

From Awareness to Full Adoption: A DOI Framework for Business Intelligence Adoption

ABSTRACT

The positive outcome achieved by experiencing the use of digital supports in response to an increasingly competitive market has led to an ever higher propension to use Business Intelligence (BI) for enterprises in all sectors of business when making decisions. Scholars and practitioners have investigated the impacts and fields of application related to its use so far, concluding that in most cases this technology can positively affect strategic decisions and firms' operational capability. By critically analysing such a pivotal topic among business practices, this study aims to systematically review the existing literature on BI from a diffusion of innovation (DOI) theory perspective. A structured framework considering the timeframe 2018-2023 has been proposed to explore three dimensions of BI (i.e., process, technology and software) along with the stage of firms' innovation diffusion (i.e., awareness, experimentation and transition) as identified in a recent update of DOI theory. By analysing a final sample of 158 papers, this article endeavours to offer a comprehensive examination of how organizations are approaching BI as a game-changer. Moreover, a flourishing generation of scientific articles on such a technological solution reports an ascending cross-fertilization between Business Intelligence Systems (BISs) and digital technologies (e.g., artificial intelligence, big data analytics and blockchain). A comprehensive overview of this progressive evolution has been provided, together with its related implications for academicians and practitioners in several fields of economy.

Keywords Business Intelligence, Digital technologies, Digital transition, Diffusion of innovation (DOI) theory, Big Data and Analytics.

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1. Introduction

Business Intelligence (BI) is a multilateral concept with several definitions, all of which confirm its role as a strategic milestone for corporate governance (Gastaldi et al., 2018; Ratia et al., 2018). Starting from the introduction of such a term in the banking environment by Richard Miller Devens (Devens, 1868), several authors attempted to propose a more and more comprehensive definition of BI over the years. Among them, Negash (2004) argued that BI encompasses a coordinated integration of data collection, data storage, and knowledge management with analytical tools. Such a process provides both internal and competitive information, ideally at the right time, location, and format, thereby enhancing the timeliness and quality of decision-making inputs and supporting managerial tasks. As a result, it seems to be fairly clear the reason why Business Intelligence Systems (BISs) have gained the attention of organisations all over the world (Choi et al., 2018; Niño et al., 2020), thus implying that in recent years heterogenous public and private sectors are approaching a larger and larger number of information with a renewed critical insight (Božič & Dimovski, 2019b; Di Vaio et al., 2022; Gupta et al., 2023). The rise of BI has completely disrupted corporate practices, making it necessary for corporate executives, business managers and other operational workers to rely on BI for enhanced and informed decision-making (Sia et al., 2004; Rahman et al., 2021), to boost coordination within the supply chain (Jayakrishnan et al., 2022), to boost inventory planning and management (Naeini et al., 2019), to monitor competitors' innovativeness (Kronemeyer et al., 2020), increase revenue (Kiani Mavi & Standing, 2018), and even to enhance resilience and adaptability during recent crises, such as the COVID-19 pandemic (Chaubey & Sahoo, 2021).

By analysing the variety of BI features through the pattern of the updated Diffusion of innovation (DOI) theory as per recent findings from the literature (Puklavec et al., 2014), what stands out most

is the predominance of a transition phase among enterprises aiming to tie BI with an increased corporate performance (Mangwayana & Budree, 2022). Case reports have also revealed an ever-changing scenario that includes a widespread interest not only from large multinational companies (Moreno et al., 2020), but also start-ups (Caseiro & Coelho, 2018; Peng & Wan, 2022) and small, medium and micro-organisations (SMMEs) (Gomwe et al., 2022).

Despite the publication of several literature reviews intended to systematise existing findings on BI, to the best of our knowledge, none of them has pointed out the BI diffusion from a DOI theory perspective in the light of its ongoing evolution through the digital transition, while concurrently considering its dimensions of a process, a technology and a software. For such a reason, this paper has conducted a systematic review of the body of literature on the topic of BI and it is complementary to, but does not substitute, the previous review by Ain et al. (2019), which took into account three key aspects of BI: adoption, use and success of BISs over the years from 2000 to 2019, without considering their growing crossing with digital technologies and machine learning (ML) techniques, e.g. data mining. More precisely, in order to overcome such a gap, we opted for circumscribing the scope of our study to the articles published between 2018, when the post-adoption stage of Industry 4.0 was taking shape (Himang et al., 2020), and 2023, when based on our analysis, a clear understanding of the changes in business models could be provided (Marcon et al., 2022). Indeed, the adoption of relevant industrial plans by governments worldwide started from 2011 in Germany to 2017 in Italy (Castagnoli et al., 2022), thus demonstrating that the phase of transformation of enterprises towards Industry 4.0 was coming to its end (Kagermann et al., 2013), while the phase of transition was about to emerge. Consequently, to provide a clear and complete road map of BI diffusion among enterprises is the challenge and the main aim of this paper. Thus, by examining a broad variety of contributions, we outlined our point of view on two main issues:

RQ1. How can BI be systematized into a comprehensive framework taking into account both the phases of its progressive implementation and its phases of diffusion within an enterprise?

RQ2. How does the choice to adopt BI whether it be the process, the technology or the software, influence firms' operational capability and decision making in practise?

As a result, in this paper we aim to provide an in-depth analysis of the developments characterising BI from a DOI theory standpoint. From such a point of view, we investigate the academic literature providing remarkable insights for a comprehensive overview of BI implications on corporate performance.

To shape our study, we take into account three main dimensions that we considered the most representative ones, which are:

- 1) BI as a business process
- 2) BI as a technology, and
- 3) BI as a software.

In reviewing and categorizing the existing literature, we cross-reference each of these aspects with the three phases of diffusion derived from a recent reinterpretation of DOI theory. Specifically, these phases are:

- 1) Awareness
- 2) Experimentation, and
- 3) Transition.

To achieve this aim, we propose a structured, two-dimensional framework to explore how the adoption, use and complete integration of BI can be intertwined with its main applications. In addition, we attempt to emphasize a new trend in the merging of BI with digital technologies, namely cloud BI (Hamidinava et al, 2022), blockchain (O'Leary, 2018), virtual reality (Sahu et al., 2019), big data analytics (Sheng et al., 2019), and machine learning (Srinivasan et al., 2021). As an outcome, our research paper allows to focus on pivotal features of BI that have been widely

explored in literature and provides a benchmark for further conceptual efforts in order to identify still unexplored key points.

The subsequent sections of the paper are organized as follows. In section 2, we elucidate the theoretical background and delineate the conceptual framework proposed to comprehensively grasp the progressive diffusion of BI, while concurrently addressing both DOI theory and the three dimensions of BI. Section 3 clarifies the methodology employed for the collection and selection of relevant papers for review, while section 4 presents an overview of the findings. Section 5 identifies potential routes for future investigation. Finally, section 6 addresses implications and limitations of our conceptual effort.

2. Theoretical background and conceptual framework

2.1 Business Intelligence overview

When referring to Business Intelligence, a full understanding of its functions cannot prescind from embracing all processes and systems including several technological components (Alsaad et al., 2022). The so called BISs are characterized by functions related to data management including data warehouses (DWs), data marts, online analytical processing (OLAP) and analytical tools such as ad hoc analytics, in-memory analytics, reporting, planning, alerts, forecasts, scorecards, dashboards, data mining, but also decision support systems (DSSs), executive information systems (EISs), and extract, transform, load (ETL) tools (Shaqrah, 2018; Sousa & Dias, 2020). Caseiro & Coelho (2019) suggest that BI can be defined both as a process and a product: the process involves techniques employed by organizations to achieve valuable information, or intelligence, while the product consists of information allowing the prediction of the behaviour of competitors, suppliers, customers, technologies, markets, products and services, and the overall business environment with a certain degree of accuracy. The multi-faceted ways of adopting BI within the scenario of such a progressive digital transformation affecting enterprises, led some scholars to regard BI as a novel

culture of working with information or a specific philosophy and methodology for managing information and knowledge (Liautaud & Hammond, 2002). Furthermore, BISs enable data transformation into meta-knowledge which can generate analytical insights for identifying bottlenecks, simulating scenarios, measuring performance, and monitoring progress through BI technologies (Mathrani, 2021).

2.1.1 BI dimensions: process, technology and software

Talaoui et al. (2020) claim that the construct with the greatest number of descriptive and prescriptive studies is BI as a process. Indeed, being organizations centred on the flow of activities; they can be viewed as a series of functional processes. As a result, businesses have increasingly called for a more structured corporate intelligence approach to systematically and consistently identify opportunities and threats within their business environment (Calof & Wright, 2008). Bucher et al. (2009) introduced the term "process-centric business intelligence" to describe BI's capability to transform business-relevant data into analytical insights, with the aim of generating new knowledge for relevant process changes and supporting operational decision-making during process execution (Suša Vugec et al., 2020). On the other hand, the introduction of BISs in complex business environments has fostered the awareness of the benefits deriving from the use of BI as a technology (Ouriniche et al., 2022), thus showing that BISs can support operational processes by providing analytical information as an input for process execution. The novelty introduced by BISs lies in their capacity to deliver information swiftly, easily, and effectively, while enabling users to comprehend the rationale and meaning behind the data (Chen et al., 2012). As a consequence, BISs and user interface meet the need to bridge the gap between the business user and the access to information. Lastly, business applications, data management and interpretation processes find integration into BI tools (Ishaya & Folarin, 2012). From Sabanovic & Søylen (2012) perspective, BI software are used as effective reporting and analysing tools to better understand a company's

organizational surroundings and environment. Moreover, Gartner characterises a BI platform as a software platform offering functionalities such as BI infrastructure, metadata management, development tools, collaboration, reporting, dashboards, ad-hoc queries, integration with Microsoft Office, searching tools, Mobile BI, OLAP, interactive visualization, predictive modelling, data mining and scorecards (Hagerty et al., 2012).

2.2 DOI theory

According to the literature review conducted by Jeyaraj et al. (2006), the Diffusion of Innovation (DOI) theory proposed by Rogers (1995) has been the most often cited work dealing with innovation adoption (Boonsiritomachai et al., 2016). More precisely, the DOI theory suggests that the diffusion of technologies can be influenced by their intrinsic characteristics, including advantages, complexity, trialability, observability of the end results deriving from implementation, and compatibility. Moreover, the decision-making process for technology adoption within an organization progresses through five different stages: knowledge, persuasion, decision, implementation and confirmation (Rogers, 1995).

DOI theory acts as a useful template for understanding the BI diffusion, as the decision to implement BI and BISs in an organization may vary based on several features across time and depending on the context-specific field of economy within which the firm is active. Although Rogers highlighted a five-stages diffusion process, most studies have often proposed a specific focalization reduced to only three of them – evaluation, adoption and routinization (Zhu et al., 2006). Hence, such a theory has been revisited by most studies on innovation diffusion that proposed evaluation (persuasion stage), adoption (decision stage), and use (implementation stage) (Chong & Chan, 2012). According to our interpretation, the evaluation stage occurs when organizations guided by the intention to adopt BI are considering the factors which may contribute to a successful implementation. We opted for referring to an “awareness stage”, since the firm is

becoming more and more aware of the benefits related to the introduction of BI. The next stage is the actual adoption of BI, that takes place when an organization is heading towards a BI adoption phase by allocating the necessary resources. We suggest considering it as an “experimentation” stage. The last phase we decided to refer to is the “transition” one, during which the use of BI is fully integrated across the organization, and most likely with its supply chain partners (Aunyawong et al., 2020), hence it represents the routinization stage. Despite being able to provide recommendations for BI diffusion concerns and solutions, such a multi-staged diffusion approach is not sufficiently covered by almost the totality of BI studies published so far, being the majority of them exclusively focused on a single diffusion stage. Nonetheless, DOI theory has encountered criticism for its heavy reliance on the technology aspect of the adoption process (Fichman, 2000). Actually, organisations' adoption of IT innovation is still influenced by other social, organisational, and individual factors, even when technological superiority is guaranteed (Segal, 1994). A successful BI implementation is related to the suitable integration of many tasks and components which have already been deeply investigated by scholars and enterprises (Adjie Eryadi & Nizar Hidayanto, 2020). Indeed, Moss & Atre (2003) reported that 60% of BI projects failed owing to inadequate planning, poor project management, unmet business needs, undefined tasks, inadequate data, and failure to understand the significance of some parameters such as metadata. In general, many BI applications programs didn't succeed due to infrastructural, cultural, organisational, and technical issues, including the lack of commitment from business supporters, the lack of access of business representatives, the insufficiently skilled and trained personnel, the lack of business activities analyses, the misinterpretation of the impact of acquired information on business profitability, and the non-utilization of information by users and staff (Rezaie et al., 2018).

Numerous articles have been published on the factors that influence the success of BI, including the critical factors that influence the user's intention to implement BI in the decision-making process (Villamarín-García, 2020), the key success factors to take into account before the

implementation of BI with a limited budget (Ramirez-Angulo & Guevara, 2020), the factors influencing the use of self-service business intelligence (SSBI) applications (Passlick et al., 2020), and so on.

2.3 Heading towards a double-track conceptual framework

By way of analysing the existing literature from a novel conceptual framework, our study advocates a meaningful bond between the corporate decision to adopt a certain type of BI and its stage of diffusion. More in detail, the choice to embed technology in the way of working is suitable to be analysed from a DOI theory perspective (i.e., awareness, experimentation and transition phases) and can have the features of a business process, a technology or else a software. As a result, we modelled a double-track matrix (figure 1) to concurrently take into account both the DOI theory and BI dimensions.

Insert Figure 1 about here

3. Methodology

3.1 Sampling

The theoretical framework proposed in figure 1 was investigated by adopting the systematic literature review methodology proposed by Tranfield et al. (2003). This methodology advocates for the establishment of explicit criteria in the review protocol to be met all at once when selecting the publications to be reviewed. It also outlines the phases that must be followed when planning the review to implement a replicable, scientific and transparent process.

First and foremost, an initial set of keywords and search terms was formulated in accordance with the scope of the literature review. The keywords were identified through an extensive analysis of key documents defining BI features, indeed we opted for delimiting our search to papers including

“business intelligence” into their title, abstract or keywords during the period from 2018 to 2023. To take an article into account when systematically reviewing literature, one of the combinations of keywords in the title, abstract or keywords is required to be included (Ardito et al., 2022). The search concluded on April 21, 2024, and was conducted using the reputable online Scopus database, which is one of the largest abstract and citation databases of its kind, according to Bolden (2011). We started from exploring the contribution published in the literature between 2000-2023 to gain insight into the specific features of BI, but we ultimately set our sample to the period 2018-23, when an increasing adoption of digital technologies in conjunction with BI has emerged. The published journals were required to encompass at least one of the following principal fields: business, management and accounting, decision sciences, engineering, economics, econometrics, or finance. In such a way, the range of articles producing instrumental insights for managers has been extended to other fields. By way of example, some notable journals mainly focused on environment and sustainability (e.g. Journal of Cleaner Production) as well as health and sport (e.g. Sport Mont) were not excluded. The review was limited to peer-reviewed journal articles, whereas book chapters and conference proceedings were not taken into account, apart from studies deriving from a snowball sampling. An initial sample of 440 articles was obtained by following to these selection criteria. Subsequently, to restrict the review to high-quality journals, we considered only those with an impact factor. This selection resulted in a list of 293 papers, the titles and abstracts of which were examined to remove those deemed irrelevant to our study. A final set of 196 articles was collected and fully read. Among them, a total of 158 articles were deemed specifically relevant for the period 2018-2023. The content analysis for sample selection was directed by specific inclusion and exclusion criteria, including cover period, language, document type, research area, and categories, to ensure that the analysis focused solely on papers pertinent to the topic under investigation, as is standard practice in systematic literature reviews. Moreover, the decision to include exclusively English-language is a result of its widespread use as an international language

for research. More in detail, first, by considering the focus of their abstracts, the articles to be selected had to underline the interconnection between BI and organizational performance. Second, by considering the focus of the article, they had to provide instrumental insights in the domain of management. Third, any article considering conventional information on digital systems and decision-making (e.g. conventional enterprise resource planning systems) and not providing a comprehensive perspective on the selected inclusion criteria according to authors' opinion, was excluded. For instance, articles focusing on text mining, semantic network analysis, and visual analytics, although they provide valuable insights, were not included in the sample, since they do not directly address the comprehensive scope of BI explored in our study. On the opposite, any article analysing technical aspects and/or new algorithms related to BI hands-on applications was deemed relevant for including into the set. The articles' content was thoroughly analysed using full-text reading and those that did not focus on the research topic were discarded. Finally, in order to identify potentially pertinent studies, an additional inclusion criterion, known as the "snowball" technique, was implemented (Greenhalgh & Peacock, 2005). Notably, snowballing is the method of identifying pertinent publications by examining a paper's reference or citation list (Abbate et al., 2023). As a result, we added 19 more papers into the text corpus. The entire selection process was collaborative, and discussions were encouraged when articles were deemed not entirely aligned with all the criteria (Combs et al., 2010). Finally, the collected papers were sorted according to the extent to which their content aligned with the scope of our research. This subsequent selection resulted in a final list of 158 articles.

3.2 Descriptive statistics

As shown in figure 2, the most significant number of articles in the sample (26%) was published in 2023, thus highlighting the current relevance of the topic under investigation. This is followed by 2019, with 17% of the publications, providing a clear preview that the object of our study has

been deeply investigated at the time when an increasing attention to digital technologies, deriving from the transition phase of enterprises towards Industry 4.0, has emerged (Ardito et al., 2022).

Insert Figure 2 about here

This is especially the case for papers focusing on Artificial Intelligence and BI & Big Data analytics, which represent one-third (33%) of the sample, as per figure 3.

Insert Figure 3 about here

The digital shift towards a fully integrated BI into the corporate routine, as it relates to the DOI theory stages, is analysed in Figure 4. More precisely, the data reveals a notable emphasis on the transition stage, with an equivalent number of studies focusing on the experimentation phase. This suggests a robust scholarly interest in understanding the complexities of transitioning from the initial adoption to the full-scale integration of BI solutions. Conversely, a smaller number of articles in the awareness stage suggests that although the initial introduction of BI is crucial, the primary challenges arise during the practical stages of implementation and scaling.

Insert Figure 4 about here

Furthermore, with respect to the specific BI dimensions taken into account, the bars in figure 5 exhibit a greater willingness to adopt BI as a technology, which means that organizations are mostly interested in transforming data into relevant information for decision-making.

Insert Figure 5 about here

Lastly, figure 6 provides an overview of our theoretical framework by comparing BI dimensions together with the stages of BI diffusion. Such an integrated approach allows to gather a first insight as far as each combination is concerned. More in detail, the stage of awareness is mainly explored in conjunction with the technology dimension, whereas little attention has been paid to software dimension. Most likely, being the stage of awareness mainly focused on analysing the factors supporting the choice to adopt BI in general, a particular need related to factors specifically referred to the adoption of a software has not emerged. On the opposite, the most common combination has been reported between the stage of transition and the dimension of BI as a process. Indeed, when the awareness about the use of BI is already widespread, BI becomes itself an established process within enterprises. Regarding the experimentation phase, apart from the technology dimensions which records the highest number in absolute terms, the greatest attention to the software dimension reveals the tendency of enterprises to a more hands-on approach to BI. Lastly, for what concerns the stage of transition, the primary emphasis is on the integration of BI into organizational processes, thus highlighting the crucial importance of integrating data-driven workflows and governance frameworks. Technology also plays a vital role in supporting BI systems, as it ensures that they deliver reliable and up-to-date insights.

Insert Figure 6 about here

4. Findings

Henceforth, we aim to offer an insight into the extant literature on BI with the aim to highlight the ties between such a technological support and its stages of diffusion across the company and whether and how it can actually be supporting for decision-making and performance capability. In the following subsections, we provide an overall perspective on three typical dimensions of BI (i.e.,

business process; technology and software) and three stages of DOI theory (i.e., awareness; experimentation and transition) as per figure 6.

4.1 Awareness

The project of adopting a DW technology alike BI as a whole needs to be carefully evaluated and planned, thus implying that several studies have investigated the variables affecting the users' intention to adopt BI in decision-making process (Rouhani et al., 2018; Grublješič et al., 2019; Jaradat et al., 2022), including self-service business intelligence (SSBI) applications (Passlick et al., 2020; Lennerholt et al., 2023). Similarly, the critical success factors (CSF) related to the implementation of a BIS (Jahantigh et al., 2019; Chaudhry & Dhingra, 2021) and even more specifically, in an Enterprise Resource Planning (ERP) environment, have been deeply analysed (Adjie Eryadi & Nizar Hidayanto, 2020). Furthermore, many authors paid attention to the factors influencing business intelligence-enabled success across companies (Gonzales et al., 2019; Villamarín-García, 2020) as well as the barriers preventing organizations from adopting a BI open source software (Poba-Nzaou et al., 2019).

Most of these studies emphasized the relevance of critical factors affecting the decision to adopt BI through the established technology-organization-environment (TOE) framework, which posits that the adoption of an IT innovation is shaped by three primary dimensions: technology, organization, and environment (Tornatzky & Fleischer, 1990). For example, Rouhani et al. (2018) identified four factors associated with technological attributes, i.e., perceived tangible benefits, perceived intangible benefits, perceived cost, and perceived complexity; three factors related to the organizational context: business size, organizational readiness, and strategy related; and lastly, the impact of industry competition and absorptive capacity from the competitors side as far as environmental attributes are concerned. In such a way, the existing contributions to the topic can

be of assistance for managers and BIS specialists to find out and efficiently manage the most predominant factors among various endogenous and exogenous ones during BI adoption process.

4.1.1 Awareness - Process

BI allows enterprises to access vast amounts of data to examine circumstances, trends and risks, thus explaining why according to Nuseir (2021), it can be considered as the integrating axis of the information in the organization, which allows sound business decisions as well as improved business processes and new opportunities. A body of relevant research examined the relationship between BI considered in its dimension of business process and the phase of its awareness (as a stage preceding its adoption) in modern business environments. Numerous studies have found that the relative advantage perceived is a considerable predictor of the adoption of a variety of innovations across different industries (Rouhani et al., 2018) and considerable progress has been made worldwide in terms of awareness of the benefits deriving from BI as a corporate process. On the contrary, few studies have provided an in-depth analysis of the factors related to BI adoption in developing countries where the use of BI and other related technologies may be resisted. More precisely, Jaradat et al. (2022) specifically highlighted the correlation of certain factors (e.g., relative advantage, information and system quality) potentially influencing the intention of insurance companies in Jordan to adopt BI into their decision-making processes. Among all the CSFs, user acceptance and participation play a vital role (Al-edenat & Alhawamdeh, 2022), which means that without active users, an increase in business value deriving from BI is at risk (Mangwayana & Budree, 2022). Indeed, the propensity to rely on experience and intuition for decision-making, rather than on structured and analytical approaches like BI, remains a common practice among enterprises, especially when operating in developing countries where users are resistant to technology adoption.

4.1.2 Awareness - Technology

The literature on the awareness stage related to BI in its dimension of a technology has focused on assessing the potential benefits of BISs that organizations take into account when aiming to improve the performance in value chain activities, for example by means of cost reduction and market expansion (Puklavec et al., 2018). Indeed, as reported by Adjie Eryadi & Nizar Hidayanto (2020), the success of the BIS could be ensured by understanding and focusing on the factors that are most likely to facilitate the successful implementation of the system (Venter & Goede, 2018). BISs differ from previous information system (IS) innovations by their ability to integrate data and perform analytical functions, which can subsequently provide valuable information for stakeholders' decision-making processes at various organizational levels. This is particularly true if the BIS is not maintained as a standalone IS solution, but rather integrated into an ERP architecture (Alkrajji, 2020) allowing enterprises to automatize processes over a centralized database, sheet, or any type of tool that is routinely used by the organization (Adjie Eryadi & Nizar Hidayanto, 2020). Actually, BI platforms empower enterprises to develop BI applications through three primary capabilities: analytical tools, including OLAP; information dissemination, encompassing reports and dashboards; and platform integration, which involves BI metadata management and a development environment (Gartner IT Glossary, 2023).

Awareness – Software

The most consistent body of literature offered enhanced insight into the determinants of BIS adoption, with a specific focus on CSFs influencing such a choice. Despite this, according to our conceptual framework, in none of the articles collected into our study a specific attention to the phase of awareness of BI as a software was given so far but Poba-Nzaou et al. (2019) explored the barriers preventing organizations from adopting a specific BI tool: Open Source Business Intelligence (OSBI). Indeed, the empirical evidence of the growing popularity of OSBI tools in

firms worldwide is not matched by the limited adoption of these tools by organizations, and the study of their adoption is still in its early stages (Trieu, 2017). Broadly speaking, a company aiming to implement BI tools, either on-premises or via a cloud-based service, has three primary options: proprietary, custom, or open source. Consistent with the TOE framework, the study proposed by Poba-Nzaou et al. (2019) considered 23 barriers to the adoption of OSBI tools, including fear, uncertainty and doubt (FUD) concerning the product characteristics, lack of training programs and reliable information or documentation, cultural and structural obstacles, and inadequate visibility and legitimacy within the market.

4.2 Experimentation

By applying the DOI theory to BI context, we define the experimentation phase as making the decision to adopt BI. Given that the resource allocation necessary for the general deployment of innovation is determined by such a willingness (Cooper & Zmud, 1990), this phase is considered a critical step toward the generalized use of the technology (Puklavec et al., 2018).

In many cases the adoption of BI solutions has been a key step towards counteracting the decline in revenue resulting from the lack of automated tools that could completely and efficiently support the management's decision-making processes. Nuseir (2021), for example, detailed a step-by-step guide for developing BI to enhance management decisions of a UAE-based organization. More precisely, the Pentaho tools suggested to fulfil business needs and chosen key performance indicators (KPIs) were the following ones: Kettle for the ETL process, Mondrian for OLAP analysis, Jpivot to generate reports and the community dashboard framework (CDF) to create dashboards. In another field, which is institutions, Niño et al. (2020) proposed an easy replicable BI governance framework to fulfil the needs of universities by aligning the objectives of the development plan with the institution's analytical vision.

4.2.1 Experimentation - Process

Some scholars have investigated the innovative impact of BI as a process combined with many other corporate processes, including Design Thinking (Chongwatpol, 2020), blockchain transactions (O'Leary, 2018), Customer Relationship Management (CRM) (Hadhoud & Salameh, 2020) and Project Procurement Management (PPM) (Rane et al., 2020). Being it suitable for claim analysis and fraud prevention, for management of fleets, for reducing the information asymmetry when taking make-buy-rent decisions and estimating timelines and costs, and also for customer value management, enterprises from different sectors of economy have deployed BI as a booster for the proactive development of strategies.

By focusing on another point of view, i.e. some limitations that organizations should be aware of, according to O'Leary perspective, the use of open information deriving from blockchain transactions, that may be deemed a considerable opportunity to gather data for BI, can become harbinger of the creation of illusory transactions, since spoofing and wash transactions may produce and disseminate manipulated information (O' Leary, 2018).

4.2.2 Experimentation – Technology

The stage of experimentation concerning BI as a technology has been deeply investigated across the most varied sectors, including Sports Business Intelligence (Nova, 2018), food processing industry (Jayakrishnan et al., 2018; Bouaoula et al., 2019), retail business industry (Sivamathi & Vijayarani, 2020), telecommunications sector (Al-Eisawi, et al., 2020), cryptocurrency market (Yasir et al., 2021), digital workplaces (Schwade, 2021), petrochemical industry (Farzaneh et al., 2018) and so on. Nonetheless, the BI use process is not free of issues, among which individual user acceptance and its effective use are one of the greatest challenges for BISs (Aws et al, 2021), since an ineffective use is likely to result in problems of data gathering, workflow, reporting, role authorization, user's lack of knowledge and system error (Mangwayana & Budree, 2022).

Indeed, a specific attention to human factor and users' business requirements has emerged when considering the correspondence between the adoption of BISs and the achievement of the company's goals (Venter, 2019).

4.2.3 Experimentation - Software

The examination of academic contributions revealed that the research on BI has evolved gradually and a growing attention among scholars and practitioners has emerged over the last decade, evidently in line with the progressive adoption of BISs by enterprises. Among all features of a BIS, the opportunity to obtain an immediate visualization of business metrics, thus allowing quick and informed decisions by exploring the gathered data, is one of the most appreciated (Mehanović & Durmić, 2022). Indeed, a combination of the use of Open Government Data (OGD) to generate BI and topic modelling and visualization tools has been proposed for the identification of market opportunities (Gottfried, 2021).

Several case studies in many sectors have been investigated so far and a number of BI tools has been proposed, including Microsoft Platforms in the field of healthcare (George & Jeyakumar, 2020), OLAP cube and ETL for the Bank intelligence (Mathur et al., 2021; Al-Okaily et al., 2022), dashboards in journalism field (Girsang et al., 2020), Tableau software in the oil and gas and construction industry (Andiani et al., 2020). In journalism, for example, a BI dashboard has been introduced to display data collected from Social Media platforms in form of a report. In such a way, by providing journalists with the content type that is attracting engagement of the public in certain specific hours of the day, viral news management can be facilitated.

4.3 Transition

Although in many cases the meaning of adoption and use may be mistaken, they are two distinct phases of BI diffusion within an enterprise. For such a reason, we opted for using the term

“transition” when referring to the use stage of BI, so that the dividing line between the decision to adopt BI and its actual integration into corporate processes will not be blurred. Over the years, many firms invested huge amounts of resources in BI among several sectors including retail, banking, finance, manufacturing, telecommunications, luxury hotels and services (Masa’Deh et al., 2021). Such an extensive interest stemming from more and more enterprises further confirms an acquired and widespread awareness of BI benefits on corporate and supply chain performance (Jafari et al., 2021), already evident in academic literature (Havel et al., 2022).

4.3.1 Transition - Process

The improved performance deriving from the use of BI has been the most analysed subject as far as studies on the phase of transition to BI are concerned. Numerous authors have contributed to elucidating the influence of BI capabilities on the performance of new service products (NSPs) (Alsaad et al., 2022) and organizations (Zarine & Saqib, 2022), investigating the causal relationship between BI and both decision making speed (Khaddam et al., 2021) and speed of internationalization (Cheng et al., 2020), as well as assessing the level of BI within enterprise systems (Dahooei et al., 2018). As a result, the maturity level of BI positively impacts its overall success (Suša Vugec et al., 2020; Mathrani, 2021), especially for larger organizations achieving a higher degree of BI maturity and effectiveness. By integrating data collection, storage and knowledge management with analytical tools to deliver complex data (Shaqrah, 2018), BI attempts to enhance organizational performance (Paulino, 2022) as far as to acquire customer insights (Qhal & Mohammed, 2022) and to expedite information delivery (Pool et al., 2018).

4.3.2 Transition - Technology

By exploring the impact of BISs on management accounting practices (Youssef & Mahama, 2021) individual performance (Kapo et al., 2021), firms’ operational capability (Yiu et al., 2020) and risks

management (Yiu, et al., 2021), a vast body of literature on post-adoption phase of BISs aims to provide instrumental insights for managers and decision-makers (Abusweilem & Abualoush, 2019). For instance, an accurate analysis regarding the correlation between the availability of information and its influence on the mind of managers for decision-making has been proposed by Ganesan & Gopalsamy (2019) to better design BI and advanced analytics (BI&AA) systems. Similarly, a critical attention to the influence of cognitive bias on decision-making had been highlighted by Ni et al. (2019), whereas Constantiou et al (2019) investigated the role of intuitive judgements compared to BISs' output when making decisions. Indeed, although many organizations have adopted BISs, the high failure rate is a real concern and a number of studies investigated both the causes of their implementation failure (Gastaldi et al., 2018; Divatia et al., 2021) and the factors affecting users' intention to continue using them after their adoption (Hou, 2018).

4.3.3 Transition - Software

The overall scientific production regarding several sectors of economy reveals that the effective use of BI tools has been investigated so far, including its impact on the decision-making process regarding human capital management by using e.g. Talentia Software (Sousa & Dias, 2020), and the relevance of SSBI tools e.g., Power BI, QlikView and Tableau, for university management (Arnaboldi et al., 2021). During the transition phase, software plays a crucial role in enhancing organizational efficiency and fostering innovation, indeed, these tools enable users to autonomously investigate and depict data, greatly improving decision-making processes. A recent study conducted by Dai (2023) on modular architecture in digital platforms, particularly Microsoft Power BI, underscores the potential of BI software to leverage network effects. The modular architecture of Power BI enables the smooth integration of third-party graphics, hence improving the functionality and user value of the solution. Moreover, the continuous development of BI

software has led to a greater and greater trend of integrating between BI and Big Data Analytics over recent years (Pollono & Pupkevičs, 2023). In particular, a better understanding of the correlation between BI&A and the increase of organizational efficiency deriving from the redirection of decision-making towards appropriate areas has been provided (Al-Malahmeh, 2022), as well as some insights into the future-oriented Big Data potential (Ratia et al., 2018).

4.4 Cross-cutting features between dimensions

In the light of the aspects emerged when analysing the papers, an increasing amount of research on BI has enlarged the object of investigation from understanding the activities that can be made more efficient or effective, to identifying the reasons behind make-or-buy choices (reflecting the phase of awareness), to the necessary efforts required to ensure that the BI solution may be accepted and perceived as a normal part of organizational work (phase of experimentation), to the benefits at strategic level deriving from BI implementation (phase of transition) (Vallurupalli & Bose, 2018). Nonetheless, a clear-cut distinction when categorizing few papers based on DOI theory was not easily achieved. Indeed, as further detailed below, some authors did not consider an exclusive focus, but several features related to both the stages of awareness and experimentation, or awareness and transition, thus showing the existence of a cross-cutting nature connecting these different dimensions. For sake of clarity, in order to identify the most appropriate dimension for each paper, priority was given to their prevailing dimension when categorizing them, as per the abovementioned figure 4. To offer just a few examples, for what concerns a joint approach regarding the phases of awareness and experimentation, Rezaie et al. (2018) explored the factors affecting both the development and the effective implementation of BISs, revealing a clear dyadic relationship that significantly impacts the implementation and efficacy of business intelligence. On the other hand, Arefin et al. (2021) triangulated the role of organizational learning culture, BISs and organizational performance. The study identified a mediating role of BISs concerning seven

critical factors of an effective organizational learning culture, including continuous learning opportunities, inspiring collaboration, creating a system for acquiring and sharing learning, connecting the organization to the external environment and delivering strategic leadership across all organizational levels.

5. Analysis and results

This study aims to design a literature map by crossing drivers, barriers, success factors and impacts resulting from a conceptual framework that integrates the BI dimensions and three stages of DOI theory to the previous theories adopted to analyse BI. To achieve such an aim, this review included six constructs, namely, process, technology and software, as far as the former dimension is concerned, and awareness, experimentation and process related to the latter one. The results of such an integration offer a comprehensive understanding on the topic of BI, as well as the most significant drivers, factors and impacts identified in each field.

As reported in figure 7, several barriers have been identified for each phase of BI adoption within enterprises, ranging from the uncertainty about product characteristics and capabilities before adopting BI, to cultural and structural obstacles emerging after its implementation, such as the monopolization of BI initiatives by IS departments, insufficiency of internal resources and lack of dissemination of knowledge concerning BI at educational level. Many other factors, such as project leaders, technological skills and data sources, being them either-or factors, can play a crucial role in BI success or failure. Indeed, as for the research implications, this study highlights that the progressive adoption of BI across a variety of sectors and domains has been widely investigated in literature, thus providing a clear overview of both factors influencing BI experimentation and the potential challenges for its deeper integration within enterprises. A strategic BI vision supported by the top management and combined with the engagement and training of specific and mixed skills teams using BI solutions with a flexible architectural design, can lead to competitive advantage of

information, sustainability practices, operational efficiency and supply chain management. This implies a crucial role of enterprises, particularly for senior managers, in acquiring more and more awareness regarding the need to adopt a context-specific BI solution. Additionally, our results stress that, even though BI adoption is becoming common practise, the failure risk shouldn't be underestimated. Budgeting and financial commitment of firms should be considered as a matter of high priority, since the benefits of using BI, which it can return be two or three times greater, will require a long term vision (Rouhani et al., 2018).

The research findings allow to effectively answer the research questions of the study. In particular, a comprehensive framework taking into account both the phases of BI diffusion and its dimension of use has been identified and developed. Likewise, several impacts deriving from the use of BI have been reported in a literature map crossing drivers, barriers, success factors and impacts, ranging from individual and organizational benefits to improved decision making speed and firm performance.

Insert Figure 7 about here

6. Conclusions and future research directions

In providing a clear overview of BI dimensions and their relevant phases of diffusion among enterprises, this literature review has pointed out that such a pivotal topic has been heavily explored by authors worldwide, ranging from BI considered as a process, a technology and a software to its phases of awareness, experimentation and transition. As for the research implications, this study claims that the adoption of BI is becoming more and more imperative in order to gain a deeper understanding of enterprise processes and needs and to achieve competitive advantage. The exploration of advanced functions related to data management, such as reporting tools, ad hoc analytics, scorecards, dashboard and data mining, provide managers and user with new and enhanced tools for making more sound business decisions and improve the overall performance.

Furthermore, the awareness of the specific drivers of BI adoption as well as the potential barriers to its integration into core business processes can have a pivotal role for a successful implementation. Nevertheless, and although the timeliness of the topic, in the research conducted so far appears to be a trend still at early stages in the matters of sustainability and digital technologies. This means that, even if a progressive broadening of BI characterization has emerged, a gap in literature may open up new and challenging routes.

Sustainability directions

The necessary cultural change in production processes which emerges from sustainable information societies will inevitably lead to more sustainable information systems. BI can be of great support for sustainable development management by allowing a better control of strategic corporate social responsibility (CSR) information due to its ability to process a large volume of data with improved quality (Ouriniche et al., 2022) and analytical capabilities (Chalmeta & Ferrer Estevez, 2023). Nonetheless, from the analysis we carried out, a specific attention to the sustainability of BIS itself has not emerged but only one study more future-oriented proposed how to design and develop a BIS to ensure that it is sustainable, whether sensitive to resource consumption and designed for the future needs of the organisation (Goede, 2021). A better understanding of the development of sustainable BISs when evaluating each phase of the software lifecycle, namely planning, analysis, design, implementation, maintenance and disposal, would certainly be of interest.

Digital transition directions

The body of literature on the topic of BI clearly displays a growing interest towards its positioning and its moderating role within corporate practises (Torres, et al., 2018; Arefin et al., 2021). Several studies have pointed out some almost inevitable close connections with digital technologies

(Bordeleau et al., 2020), namely Artificial Intelligence (Seidlova et al., 2019; Alzeaiden, 2019; Yasir et al., 2021; Symeonidis et al., 2022) and Big Data Analytics (Vallurupalli & Bose, 2018; Dayana et al., 2019; Ilmudeen, 2021). Nonetheless, apart from the combination of BI and the aforementioned specific technologies, a knowledge gap emerges in literature as far as blockchain, AI chatbot, additive manufacturing and robotics adopted in conjunction with BI are concerned. Future studies could be conducted in the proposed direction, especially due to the increasing and appealing presence of enterprises into the new virtual reality of Metaverse. Furthermore, a specific focus on Mobile BI has emerged only in a study conducted by Adeyelure et al. (2018). Finally, according to our findings, this gap allows us to yet identify another gap as a result: a topic of such a huge interest and deeply contemporary, which is the integration of BI and digital technologies to enhance sustainability within enterprises, is still unexplored in literature.

Implications and concluding remarks

This study has critically reviewed the existing literature on BI dimensions based on DOI theory by proposing a two-dimensional structuring framework. From the theoretical perspective, it aims to provide a comprehensive insight into the characterizations of BI (i.e., process, technology and software) while exploring the specific stages of awareness, experimentation and transition tied to BI diffusion among enterprises. Our academic contribution based on such a theoretical framework allows us to identify two main concluding remarks.

First, it contributes to profiling the characterization of BI, thus by pointing out the features of BI as a business process, a technological support and a management tool according to three diffusion phases: awareness of the benefits related to the adoption of BI; experimentation of its adoption and finally transition to its integration within the enterprise processes. As a result, our contribution highlights the scenario currently emerged in literature and the characteristic aspects of BI based on the nature of the industry. Second, our systematization into a literature map crossing drivers,

barriers, success factors and impacts, provides a synthesis of the development of future directions of research as from our proposed framework.

From a managerial perspective, we highlight the specific factors contributing to the success of BI; the exogenous and endogenous variables related to the choice of its adoption; the benefits deriving from the introduction and the wider integration of such a business practise as well as the potential weaknesses and challenges referred to its use. Managers represent a key user of BISs and are considered instrumental in the initial decision to adopt an IS since they necessitate the engagement of other users to utilise BI and supply them with deliverables to support their decision-making tasks. From our findings, it seems to be clear that the adoption of the right BIS is closely tied to the specific context, especially with regard to the final user competences.

This study is not free from limitations that can be a starting point for future studies and contributions. The proposed framework explores several aspects deriving from a number of studies by advocating for a shift in perspective that encourages researchers to adopt a more holistic understanding of BI, but an in-depth analysis has revealed that neither a real awareness nor an even diffusion across different sectors can be argued. Many articles proposed new models to evaluate the maturity of BI across firms, but a step-by-step approach starting from the diagnosis of the actual level of digitalization of an enterprise to the design of a BIS and the subsequent monitoring of its alignment with the objectives and the vision of the firm didn't find a match apart from a few cases. Future studies on this subject could help managers and decision-makers to find a replicable framework to approach BI into their organizations. Finally, further contributions could explore the possible extensions to the current BISs to include the decisions that are not yet optimised by the decision-makers, including the analysis of trade and the ongoing monitoring of their reference market.

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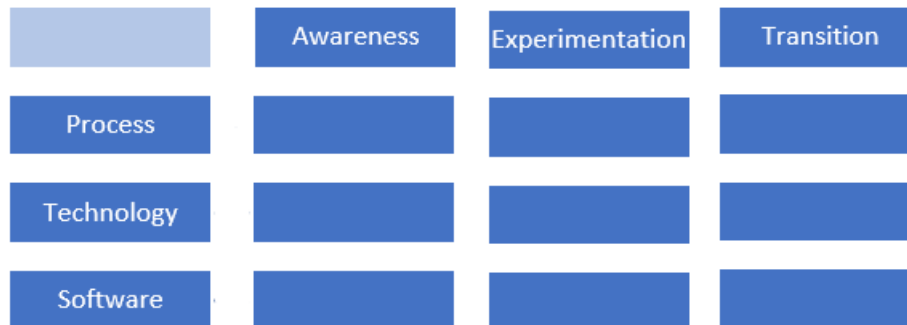
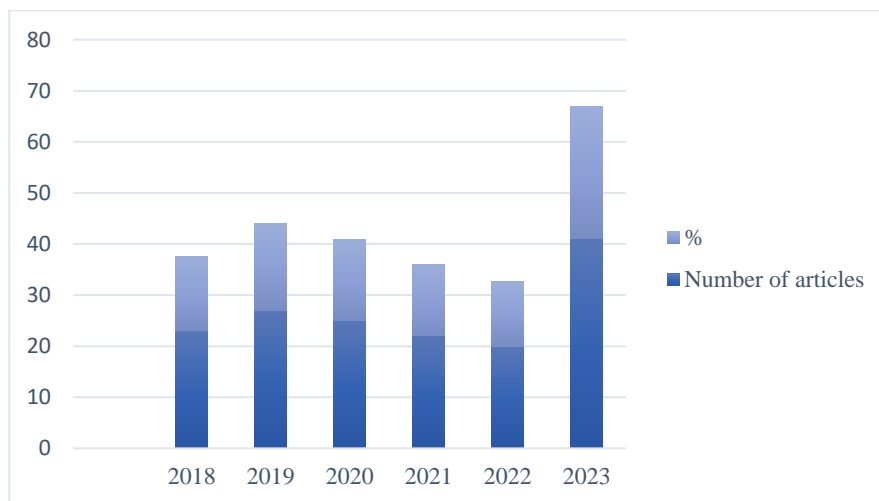
FIGURE 1**Two dimensional framework****FIGURE 2****Number of collected articles**

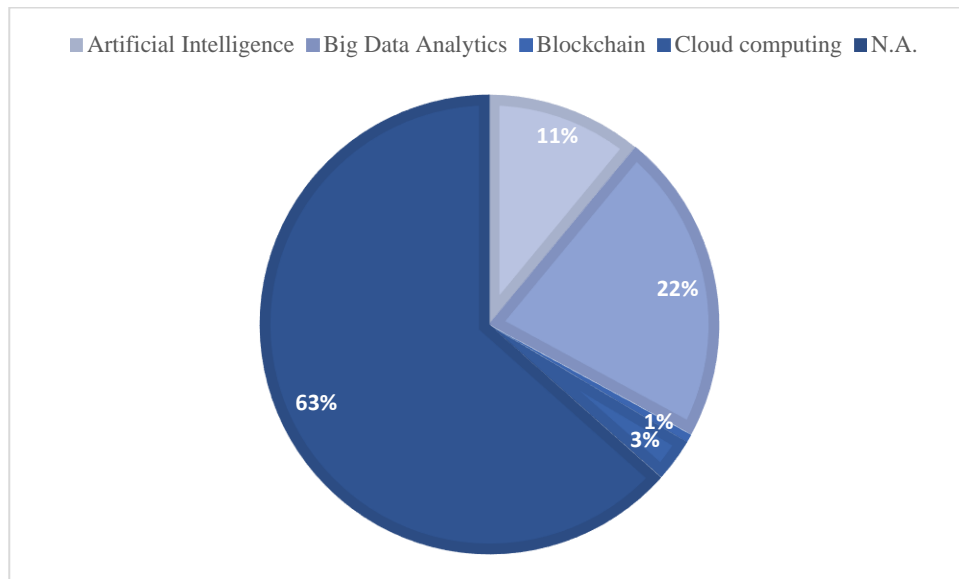
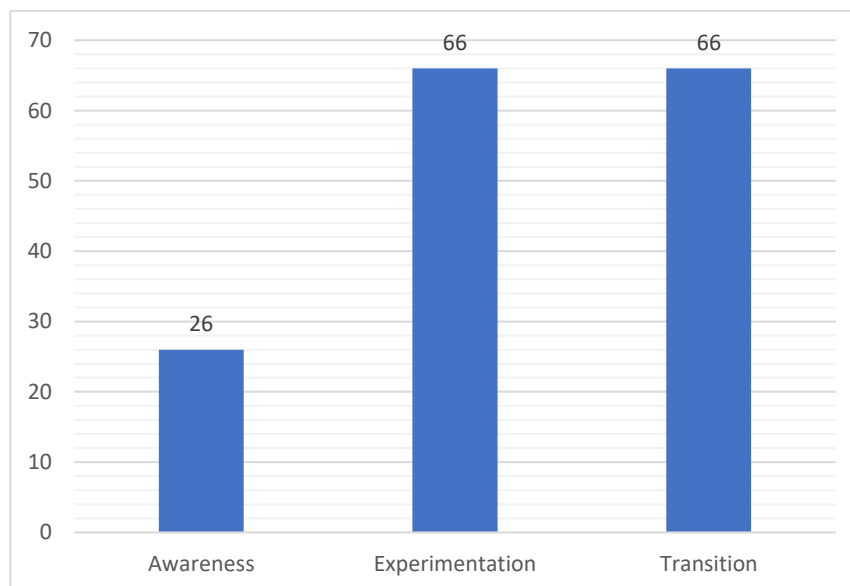
FIGURE 3**Percentage of articles taking into account BI & digital technologies****FIGURE 4****Number of articles per DOI dimension**

FIGURE 5

Number of articles per BI dimension

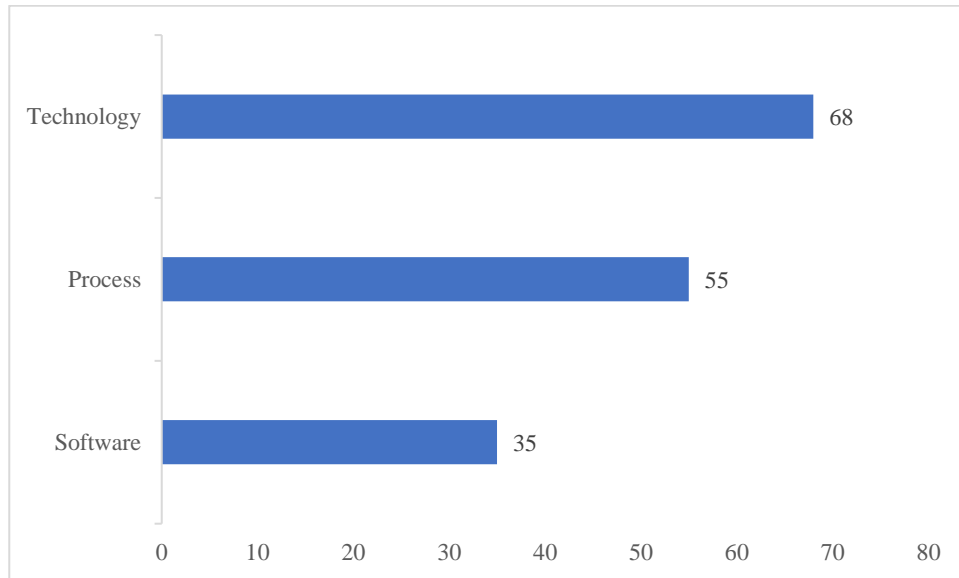


FIGURE 6

BI dimensions distribution per DOI theory stages during the period 2018-2023

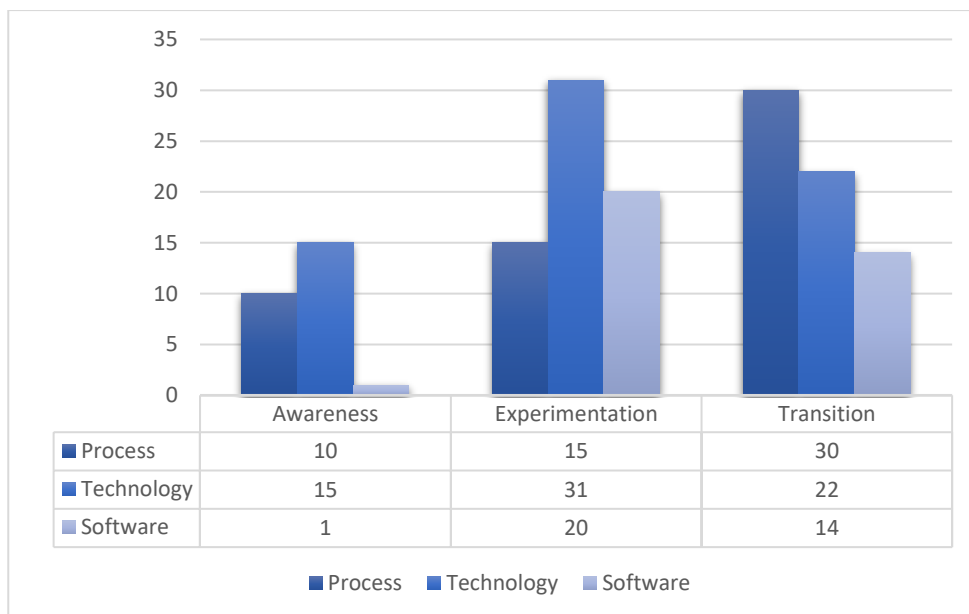


FIGURE 7

Literature map on BI per DOI theory stages by crossing drivers, barriers, success factors and impacts

