failure to meet the intended objectives, not promoting changes in the organization and loss of confidence in the agreed commitments aimed at benefits for the organization. Such concerns end up falling on the execution of the projects, evidencing the search for the success of the projects to the detriment of their failure. There is no consensus in the literature on the definition of project success, which is often an ambiguously established concept (Nguyen et al., 2004). According to Cooke-Davies (2002), success and failure of a project are mutually exclusive binary conditions that are based on the achievement or not of the project objective. However, such perspectives of success have been expanded, as several contributions introduce new elements, such as the look at success in project management (Berssaneti et al., 2014). Marques Júnior and Plonski (2011) argue that efficiency in the relationship established between the project scope, its cost and deadline is also seen as a measure of success in managing these project components. This relationship is commonly referred to as the iron triangle.

From this aspect derives the debate about project management, where contributions from two different approaches are discussed. The first one, called the traditional approach, adopts planning techniques, intensive use of control tools, good practices and a strong rationalist and normative character to ensure the efficient use of resources and coordination of project activities (Shenhar, 2001; Carvalho & Rabechini Junior, 2007). The central argument of the traditional approach is that any project can be managed under widely accepted conditions (Cleland & Ireland, 2006). Shenhar (2001) and Shenhar and Dvir (2007) criticize the traditional approach, since it completely ignores the dynamics of the project implementation process and its susceptibility to the influence of external elements. Thus, these authors launch arguments in favor of an adaptive approach, proposing a contingency perspective, taking into account the uncertainty and complexity of different types of projects.

IT projects, in particular, have specific characteristics. In general, its objectives are associated with the development and implementation of organizational process automation solutions, as well as the insertion of a new business process for the organization based on a new type of technological solution (Weiss & Thorogood, 2011). As pointed out by Varajão et al. (2022), the success of information systems projects is extremely important not only for IS, but also for the overall success of organizations, as the two are closely linked. Additionally, research has identified critical success factors for IS projects, including effective organizational communication, project team capability/competence and executive commitment, among

others (Yohannes & Mauritsius, 2022; Abule & Aduomer, 2022). However, the progress of these projects can be compromised due to breaks and delays in the schedule, difficulties in defining the scope and inadequate allocation of organizational resources (Cooke-Davies, 2002). Such occurrences can make other initiatives of the organization unfeasible and even the defined strategies (Gray & Larson, 2009). Projects that aim to develop information systems use a wide range of development methodologies that aim to reduce such impacts (Sommerville, 2011; Pressman, 2011). The purpose of an IT project is, in a global interpretation, to promote value to the business area through the skills of the IT area (Kearns & Sabherwal, 2006). These skills derive from the responsibilities assumed by the IT area which, according to Cassidy (2006), are hierarchically established according to the proposed business value, ranging from back-office activities to those that deal with the organization's strategies.

3. Methodology

In regard to the research strategy used, the field survey was chosen. According to Babbie (1999) and Creswell (2010), the survey presents a quantitative description of measurement units as measured by the researcher from the answers obtained from a sample of the researched population, through closed questionnaires or structured interviews.

The motivation to carry out the research in the chosen company was due to the adoption, from the year 2010, of methods and techniques of project portfolio management, aiming to consolidate the governance of IT through an IT strategic committee. The focus of this committee's activities is on business and IT plans, as well as the prioritization of IT projects. These efforts were recognized by the 2012 iGovTI survey, where the company achieved first place overall in the rank of good IT governance practices (Tribunal de Contas da União, 2013).

The delimitation of the population of this research advocated the fundamentals highlighted by Hair Junior et al. (2005), composing it with actors directly related to the researched phenomenon. Thus, the research population was clearly defined, being composed of 378 functional managers and advisors from the business areas and by 96 functional managers, advisors and employees, in non-management functions, belonging to the IT area, totaling 474 individuals. This set of actors is the one that is closest to the context of IT project management at the company, as they assume the key roles in the prioritization process for the execution of these projects (sponsor, requestor, project manager, and project team member).

Bearing in mind the characterization established above for the research population, for the purposes of establishing its sample, the probabilistic, stratified and proportional sampling typology was adopted, dividing it into two distinct groups: business stratum and IT stratum. As taught by Fávero et al. (2009) and Flick (2012), such groups were defined as the research analysis units, including, individually, the respective respondents from each stratum.

Thus, using the formula for the sample calculation of a finite population (Fávero et al., 2009), a sample space of 80 individuals was obtained in total (64 business strata and 16 IT strata), defined for a sampling error of 5%, with a confidence level of 95% (Hair Junior et al., 2005) and observing the proportions of strata in the population (79.75% business stratum and 20.25% IT stratum).

Considering the characteristics and assumptions of data analysis techniques, it is important to note that bivariate techniques typically require a sample size of at least 30 individuals or cases, while multivariate techniques necessitate a minimum of 100 individuals or cases (Corrar et al., 2012). Therefore, we defined the sample size as 148 individuals, comprising 118 from the business strata and 30 from the IT strata, ensuring that the proportions of each stratum reflect those in the overall population.

The study participants were identified through the company's employee records. They were then invited to take part in the research by receiving direct email communications. These emails contained a link that allowed the participants to access and complete the electronic version of the survey questionnaire. The sample is predominantly composed of individuals

with employment at the company for a period between 6 and 15 years. There is also a portion of individuals with a tenure between 16 and 25 years. Furthermore, the sample shows that these individuals were involved in at least one IT project during the 2013 to 2015 period. Additionally, the sample contains a share of individuals who identified themselves as requestors of the IT projects in which they were involved. Predominantly, the sample consists of individuals who participated in IT projects as clients, with a portion of projects focused on the modeling and automation of organizational processes.

The instrument used in data collection contained twelve closed questions, referring to the influence of factors promoting alignment on the success of IT projects, constituting the metric variables of the research.

In order to preserve the assumption of randomness of the probabilistic sample, the instrument was sent to the entire population through specific messages for the business and IT strata, allowing the identification of the respondent's origin group. Each message had a link that directed the respondent to a digital version of the instrument, counting the number of accesses and attempts to complete it, discarding those not carried out in its entirety and ending access to the questionnaire as the number of respondents reached the requirement sample.

For the elaboration of the instrument, a methodological procedure was adopted following Gil (2008) and Flick (2012), presenting questions and scales that obeyed the principle of exhaustiveness, maintaining the link between the questions and the research objective. Due to material and research performance reasons, an arbitrary criterion was adopted, intending to limit the number of variables evaluated. For Cooper and Schindler (2003), this contributes to avoid research instruments excessively long.

This criterion consisted of inserting, as research metric variables, only the factors promoting the strategic alignment of IT that were included in at least two different works identified in the investigated literature. Thus, the development of a consistent instrument was expected, since the factors used were the most widespread in the literature. The selected promoting factors, as well as their respective coding in the instrument, are shown in Table 1.

Table 1. Survey metric variables

Promoting Factors	
Top management support to the IT area (QSP02A)	IT's staff understanding of the business (QSP02H)
Proper communication between IT and the business (QSP02B)	IT's staff involvement in strategic formulation (QSP02I)
Connection between IT and business plans (QSP02C)	Appropriately estimated budget and resources for IT (QSP02J)
Confidence in achieving the commitments made by IT and the business (QSP02D)	Partnerships, alliances and close relationships between IT and the business (QSP02L)
Proper prioritization of projects (QSP02E)	Qualification of IT staff (QSP02K)
Understanding of IT by the business (QSP02F)	IT is applied to achieve competitive advantage (QSP02M)

Source: Compiled from Luftman et al. (1999), Teo and Ang (1999), Reich and Benbasat (2000), Burn and Szeto (2000) and Galas and Ponte (2006).

To measure the variables, a five-point interval scale was used, where each point received the labels of totally inhibit (1), partially inhibit (2), neither promote nor inhibit (3), promote partially (4) and promotes fully (5). For this scale, as argued

by Cooper and Schindler (2003) and Fávero et al. (2009), the relative zero is established by the median of the scale, which is the value 3.

Regarding the analysis of the collected data, a technique of interdependence analysis called multidimensional scaling (MDS) was used, since the metric variables investigated do not have a dependence relationship with other variables, and their measurements are restricted to the participants' perceptions of the variables associations of the factors evaluated and the success of IT projects.

Such characteristics meet the requirements for using the MDS pointed out by Manly (2008) and Hair Junior et al. (2009). In addition, the choice for the MDS also resided in its presentation characteristic, since it uses a multidimensional plane, called perceptual map, demonstrating the associations established between the investigated variables, based on the impressions obtained on them (Cooper & Schindler, 2003). A perceptual map is a graphical representation that divides a diagram space into distinct regions based on varying characteristics and then plots objects within the diagram based on their values compared to those regions. This type of map is commonly employed to illustrate the connections between various subjects that can be evaluated across a range of attributes. By utilizing a perceptual map, one can visualize the relative positions of these subjects in relation to each other, as well as their positions in relation to the evaluative attributes (Zheng & Vaishnavi, 2011).

As instructed by Fávero et al. (2009), the DMS perceptual map was obtained from the calculation of Euclidean distances and the correlations established between the variables investigated, resulting in a matrix of distances or dissimilarities of measurements obtained for each variable.

The tests of stress or tension S from Kruskal and Young's S-stress were adopted in order to obtain the degree of adjustment to which the matrix was submitted to form the perceptual map, with values between 0 and 0.20 being preferable, as well as said by Hair Junior et al. (2009). Finally, it was necessary for the MDS, to measure the reliability, safety and quality index (RSQ), to assess the quality of the adjustment suffered by the distance matrix, with values close to 1 being preferable.

According to Cohen (2003), the interpretation of perceptual maps resulting from the DMS has been enriched with the use of facet theory, a quantitative data analysis resource that aims to identify existing patterns among the analyzed variables, expressing them in facets. The use of facet theory has been common in research related to social science fields (Bilsky, 2003), but less so in IS research (Soper & Turel, 2016).

The most common facet patterns are polar, modular, and axial. The polar pattern presents an opposition between facets formed by distinct sets of variables, with the underlying facets having some degree of association. On the other hand, the modular pattern is characterized by presenting layered facets, with the innermost layers being those that have a greater association with the object of analysis. Finally, the axial pattern scales parallel facets, where underlying facets have some level of association with each other and non-boundary facets have no level of association (Guttman & Greenbaum, 1998).

As pointed out by Guttman and Greenbaum (1998), it is perfectly possible that, in the same analysis, more than one type of the mentioned patterns are identified. Thus, new patterns are constituted, such as radex, duplex and cylindrex, inheriting the characteristics of the patterns involved. Figure 1 presents some of the mentioned patterns.

The identification of facets in the perceptual maps was supported by theoretical elements from the literature on the strategic alignment of IT with business, as well as contributions related to project management. According to Bilsky (2003) and Greenbaum (2009), this approach enables researchers to design the facets by identifying the associations between variables and the relationships among the facets.

In carrying out this research, a rigid posture was adopted in the control of the occurrence of missing values which, according to Hair Junior et al. (2009), enable the production of data sets with biases in their formations. Coding was also used for the questions contained in the instrument, facilitating the preparation of the data file and avoiding the occurrence of measurement and analysis errors with the statistical software, as recommended by Gil (2008).

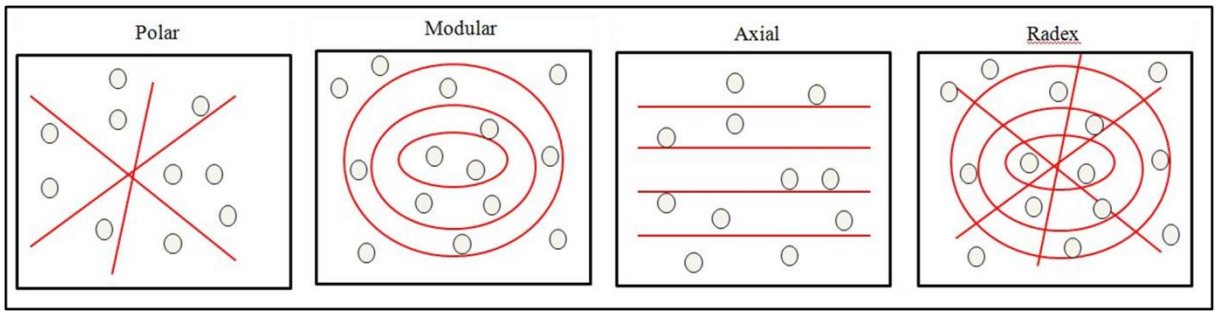

Fig. 1. Facet patterns in multidimensional scaling
Source: Adapted from Guttman and Greenbaum (1998) and Bilsky (2003).

4. Results

For descriptive purposes and with the intention of identifying the existing associations between the factors promoting the strategic alignment of IT and the success of IT projects, the perceptions of the strata of the sample regarding these factors were measured. Table 2 shows the absolute frequency (ni) of the answers obtained regarding the success of IT projects (n = 148), distributed according to the scale points reported by the respondents.

Table 2. Absolute frequency of variables that influence the success of IT projects

Variable	1	2	3	4	5
Top management support to the IT area	3	4	2	30	109
Proper communication between IT and the business	3	3	2	70	70
Connection between IT and business plans	2	4	9	64	69
Confidence in achieving the commitments made by IT and the business	3	1	14	57	73
Proper prioritization of projects	2	3	11	59	73
Understanding of IT by the business	1	3	45	65	34
IT's staff understanding of the business	1	2	5	52	88
IT's staff involvement in strategic formulation	2	3	21	77	45
Appropriately estimated budget and resources for IT	2	4	15	84	43
Partnerships, alliances and close relationships between IT and the business	1	3	14	67	63
Qualification of IT staff	2	3	8	54	81
IT is applied to achieve competitive advantage	3	4	27	62	52

The constitution of the distance matrices in this research considered the peculiar characteristic of the MDS, which uses only a general measure of preference or similarity between objects (Hair Junior et al., 2009). Thus, the coordinates of the variables in the perceptual map do not reflect a measure of causality, but of dissimilarity between the variables analyzed (Manly, 2008).

Table 3 presents the coordinates obtained for the factors promoting IT strategic alignment. Stress tests showed an adequate adjustment of the variables and their associations for two arbitrary dimensions (S = 0.125; S-stress = 0.096), with a high-quality index (RSQ = 0.938).

Table 3. Matrix of distance from factors promoting strategic alignment to the perceptual map of success in IT projects

Variable	Code	Dimension 1	Dimension 2
Top management support to the IT area	QSP02A	1.9966	-.0191
Proper communication between IT and the business	QSP02B	.6227	.3405
Connection between IT and business plans	QSP02C	.3231	-.5919
Confidence in achieving the commitments made by IT and the business	QSP02D	.5434	.5716
Proper prioritization of projects	QSP02E	.1780	.4503
Understanding of IT by the business	QSP02F	-2.9275	-.5821
IT staff understanding of the business	QSP02H	1.1478	-.4437
IT staff involvement in strategic formulation	QSP02I	-.9599	-.9983
Appropriately estimated budget and resources for IT	QSP02J	-.6886	.0991
Partnerships, alliances and close relationships between IT and the business	QSP02K	.1720	-.8057
Qualification of IT staff	QSP02L	.6368	.2025
IT is applied to achieve competitive advantage	QSP02M	-1.0445	1.7768

The resulting perceptual map is presented in Figure 2. The elements extracted from the literature review were used to interpret the perceptual map meaning. The facet patterns found and what researchers think about them are discussed in the next section.

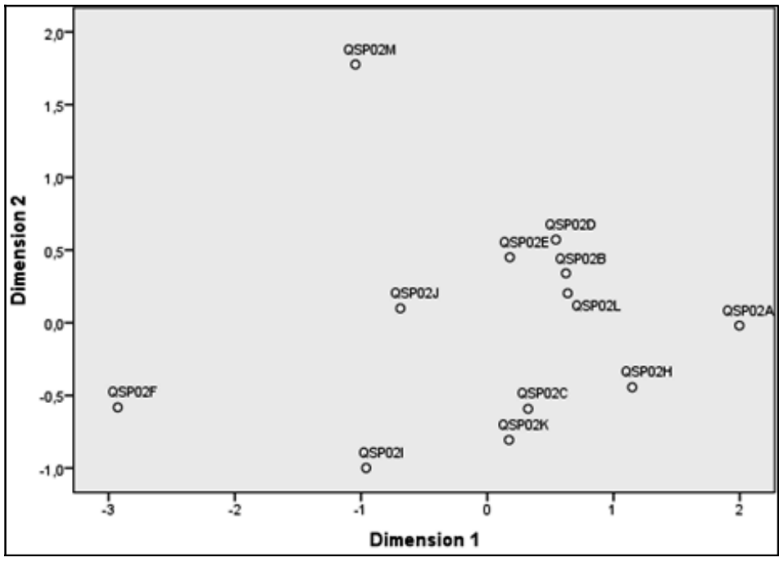

Fig. 2. Perceptual map of factors promoting alignment for the success of IT projects

5. Discussion

As can be seen in the Figure 2, there is a clear distance between certain pairs of variables, such as support from top management and the understanding of IT by the business, as well as involvement in strategic formulation and the achievement of competitive advantage. In general, these findings lead to the interpretation that, for the investigated population, there are different levels of association between the factors promoting the strategic alignment of IT and the success of IT projects. In the map, the variables that are closer together express a lower level of dissimilarity, while those

that are farther apart exhibit higher levels of dissimilarity. However, this information does not fully clarify the interpretation of the perceptual map, necessitating the use of other elements to understand the identified associations.

By applying facet theory, as described by Canter (1996), it was possible to identify several dissimilarities among the metric variables, relying on the assumptions that these variables are mutually exclusive and possess conceptual relationships. Two main patterns were identified on the perceptual map. The axial pattern (blue lines) presents four facets and the modular pattern (red ellipses) is designed with two of them. The identification of facets involved interpreting the groups of variables to understand their meaning and relationships to the overall phenomenon being studied. The perceptual map with the facet patterns found is shown in Figure 3, and it is possible to notice the concomitant presence of the axial (blue) and modular (red) facet patterns, thus constituting a third facet pattern, the radex pattern.

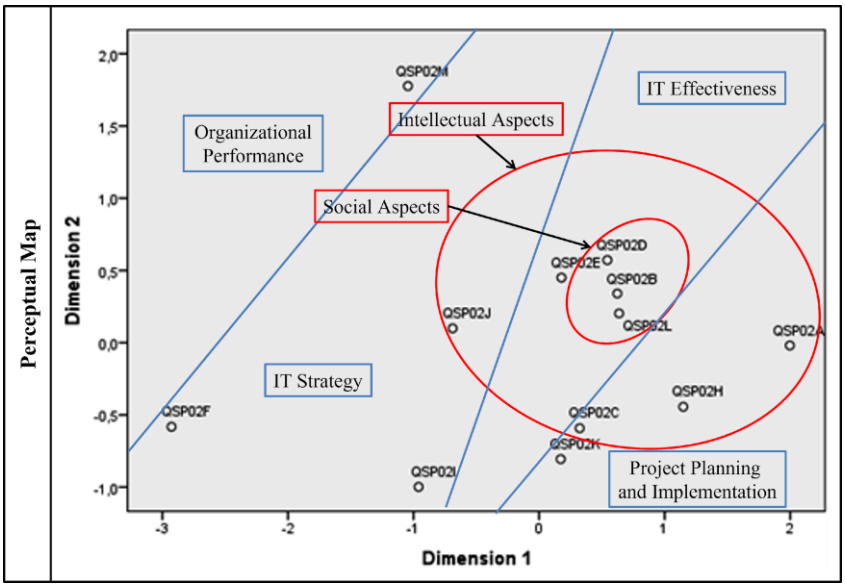

Fig. 3. Radex pattern of factors promoting alignment for the success of IT projects. Blue lines represent the axial pattern and red lines represent the modular pattern

First, we discuss how the axial pattern was interpreted. Based on the contributions of Kearns and Sabherwal (2006), the "project planning and implementation" axial facet was constituted by grouping the variables "support from top management to the IT team" (QSP02A), "connection between IT and business" (QSP02C), "IT understanding about business" (QSP02H), and "partnerships, alliances, and close relationships between the business and information technology teams" (QSP02K).

Following those authors' view, the IT projects planning gets positive effects when the business strategic plan and the IT strategic plan are built together both by business and IT managers. Once the IT strategic alignment is established, the organization perceives less problems on IT projects implementation. These factors presented dissimilarities that allowed inferring their associations to project planning and successful implementation, as can be seen in their grouping at the right side of the Figure 3. That agrees with Hacker and Doolen's (2007) statement that the success of IT projects is sustained by the sponsorship of top management and the mutual understanding of the relationship between IT and business.

The “IT effectiveness” axial facet derives from Chan et al. (1997) understanding that the IT effectiveness is directly related to the implemented IT strategy. This facet encompasses the following variables: "adequate communication between business and IT" (QSP02B), "confidence in reaching commitments made by business and IT teams" (QSP02D), "proper project prioritization" (QSP02E), and "IT staff qualification" (QSP02L). This perspective is similar to Cassidy's (Cassidy, 2006) view that inadequate prioritization and deficient resources hinder the IT strategic planning execution and reduce IT effectiveness. This interpretation is grounded on these author’s conceptions, but it is clear the proximity of the variables grouped in the center right of the Figure 3.

The next axial facet was called the "IT strategy". Its starting point is Henderson and Venkatraman's (1993) thought, IT strategy is a consequence of the business perception about the IT role in the organization. The variables "understanding of IT by the business" (QSP02F), "IT team involvement in strategic formulation" (QSP02I), and "properly estimated budget and resources for IT" (QSP02J) showed dissimilarities that associated them with the development of IT strategy and how IT supports business strategies.

The last axial facet of the perceptual map displays only one variable, "IT is applied to achieve competitive advantage" (QSP02M). This facet was declared "organizational performance" and its high dissimilarity degree shows differences between the application of IT to achieve a competitive advantage and other variables. Also, it means differences in their association with IT projects success. The axial facets (organizational performance, IT strategy, IT effectiveness, and project planning and implementation) exhibit an increasing intensity and relevance from left to right in the Figure 3.

In regards to the second pattern interpretation, the modular pattern, we used Reich and Benbasat (1996) contributions to define the "social aspects" modular facet. For those authors, the IT strategic alignment with business is established through social factors like "adequate communication between business and IT" (QSP02B), "confidence in reaching commitments made by business and IT teams" (QSP02D), and "IT staff qualification" (QSP02L).

Such aspects are related to the understanding of business and IT plans by managers from both teams, the establishment of win-win ties between them, and the communication adjustment for better planning integration. The social aspects facet brings together elements with dissimilarities that endorse the understandings of Teo and Ang (1999) and Cassidy (2006) about their repercussions on IT and business plans and IT value delivery to the business.

On the other hand, the modular facet “intellectual aspects” represents the associations between “support from top management to the IT team” (QSP02A), “connection between IT and business” (QSP02C), "proper project prioritization" (QSP02E), “IT understanding about business” (QSP02H), and "properly estimated budget and resources for IT" (QSP02J). For Reich and Benbasat (1996), such aspects are linked to the validation and consistency of IT and business plans, covering methodologies and tools used in planning and strategy formulation, and also how IT initiatives are managed.

Furthermore, the modular pattern can also be interpreted in light of the debate between traditional and adaptive approaches to project management. This interpretation relies on the association between the variables that refer to intellectual aspects and the rationalist and normative character expressed in the traditional approach, as described by Carvalho and Rabechini Junior (2007). The variables that refer to social aspects are close to the contingency issues of the adaptive approach, as pointed out by Shenhar and Dvir (2007).

Under the conditions presented in this research, a radex-type standard is constituted and, given its nature (Guttman & Greenbaum, 1998), establishes the understanding that top management support for the information technology area (QSP02A), the connection between IT and the business (QSP02C) and the understanding of the business by IT (QSP02H), are intellectual aspects of strategic alignment that focus on the planning and implementation of projects, while the correct prioritization of projects (QSP02E) and the occurrence Estimated budget and resources for IT (QSP02J), are intellectual aspects of strategic alignment associated with IT effectiveness and IT strategy. Figure 3 further illustrates that the variables present in the modular facets (intellectual aspects and social aspects) have more intense and relevant associations, moving from the inside out, regarding the success of IT projects. Meanwhile, the axial facets (organizational performance,

IT strategy, IT effectiveness, and project planning and implementation) show an increasing intensity and relevance from left to right in terms of associations.

Therefore, the intellectual elements are instruments that allow connecting the social aspects of the strategic alignment, such as adequate communication between IT and the business (QSP02B), establishing trust in the achievement of the commitments made between the two areas (QSP02D) and qualification of the IT staff (QSP02L), with what is planned for an IT project and the strategic vision that the IT area has of its activities.

In other words, the success of IT projects and their consequences for organizational success is based on elements associated with the social aspects and the effectiveness of the IT area in establishing the connection between the elements of the IT strategy and the elements of planning and implementation of projects, through the intellectual aspects.

6. Conclusion

This study contributes to the academic field by examining the factors that promote strategic alignment between IT and business and their association with project success. The findings highlight the diverse levels of association between these alignment factors and project outcomes, providing valuable insights into their influence. The study's interpretation of these associations underscores their fundamental role in the success of IT projects, particularly in terms of social aspects such as effective communication between IT and business departments, confidence in meeting commitments, and the competence of the IT staff. These findings deepen our understanding of IT project management and strategic alignment, adding empirical evidence to the existing body of knowledge.

In addition to its academic contributions, this study offers practical implications for organizations seeking to enhance the success of their IT projects. The identification of factors that promote strategic alignment and their connection to project outcomes provides actionable insights for decision-makers. The study emphasizes the importance of fostering robust communication channels between IT and business teams, instilling confidence in fulfilling commitments, and prioritizing the development of a skilled IT workforce. Implementing these findings can help organizations improve their IT project performance and increase the likelihood of achieving desired outcomes. Furthermore, the study's focus on the social aspects of alignment highlights the significance of interpersonal relationships and collaborative efforts in project success. This practical knowledge can guide organizations in designing effective strategies and practices that align IT initiatives with business objectives, leading to more successful project outcomes.

It is important to acknowledge certain limitations of this study. Firstly, the research was conducted within a specific context, focusing on a particular public company in the Brazilian electricity sector. Therefore, the findings may not be fully generalizable to other industries or organizational settings. Secondly, the study relied on self-reported perceptions of business and IT managers, which may be subject to bias or individual interpretations. Future studies could consider incorporating multiple data sources or utilizing objective performance metrics to enhance the robustness of the findings. Lastly, the research did not explore potential external factors or environmental dynamics that could influence the strategic alignment of IT and project success. Considering these factors in future studies could provide a more comprehensive understanding of the subject.

Building on the insights gained from this study, future research avenues can be pursued. Firstly, conducting similar investigations in different industries or organizational contexts would help validate and expand the generalizability of the findings. Additionally, exploring the role of external factors, such as market competition or regulatory changes, in shaping the strategic alignment of IT and project success would provide a more holistic understanding. Furthermore, investigating the temporal dynamics of alignment factors and project success over the project lifecycle could offer valuable insights into the evolving nature of IT project management. Finally, integrating qualitative research methods, such as interviews or case studies, could provide in-depth perspectives and rich narratives that complement the quantitative findings. These future

research directions would contribute to a deeper understanding of IT strategic alignment and project success, further advancing the field.

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Appendix A. Research instrument

QCR01 - How long have you been employed at the company?

(1) Less than 5 years

(2) 6 to 15 years

(3) 16 to 25 years

(4) 26 to 35 years

(5) More than 35 years

QCR02 - During the period from 2013 to 2015, how many IT projects were you involved in?

(0) None

(1) Only 1 project

(2) 2 to 3 projects

(3) 4 to 5 projects

(4) 6 or more projects

QCR03 - Indicate the role(s) you played in the most recent IT project you were involved in:

(0) I was not involved in any IT projects during that period

(1) Project requestor (presented a need that resulted in an IT project)

(2) Project sponsor (created the conditions for the IT project to exist and be prioritized and executed)

(3) Project manager (responsible for the execution activities of the IT project)

(4) IT team member on the project (supported the execution activities of the IT project)

(5) Business team member on the project (supported the execution activities of the IT project)

QCR04 - What was the nature of the most recent IT project you were involved in?

(0) I was not involved in any IT projects during that period

(1) Client project (IT projects generated from business area demands)

(2) Structuring project (IT projects generated from IT area demands)

QCR05 - What was the objective of the most recent IT project you were involved in?

(0) I was not involved in any IT projects during that period

(1) Only automating a previously modeled process

(2) Only modeling a process without the need for automation

(3) Contracting IT services

(4) Modeling and automating a process in sequence

(5) Providing specific IT infrastructure

QSP01 - Briefly describe what you consider to be the success of an IT project:

QSP02 - According to your view, evaluate the elements below and their relationship to the success of IT projects:

(1) Totally inhibits – (2) Partially inhibits – (3) Neither promotes nor inhibits – (4) Partially promotes – (5) Totally promotes

QSP02A - Top management support

QSP02B - Adequate communication between the IT area and the other areas of the company

QSP02C - Proper connection between the strategic planning of the IT area and the strategic planning of the company

QSP02D - Full confidence in achieving the commitments made between the IT area and the other areas of the company

QSP02E - Correct prioritization of projects

QSP02F - The understanding, by the other areas of the company, of the activities of the IT area

QSP02G - This is a verification question. If you are reading it, mark the "totally inhibits" option.

QSP02H - The understanding, by the IT area, of the activities of the other areas of the company

QSP02I - The involvement of the IT area in strategic planning

QSP02J - Proper estimation of budget and resources for the IT area

QSP02K - The existence of partnerships, alliances and close relationships between the IT area and the other areas of the company

QSP02L - Good qualification of the IT staff

QSP02M - The application of IT to achieve a competitive advantage

QFP01 - Briefly describe what you consider to be the failure of an IT project:

QFP02 - According to your view, evaluate the elements below and their relationship to the failure of IT projects:

(1) Totally inhibits – (2) Partially inhibits – (3) Neither promotes nor inhibits – (4) Partially promotes – (5) Totally promotes

QFP02A - Lack of top management support

QFP02B - Incipient communication between the IT area and the other areas of the company

QFP02C - Fragility in the connection between the IT strategic planning and the company's strategic planning

QFP02D - Lack of confidence in achieving the commitments made between the IT area and the other areas of the company

QFP02E - Inadequate prioritization of projects

QFP02F - Incomprehension, by the other areas of the company, of the activities of the IT area

QFP02G - This is a verification question. If you are reading it, mark the "neither promotes nor inhibits" option.

QFP02H - Incomprehension, by the IT area, of the activities of the other areas of the company

QFP021 - Non-involvement of the IT area in strategic planning

QFP02J - Improper estimation of budget and resources for the IT area

QFP02K - The absence of partnerships, alliances and close relationships between the IT area and the other areas of the company

QFP02L - Poor qualification of the IT staff

QFP02M - The non-application of IT to achieve a competitive advantage

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RESEARCH ARTICLE

A framework of critical success factors of cloud-based project management software adoption

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Abstract
Project Management (PM) software is an enabler of project success and is now being offered as a cloud-based software with the advancement of cloud computing. This research was conducted to explore the critical success factors affecting the adoption of cloud-based PM software. Semi-structured interviews were carried out with Information Technology (IT) professionals following the qualitative approach. Through thematic analysis, four themes were identified as areas considered when adopting cloud-based PM software: technological, organizational, environmental, and vendor-specific factors. Relative advantage, ease of use, compatibility, and reliability were categorized as the technological factors. Organization size, the technological readiness of the organization, employee willingness, top management support, and change management process were identified under organizational factors. Competitors' adoption, industry trends, and dedicated internet connectivity were identified under environmental factors. Additionally, features such as maintenance and service support from the vendor, popularity of the brand name, and availability of free trials emerged as vendor-specific factors.

Keywords
project management; project management software; cloud-based software; cloud-based project management software; critical success factors.

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1. Introduction

Software development is the process of designing, developing, deploying, and maintaining software applications that can be used to carry out daily tasks using computers (IBM, 2021). Project management has become a crucial component of the software development process to guarantee the success of development projects because it is constrained by time, scope, cost, and quality aspects (Schwalbe, 2015). The PMBOK Guide (Project Management Institute, 2017) defines project management as "the application of knowledge, skills, tools, and techniques to project activities to meet project requirements".

Project Management (PM) software is an important tool that helps project teams accomplish their goals by combining multiple tools and techniques like Gantt charts, Work Breakdown Structures (WBS), Network Diagrams, resource allocation, reporting, and more into a single application (Bajwa & Deichmann, 2018; Schwalbe, 2015).

With the development of networking and Internet technologies, cloud computing revolutionized the way that IT resources are digitally provided via the Internet without the need for any physical infrastructures (Calheiros et al., 2009; Munguti & Opiyo, 2018). It comprises three main models (Ahmad & Waheed, 2015; Palos-Sanchez et al., 2017):

- Infrastructure as a Service (IaaS): Provision of various virtual pay-per-use IT infrastructure solutions, including networking, storage, etc.
- Platform as a Service (PaaS): Platforms for application development are delivered virtually on a rental basis.
- Software as a Service (SaaS): Internet-based third-party software delivery with usage-based billing that eliminates the need for download and installation.

Recently, PM software has begun to be provided as a cloud-based or Software as a Service (SaaS) application due to developments in cloud computing that have transformed how Information Technology (IT) resources are provided through internet channels without any physical boundaries (Ahmad & Waheed, 2015; Słoniec, 2015). Due to the benefits of cloud-based software, 60% of 400 project management professionals surveyed by Capterra Inc. in the United States in 2019 changed their software usage habits (Capterra Inc., 2019). Project teams can save money and avoid license concerns by using cloud-based PM software, which is easily accessible on any device and offers the most recent version upgrades (Bajwa & Deichmann, 2018).

Though these software programs have advantages, prior research indicates that their uptake is still in its early stages, particularly in developing nations like Sri Lanka. As such, more research is necessary to fully understand the acceptance of these applications (Asirvatham & Ayoobkhan, 2018; Assalaarachchi et al., 2022; Das & Dayal, 2016; Munguti & Opiyo, 2018). For instance, there is still a dearth of research on the use of cloud-based PM software in Sri Lankan software development companies, despite some studies on the use of cloud-based software in various other industries in the country (Ayoobkhan & Asirvatham, 2018; Dakshina & Perera, 2018; Livera, 2017). A recent study conducted to identify the factors that affect the usage of cloud-based PM software in the software development industry of Sri Lanka using the Unified Theory of Acceptance and Use of Technology (UTAUT) model in a quantitative approach has pointed out that Effort Expectancy and Social Influence are significant factors that affect Behavioral Intention to use cloud-based PM software. In contrast, the Behavioral Intention and Facilitating Conditions significantly affect the Use Behavior of such software. They highlight the limitation of applying an established theoretical framework, which focuses solely on the attitudes that people have when embracing new technologies to test in an environment with little available literature. Instead, they recommend conducting additional qualitative research to develop a model that will enable further investigation into adopting cloud-based PM software (Assalaarachchi et al., 2022). The same limitations have been identified by most of the previous studies done in different contexts using a quantitative approach, and more qualitative studies have been suggested to be conducted to overcome that limitation (Bajwa & Deichmann, 2018; Livera, 2017).

This study was carried out to fill the research gap mentioned earlier by exploring the critical success factors affecting the adoption of cloud-based PM software in managing software development projects within the software development industry. Additionally, a conceptual framework for the critical success factors of cloud-based PM software adoption was proposed as the study's outcome.

A conceptual framework for critical success factors of Cloud-based PM software adoption is introduced as the novel outcome of this study to fill the theoretical gap identified and software development firms can adopt that to promote the successful adoption of such software.

Literature related to this study is discussed in the second section of this article. Later, the methodology section presents an overview of the qualitative research approach used in this study, the sample, the data collection procedure using semi-structured interviews, and the thematic analysis carried out in analyzing the data. The fourth section explains the results of this study derived from the thematic analysis. It discusses how the proposed conceptual framework for critical success factors of Cloud-based PM software adoption was developed by identifying the factors based on technological, organizational, environmental, and vendor-specific categories. Then, in the next section, the results of this study will be discussed along with the similar literature. Finally, the conclusion section summarizes the overall study while highlighting the implications of this study, its limitations, and future research suggestions from this study.

2. Related Literature

In the research conducted by Bajwa and Deichmann (2018), they found that several factors, including Subjective Norm, Output Quality, Result Demonstrability, Perceived Ease of Use, and Perceived Usefulness, have a significant impact on project managers' acceptance of cloud-based PM tools in the oil and automotive industries. In their study, they employed the Extended Technology Acceptance Model (TAM2), an established technology acceptance theory, and tested the model using a quantitative methodology. Thus, they highlight the limitations of focusing only on the variables in the current model and recommend that more exploratory research be done in the future to fully understand the impact of all potential factors that affect the adoption of cloud-based PM software (Bajwa & Deichmann, 2018).

A similar study by Assalaarachchi et al. (2022) adopting a quantitative methodology and the Unified Theory of Acceptance and Use of Technology (UTAUT) was carried out recently in Sri Lanka to determine the factors influencing the use of cloud-based PM software in the software development sector. The researchers have determined that behavioral intention to use cloud-based PM software is highly influenced by effort expectation and social influence. In contrast, the actual use of the program is largely determined by facilitating conditions and behavioral intention (Assalaarachchi et al., 2022). They also elaborate on the limitations of using an existing theory and suggest more research to be carried out qualitatively to identify the real picture of cloud-based PM software adoption. Further, they have pointed out the need for new models to be created with factors identified, thereby contributing to a theory area that lacks literature (Assalaarachchi et al., 2022).

Another survey carried out with cloud workers to identify the factors influencing the organizational adoption of cloud computing revealed that factors such as relative advantage, compatibility, security, and less complexity will create a more positive attitude towards such software that increases their use. However, they have elaborated that limiting factors of existing technology adoption theories might hinder the prediction of actual usage. Therefore, they suggest future research to explore various other factors to better predict the usage of such software. Further, they recommend that studies be carried out with various cloud applications that are used in different contexts (Livera, 2017). Most of the cloud-based software adoption studies done in other sectors have also followed the same approach and pointed out the same limitations (Assalaarachchi et al., 2023; Ayoobkhan & Asirvatham, 2018; Irshad, 2021; Stieninger et al., 2022; Wamuyu, 2017).

A systematic review has been carried out by Al Hadwer et al. (2021) to identify the factors affecting cloud-based technology adoption using the Technology-Organization-Environment (TOE) framework, considering recent literature within seven years. In their study, the authors have identified that most similar studies have adopted the TOE framework as it reveals

not only the technology-specific factors but also important organizational and environmental factors such as top management support, regulatory support, and organization size. However, they highlight the need to conduct future research in similar contexts to validate those findings (Al Hadwer et al., 2021).

Few studies have been conducted by adopting a qualitative approach to research cloud computing adoption and cloud-based software adoption in different contexts such as the Enterprise Resource Planning (ERP), healthcare, and education sectors. But they also have limited to the factors available in already existing theories, such as the TOE framework, to identify the various technological, organizational, and environmental factors influencing the adoption (Ahmad & Waheed, 2015; Das & Dayal, 2016; Nedev et al., 2014; Sulaiman & Magaireah, 2014).

Upon reviewing the previously mentioned literature, it became evident that there was insufficient research about the critical success factors that influence the adoption of cloud-based PM software. Additionally, most of the literature has only considered already existing theories using a quantitative method. This study was carried out to fill the research gap by exploring the critical success factors affecting the uptake of this type of software and to develop a new framework in a field with limited literature.

3. Methodology

Previous studies have highlighted the limitation of testing already existing frameworks in a context where little study has been conducted and recommends further exploration by the inductive approach of qualitative research (Assalaarachchi et al., 2022; Ayoobkhan & Asirvatham, 2018). Therefore, this research followed a qualitative approach to explore the critical success factors influencing the adoption of cloud-based PM software. Further adopting a case study method, the software development industry in Sri Lanka was chosen as the case for this study. The software development sector accounts for 29% of all service exports from Sri Lanka, making it the nation's fourth-largest exporter (SLASSCOM, 2021). It has become an accelerator for multi-sector growth by offering advanced software solutions to digitalize the business activities of other industries and supporting them in achieving industrial competitiveness (Dahanayake, 2022).

Since most software development companies in Sri Lanka are based in the Colombo district, the study's related population consisted of IT professionals from software development companies that operate in the country. The target population for this study was limited to team members of software development companies located in Colombo (SLASSCOM, 2020).

Semi-structured interviews were used to collect data to explore the critical success factors influencing the adoption. Thirteen (13) interviews were carried out with selected software development team members, including project managers, business analysts, software engineers, and quality assurance engineers from each software development firm of various sizes representing small, medium, and large scales. Participants were selected based on the snowball sampling technique, where the next participant was referred through the industry connection of the previous participant. Participation in these interviews was completely voluntary, and anonymity of the responses was ensured by giving codes for each respondent with their organization size and job role (for example, "Large-PM1"). Interviews were stopped at the thirteenth interview as it reached the saturation point. A summary of the respondents' details is given in Table 1.

Collected data was analyzed using thematic analysis, where the recorded interviews were transcribed and coded into various themes to identify the critical success factors of cloud-based PM software adoption. NVivo, one of the most used qualitative data analysis software, was used for the above purpose. First, transcripts of the meetings were generated through MS Teams, which was used to conduct the interviews. Later, they were edited accordingly by re-reading to get an in-depth understanding of the data. Data were then coded using NVivo and categorized into themes by grouping similar codes. These themes were refined into four major themes and several sub-themes under them with reference to the literature. Finally, with the themes, a framework for critical success factors affecting cloud-based PM software adoption was proposed as the outcome of this study.

Table 1: Summary of Respondents' Details

Respondent	Job Role	Company Scale	Adopted Cloud-based PM Software
Large-PM1	Project Manager	Large Scale	Jira
Large-PM2	Project Manager	Large Scale	Jira
Large-BA	Business Analyst	Large Scale	Azure DevOps
Large-SE	Software Engineer	Large Scale	Jira
Large-QA	Quality Assurance Engineer	Large Scale	Azure DevOps
Medium-PM1	Project Manager	Medium Scale	Jira Monday.com
Medium-PM2	Project Manager	Medium Scale	Jira
Medium-BA	Business Analyst	Medium Scale	Jira
Medium-SE	Software Engineer	Medium Scale	Jira
Medium-QA	Quality Assurance Engineer	Medium Scale	Jira
Small-PM/BA	Project Manager/Business Analyst	Small Scale	Asana
Small-SE	Software Engineer	Small Scale	Trello
Small-QA	Quality Assurance Engineer	Small Scale	Trello

4. Results

4.1. Critical Success Factors of Cloud-based PM Software Adoption

It was found that all the respondents were aware of the subject and their companies had already adopted cloud-based PM software. The majority of respondents most popularly used Jira and Azure DevOps was identified as famous for its advanced features. Large-scale companies mostly use it due to the cost of getting those features. Asana, Monday.com, and Trello were mentioned as the other cloud-based PM software used in the industry, mostly among small and medium-scale companies.

Four broader themes were identified as critical success factors of cloud-based PM software adoption through the thematic analysis of interview transcripts:

I. **Technological Factors;**

II. **Organizational Factors;**

III. **Environmental Factors;**

IV. **Vendor-specific Factors.**

I. Technological Factors

This theme includes the factors that are more technology-oriented and considered to be critical for the successful adoption of cloud-based PM software. Sub-themes such as Relative Advantage, Easy to use, Compatibility, and Reliability were identified as technological factors affecting the successful adoption of cloud-based PM software.

I.I. Relative Advantage

Relative advantage refers to the benefits of using cloud-based PM software to manage software development firms over other platforms. All the respondents commented that the major factor affecting the adoption of cloud-based PM platforms is the benefits available specifically when compared to in-house PM software.

> *"There are lots of advantages of using these tools definitely. Otherwise, people weren't using them." (Large-QA)*

> *"Drawbacks are not enough to force anyone away from cloud-based tools because their advantages outweigh the disadvantages." (Medium-PM1)*

Collaboration, real-time updates, accessibility, cost-effectiveness, no storage issues as in in-house software, and scalability were commented on as relative benefits of using these tools by the IT professionals.

Most respondents discussed that this software is easily accessible with little infrastructure and is accessible anywhere, anytime, on any device. They mentioned that as one of the advantages of adopting cloud-based PM software over in-house platforms.

> *"So, I would say the main benefit is it is cloud-based, and it can be accessed by anyone at any given time, providing they have a proper Internet connection and access that is granted. So that enables anyone to work from anywhere." (Medium-PM1)*

> *"There's a really good mobile application for JIRA. Because of that, I have worked on some locations other than using a laptop, I mean like traveling." (Medium-SE)*

> *"When we shift to another laptop and other devices, we can access it by using just the URL." (Small-QA)*

Also, it was evident from the findings that this software does not require dedicated storage capacity as in-house PM software does, as they are available in the cloud and accessible over the Internet.

> *"And even I would say if you're using in-house, storage issues might come. But I think if you have this Jira software, that won't be a problem at all." (Large-PM1)*

> *"Cloud-based PM software doesn't need to have a separate program or software installed into your device and supports easy access to this software via the internet." (Medium-PM1)*

They also mentioned that cloud-based PM tools enable team members to facilitate better collaboration, which is necessary for better project management.

> *"So, the most important thing that these tools provide is, I think, collaboration. Because as a BA, I might be working with requirements, but in the end, ultimately, that is what becomes the product at last, right? So, to take that requirement up to the level of deliverable, there are certain stages that we have to go through, and there are certain people, like team members and different stakeholders, who are engaged. So, these tools really help you know and collaboratively manage the requirements. You can easily manage them and collaboratively work on them with the team, not only your team, but they can be used cross-functionally, which makes things easier." (Large-BA)*

> *"So, when it comes to project management, it's easier when we can collaborate with all the team members on one platform. So, when it comes to the task of project manager, I don't always have to keep track of tasks and*

updates personally. Team members can update when they finish the task; they move the task like the done part. So, it's much more collaborative and easier." (Medium-PM2)

"The first benefit that comes to my mind when it comes to cloud-based PM software is collaboration, of course, because that's the great thing about being a project manager and a BA in my role. Everyone can work together on one platform and are on track about one particular thing." (Small-PM/BA)

Also, as these tools are cloud-based, all those updates are available in real-time, making project management easier.

"A key feature that I see that helped me was that we can see the real-time activities in Jira." (Large-SE)

"You know, when I'm getting a task update in the in-house project management software, I have to update it from my end and send it through e-mail. Then, other team members will update it and send it back to me again. So, it's not like real-time updates are not there, but when it comes to this software, real-time update is there." (Small-PM/BA)

"I update all tasks that I work on so that the project manager can get the update. These updates are real-time and easy to track with frequent updates." (Small-SE)

Cost-effectiveness is another advantage discussed by most respondents when it comes to cloud-based PM software. Since it does not require additional infrastructure and license payments as in in-house PM software, the majority of firms have shifted to this type of software. Also, a small-scale startup can run on a free version without any licensing costs.

"For in-house software, we need servers. Rather than using that, using a cloud-based software is really cost-effective as we don't need to maintain dedicated servers." (Large-SE)

"So, the first thing that comes into our mind is cost efficiency. In mid-size businesses, we are trying to pound with some heavy expenses. So, to reduce our expenses, we must go for tools that we can use to get maximum outcomes with little pay. So, when we compare it with the tools in the market, we thought JIRA would be a better call when it comes to cost efficiency." (Medium-BA)

Cloud-based PM software is easily scalable as it is just a matter of creating another user account and adding it to the relevant projects.

"So basically, in most projects I am working on, the development party is outsourced or outside vendors. So rather than introducing MS Project sort of a thing, it's easier for us to get the user Jira accounts created and get them onboarded to Jira projects, which means it's easy for the configuration and scale." (Large-PM2)

The above findings revealed that relative advantages obtained via adopting cloud-based PM software affect as a factor when deciding to adopt this software.

I.II. Easy to use

Easy to use in this study refers to the degree of complexity of cloud-based PM software when adopting it. It was evident from the findings that these tools are easy for anyone to get used to when they adopt them.

"It is easy to understand because even within my team, the newcomers also easily adopt this type of software." (Large-PM1)

"It's easy to use, and I understand, so like even though we get a newbie, they can get along with the tool as soon since it's so easy." (Medium-QA)

Further, most respondents commented that they find Jira the easiest software to get used to based on their experience. That has become one reason for the popularity of Jira as a cloud-based PM software.

"Jira is very straightforward, very easy, and colorful as well. You know, colors are important when it comes to projects. If it's a bug, you'd have to show it in red and stuff like that." (Large-QA)

"So personally, for me, rather than adapting to DevOps board, I just felt really easy to adapt to Jira." (Medium-PM2)

Also, it was found through the analysis that this software became easy to use because of its user-friendliness and availability of learning materials.

"I didn't have to go through any tutorials, and it was user-friendly. For example, when you open up a board or dashboard, you can see everything there to navigate. I find this so easy to use, interface-wise. also, it's very well managed, I would say." (Large-SE)

"UI is also pretty much easy, like even if you go through it, you can understand what is here, what is there. So, it's easy to learn." (Medium-QA)

"It was not too hard. By looking at a couple of demos or user guides, I guess it was easy to understand and handle from the next day. So yeah, it's not that something has to worry about." (Large-BA)

"These tools are not very difficult to learn. Simply you can go to YouTube and other platforms, so they do have their own community pages." (Medium-BA)

With what the majority of respondents explained, it was also identified that having some prior knowledge or awareness through their degree programs or online courses makes it easier to practically adapt in the workplace.

"I have heard of these tools before. But yeah, I started working on the tool when I got into the job. But it wasn't that hard because for me, at least, I think I had a foundation-level understanding of what agile is, what project management is, what these tools are, and how things happen." (Large-BA)

"During my time at university, we were introduced to a project management tool called Trello. So, it was easier for me to adapt that knowledge and apply it to Jira when I joined the company. So, I would say it supported me in that aspect of having prior knowledge of a tool like that during my university." (Large-PM2)

Therefore, it can be concluded from the findings that the tool's ease of use will be a critical factor in adopting cloud-based PM software.

I.III. Compatibility

Compatibility can be referred to as the level of compatibility of the cloud-based PM software with the organization's available technical infrastructure. Respondents stated that since this software is offered via the cloud, they require only a device and internet connectivity to access it. Companies do not need any additional hardware and software when adopting these types of software.

"Because this is a cloud application, we don't need any hardware to purchase. We just need a good Internet connection with a continuous power supply because otherwise, we can't run the software. So, I don't see any need for any special technical infrastructure to adopt this software." (Large-PM1)

"Since this software is cloud-based, they are compatible with existing technical infrastructure. So, we don't need to buy any extra hardware or software or anything; you know, having Internet connectivity is enough. So it also affects the adoption, I guess, because we can easily, you know, adopt them with our existing technical infrastructure, and especially when we are a startup, that's an easier thing because we can't go for, like, you know, pay and get any hardware also software. Now we can manage everything easily with the existing technical infrastructure." (Small-PM/BA)

Therefore, it was realized that the compatibility of cloud-based PM software is a critical success factor affecting the adoption of such software.

I.IV. Reliability

To what extent the users rely on the security aspects of cloud-based PM software can be termed reliability. Most respondents stated that they could trust this software as all needed security mechanisms are in place or their organization has taken actions to make it secure. None of the respondents or their work colleagues have encountered any security threat during their work period so far.

> *"I mean, from our side, at least during my time, we haven't come across any incidents as such from the security perspective. I believe that there are procedures in place for them in these tools." (Large-BA)*

> *"So far, we haven't faced any issue like in my experience I haven't faced any issue. So, I feel confident in working with those tools." (Medium-QA)*

> *"So far, I have not heard or personally faced such security there. And when it comes to, like, as I mentioned, even before, there are functionalities, we can just give access to outsiders for their project only, just for their project as well. So, from our side, also the security, I feel like they have secured the platform." (Medium-PM2)*

A few respondents said they are reluctant to trust this software because they use a free version where security aspects are not fully available. All such respondents are from small-scale companies with free versions of cloud-based PM software.

> *"I fear to trust because there is a free version we are using. So there it may be a third party person can access our system." (Small-QA)*

> *"But when we are using a free version, there's a bit of a security issue, but I have never encountered any so far." (Small-PM/BA)*

Therefore, it can be concluded that reliability is another critical success factor in adopting cloud-based PM software.

A summary of the findings relevant to the technological factors is given in Table 2.

Table 2: Summary of Technological Factors

Broader Category	Themes	Sub-themes (if any)
Technological Factors	Relative Advantage	Collaboration Real-time updates Accessibility Cost-effectiveness No storage issues as in in-house software Scalability
	Easy to use	Prior awareness User-friendliness Availability of learning materials
	Compatibility	-
	Reliability	-

II. Organizational Factors

Factors that are within the control of the organization and affect the process of adopting cloud-based PM software are considered under the broad theme of organizational factors. Sub-themes such as Organization size, Technological

readiness, Employee willingness, Top management support, and Change management process were identified as organizational factors affecting the successful adoption of cloud-based PM software.

II.I. Organization Size

Analysis of the interview data elaborated that the organisation's size or scale can be a factor in the successful adoption of cloud-based PM software. As the financial capability and requirements for cloud-based PM software will be determined based on the company scale, it was evident that large and medium-scale companies have successfully adopted paid versions of cloud-based PM software with more functionalities. Comparatively, small-scale companies face financial struggles in adopting better versions of such software during the initial stages, and free versions can also be sufficient for their team sizes.

> *"I think not all organizations from different scales can afford the same software, both from a financial and technological aspect. They might not need it sometimes or from a financial aspect as well, even if they wanted to; they might not be able to adapt in the early stages of the organization. So, I think it's a large investment for the organization." (Large-BA)*

> *"When we started, we had only around ten members, and the free version was enough, but now, when expanding, we need more functionalities. And now, we are going to move to a paid version with extra functionalities and integrations. Previously, we didn't have enough finance, but now we can also manage that." (Small-SE)*

> *"I think the company size affects the adoption, specifically the level of adoption. Because it has become a trend, especially in the IT sector. So, every company has to, you know, adjust to, but the level of adoption, you know, whether we can afford a free version or have a highly paid customization will depend on company size." (Small-PM/BA)*

With the above findings, it can be stated that Organization size is a critical success factor for cloud-based PM software adoption.

II.II. Technological Readiness

The availability of necessary technical infrastructure, technical expertise, and provision of training to employees by the organization can be termed as the technological readiness of an organization to adopt new technologies such as cloud-based PM software. Respondents commented that their companies have successfully adopted cloud-based PM software as they have better infrastructure and technical expertise, and employees have been given sufficient training. From the findings, it was identified that the majority of large-scale and some medium-scale companies have separate support teams for these kinds of software and provide extensive training even during the onboarding of an employee. Small-scale companies do not seem to have such special teams but are managed by the management itself.

> *"I would say that our company had a separate customer support team. So, when we have any issues regarding Jira, we simply need to raise a Jira ticket. So we can get support from the customer support team anytime. Also, we had pretty much knowledgeable people regarding Jira, so they also do training sessions." (Large-PM1)*

> *"There is a mail group called Jira support, so I can contact them via e-mail or mobile and say what issue I'm facing with Jira. That also plays a huge role because, especially if there are downtimes and log-in issues or something like that, it can get very frustrating sometimes. So, it's good to know that kind of support is available in the company." (Large-PM2)*

> *"But let's say if the tools are like whole new to us and none of us are familiar with it, obviously from our organization side, they will provide any support to follow the tutorials and like if there is any cost for that, they will consider covering it or else if we need technical skills for using it, they would like to arrange training programs for us." (Large-SE)*

Therefore, the technology readiness of an organization when adopting cloud-based PM software can be considered a factor affecting its successful adoption.

II.III. Employee Willingness

Acceptance and willingness to use cloud-based PM tools by employees without any force from the company can be defined as employee willingness. The majority of respondents stated that they adopt this software willingly rather than just getting used to it as a part of a system in the workplace as it easy their work.

> *"In this case, if I take our team and myself and like with the way we use Azure, we are using it willingly because, you know, if I imagine my job without it, it would have been like 100 times worse or like difficult for me to manage and everything." (Large-BA)*

> *"Employees are very willingly adopting the software, I would say. Because they find this software easy their work. So, because of that, all the employees willingly adopted these new tools, and they also suggested new plugins that we can freely adapt to these things." (Small-PM/BA)*

With those findings, it can be concluded that employee willingness is a factor affecting the successful adoption of cloud-based PM tools. Once employees adopt it willingly, the company does not need to put effort into managing employee resistance, and the productivity of project management tasks can be improved by better using these tools.

II.IV. Top Management Support

Acceptance and support while using systems such as cloud-based PM software by the senior management of the organization were identified under the sub-theme of Top management support. Through the analysis, it was identified that top management support is a crucial factor in supporting the adoption of any new technology in an organization, as they are the ones who decide and approve such strategic decisions. Also, most respondents stated that their support is necessary not only to introduce this software but also to facilitate relevant support for using this software to get the maximum benefits from them.

> *"Anybody can initiate a decision that we are going to take this software for project management or something. But to gain the benefit of it, I think you have to direct it in the right way. So, in our organization, whenever we get to use something like this, our top management closely follows the process even after it is adopted. They provide continuous service and feedback forms to understand how people have adapted it. So yeah, I think top management has to work along this kind of process in order to get the maximum out of it." (Large-BA)*

> *"Top management support is always necessary for any kind of change, especially if you're moving towards a new tool that is affecting the entire organization. And at our company, top management was heavily involved and heavily supportive of this change since it increases efficiency and reduces redundancies." (Medium-PM1)*

> *"Top management are the ones who actually decide which software to take and manage the whole process. So yes, that support is needed when moving forward with new technologies in the organization." (Small-SE)*

Therefore, with the above findings, it can be concluded that Top management support is another critical factor affecting the successful adoption of cloud-based PM software.

II.V. Change Management Process

The introduction of tools and technologies to an organization is a change for that organization, and having a better change management process to ensure everyone adopts it smoothly and without resistance is essential. From the analysis, it was evident that a better change management process is also necessary for cloud-based PM software as it is a change for that organization. Companies that have managed this change successfully and with a better change management process have gotten the maximum benefit from using such software.

"So, I think one of the major factors would be having a proper change management structure. Because you know, managing change is always an important element of any proper company. If you don't manage change properly, it's bound to cause trouble. So, I think that we had in abundance. So, when this change was announced, I think everyone was fully on board since we had a great change management process." (Medium-PM1)

"One other thing is that we need to have a better change management process along with all these companies, as I feel. You know, introducing these tools to the organization is a change, and that must be managed well. So, everyone will smoothly adopt it." (Small-SE)

Therefore, the change management process can be categorized as another crucial sub-theme under the organizational factors affecting the successful adoption of cloud-based PM software.

A summary of the findings relevant to the organizational factors is given in Table 3.

Table 3: Summary of Organizational Factors

Broader Category	Themes	Sub-themes (if any)
Organizational Factors	Organization size	Financial capability Requirements in the software
	Technological readiness	Technical expertise Training
	Employee Willingness	-
	Top Management Support	-
	Change Management Process	-

III. Environmental Factors

All the external factors that are outside the control of the organization but might impact while adopting cloud-based PM software are termed using the theme of environmental factors. Sub-themes such as competitors' adoption, industry trends, and dedicated internet connectivity were identified as environmental factors affecting the successful adoption of cloud-based PM software.

III.I. Competitor's Adoption

It was evident through findings that the adoption of cloud-based PM software by similar rival organizations in the industry can influence the decision to adopt such software by the organization. Respondents commented that to keep up with the competition, they must adopt this software if their competitors are adopting it. They further elaborated that they perform analysis before adopting this type of software to see what their competitors have adopted and how they have achieved productivity through this software.

"Otherwise, we can't compete with the competitors within the industry, I would say. So, we have to adapt because we clearly see there is a benefit when they are using these in their projects. So, I would say the competitor's adoption also affects the decision-making." (Large-PM1)

"We would consider what other organizations or competitors or whoever is adopting because, of course, they might be changing for a good reason, and you know, if it's an advantage that can be gained by us as well, why not go forward with it." (Medium-PM1)

"Other IT startups are also using this software, and they perform well when they use the software. So, to face the competition, we also need to adopt." (Small-QA)

Therefore, with the above findings, it can be stated that competitor adoption is a factor in the decision to adopt cloud-based PM software.

III.II. Industry Trend

It was evident through the findings that moving most of the work resources and processes into the cloud has become the new norm, specifically in the IT industry. Therefore, most organizations also move to cloud-based PM software when managing software development projects because it is the industry trend. Respondents stated that to survive and gain a competitive advantage, it has become a necessity to adapt according to the industry trends, and they adopt this type of software for that.

> *"Yeah, one thing would be the tendency of organizations across the globe to move to the cloud. I think most companies are trying to get to the cloud as soon as possible; something like that is being gone right now in the industry as a trend. So, I think that could be a contributing factor." (Large-BA)*

> *"Nowadays, almost all companies are moving forward to the cloud, and every service is moving forward to the cloud. So, project management is also moving to cloud-based software. That's the industrial trend nowadays. So, every company has to, you know, adjust to it and adopt such software to survive." (Small-PM/BA)*

Therefore, it can be stated that moving to cloud services could become an industry trend that could be another environmental factor affecting the adoption of cloud-based PM software.

III.III. Dedicated Internet Connectivity

A few respondents commented that having a dedicated internet connection is another factor that determines the successful adoption of cloud-based PM tools, as this software is accessed and used over the Internet. They mentioned it has become a bit challenging with developing countries like Sri Lanka.

> *"One of the negative aspects of the cloud tools is that it is dependent on, you know, certain factors such as the dedicated internet connectivity." (Medium-PM1)*

> *"We must need a good internet connection, and we would be logged in from any laptop to the Jira." (Large-PM1)*

Therefore, it can be concluded that having a dedicated internet connection can affect the successful adoption of cloud-based PM software.

A summary of the findings relevant to the environmental factors is given in Table *4*.

Table 4: Summary of Environmental Factors

Broader Category	Themes	Sub-themes (if any)
Environmental Factors	Competitor's adoption	-
	Industry trend	-
	Dedicated internet connectivity	-

IV. Vendor-specific Factors

Factors that are in the control of the vendor of the cloud-based PM software and are considered when adopting a particular software were grouped under the theme of vendor-specific factors as these factors change from vendor to vendor. Innovative features, maintenance and service support, the popularity of the brand name, and the availability of free trials have emerged through analysis as vendor-specific factors affecting the adoption of cloud-based PM software. Mostly, these factors are considered when users select a particular software vendor of cloud-based PM software to be adopted by them.

IV.I. Innovative Features

How well a cloud-based PM software vendor can introduce new features to the current versions that make it easier and more productive for users is another factor considered when selecting a particular cloud-based PM software. As having innovative features would enhance productivity, respondents stated that they select a particular vendor over the other mostly based on such factors.

> *"I think maybe one thing that the modern organization would like to consider is how much software can be innovative. For example, you know you purchased something but don't stay in the current version forever. However, the way that it can progress could be a consideration. I think at least in this, you know, most of the tools and software that we are using now get along with, like, you know, a little bit of touch of AI, generative AI." (Large-BA)*

> *"I would like to highlight the integrations with the other systems. Those will be key points for management software. I think as a developer, I would love to use those integrations." (Large-SE)*

Also, through the analysis, it was evident that one reason for Jira becoming the popular cloud-based PM software was mainly its innovative features.

> *"Jira has this functionality where there are some instances that can get our clients request and to like access to their project. And also, all the analyzing part we can do with Jira, which is much more helpful because we can adopt Jira dashboard." (Medium-PM2)*

> *"So, for the technical employees such as developers and testers, they prefer Jira with more functionalities which enables them to add in a lot of automated workflows to their tasks." (Medium-PM1)*

> *"Jira comes with its own repository management; it's something just like GitHub, and for documentation, there is Confluence. So, everything comes with these packages. So, I think that's a plus mark when it comes to choosing these PM tools." (Medium-SE)*

Therefore, it can be concluded that the innovativeness of the software is another factor considered when adopting cloud-based PM software and specifically when selecting a particular vendor.

IV.II. Maintenance and Service Support

The provision of routine updates to the software versions and proper mechanisms to handle customer inquiries, such as support teams, can be considered under the sub-theme of maintenance and service support. In cloud-based services, maintenance is provided by the vendor itself, and that has become the major reason why companies are adopting them. Through the analysis, another factor was identified when selecting a vendor for cloud-based PM software, as users expect proper maintenance and service support from them to carry out their work smoothly using these tools.

> *"They provide routine updates, and whenever we face issues, they are willing to jump on calls and support us with any issues we have. So, there are extremely good services, so we continuously use them." (Medium-PM1)*

> *"Yeah, there are zero downtimes we are made aware of such prior, so we can work around and keep that our stream. So pretty satisfied." (Large-PM2)*

Also, it was proven that small-scale companies mostly adopt cloud-based PM software because they do not need to spend money and effort maintaining their software.

> *"We used Trello previously and then introduced company-built in-house PM software. But now we are in the process of moving back to the cloud tool as it is very beneficial. They provide frequent updates and maintenance support, which we don't need to spend our time and effort on like an in-house tool. That's a great thing." (Small-SE)*

Therefore, it can be stated that maintenance and service support is another crucial factor when adopting such software and when deciding to continuously use that software.

IV.III. Popularity of the Brand Name

Respondents mentioned that the popularity of the brand name of cloud-based PM software also affects the decision on which cloud-based PM software to adopt to some extent. They highlighted that particular software is becoming popular because of its features and reliability to many users. Therefore, it is always good to adopt such software with a proper brand name in the industry. As stated by the respondents, companies carry out an analysis of software used by similar competitive firms and decide on the software the majority has adopted.

> *"So, in that aspect, if the particular thing we are introducing is well-known and popular, it means it's doing something positive there. There must be positive reasons for that thing to be popular among peer companies, right? So, I think that plays a huge role in the adoption." (Large-PM2)*

> *"The point I would say is if a particular software or any tool is popular, it is for a reason. If the reason should be that it works and it's reliable." (Medium-PM1)*

> *"When you come to this cloud-based PM software, we are looking into its popularity. When buying something, humans look into how many reviews a certain product has, how many ratings they have, and, you know, how popular they are. So that they have a good reputation implies that it's a great software with great features." (Small-PM/BA)*

Therefore, it can be concluded that the popularity of the brand name of cloud-based PM software also affects another vendor-specific factor in the decision to adopt cloud-based PM software.

IV.IV. Availability of Free Trials

Most of the cloud-based PM software comes with free trials for a certain period or with limits on users and projects. Respondents stated this as another main factor they consider when selecting cloud-based PM software because they can try to see whether the specific software could meet their requirements without any cost. Also, it was realized that it is the major factor affecting small-scale companies adopting cloud-based PM software as they can manage with the free trial until they grow and become financially stabilized and move to customized versions.

> *"Simply you can search for anything and there's a free trial. Free trial is very essential when we are actually considering buying a platform." (Medium-BA)*

> *"I would say having the free version is great because even a startup company can use this free version and manage some tasks until a certain time. They can go to the customised version when they need to upgrade it and have financials. Also, people can try out free trials, and if that platform is great for them, they can, you know, move ahead with the customizations, paid versions, integrations like that." (Small-PM/BA)*

Therefore, it can be stated that the availability of free trials also affects another vendor-specific factor during the cloud-based PM software adoption process. A summary of the findings relevant to the vendor-specific factors is in Table *5*.

Table 5: Summary of Vendor-specific Factors

Broader Category	Themes	Sub-themes (if any)
Vendor-specific Factors	Innovative features	-
	Maintenance and service support	-
	Popularity of the brand name	-
	Availability of free trials	-

4.2. Proposed Framework and Hypotheses from the Findings

After the thematic analysis, the conceptual framework in Fig. 1 can be proposed, along with factors affecting the adoption of cloud-based PM software, to achieve the main objective of this research.

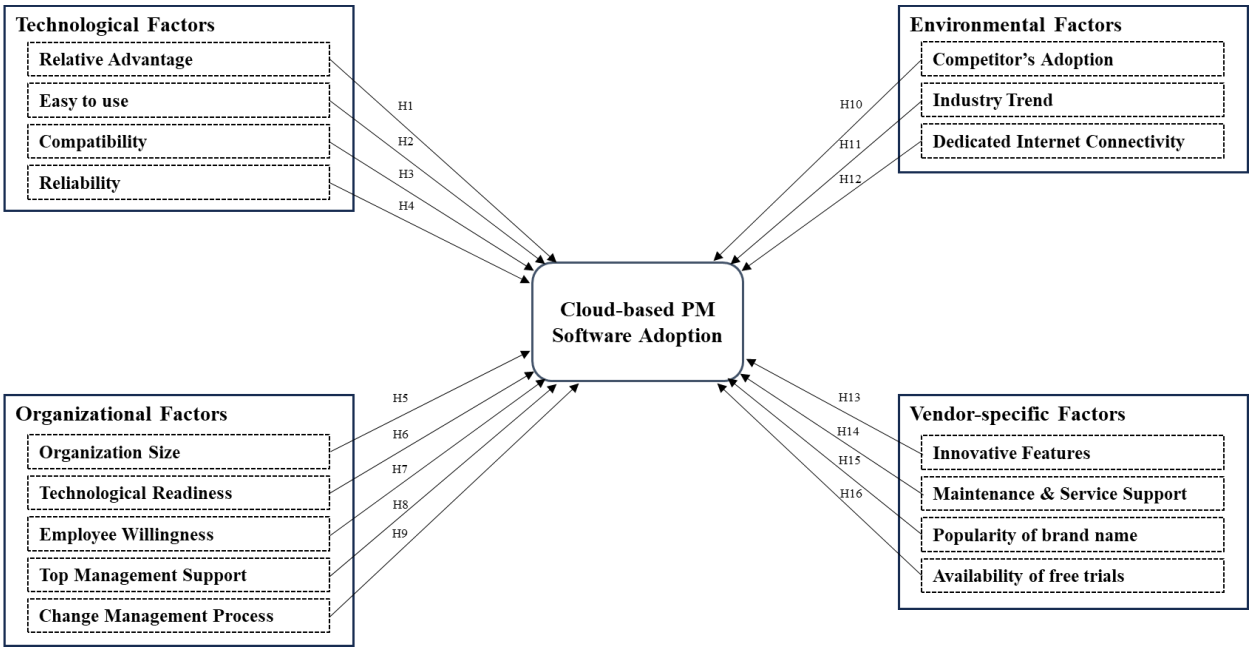

Fig. 1. A Conceptual Framework for Cloud-based PM Software Adoption

H1: Relative advantage positively affects the cloud-based PM software adoption.
H2: Easy to use positively affects the cloud-based PM software adoption.
H3: Compatibility positively affects cloud-based PM software adoption.
H4: Reliability positively affects the cloud-based PM software adoption.
H5: Organization size positively affects the cloud-based PM software adoption.
H6: Technological readiness of the organization positively affects the cloud-based PM software adoption.
H7: Employee willingness positively affects the cloud-based PM software adoption.
H8: Top management support positively affects the cloud-based PM software adoption.
H9: The change management process positively affects the cloud-based PM software adoption.
H10: Competitor's adoption positively affects the cloud-based PM software adoption.
H11: Industry trend positively affects the cloud-based PM software adoption.
H12: Dedicated internet connectivity positively affects cloud-based PM software adoption.
H13: Innovative features in the software positively affect the cloud-based PM software adoption.
H14: Maintenance and service support from the vendor positively affect the cloud-based PM software adoption.
H15: The popularity of the vendor's brand name positively affects cloud-based PM software adoption.
H16: Availability of free trials positively affects the cloud-based PM software adoption.

5. Discussion

Once compared the findings of this study with the findings of similar previous research it was evident that most of the factors identified are more in line with the factors of the Technology-Organization-Environment (TOE) framework (Ahmad & Waheed, 2015; Das & Dayal, 2016; Livera, 2017; Nedev et al., 2014; Oke et al., 2021; Sulaiman & Magaireah, 2014; Wamuyu, 2017). Technological factors such as Relative advantage, Easy to use, Compatibility, and Reliability were also proven to be factors that significantly affect the adoption of other similar cloud technologies as well (Ahmad & Waheed, 2015; Das & Dayal, 2016; Livera, 2017; Sulaiman & Magaireah, 2014; Wamuyu, 2017). Relative advantages such as collaboration, real-time updates, accessibility, cost-effectiveness, no need for dedicated storage, and scalability are also in line with the benefits identified in most similar literature (Ahmad & Waheed, 2015; Das & Dayal, 2016; Nedev et al., 2014). Through this study, it was identified that this software becomes easy to use with user-friendly interfaces, availability of necessary learning resources, and prior awareness of users with similar tools. This can be added as a novel finding to the literature. Also, Organizational factors such as Organization size, Technological readiness of the organization, Top management support, and Environmental factors such as Competitor's adoption were consistent with the findings of previous similar literature (Ahmad & Waheed, 2015; Al Hadwer et al., 2021; Das & Dayal, 2016; Livera, 2017; Nedev et al., 2014; Oke et al., 2021; Sulaiman & Magaireah, 2014). The findings of this study were consistent with the systematic review findings of Al Hadwer et al. (2021), where a majority of factors in the TOE framework were also proven to be significant in this context.

Having a better change management process and employee willingness emerged as novel findings under the broad theme of organizational factors as they are under the control of the organization and influence the successful adoption of such new technology. As novel, the environmental factors, industry trends, and dedicated internet connectivity, which can be more specific to the context of Sri Lanka, which is a developing country but famous for software development, were identified once compared with similar literature (Ahmad & Waheed, 2015; Das & Dayal, 2016; Oke et al., 2021; Sulaiman & Magaireah, 2014). Some studies have considered similar concepts to industry trends in terms of the nature of the industry (Oke et al., 2021).

Another novel theme, vendor-specific factors, was identified through this study, including innovative software features, maintenance and service support from the vendor, popularity of the vendor's brand name, and availability of free trials as sub-themes. Although trialability has been identified as a technological factor in a few similar studies (Das & Dayal, 2016), it was restructured as a vendor-specific factor under the current study as it depends on the vendor of the specific cloud-based PM software. Considering the previous literature and the significance highlighted by the respondents that they highly consider vendor-specific features, a separate category called vendor-specific factors was proposed in this study.

Therefore, this research proposed a novel framework for critical success factors of cloud-based PM software adoption, filling the gap in the literature where an exploratory study was needed to identify factors without just limiting to existing technology adoption theories. In the construction of the above framework, some factors emerged that were similar to existing findings. However, some novel factors that can be validated in new contexts have also emerged.

6. Conclusion

This research was carried out with the main objective of identifying the critical success factors of cloud-based PM software adoption to develop a proposed framework by fulfilling the gap in the literature. Therefore, this study was undertaken using the qualitative approach in the context of the Sri Lankan software development industry. Thirteen (13) interviews were held with a sample of IT professionals in the industry, and results were then subjected to thematic analysis. Findings can be categorized into four major themes: technological, organizational, environmental, and vendor-specific factors, which should be considered when adopting cloud-based PM software. Technological factors included relative advantage, Ease of use, compatibility, and reliability. Factors such as Organization size, Technological readiness of the organization, Employee

willingness, Top management support, and Change management process were identified under the major theme of Organizational factors, while Competitors' adoption, Industry trends, and Dedicated internet connectivity were identified under Environmental factors. Another theme called vendor-specific factors, including innovative features in the software, maintenance and service support from the vendor, popularity of the vendor's brand name, and availability of free trials has emerged.

This research has proposed a new technology adoption framework with a wide range of factors covering aspects such as technology, organization, environment, and vendor services. Previous research has highlighted the limitations when using existing theories to test in areas where little literature is available and this proposed framework can be adopted for such studies to overcome that limitation (Assalaarachchi et al., 2022; Bajwa & Deichmann, 2018; Irshad, 2021; Livera, 2017). The framework developed as the main outcome of this study can be adopted to identify factors that affect not just adopting cloud-based PM software but also any cloud-based service.

As a practical implication, this study supports software development firms by providing a framework of critical success factors affecting the adoption of cloud-based PM software that can be used to promote the adoption of such software within companies. Also, this framework can be adopted by other similar industries engaging in project management without limiting it to the software development industry. Therefore, they can increase the adoption of such software to manage the project successfully.

This research uses a qualitative approach to propose a conceptual framework of critical success factors of cloud-based PM software adoption. Therefore, a further study should be carried out using a quantitative approach to validate the above framework. Since a qualitative study was carried out, interviews were held only with a few samples limited to the software development industry in Sri Lanka, and future studies should be carried out with a wider sample representing different contexts.

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