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VILNIUS UNIVERSITY

Justina Valentukevičė

Business Intelligence and Organizational Agility: Organizational Agility through the Agility of Business Intelligence Applications and the Moderating Effect of Organizational Culture

DOCTORAL DISSERTATION

Social Sciences,
Management (S 003)

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VILNIAUS UNIVERSITETAS

Justina Valentukevičė

Verslo analitika ir organizacinis judrumas: organizacinis judrumas per verslo analitikos sistemų judrumą ir organizacinės kultūros moderuojantis efektas

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Information Technologies (IT) – the hardware, software, communication and other facilities used to input, store, process, transmit and output data in whatever form (ISACA).

Information Systems (IS) – the combination of strategic, managerial and operational activities involved in gathering, processing, storing, distributing and using information and its related technologies. Information systems are distinct from information technology (IT) in that an information system has an IT component that interacts with the process components (ISACA).

Business Intelligence (BI) – a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions (Watson, 2009). The terms "BI" and "business analytics" are often used interchangeably, as the distinction between them in the literature is minimal (Chen & Siau, 2020). Similarly, the term "big data analytics" refers to analytics technologies capable of processing large amounts of data.

Artificial Intelligence (AI) – an advanced computer system that can simulate human capabilities, such as analysis, based on a predetermined set of rules (ISACA).

Business Intelligence Agility (BI Agility) – the ability to efficiently and quickly react to changes in foreseen or unforeseen requirements based on structural and behavioral characteristics of the BI system as well as anticipating change proactively (Zimmer et al., 2012).

Organizational Agility – the ability of firms to sense environmental change and respond readily (Overby et al., 2006). It is also described as the capacity of an organization to efficiently and effectively redeploy/redirect its resources to value-creating and value protecting (and capturing) higher-yield activities as internal and external circumstances warrant (Teece et al., 2016).

Organizational Culture – a pattern of basic assumptions – invented, discovered, or developed by a given group as it learns to cope with its problems of external adaptation and internal integration – that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems

(Schein, 1985). Or, simply described, as the underlying shared beliefs, values, norms, and priorities that shape the behaviors of an organization's members (Schein, 2017).

Exploratory Factor Analysis (EFA) – one of a family of multivariate statistical methods that attempts to identify the smallest number of hypothetical constructs (also known as factors, dimensions, latent variables, synthetic variables, or internal attributes) that can parsimoniously explain the covariation observed among a set of measured variables (also called observed variables, manifest variables, effect indicators, reflective indicators, or surface attributes) (Watkins, 2018).

Confirmatory Factor Analysis (CFA) – a statistical technique that focuses on modeling the relationship between manifest (i.e., observed) indicators and underlying latent variables (factors). CFA is a special case of structural equation modeling (SEM) in which relationships among latent variables are modeled as covariances/correlations rather than as structural relationships (i.e., regressions) (Gallagher & Brown, 2013).

INTRODUCTION

Relevance and novelty of the research

Amidst increasing market volatility, rapid technological advancements, sustainability challenges, and other ongoing disruptive and evolutionary changes, organizational agility has become a critical strategic objective. To enhance agility, organizations are transforming their operating models and optimizing across strategies, structures, processes, people, and technology (Aghina et al., 2021). In the technological realm, significant investments are being made in advanced informing systems like Business Intelligence (BI) to help organizations become more dynamic and adaptive to a changing world.

As data has gained recognition as the "world's most valuable resource" and the "oil of the digital era" (The Economist, 2017; World Economic Forum, 2019), organizations that successfully harness BI technologies to leverage data, gain a competitive edge and achieve the sought-after agility. This aligns with the common characterization of organizational agility as the ability to sense and respond to changes (Overby et al., 2006), a capability heavily reliant on efficient information processing enabled by BI.

BI, encompassing technologies such as business analytics (BA) and big data analytics (BDA), has become an essential tool for organizations aiming to gain and sustain competitive advantage through data-driven decision-making. BI, which initially served as a tool enabling company employees to gain insights from historical data and understand past events, has evolved into more advanced systems. These tools now not only support human decision-making but also augment it by predicting future outcomes, prescribing actionable recommendations, and, in some cases, automating decision-making processes (Gartner, 2014; White & Rollings, 2021). This area is moving fast due to exponential growth of data and technological advancements, largely facilitated by Artificial Intelligence (AI).

The impact of BI on organizational outcomes, especially organizational agility, remains a significant area of interest among researchers (Chen & Siau, 2012, 2020; Kuilboer et al., 2016; Park et al., 2017; Xie et al., 2022; Barlette & Bailette, 2022; Hyun et al., 2023; Zhang et al., 2024). However, while BI is widely acknowledged as an enabler of organizational agility, its presence alone does not guarantee this outcome. It is essential to identify and address the additional conditions necessary to achieve enhanced agility with BI. This research prioritizes the exploration of two such critical conditions: BI agility and organizational culture.

This study proposes that for BI to enable organizational agility, organizations must ensure that their BI systems are sufficiently agile to

support the timely sensing of and effective response to changes. Organizations increasingly require real-time insights from their data to inform decision-making and strategic priorities. However, in a rapidly changing environment, reports, dashboards, predictive models, and other analytics outputs that were once effective in predicting future trends and guiding actions may quickly become obsolete, losing their ability to detect emerging trends and support decision-making (Bieda, 2020).

Despite empirical studies supporting a positive association between BI investments and organizational agility (Baars & Kemper, 2008; Chen & Siau, 2012; Park et al., 2017; Ashrafi et al., 2019), there is a scarcity of research exploring the impact of a BI function that is itself agile and adaptable to dynamic environments (Zimmer et al., 2012; Knabke & Olbrich, 2013; Baars & Zimmer, 2013; Baars et al., 2014; Krawatzeck & Dinter, 2015; Knabke & Olbrich, 2017). Earlier definitions of BI agility primarily framed it as a technical feature (Zimmer et al., 2012; Knabke & Olbrich, 2013; Baars & Zimmer, 2013; Baars et al., 2014; Krawatzeck & Dinter, 2015; Knabke & Olbrich, 2017). However, as noted by Storey et al. (2024), recent trends in decision support systems (DSS) research are shifting beyond mere technological improvements to better align with the socio-technical systems focus, which has the potential to enhance both human behaviour and technical design to improve decision-making. Consequently, there is an emerging need to incorporate human-centered dimensions alongside technical in conceptualizations of BI agility—an area where existing literature falls short. It is critical to understand how the partnership between humans and technology works in tandem and to identify the human-centered aspects that influence and even drive BI agility.

The ambiguity surrounding the concept of BI agility also reveals lack of studies that examine the construct development to enable a more precise definition and assessment. While Knabke and Olbrich (2017) made valuable strides in quantitatively assessing BI agility by defining its dimensions primarily in terms of "what" pertains to change characteristics within BI, they haven’t covered the equally crucial "how" aspect, which is human-centered and is critical for determining the existence of the factors necessary for achieving and sustaining long-term agility. This study develops a novel, redefined conceptualization of BI agility that integrates both human and technical dimensions, along with a corresponding measurement instrument for assessing BI agility, which serves dual purpose: guiding academic research as well as aiding practitioners in assessing and improving BI agility within their organizations.

This study further highlights the critical role of organizational culture in the context of BI and organizational agility. While the human-centered dimensions specific to BI are essential for achieving BI agility, it is important to recognize that BI does not operate in isolation. Instead, it is influenced by organization-wide human-centered factors often referred to as organizational culture – enduring characteristics rooted in shared beliefs, values, norms, and priorities (Schein, 2017). These cultural traits, while fundamental, are challenging to research, quantify, and change. Despite its complex nature, organizational culture is widely acknowledged in business research as a crucial factor in fostering organizational agility (Crocitto & Youssef, 2003; Felipe et al., 2017). In IS research, organizational culture has also been identified as a key determinant of IT adoption success (Leidner & Kayworth, 2006), a finding that applies equally to BI systems.

Importantly, for this study's focus on BI, scholars have recognized the role of data-driven culture, analytics culture or big data culture in deriving business value from BI (Popovič et al., 2012; Dubey et al., 2019; Wong & Ngai, 2023; Thanabalan et al., 2024; Wamba et al., 2024), emphasizing the need for organizations to nurture specific cultural traits to leverage data and analytics effectively. Additionally, research has confirmed the significant impact of organizational culture on information flow (Westrum, 2004), which is particularly relevant to BI systems that rely heavily on data and information flow. Gartner analysts (James & Duncan, 2024) predict that by 2026, Chief Data and Analytics Officers' (CDAOs) ability to drive cultural change, enhance data and AI literacy, and develop a skilled workforce will rank among the top three factors for supporting business strategy.

Even as data collection, processing, and analysis become increasingly automated and AI capabilities assist or replace some human decision-making tasks (Edwards et al., 2000; Duan et al., 2019), these technologies primarily augment rather than replace human role in leveraging data so human factors, and specifically organizational culture, remain important area of research in BI context.

These insights, along with prior academic studies, highlight the importance of cultural traits in distinguishing organizations that successfully leverage BI and achieve organizational agility from those that do not. Despite this recognition, the literature inadequately addresses how specific company-wide cultural traits can foster an environment that supports both BI agility and organizational agility. This study aims to address this gap by advancing the body of knowledge and providing guidance for practitioners through exploring and empirically testing the role of overall organizational culture in enhancing BI agility's ability to influence organizational agility.

The research presented in this dissertation investigates the intertwined relationships between BI agility, organizational agility, and organizational culture, addressing gaps in the existing literature. In an increasingly volatile and dynamic environment, BI systems play a pivotal role in enabling agility by assisting, augmenting, or automating data-driven decision-making. However, BI systems can become obstacles rather than enablers of organizational agility if they lack the flexibility and adaptability required to effectively sense and respond to change. This study introduces a novel conceptualization of BI agility that incorporates both human-centered and technical dimensions, emphasizing the importance of socio-technical alignment, not adequately addressed in prior literature. Additionally, it highlights the vital role of organizational culture in creating an environment that supports both BI agility and organizational agility. Through the development of a BI agility measurement instrument, the empirical testing of key relationships, and gathering insights from industry experts, this research provides guidance for academia and practitioners, offering a framework for organizations to effectively leverage BI systems and achieve sustained agility in a rapidly evolving world.

The problem statement

Organizations face significant challenges in leveraging BI to enhance organizational agility, primarily due to a lack of understanding of how to effectively develop and apply BI agility and a failure to recognize the pivotal role that organizational culture plays in this process. Compounding this issue is the limited research on BI agility's impact on organizational agility and the critical role of organizational culture in supporting and amplifying this relationship. Without addressing these gaps, organizations struggle to achieve the desired agility through BI.

The object of the research is the BI agility, it’s relationship to organizational agility and the role of organizational culture.

The research questions

This research is guided by five research questions:

1. What is BI agility, and how do human-centered factors along with technical contribute to shaping it?
2. How can BI agility be effectively measured?
3. What influence does BI agility have on organizational agility?
4. How does organizational culture affect the relationship between BI agility and organizational agility?

5. How can organizations strengthen their BI agility and cultivate an appropriate culture to enhance organizational agility?

The aim of the research

The aim of this dissertation is to investigate the multifaceted nature of the BI agility concept and its impact on organizational agility, with a particular focus on the moderating role of organizational culture in this relationship.

Objectives of the research

To achieve the aim of the dissertation, the following objectives are set:

1. Conceptualize BI agility by examining its technical, social, and organizational aspects, synthesizing insights from existing literature and input from practitioners.
2. Operationalize BI agility by developing indicators for a measurement instrument, ensuring its relevance for scholarly research and practical application in organizations.
3. Refine and validate the BI agility measurement instrument using statistical methods, including Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA).
4. Evaluate the relationship between BI agility and organizational agility, and assess the moderating effect of organizational culture on this relationship using Structural Equation Modeling (SEM) analysis technique.
5. Interpret the findings, identify practical implications, and derive actionable insights in collaboration with industry experts to provide practical guidance for organizations aiming to enhance their organizational agility through BI.

Research methodology

Given the complex and interdisciplinary nature of the phenomena under study—situated at the intersection of IS, strategic management, and organizational psychology disciplines—and the limited availability of existing research on the topic, a single-method approach would be insufficient to achieve a deeper understanding and develop novel theoretical perspectives. Therefore, this dissertation adopts a pluralistic approach, combining research methods associated with both interpretivism and positivism – qualitative and quantitative methods.

In IS research, scholars have raised concerns about the lack of mixed-methods studies despite their potential to provide richer insights into IS phenomena, which are socially constructed and not fully deterministic

(Venkatesh et al., 2013, 2016). Mixed-methods research is defined as a methodology that integrates qualitative and quantitative approaches to achieve both breadth and depth of understanding (Johnson et al., 2007). Typically, qualitative methods in IS research are used for exploratory purposes, such as developing deeper insights into phenomena and generating new theoretical perspectives, while quantitative methods are employed for confirmatory studies, including theory testing (Venkatesh et al., 2013). By combining these methods, this study employed a mixed methods approach to address both exploratory and confirmatory questions and additionally gathered qualitative method-backed complementary findings that further enriched the understanding of the phenomena.

The research design is structured into five primary phases, as illustrated in Figure 1:

1. **Phase 1: Literature Review**
   This phase focused on exploring the existing body of knowledge to conceptualize BI agility, organizational agility, and organizational culture. It also supported hypothesis development by synthesizing relevant theories and identifying gaps in the literature.
2. **Phase 2: Interviews**
   Semi-structured interviews with BI practitioners were conducted to gather qualitative insights. This phase aimed to identify factors associated with BI agility and to refine the conceptual framework. The findings from the interviews, combined with the literature review, informed the development of the BI agility measurement instrument.
3. **Phase 3: Survey No. 1**
   This phase involved collecting data through a survey to perform exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The purpose of EFA was to refine the measurement instrument by determining the most effective indicators for each dimension and CFA was then conducted to validate this structure, ensuring that the identified indicators were both reliable and valid in accurately capturing the three dimensions of BI Agility.
4. **Phase 4: Survey No. 2**
   The second survey was conducted to test hypothesis and evaluate the relationships between BI agility, organizational agility, and organizational culture using Structural Equation Modeling (SEM).

5. **Phase 5: Focus Group**
   The final phase involved a focus group discussion with experts to confirm the study's findings and provide additional insights. This qualitative method offered practical implications and recommendations for organizations aiming to enhance their agility through BI.

The sequential integration of these phases ensured both breadth and depth in understanding the phenomena under study. Figure 1 visually represents the interplay between exploration, measurement instrument development, hypothesis testing, and comprehension with additional practical insights. Furthermore, the mixed-methods design facilitated triangulation of findings from the qualitative and quantitative phases, enhancing the validity of the results and providing more comprehensive, informative, and effective answers to the research questions.

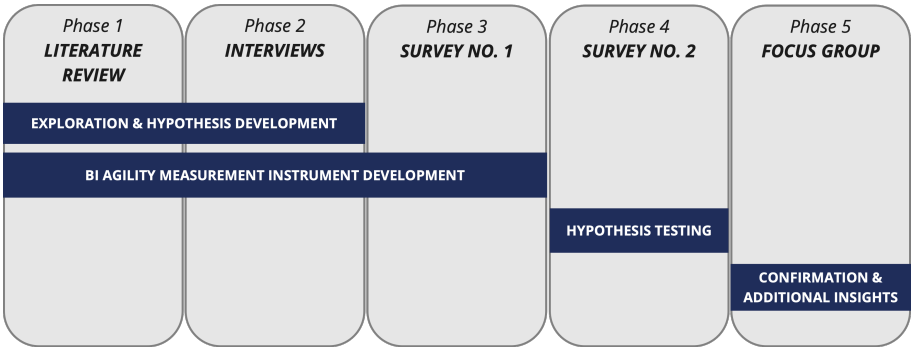

Figure 1. Research phases and methods aligned with research purposes (prepared by the author)

Given that BI agility and its relationship to other organizational traits are central to this research—and recognizing that earlier academic literature has not established a comprehensive measurement scale for BI agility that encompasses both technical and human-centered aspects—this study aimed to develop a valid and reliable measurement instrument for assessing BI agility. The goal is to provide a tool that can be utilized in this research and to encourage further empirical studies in this area. To ensure academic rigor, the study adhered to the scale development process guidelines outlined by MacKenzie et al. (2011).

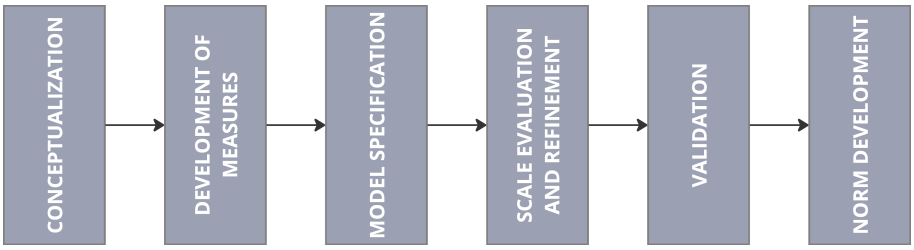

Figure 2. Measurement instrument development process (adapted from MacKenzie et al., 2011)

The initial step in this process was the conceptualization of BI agility, guided by a thorough literature review, particularly focusing on the Senior Scholars' List of Premier Journals, which helped define the construct conceptually. Following this, the critical next step was the operationalization of BI agility, involving the development of measures and the specification of the measurement model. While the literature review provided a foundation, it proved insufficient to capture all the nuances of BI agility or to develop a comprehensive list of indicators for the measurement scale. To address this gap, interviews with BI practitioners were conducted to complement the existing literature with practical insights. The interview method is invaluable for uncovering hidden patterns and dynamics within organizations (Gerson & Damaske, 2020). The insights gained from these interviews informed the generation of indicators that accurately capture the construct. To ensure the quality and validity of the developed indicators, they were initially evaluated by a panel of experts, including both practitioners and academics. The measures were refined and validated using data collected from Survey No. 1, with EFA used for refinement and CFA for validation, prior to testing the hypotheses posed in this study.

In the development and testing of the hypotheses in this research, two methods played a crucial role: the literature review and Survey No. 2. The literature review provided the theoretical background and foundation, offering a comprehensive understanding of the existing body of knowledge on the core concepts of this study, and guided the hypothesis development process. Meanwhile, the data collected through Survey No. 2 enabled the testing of these hypotheses using partial least squares structural equation modeling (PLS-SEM) algorithms. The conceptual research model presented in Figure 3.

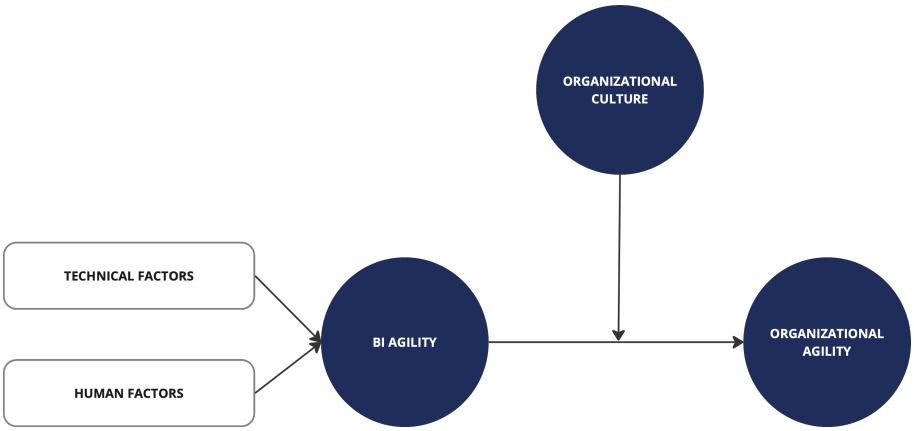

Figure 3. Conceptual research model (prepared by the author)

The final method employed in this study was a focus group. This method aimed to gather a purposefully selected group of experts for a facilitated discussion to generate insights that would help validate and interpret the findings from the earlier stages of the research. Through moderated interaction, the experts shared their personal experiences, beliefs, and perceptions, providing valuable perspectives that enriched the study's conclusions.

Scientific novelty of research and contribution to science

This research contributes to science in several keyways:

1. *BI agility conceptualization aligned with its socio-technical nature*. This research challenges the currently dominating view of BI agility as purely technical feature (Zimmer et al., 2012; Knabke & Olbrich, 2013; Baars & Zimmer, 2013; Baars et al., 2014; Knabke & Olbrich, 2017) by offering a redefined conceptualization aligned with socio-technical perspective, emphasizing the importance of human-centered dimensions (Agile BI culture and BI governance agility) alongside technical aspects (BI architecture agility). It provides comprehensive understanding of the factors contributing to each dimension, filling gaps in the existing literature.
2. *Introduced new measurement scale for BI agility*. A novel measurement scale integrating technical and human-centered dimensions of BI agility was developed, addressing limitations in prior research that focused only on capturing characteristics on the state of BI agility at a specific moment (Knabke & Olbrich, 2017), but failing to encompass the capability to adapt to changing environments over time. The scale, developed using a combination of qualitative

and statistical methods, equips scholars with a robust tool for future empirical research and enables organizations to assess their BI agility capabilities.

3. *Empirical results supporting the proposed research model*. This study empirically confirms the significant positive impact of BI agility on organizational agility and the moderating role of a performance-oriented organizational culture. While prior research has investigated the broader impact of BI on organizational agility (Chen & Siau, 2011, 2012, 2020; Corte-Real et al., 2017; Park et al., 2017; Ashrafi et al., 2019; Hyun et al., 2020; Xie et al., 2022; Al-Darras & Tanova, 2022), none have specifically examined the role of BI agility in this relationship. Additionally, this study identifies critical cultural traits based on Westrum's (1988, 2004) framework and reveals that the supportive effect of organizational culture intensifies with higher levels of BI agility, providing novel insights to the academic literature.

Practical implications

This study provides research-backed insights and guidance for organizational leaders striving to enhance their enterprises' agility through BI, as well as for management consultants advising organizations. The key practical implications derived from the study are as follows:

1. *Raising awareness of the role of BI agility and organizational culture*. Organizations can leverage the insights from this research to capture leadership's attention on the benefits of fostering BI agility and cultivating a BI- and agility-friendly culture. These research-backed insights can inform strategic decisions and initiatives that enhance BI agility and it's enabling role in organizational agility, ultimately strengthening competitive positioning in the market.
2. *Utilization of the BI agility scale*. Leaders can utilize the validated BI agility scale to assess their organization's current BI capabilities across three dimensions: BI Architecture Agility, BI Governance Agility, and Agile BI Culture. By identifying specific strengths and weaknesses within these areas, organizations can prioritize initiatives that enhance their BI functions. Regular assessments using this scale can help track progress over time and adapt strategies as needed.
3. *Cultural assessment and alignment*. Using Westrum's (1988, 2004) culture framework based measurement scale combined with cultural traits identified by industry experts in focus group, organizations can conduct a thorough assessment of their current culture against the

traits identified in the research. This assessment can help leaders identify cultural gaps that may hinder both BI agility and overall organizational agility, motivating cultural transformation to align with essential traits like high cooperation, trained messengers, shared risks, encouraged bridging, and implemented novelty.

4. *Actionable insights and best practices derived from industry experts*. Insights from the focus group discussions confirm that the challenges addressed in this research are highly relevant to practice and provide practical insights into common challenges and solutions for building an agile BI function.

Research statements to be defended

The author of this dissertation aims to defend the following research statements:

1. Achieving BI agility requires an integration of human-centered factors, including BI governance and BI culture, alongside technical factors.
2. BI agility serves as enabler of organizational agility, with higher levels of BI agility resulting in a stronger positive impact on organizational agility.
3. A performance-oriented organizational culture positively moderates the relationship between BI agility and organizational agility, with this moderating effect becoming stronger as level of BI agility increase.

Dissertation structure

The dissertation structure is based on five stages of conducted research, followed by sections on conclusions, recommendations for future research, and practical implications.

1. The first section, “Literature review”, sets the foundation for the upcoming stages of the dissertation as it explores the body of knowledge of the key concepts and their relationships important for this research. A literature review is focused on the Senior Scholars' List of Premier Journals that offer valuable insights. The key concepts being explored in this stage are Organizational Agility, BI Agility, Organizational Culture, the relationship between BI Agility and Organizational Agility and the role of Organizational Culture in the contexts of agility and BI.

2. The second section, “Qualitative exploration and item generation for the BI agility scale”, aims to build upon the insights gathered from the literature review by incorporating perspectives from practitioners. This was achieved through 15 in-depth interviews with BI experts and analysing the data in accordance with qualitative research guidelines. The insights obtained reinforced the need to redefine the BI Agility concept to include human-centered dimensions alongside technical aspects. These insights also informed the generation of BI agility indicators for the measurement scale to operationalize the BI agility construct. The measurement model for the BI agility construct also covered in this section.
3. The third section, “Quantitative refinement and validation of the BI agility scale”, involved the refinement of a measurement scale, developed in previous section, for the latent BI agility construct following statistical methods. For this purpose the survey was prepared including the indicators for BI agility scale developed in previous section and data collected from 100 BI specialists and users, majority working in companies operating in Lithuania. This data was used to perform EFA to refine the scale and identify the strongest indicators with the power to represent the construct. Subsequently, the newly developed BI agility measurement scale was validated using CFA to ensure its reliability and validity.
4. The fourth section, “Hypothesis testing”, presents the empirical study conducted to examine the hypotheses proposed in this research, focusing on the relationship between BI agility and overall organizational agility, as well as the moderating effect of organizational culture. Data for this analysis was collected through a survey of 103 BI specialists and users, including respondents from Lithuania and other countries in the Baltics and Nordics.
5. The fifth section, “Expert group insights”, details the part of the study conducted using the focus group method. A group of five BI experts and one organizational psychologist was convened for a facilitated discussion centered around the key research questions. The discussion aimed to explore real-world challenges faced by companies, validate whether these challenges align with the insights gathered in earlier stages of the research, and identify potential solutions for overcoming these obstacles. The transcript of the discussion was analyzed using qualitative analysis methods, with the results presented in this section.

Approbation and dissemination of research results

Conference Presentations:

- Conference paper titled "Informing Agility in the Context of Organizational Changes" presented at the international conference "InSITE 2021: Informing Science + IT Education Conferences" held online, July 6-7, 2021.
- Conference paper titled "Redefining Business Intelligence Agility: Integrating Human-Centered Dimensions and Developing a New Measurement Scale" presented at the international conference "IFIP WG 8.3 Decision Support Open Conference 2024: Decision Systems and Analytics for the Common Good", held June 5-7, 2024, in Elche, Spain.
- Conference paper titled "The Dynamics and Agility of Business Intelligence: The Maturity of Being Immature" presented at the international conference "InSITE 2024: Informing Science + IT Education Conferences" held online, July 24-25, 2024.

Scientific Research Journals:

- Skyrius, R., & Valentukevičė, J. (2021). Business Intelligence Agility, Informing Agility, and Organizational Agility: Research Agenda. *Informacijos Mokslai / Information Sciences, 90*, 8-25. https://doi.org/10.15388/Im.2020.90.47
- Skyrius, R., Krutinis, M., Nemitko, S., Valentukevičė, J., Gulbinovič, N., & Sanosianaitė, M. (2021). Informing Agility in the Context of Organizational Changes. *Informing Science: The International Journal of an Emerging Transdiscipline, 24*, 19-30. https://doi.org/10.28945/4789
- Skyrius, R., & Valentukevičė, J. (2024). Redefining Business Intelligence Agility: Integrating Human-Centered Dimensions and Developing a New Measurement Scale. *Journal of Decision Systems*, 1-15. https://doi.org/10.1080/12460125.2024.2354581
- Skyrius, R., & Valentukevičė, J. (2024). The Dynamics and Agility of Business Intelligence: The Maturity of Being Immature. *Proceedings of the Informing Science + Information Technology Education Conference*. https://doi.org/10.28945/5323

1. LITERATURE REVIEW

1.1. Organizational agility

1.1.1. Conceptual foundations of organizational agility

Organizational agility is regarded as the solution for dealing with fast-paced reality. Organizations should adopt agility as a fundamental principle to effectively respond to the changing requirements of customers, environments, and stakeholders. It is crucial for organizations to keep changing faster than the market to avoid being surpassed by competitors. Historically, the most established companies have prioritized efficiency over strategic agility. The hierarchical structures and organizational processes that have been instrumental for decades to run and improve enterprises are no longer sufficient for securing success in today's fast-paced world (Kotter, 2014). Agile organizations are structured to anticipate and adapt to business changes swiftly and effectively within defined timeframes, ensuring both customer and employee satisfaction (Balaji et al., 2014; Mehdibeigi et al., 2016).

There are numerous definitions that seek to capture the concept of agility (Table 1), highlighting the complexity that lies behind this term.

Table 1. Organizational agility definitions in literature (prepared by the author)

Authors	Definition
Sambamurthy et al., 2003	The ability to detect opportunities for innovation and seize those competitive market opportunities by assembling requisite assets, knowledge, and relationships with speed and surprise.
Conboy and Fitzgerald, 2004	The continual readiness of an entity to rapidly or inherently, proactively or reactively, embrace change, through high quality, simplistic, economical components and relationships with its environment.
van Oosterhout et al., 2006	Agility means a high state of responsiveness and adaptability on the part of the organization to sudden changes.
Overby et al., 2006	The ability of firms to sense environmental change and respond readily. As such, enterprise agility consists of two components: sensing and responding.

Authors	Definition
Lu and Ramamurthy, 2011	The capacity to respond quickly and creatively to changes in the business environment that are unanticipated and unexpected.
McKinsey, 2015	Agility is the ability of an organization to renew itself, adapt, change quickly, and succeed in a rapidly changing, ambiguous, turbulent environment.
Teece et al., 2016	The capacity of an organization to efficiently and effectively redeploy/redirect its resources to value-creating and value protecting (and capturing) higher-yield activities as internal and external circumstances warrant.

No matter how one defines organizational agility, it is evident that evolving from static models to genuinely adaptive learning organizations is a complex and enduring process. Agile transformations give rise to a new kind of corporation, characterized by dynamic capabilities that enable it to adapt not only to a specific vision of the future but also to its continually changing conditions (Appelbaum et al., 2017). Agility is an ongoing process, similar to continuous improvement, suggesting that organizational agility should be viewed more as a process of becoming rather than a state of being. The challenge for large organizations is to revive their innovative agile origins, while startups must continue to cultivate their dynamic capabilities as they expand (Appelbaum et al., 2017).

Agility requires two fundamental elements: dynamic capability and stability. The ability to move quickly, characterized by speed and responsiveness, is crucial. However, this must be supported by a stable foundation—elements that remain constant despite ongoing changes elsewhere (Aghina et al., 2015). Teece and Leih (2016) encourage us to recognize that while organizational agility is often viewed as a desired state, agile transformations can be expensive and are not always essential or feasible.

The literature clearly demonstrates a strong correlation between increased agility and improved business performance, emphasizing the critical role of organizational agility in the modern dynamic business landscape. By enhancing agility, companies can react more swiftly and efficiently to unforeseen changes, thus maintaining high performance levels. Significantly, achieving true agility requires organizations to go beyond just procedural enhancements. Agility should be deeply embedded as a fundamental trait of their employees, teams, and the overarching organizational culture.

1.1.2. Dynamic capabilities theory and its relevance to agility

The dynamic capability theory originated from the resource-based view (RBV) theoretical framework, which aims to elucidate how firms achieve and sustain competitive advantages over time (Barney, 1991; Wernerfelt, 1984; Prahalad and Hamel, 1990). RBV posits that firms can be seen as collections of resources, with these resources distributed heterogeneously among firms and differences in resources persisting over time. Central to RBV is the concept that resources - encompassing assets, business processes, capabilities, attributes, knowledge, and information - are controlled by a firm to develop and execute strategies that enhance its efficiency and effectiveness (Barney, 1991). According to researchers, when firms possess resources that are valuable, rare, imperfectly imitable, and non-substitutable, they can secure a sustainable competitive advantage by implementing strategies that competitors cannot easily replicate (Barney, 1991).

However, RBV has been criticized for inadequately explaining how and why certain firms maintain competitive advantages in environments characterized by rapid and unpredictable change (Teece et al., 1997; Kathleen & Martin, 2000; Kleinschmidt et al., 2007). In markets where the competitive landscape is constantly evolving, firms require dynamic capabilities, which Teece et al. (1997) define as "the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments." Dynamic capabilities have expanded RBV research by examining changes in the capabilities needed to navigate rapid shifts in an organization's environment. This approach shifts the focus from purely internal to viewing firm resources and capabilities as an interplay between the internal organization and the external environment.

Teece (2007) identified three principal clusters of high-level capabilities: sensing, seizing, and transforming. These capabilities are essential for organizations and management to determine the direction of markets and technology, develop strategies to capitalize on these opportunities, and modify the organization as needed to achieve their goals. Further refinements to dynamic capabilities concept include the delineation of the need for both organizational routines and entrepreneurial actions by individual managers (Teece, 2012), the distinction between dynamic capabilities (embedded within the organization and its personnel) and strategy (crafted and refined by management to define a market position and counteract competitors), and the differentiation between ordinary and dynamic capabilities (Teece, 2014). Teece's framework for dynamic capabilities ultimately highlights the importance of corporate agility, which he describes as "the capacity to (1)

sense and shape opportunities and threats, (2) seize opportunities, and (3) sustain competitiveness by enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets".

Eisenhardt and Martin (2000) offer a more focused definition of dynamic capabilities, defining them as "the firm's processes that use resources—specifically the processes to integrate, reconfigure, gain, and release resources—to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die". They argue that dynamic capabilities consist of specific and identifiable processes such as product development, strategic decision making, and forming alliances. Moreover, they suggest that although these capabilities share similarities among successful companies—often considered "best practices"—they also differ according to market dynamics: in moderately dynamic markets, dynamic capabilities take on traditional, complex, detailed, and analytical forms; whereas in highly dynamic markets, they become simpler, more experiential, and less stable, depending on swiftly produced new knowledge and iterative implementation. Eisenhardt and Martin (2000) work address the critical connections among dynamic capabilities, resources, and competitive advantage, which has been a problematic area within RBV. They suggest that effective dynamic capabilities are necessary but not sufficient conditions for competitive advantage. Long-term competitive advantage is achieved by employing dynamic capabilities sooner, more astutely, or more fortuitously than competitors to create resource configurations that have this advantage.

While the development of dynamic capabilities follows a distinct trajectory for each firm, their core is rooted in organizational learning (Bendig et al., 2017; Chirumalla, 2021). Learning mechanisms are crucial in guiding the evolution of dynamic capabilities (Eisenhardt & Martin, 2000). Mechanisms that facilitate learning and the development of dynamic capabilities include repeated practice and learning from mistakes.

The dynamic capabilities framework is closely associated with organizational agility. Organizational agility is defined as a higher-order dynamic capability that enables businesses to thrive in continuously changing and unpredictable business environments. This capability involves a firm's ability to detect and rapidly adapt to environmental shifts (Mao et al., 2015; Ravichandran, 2017). Chakravarty et al. (2014) define organizational agility as consisting of two components: entrepreneurial agility and adaptive agility. Entrepreneurial agility involves creating new products, services, processes,

and markets to establish new competitive advantages or disrupt those of competitors. On the other hand, adaptive agility emphasizes resilience and the ability to adapt in the face of risks and challenges that stem from environmental changes (Overby et al., 2006). The discussion extends to how organizations develop and integrate agility-enhancing dynamic capabilities such as coordination, cooperation, capability development, and connection into their operations. Goldman et al. (1995) categorize the capabilities of agile organizations into four strategic dimensions: customer enrichment, competitive enhancement through cooperation, mastery of uncertain change, and leveraging key personnel and information.

Intensifying competition, both globally and locally, indicates that companies unable to develop and sustain the dynamic capabilities necessary to adapt to evolving customer demands are likely to face significant challenges to their survival. Implementing principles and practices to transform into agile enterprises offers a potential solution.

1.1.3. Agile transformations

Research on organizational transformation emerged in the 1980s (Tichy, 1983; Pettigrew, 1985; Manganelli & Klein, 1994) and has remained a central theme in both academic and practitioner literature. Today, shifting economic, social, and cultural conditions - along with rapid technological advances, digitalization, de-carbonization, natural disasters, and pandemics - pose significant challenges to firms' survival, driving the need for various forms of business transformation. This phenomenon, also referred to as radical change, strategic change, or revolutionary change, includes IT-enabled transformations commonly termed digital transformations, as well as agility-focused transformations known as agile transformations.

Knowledge on organizational change is often being used to explain organizational transformation phenomena (Pettigrew, 1987). The literature distinguishes two main types of organizational change: convergent change, occurring within a relatively stable structure, and deep structural change, where the organization's foundational structures are transformed (Tushman & Romanelli, 1985; Gersick, 1991). Organizational transformation is understood to take place when these deep structures are fundamentally altered. As Besson and Rowe (2012) explain, "if the organization were perfectly fluid and plastic, the question of transformation would not surface." They also highlight that organizational inertia creates both theoretical and practical challenges, as transformation requires overcoming this inertia to realign the organization with its external environment.

In today's fast-paced business environment, the accelerating rate of change is driving firms to pursue transformation in response to disruptive shifts. Scholars emphasize the need for organizations to adapt to discontinuous changes through transformation to maintain resilience (Magnani et al., 2024; Grego et al., 2024). Grego et al. (2024) identify two primary paths to resilience - adaptive and absorptive. Their research suggests that innovative, internationally oriented companies are more likely to follow an absorptive approach, thus reducing the need for radical transformation when faced with shocks. High resilience can often be achieved through incremental adjustments that maintain a constant steadiness. However, the ability to sense and respond to these incremental changes depends on strong dynamic capabilities, which are also essential for organizational agility (Teece et al., 2016). This implies that agility-focused transformation can play a pivotal role in creating fluid and flexible organizational structures, supporting absorptive adjustments, and reducing the need for radical change in response to disruptive shifts - ultimately enhancing organizational resilience.

According to research performed by McKinsey (Aghina et al., 2021) "highly successful agile transformations typically delivered around 30% gains in efficiency, customer satisfaction, employee engagement, and operational performance; made the organization five to ten times faster; and turbocharged innovation." Similarly, a study by Stettina et al. (2021) concluded that "agile transformations positively impact organizational performance, with reported improvements in many cases going way beyond 30% across the reported dimensions." These performance gains translate into a competitive advantage. In the same earlier mentioned. research McKinsey compared organizations that have not undergone transformation with those that have successfully implemented agile practices and found that the latter were three times more likely to become top-quartile performers among their peers (Aghina et al., 2021).

Enterprise agility represents a shift away from traditional organizational models characterized by multilayered reporting structures, rigid annual budgeting, a compliance-oriented culture, the separation of business and technology—features that have dominated organizations for the past century. As Kotter (2014) defined most well-established companies are optimized much more for efficiency than strategic agility and this won't help to win in today's world. Enhancing enterprise agility provide an opportunity for organizations to turn their operating models into a competitive advantage. The challenge lies in transforming corporations that have become complacent due to prolonged market dominance into highly adaptive, flexible learning organizations. These organizations must possess the necessary skills to

effectively implement strategically driven waves of change and renewal (Meredith and Francis, 2000). Agile transformations represent a relatively new phenomenon within organizational contexts. While the short-term challenges of implementing transformational change are significant, the new reality is that failing to adapt to environmental changes poses a much greater risk of long-term failure (Appelbaum et al., 2017).

Originally developed for use in specific teams and initiatives within software development, agile methods and principles have now been expanded to the enterprise level. This broader application impacts multiple organizational layers—including teams, programs, and portfolios—and spans various business domains such as HR, finance, and sales (Stettina et al., 2021). As competition intensifies and the adoption of new technologies accelerates, organizations must embrace continuous strategic change to maintain relevance and competitive advantage. As a result, many organizations are rapidly transitioning to an agile operating model, which is becoming increasingly prevalent across various sectors.

Meredith and Francis (2000) offer a comprehensive framework that categorizes the various interdependent elements contributing to organizational agility into four main groups: agile strategy, agile processes, agile linkages, and agile people. Similarly, McKinsey (Aghina et al., 2021) emphasizes that the core of an agile transformation involves reenvisioning the organization as a network of high-performing teams, supported by a robust backbone that integrates strategy, structure, processes, people, and technology.

A team composed of the right individuals with diverse capabilities enables organizations to move swiftly, enhance customer satisfaction, and improve operational performance. Such teams also foster a safe environment for experimentation, driving innovation. Edmondson's (1999) study introduced the concept of team psychological safety—defined as the "shared belief held by members of a team that the team is safe for interpersonal risk-taking"—and demonstrated that psychological safety is linked to learning behavior, which in turn mediates the relationship between psychological safety and team performance. Since agility cannot be achieved without continuous learning capabilities, these findings are highly relevant to organizational agility research. Organizations undergoing agile transformations should recognize the importance of team leader coaching and contextual support, as these factors significantly influence team behavior and performance outcomes. In teams where psychological safety is established, employees feel more engaged, motivated by a shared purpose, empowered to make decisions, and encouraged to develop mastery in their craft.

Instead of waiting for agility to emerge organically, organizational leaders must take a proactive approach—being intentional and actively pursuing value. This requires a deliberate, delegated, and sustained effort from senior leadership to define how the organization creates value, identify where and how agility can enhance operations, and seize those opportunities. This process involves refining the entire operating model, including strategy, structures, processes, people, and technology. Key actions include adopting flat and fluid organizational structures centered around high-performing cross-functional teams, increasing the frequency of prioritization and resource allocation, cultivating a culture of psychological safety, and decoupling technology stacks (Aghina et al., 2021).

What distinguishes the most successful agile transformations is that these organizations treat their operating model as an integrated system and reconfigure all its components, recognizing the need for both stability and dynamic capability across various dimensions—strategy, structure, process, people, and technology.

In addition to agile transformation, IT-enabled business transformation is a critical area of growing scholarly interest. Digital technology is viewed not only as a driving force behind organizational transformation but also as a vital enabler of organizational agility.

1.1.4. Digitalization and digital transformation‘s influence on organizational agility

Since the 1990s, the focus on organizational transformation through IT and IS has garnered considerable scholarly interest (Henderson & Venkatraman, 1990; Scott Morton, 1991; Ciborra, 1992). With ongoing advancements and the widespread adoption of information systems, these technologies have become critical drivers of transformation, enabling organizations to create value and maintain competitiveness in an evolving market. Consequently, organizations are prompted not only to invest in specific technologies but to undertake the broader, more ambitious journey of digital transformation. While the term "digital transformation" is widely used, it is important to clarify its meaning and distinguish it from related concepts like digitization and digitalization. Research defines digitization as the process of converting analog information into digital form, whereas digitalization involves using IT or digital technologies to modify existing business processes, enabling organizations to seize new opportunities. Digital transformation, however, goes beyond digitalization by reshaping the entire organization and fundamentally changing how business is conducted, often resulting in the

creation of new business models (Sebastian et al., 2017). Verhoef et al. (2021) highlight three major external drivers of digital transformation: advancements in digital technologies (e.g., big data, AI, IoT, blockchain), increasing digital competition, and evolving consumer behavior in response to the digital revolution.

Since digital transformation involves redefining how a business creates and delivers value to customers, it often necessitates the access, acquisition, or development of new digital assets and capabilities (Verhoef et al., 2021). Assets refer to the firm's resources, both physical and intellectual, while capabilities reside within the business's human, informational, or organizational capital, binding these assets together to ensure their effective deployment. IT capability, defined as an organization's ability to acquire, deploy, combine, and reconfigure IT resources for business purposes (Sambamurthy & Zmud, 1997), plays a pivotal role in shaping dynamic capabilities that drive organizational agility, a topic that has garnered significant scholarly attention (Sambamurthy et al., 2003; Overby et al., 2006; van Oosterhout et al., 2006).

The relationship between IT and organizational agility has been extensively studied, highlighting various perspectives such as digital options (Sambamurthy et al., 2003), IT ambidexterity (Lee et al., 2015), IT competencies (Chakravarty et al., 2013; Ravichandran, 2018), IT capabilities (Lee et al., 2021), strategic IT alignment (Tallon & Pinsonneault, 2011). These studies collectively underscore the enabling role of IT in fostering organizational agility, whether through direct effects (Sambamurthy et al., 2003; Lu & Ramamurthy, 2011) or more indirect, occurring through the development of higher-order capabilities (Liu et al., 2013; Felipe et al., 2017; Mikalef & Pateli, 2017; Lee et al., 2021).

Lu and Ramamurthy (2011) identify two forms of IT-enabled organizational agility: market capitalizing agility, which focuses on knowledge management and the intellectual capacity to determine appropriate actions (Dove, 2002), and operational adjustment agility, which refers to a firm's ability to swiftly adapt internal processes in response to market or demand changes (Sambamurthy et al., 2003). Tallon et al. (2022) further explore the concept of digitally-enabled strategic agility, emphasizing its power to help organizations respond to unforeseen market disruptions with agility, speed, and adaptability when implemented effectively. While IT is broadly seen as an enabler of organizational agility, the essence of agility lies in the ability to sense environmental signals and respond efficiently and effectively (Ashrafi et al., 2005; Overby et al., 2006; Tallon & Pinsonneault, 2011; Nazir & Pinsonneault, 2012; Roberts & Grover, 2012; Lee et al., 2015).

This highlights the critical role of data technologies, which enable organizations to detect opportunities and threats in data and respond by making swift strategic, tactical, and operational decisions. Such decisions often require significant amounts of relevant data, analytical capabilities, and technologies that support data processing and analysis. Collectively, these technologies are commonly referred to as BI and business analytics.

Despite the well-established link between IT and organizational agility, and the significant investments organizations make in digitalization and digital transformations, many still struggle to achieve the desired agility gains. Given that BI plays a pivotal role in enabling sense-and-response capabilities, it is essential to focus on how organizations can leverage BI to enhance agility more effectively. By understanding how to foster agility specifically through BI, organizations can better position themselves to respond to dynamic market conditions and capitalize on emerging opportunities.

1.1.5. BI as enabler of organizational agility

Today's organizations invest heavily in developing and acquiring BI assets to support data-driven decision-making. Watson (2009) defines BI as "a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions." The terms "BI" and "business analytics (BA)" (sometimes referred to as data analytics) are often used interchangeably in the literature due to minimal distinctions between them (Chen & Siau, 2020). Increasingly, businesses are turning to big data analytics (BDA) as an extension of BI to harness the full potential of massive, complex data for strategic advantage (Huang et al., 2017). In this study, BI is used as an umbrella term, encompassing architectures, tools, databases, applications, and methodologies that transform raw data into insights, then to decisions, and finally to actions (Sharma et al., 2023).

BI is widely regarded as a strategic technology in organizations, with a strong consensus among scholars that effectively leveraging data significantly enhances organizational agility. The research literature highlights the central role of BI, including BA and BDA, in enabling firms to achieve agility. A chronological overview of key studies examining the relationship between BI and organizational agility is provided in Appendix A.

Empirical studies have consistently confirmed the positive relationship between BI use (Chen & Siau, 2011, 2012), BI technologies (Park et al., 2017), BA use (Chen & Siau, 2020), BA capabilities (Ashrafi et al., 2019), BDA technologies (Corte-Real et al., 2017), BDA capabilities (Xie et al.,

2022; Al-Darras & Tanova, 2022), advanced and basic BDA use (Hyun et al., 2020), and BDA managerial skills (Zhang et al., 2024) and organizational agility. Some studies view organizational agility as an outcome in itself (Park et al., 2017; Chen & Siau, 2020; Hyun et al., 2020; Al-Darras & Tanova, 2022), while others position it as a mediator for achieving greater competitive advantage (Corte-Real et al., 2017) or enhanced firm performance (Ashrafi et al., 2019; Xie et al., 2022).

Moderators influencing the relationship between BI and organizational agility include organizational culture (Hyun et al., 2020), IT infrastructure flexibility (Chen & Siau, 2020), and technological and market turbulence (Ashrafi et al., 2019; Zhang et al., 2024). Additionally, mediators such as data-driven organizational learning (Zhang et al., 2024), entrepreneurial orientation (Al-Darras & Tanova, 2022), information quality and innovative capability (Ashrafi et al., 2019) have been identified as critical pathways through which BI impacts agility.

Conceptual studies also contribute to this understanding. Kuilboer et al. (2016) propose that BI solutions enhance agility at operational, portfolio, and strategic levels by enabling firms to sense and respond to dynamic business needs. Literature reviews emphasize additional factors crucial to this relationship, such as cultural change, the role of top managers, intergroup leadership, the alignment between organizational needs and BDA capabilities, and customer involvement in BDA competency (Hyun et al., 2020; Barlette & Baillette, 2020). These insights underline the multidimensional and context-dependent nature of the BI-agility relationship.

Park et al. (2017) suggest that BI is instrumental in enhancing an organization's sensing, decision-making, and acting agility, aligning with the dominant view of organizational agility as a dynamic capability enabling sensing environmental changes and responding efficiently and effectively to them (Dove, 2001; Sambamurthy et al., 2003; Sharma et al., 2010). The use of BI tools help firms sense changes in the market, enabling rapid response and efficacy, which increase agility (Roberts & Grover, 2012). BI technologies facilitate the capture of environmental cues and allow the right people to access the right information at the right time to interpret and make decisions (Park et al., 2017). Scholars have contended that BI enhances organizational agility not only through data-driven decision-making but also by improving information quality, enabling easy access to information, and widespread information sharing (Chen & Siau, 2011; Ashrafi et al., 2019). These capabilities are pivotal in providing timely insights into business opportunities and disruptions, thereby increasing the organization's awareness of its surroundings.

The literature also underscores the role of BDA as a transformative digital technology that has fundamentally changed business practices and became critical for agility (Corte-Real et al., 2017; Barlette & Baillette, 2020; Hyun et al., 2020; Xie et al., 2022; Al-Darras & Tanova, 2022; Hyun et al., 2023). Big data - characterized by volume, variety, velocity, veracity, variability, and value - requires advanced analytical methods to unlock its potential value (Sharda et al., 2023). Big data by itself holds no intrinsic value unless it is actively utilized by business users to create meaningful value for their organizations. Moreover, increased data volume leads to complexities, not necessarily better decisions (Abbasi et al., 2016). Traditional data handling approaches struggle effectively and efficiently to manage massive amounts of data in various formats, including structured, semi-structured and unstructured data (Hung, 2016). Hence, BDA utilize advanced analysis techniques such as data mining, machine learning (ML) and deep learning (DL) that have become essential for extracting meaningful information from big data. BDA is increasingly becoming a crucial component of decision-making processes in businesses and is being seen as a differentiator between high-performing and low-performing organizations (Chen et al., 2012). Research by Corte-Real et al. (2017), surveying 500 European firms, supports the claim that BDA applications can allow an effective internal and external knowledge management, allowing the creation/enhancement of dynamic capabilities such as organizational agility. One of BDA primary benefits is its ability to provide real-time intelligence, enabling swift responses to market changes and proactive action on emerging opportunities or threats.

To transform raw data into actionable insights, a variety of BI tools and techniques are utilized. Analytics is often categorized into four types: descriptive (providing historical insights), diagnostic (explaining why something happened), predictive (forecasting future outcomes), and prescriptive (offering actionable recommendations) (Gartner, 2014). These types collectively enhance an organization's ability to sense and respond to dynamic environments. Figure 4, created by the author based on Gartner insights, visualizes BI technologies grouped by analytics type, organized by their sophistication. It highlights the critical questions they address, their role in decision-making, and their contribution to agility capabilities—sensing and responding. The figure also illustrates the level of human intervention required in the decision-making process as the analytics sophistication increases.

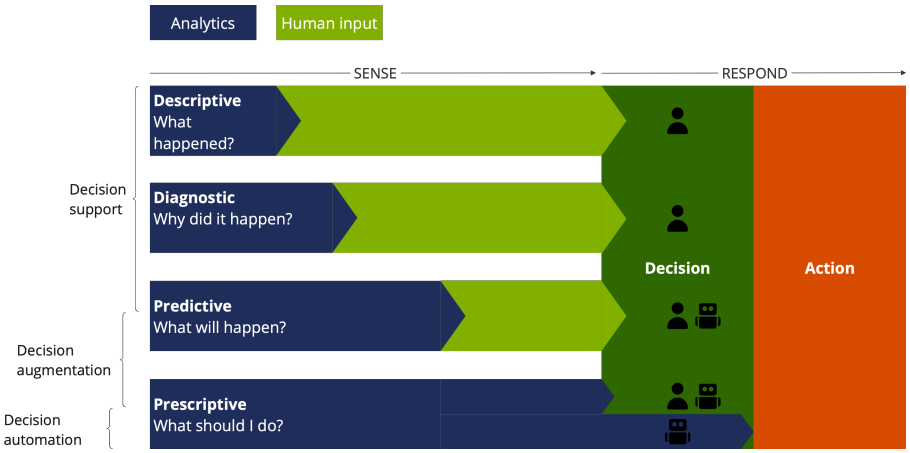

Figure 4. Analytics types and their role in agility capabilities and decision making (adapted from Gartner, 2014; White & Rollings, 2021)

Advanced analytics, which includes predictive and prescriptive analytics, requires less human input in the analysis and decision-making processes. At the highest level of sophistication, analytics platforms not only predict future outcomes but can also choose the best solution and automate actions in response to those predictions. Descriptive and diagnostic analytics primarily rely on traditional BI technologies and techniques such as data warehousing, OLAP, business reporting, dashboards, and scorecards to support decision-makers. In contrast, predictive and prescriptive analytics leverage advanced technologies, including data mining, text mining, forecasting, simulation, optimization, and decision modeling, to augment or automate decision-making.

AI techniques, particularly machine learning (ML) and deep learning (DL), play a pivotal role in driving decision augmentation and automation. Additionally, AI is also transforming traditional analytics through technologies such as natural language processing (NLP) and conversational interfaces, fundamentally altering how users interact with data and insights. Gartner predicts that the convergence of analytics and AI will continue, with projections indicating that "by 2027, 75% of new analytics content will be contextualized for intelligent applications through Generative AI, enabling a composable connection between insights and actions" (James & Duncan, 2024). This evolution underscores the increasing role of analytics in enabling organizations to achieve greater agility by utilizing machines for rapid logical problem solving at scale while combining analytics and human insights for more complex decisions that demand context and ethical considerations, or nuanced judgment.

Organizations that effectively utilize BI, encompassing the full spectrum of analytics, possess the ability to rapidly sense and respond to market opportunities or threats, facilitating timely and informed decision-making. While many organizations are increasingly investing in BI technologies with the expectation of enhancing their dynamic capabilities toward organizational agility, the mere presence of BI technologies does not guarantee these anticipated benefits. Therefore, it is imperative to identify and understand the additional conditions necessary to get business value from BI technologies and to realize improvements in organizational agility. While BI serves as an enabler of organizational agility, it must be complemented not only by strong analytical capabilities but also by the ability to adapt and evolve systems with changing circumstances, as well as a mature organizational context, to be fully leveraged for enhancing agility.

1.2. BI agility

1.2.1. Defining BI agility

While organizations are increasingly optimistic about achieving more agility and gaining competitive advantage with IT, leading to expanded IT budgets, researchers have also sought to raise awareness that IT does not automatically confer or enhance agility and can sometimes hinder or even impede organizational agility (Overby et al., 2006; Seo et al., 2006; van Oosterhout et al., 2006). As the integration between business and IS tightens, system complexity increases, leading to agility challenges when there is a need to respond promptly and adapt systems to changing business requirements. Goodhue et al. (2009) highlighted that IS agility has become a critical component of organizational agility. The concept of IS agility has gained awareness, with scholars exploring both the "dark sides" of IS that restrict agility and the factors that support agility to transform IS from a barrier to a key enabler of organizational agility (Overby et al., 2006; van Oosterhout et al., 2006, 2016; Lu & Ramamurthy, 2011).

In this research, the focus is on the agility of BI systems. The concept of BI agility has gained attention in IS literature, though it remains in the early stages of exploration. For BI to be an enabler of organizational agility, organizations must ensure the agility of their BI systems itself, enabling them to adapt to dynamic environments swiftly and efficiently (Zimmer et al., 2012; Knabke & Olbrich, 2013, 2017). BI systems must not only reactively adapt to changing conditions but also proactively anticipate future shifts by leveraging their inherent strengths that facilitate adaptability (Chen & Siau, 2011; Zimmer et al., 2012; Knabke & Olbrich, 2013).

An analysis of the published literature reveals a limited and fragmented set of definitions for BI agility, including related terms such as "analytics agility" and "agile BI," each addressing different aspects of the concept. Consequently, it is valuable to explore definitions of IT agility and IS agility as a foundation for further examination. Table 2 provides a comprehensive, chronological overview of definitions for BI/analytical agility and IT/IS agility, grouped by concept.

Table 2. Definitions of BI/analytical agility and IT/IS agility in the literature (prepared by the author)

Authors	Year	Concept	Definition	Key features
Concepts: BI and Analytical agility				
Evelson	2011	Agile BI	"An approach that combines processes, methodologies, organizational structure, tools, and technologies that enable strategic, tactical, and operational decision-makers to be more flexible and more responsive to the fast pace of changes to business and regulatory requirements."	Flexibility; Responsiveness to requirements changes; Processes; Methodologies; Organizational structure; Tools; Technologies.
Zimmer et al.; Baars & Zimmer	2012; 2013	BI agility	"The ability to react to unforeseen or volatile requirements regarding the functionality or content of a BI solution within a given time frame. This may involve changes across all layers of the BI architecture (data and ETL, logic, access)."	Responsiveness to requirements changes; BI functionality; BI content; BI architecture.
Knabke & Olbrich	2013; 2017	BI agility	BI agility includes various perspectives: change behavior, perceived customer value, time, process, model, approach, technology, and environment. "A crucial criterion for agile BI is the ability to adapt to changing environments over time. [...] agility is a fundamental feature of a BI system in terms of strategic value. Hence, the agility of a BI can also determine its	Change behavior; Perceived customer value; Time; Process; Model; Approach; Technology; environment

Authors	Year	Concept	Definition	Key features
			lifecycle - e.g. whether or not it must be replaced with a more agile system."	
Krawatzeck & Dinter	2015	Agile BI	"All actions undertaken by an organization to achieve or improve this characteristic". Actions are classified by the categories "principles," "methods," "techniques," and "technologies" and by their implementation level, spanning 12 BI agility types ("content," "functional," and "scale agility" in combination with the four architectural layers "data acquisition," "data storage," "frontend/reporting/analysis," and "data administration").	BI actions; Principles; Methods; Techniques; Technologies; Content agility; Functional agility; Scale agility; Data acquisition agility; Data storage agility; Frontend/reporting/ analysis agility; Data administration agility.
Bieda	2020	Analytical agility	"Agility comes from three areas: improving the quality and connectors of the data itself; augmenting analytical 'horsepower' at the organizational level; and leveraging talent that is capable of bridging business needs with analytics to find opportunity in the data [...] Gaps in data quality — whether it's time-lagged, disconnected, insufficient in granularity, or poorly curated (rendering analysis slow or impossible) — become intolerable amid chaos when companies must act quickly".	Data quality; Analytical power; Leveraging talent.
Concepts: IT and IS agility				
Fink and Neumann	2007	IS agility	"IT-dependent system agility refers to the ability to accommodate change in information systems through activities of system development, implementation, modification,	Change accommodation; Time and cost awareness.

Authors	Year	Concept	Definition	Key features
			and maintenance. An organization's information systems are considered agile when its IT capabilities allow the development or modification of systems without incurring significant penalties in time or cost."	
Sengupta & Masini	2008	IT agility	"The ability of a firm to adapt its IT capabilities to market changes [...] IT agility is all about reconfiguring or replacing your information technology systems when new marketplace realities change the way you have to do business."	Alignment with market changes; Reconfigurability.
Tiwana & Konsynski	2010	IT agility	"The capacity of the IT function to rapidly adapt to changing line function demands and opportunities".	Rapid adaptation to changing environment.
Van Osterhout	2010	IT agility	"The ability of IT to support an organization to swiftly change businesses and business processes beyond the normal level of flexibility to effectively manage highly uncertain and unexpected, but potentially consequential internal and external events. In order for IT to be agile it needs to support and align the three dimensions of business agility - sensing, responding and learning."	Support swift business change; Flexibility; Manage uncertain and unexpected events. Sensing; Responding; Learning.
Dove	2014	Agile IS	"Agile systems are designed for change. They can be augmented with new functional capability. They can be restructured with different internal relationships among their subsystems. They can be scaled up or down for	Designed for change; New functional capabilities; Restructuring; Scaling up and scaling down; Reshaping;

Authors	Year	Concept	Definition	Key features
			economic delivery of functional capability. They can be reshaped to regain compatibility or synergy with an environment that has changed shape. These types of changes are structural in nature, and require an architecture that accommodates structural change."	Architecture accommodating change.
Leonhardt et al.	2017	IT function agility	"The agility of the IT function is comprised of two dimensions—sensing and responding. The latter dimension refers to the ability of the IT function to be adaptive to emerging business needs. It includes, for example, the IT function's culture, the willingness to accept risk and act proactively and responsively, as well as the flexibility of IT in terms of scalability, reconfigurability, and integration abilities. [...] The IT function's sensing capabilities [...] refer to the ability to identify changes in customer needs and markets as well as emerging environmental opportunities (e.g., regulatory and legal changes, shifts in consumer preferences, technological advancements, or competitors' actions) that may affect the company's business. Sensing includes keeping current with and anticipating IT innovations and trends that may affect the core business or provide new business opportunities".	Sensing; Responding; Adaptability to business needs; IT culture; Risk acceptance; Proactive and responsive behaviour; Flexibility; Scalability, Reconfigurability; Integration abilities; Identification of changes and opportunities; Keeping up with innovation and trends.

The evolution of BI agility definitions in the literature reveals an increasingly comprehensive understanding of the concept. The early research on BI agility predominantly focused on the technical perspective, emphasizing architectural capabilities to flexibly adjust the functionality, content, and scale of BI systems to meet changing business requirements (Zimmer et al., 2012; Baars & Zimmer, 2013). This technical-centric view is evident in definitions that stress the importance of system adaptability across different architectural layers, from data acquisition to front-end reporting.

However, the conceptual understanding has gradually expanded beyond purely technical considerations. Knabke and Olbrich (2013, 2017) adopted a more comprehensive view incorporating multiple perspectives such as change behavior, perceived customer value, process and environmental factors. This evolution reflects a growing recognition that BI agility is not merely a technical capability but a multifaceted organizational characteristic. Krawatzeck and Dinter (2015) highlighted the importance of principles, methods, and techniques necessary to ensure effective BI agility. This governance perspective acknowledges that agility requires not only technical capabilities, but also organizational structures and processes to support rapid adaptation.

An analysis of the definitions reveals an important temporal dimension in BI agility. The vast majority of definitions, both in BI and broader IT/IS agility concepts, explicitly acknowledge the importance of time by incorporating expressions such as "fast pace," "within a given time frame," "ability to adapt to changing environments over time," and "companies must act quickly." This suggests that BI agility necessitates the ability to accommodate changes in BI architectures within certain time constraints to secure business value. In this regard, BI governance plays a crucial role in ensuring timely adaptations.

When comparing BI agility definitions with broader IT/IS agility concepts, an important distinction emerges. While some IT/IS agility studies focus on technical aspects, akin to the early BI agility research, others emphasize the sensing and responding dimensions of the IT function itself (Van Osterhout, 2010; Leonhardt et al., 2017). This highlights the importance of mindsets and behaviors in IT personnel that go beyond reactive adaptations to business changes, ensuring IT/IS agility. In contrast, the BI agility literature has been relatively limited in its consideration of these human-centric aspects. With the exception of Bieda's (2020) recognition of the importance of leveraging talent that can bridge business needs with analytics, the majority of BI agility definitions have focused primarily on technical and governance-related capabilities.

The technology-focused aspects are crucial for implementing an agile BI architecture that supports a dynamic and responsive BI environment and BI governance is critical for balancing between structured management of BI initiatives and ad-hoc adaptation. However, BI is a sociotechnical system, consisting of technical and social components (Oesterreich et al., 2022), and in cases of BI success or failure, human factors often outweigh technical factors (Popovič et al., 2012; Audzeyeva & Hudson, 2014), highlighting their critical importance. It is therefore essential to recognize that the attitudes, beliefs, norms and values towards BI shared by a group - referred to as BI culture (Skyrius et al., 2018) - profoundly shape the behavior of BI specialists and users, ultimately influencing BI agility.

Another gap identified is the lack of frameworks for measuring BI agility. While Knabke and Olbrich (2017) made significant progress in quantitatively assessing BI agility by defining its dimensions - such as BI's ability to handle changes, provide value to internal or external customers, absorb changes within an appropriate timeframe, sense and respond to changes, and operate with suitable architecture, data models, and infrastructure - they primarily focused on the "what" aspects of change characteristics within BI. However, they overlooked the equally critical "how" aspect, which extends beyond technology to include human-centered factors. This "how" dimension is essential for identifying and fostering the elements necessary to achieve and sustain long-term BI agility.

In conclusion, while BI holds strong potential to enhance organizational agility, it is essential to consider the agility of BI itself for it to truly enable organizational agility. The literature analysis suggests that future research should work toward a more integrated definition of BI agility that combines technical and human dimensions. Alongside this conceptual development, the research should also provide comprehensive measurement instruments for evaluating BI agility. Such frameworks would serve dual purposes – guiding academic research as well as aiding practitioners in assessing and improving BI agility within their organizations.

Building on previous research and addressing the identified gaps in the literature, particularly the need for a stronger human-centered focus, this study hypothesizes that BI agility comprises three key dimensions: BI architectural agility, BI governance agility, and agile BI culture. These dimensions warrant further investigation to clarify their specific components and assess their respective impacts on the overall BI agility of an organization.

1.2.2. Key dimensions of BI agility

BI architecture agility dimension

The term 'BI architecture' encompasses BI technology resources and conventions in a specific arrangement, and the concept of agile BI architecture implies that this arrangement possesses the necessary flexibility for both reactive and proactive adaptations across all architectural layers within BI (Baars & Zimmer, 2013; Zimmer et al., 2012). Dove (2005) defines agile IT systems as reconfigurable systems of reusable modules in a scalable framework. These modules, or components, are distinct, loosely coupled units of limited size and complexity, sharing common interaction standards for easy addition or removal. Therefore, if the BI system is designed with architecture agility, incorporating new data or analysis capabilities into the existing BI infrastructure can be done with relative ease.

BI governance agility dimension

BI governance becomes essential at a certain stage of BI maturity, after initial acceptance, as BI functions and activities become more structured and manageable, enabling the application of general IT governance principles. Implementing a BI governance framework is crucial for establishing common principles, managing information ownership, and streamlining processes like project/initiative approval, prioritization, and issue resolution. Knabke and Olbrich (2017) regard the abilities to maintain, govern, and manage BI assets, in combination with other assets like people or processes, as dynamic capabilities enabling BI agility. However, there's a challenge in ensuring that BI governance doesn't become too restrictive and inflexible, which could hinder BI agility. To truly enable agility, organizations must move away from traditional, rigid BI governance models to more agile practices that support building agile, cross-functional teams embedded in the business and accountable for insights-driven outcomes (Evelson, 2017).

Agile BI culture dimension

The role of BI culture in BI agility is critical because it can either facilitate or hinder the adaptation of BI capabilities to changing environments. BI culture is closely related to the concepts of information culture (Choo, 2013), data-driven culture (Anton et al., 2023), analytics culture (Thirathon et al., 2017), and big data culture (Dubey et al., 2019), but it is more specific, representing a subculture centered around BI, encompassing BI specialists and BI users. BI techniques, technologies, systems, practices, methodologies, and applications provide the foundation for advanced informing and decision-making.

However, based on research recommendations in the IS domain (Martinsons & Chong, 1999; Leidner & Kayworth, 2006), to maximize value from BI, organizations should also build a strong BI culture and ensure that the values of the broader organizational culture do not conflict with BI values. Moreover, a BI culture aligned with agile values can drive the effective use of BI resources and consequently BI agility in organizations.

While agile BI architecture and governance provide the technical and administrative foundation, the real catalyst is culture, which drives the effective use of these resources by fostering user motivation, indicating that agility leans more towards culture than process (Denning, 2010). Organizational culture, a major focus in management research, significantly influences informing activities, including BI. Informing processes, in turn, have the potential to reshape organizational culture (Leidner & Kayworth, 2006). Information culture includes assumptions, values, and norms related to information creation, sharing, and use (Choo, 2013). Within this, BI culture emerges as a unique subset, characterized by features like an intelligence community and insight sharing (Skyrius, 2021). To achieve true BI agility, organizations need to cultivate a BI culture that aligns with the characteristics of an agile culture, one that facilitates change and embraces continuous learning.

Figure 5, created by the author, summarizes the dimensions of BI agility as conceptualized from a literature review, and it provides references to specific features identified by scholars for their capacity to influence and contribute to BI agility.

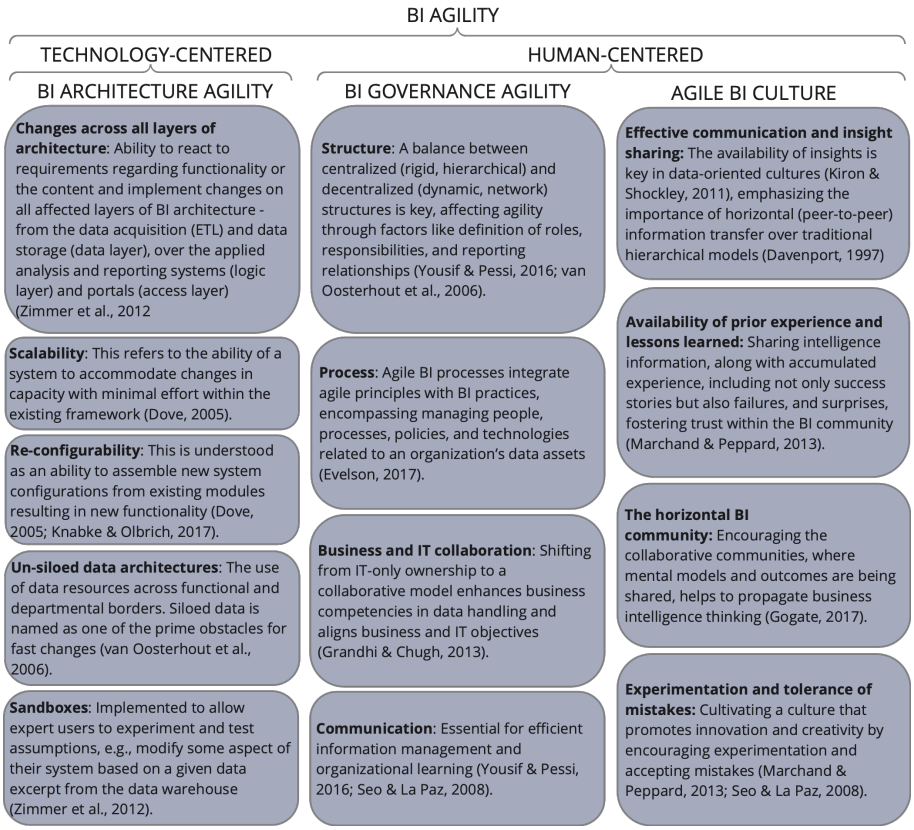

Figure 5. BI agility dimensions and associated features derived from the literature (prepared by the author)

In terms of human-centered factors, BI governance agility involves striking a balance between structured management and agile adaptation. This balance ensures that BI initiatives align with organizational goals and are efficiently executed. While another human-centered dimension, Agile BI culture, is essential for creating an environment that promotes collaboration, communication, and innovation. Meanwhile, the technology-focused aspects are crucial for implementing agile BI architecture, which supports a dynamic and responsive BI environment.

1.2.3. Tensions between BI maturity and agility

Both concepts of BI maturity and agility seek to create and maintain value from BI operations. While the concept of maturity reflects value growth, the concept of agile BI concentrates on preservation of this value. A contradiction emerges between the ultimate state of maturity and the never-ending

transformation requiring agility. The contradictions between BI maturity and agility seem to come up from different concentration focuses. For maturity, it is the value extraction from the current platform, while for agility, it is the ability to grow flexible competences that would hold against changes. The controversy also comes from longitudinal perspective: optimized target levels of maturity models cannot last for longer time and are easier to disrupt; agility aims exactly at developing and maintaining competencies for as long as possible.

Several common features to compare the two concepts are presented in Table 3.

Table 3. A comparison of features of BI maturity and agility (prepared by the author)

BI maturity	**BI agility**
Has a finite point as its goal, developing to- wards alignment and optimization.	Does not have a finite point; instead maintains flexibility and preparation for change.
Criteria of efficiency and utilization.	Criteria of resilience and competence preservation.
One path or alternative; one set of activities in its current version to be developed and optimized.	Many paths, alternatives or versions without aiming at optimization.
Maturity reflects a single instance of coupling between BI and organization.	Agility seeks to cover a larger context (includes external factors) and longer time window (covering possible future changes).

Most maturity models show overly optimistic and vague expectations regarding the last stage, especially the ones claiming aligned and optimized activities. Mettler and Pinto (2018) state, “what is mature today must not necessarily be mature tomorrow; or what works in one context, must not necessarily work in another.” The analysis of a set of existing BI maturity models (Rajteric, 2010) has shown that many of them reflect a sequence of phases towards some ideal and optimized BI instance. The exceptions are several models that declare flexible ultimate stage, important role of culture, and avoid optimization (Gartner, TDWI, and AMR models). In such cases, maturity would point to an ability to embrace future changes more easily. For BI being a fluid and dynamic set of activities, aligned and optimized activity

is not considered to last for long. Eventually, BI is doomed to be immature because its agility requires keeping extra elements of freedom – e.g., alternative approaches and processes, search for solutions outside existing boundaries, to name a few.

An emerging idea raised in this research is that BI maturity has to be redefined in its goals. The more realistic models of BI maturity in their ultimate stages present exactly this – development of sustainable competencies and capabilities to deal with the dynamic future. Such competencies should be the opposite of what is declared in the "optimized" last stage of some maturity models – rigid, and therefore fragile, processes. In other words, flexible maturity has to stay immature by the standards of maturity models, or the concept of maturity has to undergo significant expansion.

The movement between maturity stages in BI maturity models suggests several things:

1. Firstly, it is often assumed that a certain BI system – the technical or systemic foundations of BI activities – is already in place and will stay stable during the entire maturity cycle.
2. Secondly, important developments along the maturity stages lie in the area of governance of BI activities – sources of value are recognized and defined; processes are better organized and managed.
3. Thirdly, although this is not always obvious, the facilitation of future flexibility requires important changes to take place in values, people behaviors, and attitudes. Such foundation points, or "pillars" of flexible maturity often are attributed to the area of organizational culture, of which information culture and BI culture is an important part.

To sum up, BI maturity is an ongoing journey, and for organizations to remain competitive in leveraging data for value, they require dynamic capabilities like BI agility to continually adapt their BI systems to evolving requirements and stay relevant in changing environments. BI agility is crucial not only for sustaining the current level of BI maturity but also for enabling organizations to extract increasing value from their BI systems over time.

1.3. Organizational culture

1.3.1. Defining organizational culture

Organizational culture theory has been used to explain a diverse range of social behaviors and outcomes within organizational settings, including corporate performance (Surroca et al., 2003), competitive advantage (Lado & Wilson, 1994), organizational effectiveness (Denison & Mishra, 1995; Zheng et al., 2010; Hartnell et al., 2011; Choo, 2013), corporate sustainability (Linnenluecke & Griffiths, 2010) and – importantly for this study – organizational agility (Crocitto & Youssef, 2003; Felipe et al., 2017) and the successful implementation and use of IT (Leidner & Kayworth, 2006). Organizational culture often distinguishes successful companies, such as Netflix, Google, and Disney, which are praised for their outstanding cultures. An effective culture provides a foundation for launching and executing various strategies (Heskett, 2022), including the highly prioritized strategic imperatives of agile and digital transformation. Consequently, organizational culture has attracted the attention of scholars, and organizations increasingly view cultural transformations as essential for the success of their efforts to improve agility and other organizational outcomes.

Organizational culture is often described as "the way we do things around here." Schein (2017) defines culture as the underlying shared beliefs, values, norms, and priorities that shape behaviors, emphasizing the importance of understanding these powerful cultural forces that often operate outside of our awareness and help explain many experiences in organizational life. Schein (1985), widely regarded as the "father" of organizational culture, analyzed this abstract concept, demonstrated its significance in managing organizational change, and proposed that organizational culture can be analyzed on three levels: artifacts, values, and assumptions. According to this framework, the underlying assumptions of an organization give rise to its espoused values, which in turn drive the creation of organizational artifacts. This framework of organizational culture levels is presented in Figure 6.

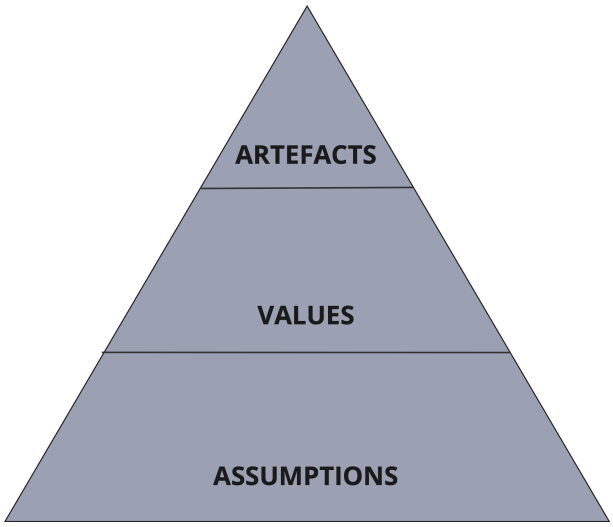

Figure 6. Levels of organizational culture (based on Schein, 1985)

Subculture researchers have challenged Schein's assumption that organizational cultures are unitary, arguing instead that distinct subcultures exist at the subunit level of organizations and that organizational cultures are rarely monolithic. Subcultures often form around occupational groupings, organizational roles, hierarchical levels, and functional or professional identities, or they may emerge based on shared understandings of tasks, missions, and authority structures (Howard-Grenville, 2006). Consequently, cultural research increasingly recognizes that organizational culture is rarely fully integrated and is more often differentiated or even fragmented (Meyerson & Martin, 1987). For instance, Hofstede's (2002) study of a large Danish insurance company identified three distinct subcultures within the organization and found that differences between these subcultures had tangible consequences. Similarly, Howard-Grenville's (2006) research in a sustainability context demonstrated that the existence of multiple subcultures leads to divergent interpretations and strategies, with the relative power of each subculture influencing which interpretations and strategies for action are adopted. This indicates that subcultures shape their members' interpretations and actions. The existence of subcultures is also a topic of interest in IT/IS research, which recognizes the impact that competing sets of values between subcultures can have on IT implementation and adoption, often resulting in resistance to certain technologies (Leidner & Kayworth, 2006).

While organizational culture is widely acknowledged for its impact on organizational outcomes, researchers argue that this influence is not direct. Instead, it operates through its effects on the behaviors of organizational

members and the development of organizational capabilities. For example, the literature points to a positive relationship between organizational culture and knowledge management capabilities, with culture shaping key behaviors related to the creation, sharing, and utilization of knowledge (De Long & Fahey, 2000; Zheng et al., 2009). Culture determines which knowledge is valued, who controls and shares it, and how it is used and disseminated within an organization (De Long & Fahey, 2000). Zheng et al. (2010) study have found that knowledge management mediates the relationship between organizational culture and organizational effectiveness, indicating that the successful management of knowledge is closely tied to how well cultural values are translated into organizational value. These findings highlight the importance of fostering a culture that supports learning and effective knowledge management. Additionally, this suggests that organizational culture plays a significant role in the adoption and use of information systems, especially those focused on data and information management, such as BI and analytics, which are central to this research.

It is also important to note that the terms "organizational culture" and "organizational climate" are sometimes used interchangeably, though they refer to different concepts. Denison (1996) identified overlaps in the culture and climate literature, noting that over time, the underlying similarities between the two have led some culture researchers to adopt the quantitative approaches traditionally associated with climate research. This shift has created a paradox in the culture literature—culture studies, originally rooted in qualitative methods, have increasingly begun to emulate a positivist research model, which culture researchers initially opposed. Organizational climate is defined as the meanings people attach to experiences they have at work, making it temporal and subjective concept. In contrast, organizational culture refers to values, beliefs, and assumptions held by members that guide life in organizations, and is therefore more evolved and historically grounded (Denison, 1996; Schneider et al., 2013). Although these two perspectives have generated distinct research agendas, methods and findings, Denison (1996) argued that the differences between these research traditions should be viewed as differences in interpretation rather than differences in the phenomena themselves. Similar conclusions drawn by Schneider et al. (2013) with proposal to integrate of climate and culture thinking and research.

In summary, while organizational culture is widely acknowledged for its critical impact on organizational capabilities and outcomes by both researchers and practitioners, the complex and elusive nature of this phenomenon makes it challenging to study. Although scholars have proposed

frameworks that facilitate the study of culture using quantitative methods, qualitative research holds significant potential to uncover hidden patterns.

1.3.2. Frameworks and typologies of organizational culture

In academic literature, several frameworks have been proposed to describe and shape the concept of organizational culture. While some critics argue that these conceptual models can oversimplify the complexities of organizational culture, they nonetheless play a crucial role in guiding empirical research and theory development (Hatch, 1993).

One of the most influential models is the Competing Values Framework (CVF), introduced by Quinn and Rohrbaugh (1981) and later popularized by Cameron and Quinn in their book "Diagnosing and Changing Organizational Culture: Based on the Competing Values Framework" (2005, 2011). This framework is structured around two key dimensions: flexibility versus stability, and internal versus external focus. These dimensions intersect to create four quadrants, each representing a distinct organizational culture: Clan (Collaborate), Adhocracy (Create), Market (Compete), and Hierarchy (Control). As authors have highlighted, no single cultural dimension is inherently superior to another. Most organizations tend to exhibit a dominant cultural dimension while incorporating elements from other dimensions to varying extents. This model is illustrated in Figure 7.

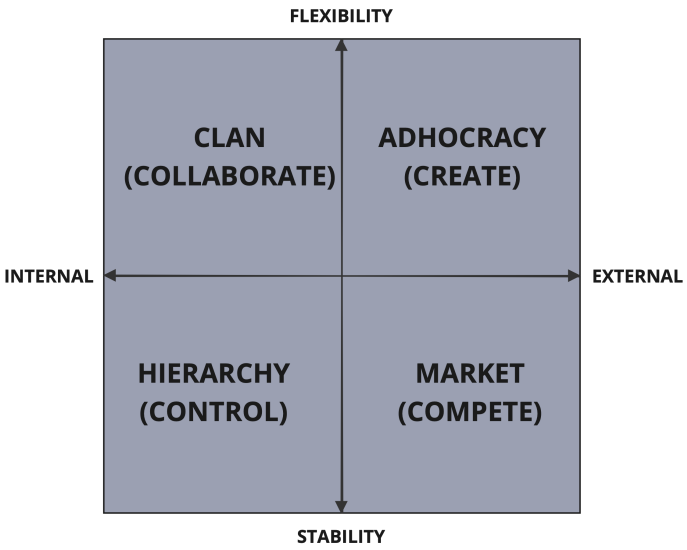

Figure 7. Competing values framework (based on Cameron and Quinn, 2005)

Hofstede's (1980) started his research in culture from the focus on national culture. His cultural dimensions theory is widely used across psychology, sociology, marketing, and management studies. Originally developed through factor analysis of a global IBM employee survey conducted between 1967 and 1973, the framework was initially intended to analyze national cultures but has since been adapted for organizational contexts. Hofstede originally identified four cultural dimensions: individualism-collectivism, uncertainty avoidance, power distance, and masculinity-femininity. Later, he added two more dimensions: long-term orientation and indulgence versus restraint. Despite its widespread use, Hofstede's model has faced criticism, particularly for equating nations with cultures and the limitations of understanding culture through numerical indices (McSweeney, 2002; Baskerville, 2003).

In a subsequent study, Hofstede et al. (1990) examined organizational culture specifically, analyzing various organizations within a single country. This research highlighted that independently of observed national culture differences, organizations varied in the way their practices were perceived by their respective members and concluded that shared perceptions of daily practices form the core of an organization's culture. The study derived a six-dimensional model of organizational culture, focusing on practices such as symbols, heroes, and rituals. The dimensions include process-oriented vs. results-oriented, employee-oriented vs. job-oriented, parochial vs. professional, open system vs. closed system, loose vs. tight control, and normative vs. pragmatic. Hofstede's work has made a significant and lasting impact on the study of organizational culture and remains a cornerstone in business research and management studies, including IT/IS management research. In a study by Ghafoori et al. (2024), Hofstede's model proved valuable in understanding the role of culture in data-driven digital transformation. The findings suggest that employee-oriented, market-oriented, and open cultures significantly enhance the success of data-driven digital transformation, thereby positively impacting operational performance.

Another notable contribution to the study of organizational culture is Westrum's (1988, 2004) work, which focused on culture within the context of safety and developed a typology to compare how organizations manage information flow—viewing it as an indicator of organizational culture. He identified three types of cultures: pathological, bureaucratic, and generative. In some organizations, information flows freely, enabling timely and appropriate responses, while in others, it is either withheld for political reasons or obstructed by bureaucratic hurdles. Generative cultures, in particular, promote effective collaboration and high levels of trust both across and within

hierarchical levels (Westrum, 2004). In these organizations, critical information reaches the right individuals in the correct form and within the necessary timeframe. This efficiency is driven by leadership that prioritizes mission accomplishment above all else. Westrum's model is presented in Figure 8.

PATHOLOGICAL	BUREAUCRATIC	GENERATIVE
Power oriented	**Rule oriented**	**Performance oriented**
Low cooperation	Modest cooperation	High cooperation
Messengers shot	Messengers neglected	Messengers trained
Responsibilities shirked	Narrow responsibilities	Risks are shared
Bridging discouraged	Bridging tolerated	Bridging encouraged
Failure -> scapegoating	Failure -> justice	Failure -> inquiry
Novelty crushed	Novelty -> problems	Novelty implemented

Figure 8. Organizational culture typology based on information processing (based on Westrum, 2004)

Westrum's typology has been adapted for use not only in academic research but also in industry-driven studies, particularly for examining the impact of organizational culture in technology organizations. The DORA (DevOps Research and Assessment) program, now under Google's ownership and in collaboration with academic researchers, publishes the annual "State of DevOps" reports (DORA, 2024), based on surveys of over 36,000 professionals across various industries and organizational sizes. Drawing on these reports and additional research, Forsgren et al. (2018) authored the book "Accelerate: The Science of Lean Software and DevOps: Building and Scaling High Performing Technology Organizations," offering valuable insights into trends and factors affecting technology organizations, including the influence of culture. Although Westrum's typology was initially developed to predict safety outcomes, DORA's research shows that it also predicts software delivery and organizational performance. The findings further confirm that Lean and Agile practices, along with other technical practices known as continuous delivery, have a significant impact on organizational culture.

In conclusion, as organizational culture is increasingly recognized as a key predictor of various organizational outcomes, there is a growing demand from both academia and industry for tools to measure its impact, despite the complexity of the phenomenon. The diversity of organizational culture measurement models indicates that no single tool is universally applicable. Therefore, scholars and practitioners should select measurement tools that are most relevant to their specific context and research objectives. Given its focus on information flow, Westrum's model is highly relevant to this research's aim of exploring the role of culture in the context of BI and organizational agility.

1.3.3. The influence of organizational culture on organizational agility

The human side of organizational agility has garnered interest within the academic community, yet empirical research in this area remains limited. Historically, research has predominantly focused on the quantitative and technological dimensions of organizational agility (Crocitto & Youssef, 2003; Felipe et al., 2017). Human-centered factors, such as organizational culture, represent enduring characteristics embedded in the underlying shared beliefs, values, norms, and priorities (Schein, 2017), making them difficult to research, quantify and alter. Nonetheless, these cultural aspects are equally, if not more, significant than technological factors and can influence a company's level of organizational agility. The shift to the culture supporting agility means recognizing and following the values related to collaboration, team building, empowerment, continuous improvement and learning, flexibility and commitment to innovation (Goncalves et al., 2020). Consequently, organizations increasingly view cultural transformations as essential for the success of their efforts to improve agility.

Though this research considers agility as a dynamic capability, distinct from "Agile" as a set of practices, methods, or ways of working, it is still valuable to examine the Agile concept from this perspective, particularly due to its synergies with the cultural impact and its influence on organizational agility. The Agile approach, initially introduced for the software development industry (Agile Manifesto, 2001), was designed to help utilize better ways of developing software. The Agile Manifesto outlined 12 principles and 4 core values: (1) Individuals and interactions over processes and tools, (2) Working software over comprehensive documentation, (3) Customer collaboration over contract negotiation, and (4) Responding to change over following a plan. This highlights the importance that Agile thought leaders placed on the role of values driving the culture within software development teams. The Agile methodology was enthusiastically adopted by the software industry and

transformed the way software was delivered. Agile approaches, which are people-centered, promote an empowered and collaborative working style, in stark contrast to the traditional IT project management practices of the time.

Over time, Agile principles spread beyond IT into broader organizational practices and other industries, becoming an umbrella term for a family of approaches that share common values and principles. However, as noted by the "Agile Alliance," some organizations, in adopting Agile practices, began rigidly enforcing specific processes rather than embracing the Agile mindset (Agile Alliance, n.d.). This underscores a critical point: organizations do not become Agile merely by changing work practices—they must realign their culture, shift behaviors, and adjust norms and mindsets across the organization to support Agile values. The intention of Agile ideologists to refocus on values, where the movement began, gave rise to the term "Agile culture."

The Agile Business Consortium, an organization dedicated to agility education and research, offers the following definition of agile culture based on their research: “Agile culture is about creating an environment underpinned by values, behaviors, and practices that enable organizations, teams, and individuals to be more adaptive, flexible, innovative, and resilient when dealing with complexity, uncertainty, and change.” They also expanded on this by defining Agile culture as a construct comprising three levels, following Schein’s (1985) conceptualization of organizational culture. In this model, assumptions, values, and artifacts are mapped to agile culture attributes, as visualized in Figure 9.

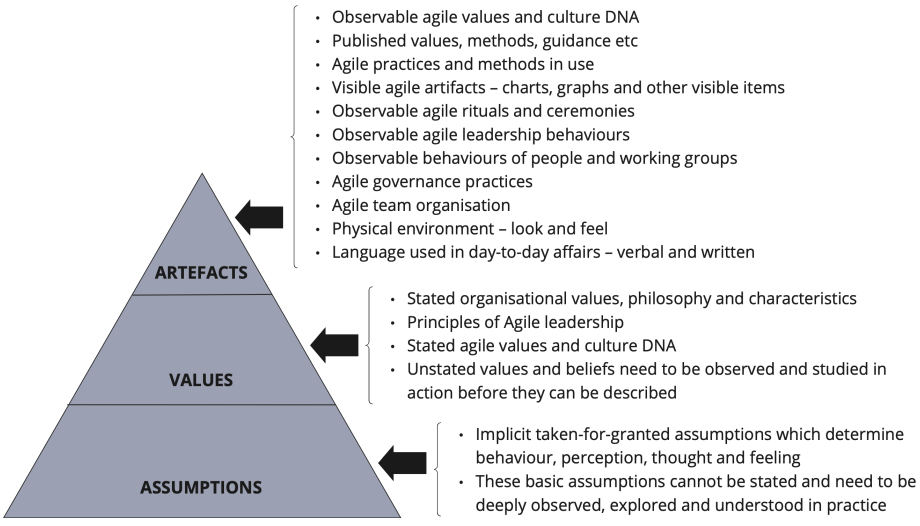

Figure 9. Agile culture layers (adapted from Agile Business Consortium, 2017)

While more commonly found in practitioner literature, agile culture concept has also been explored in academic research, with scholars attempting to conceptualize it.

The study by Gregory and Taylor (2019) took a practitioner-led approach to developing a definition of agile culture and a set of tools to aid cultural assessment. They have identified seven elements of agile culture: unleashed purpose and meaningful results; agile leadership; well-being and fulfilment; collaborative communities and distributed authority; trust and transparency; adaptability to change; innovation, learning and personal mastery. They also admitted that since culture is about behaviours, attitudes, values, and beliefs, some aspects are difficult to measure. Despite that they developed a pragmatic set of tools to help practitioners understand the situation in their organisation and initiate changes towards a more agile culture.

Scholars investigating agile culture have drawn on the Competing Values Framework developed by Cameron and Quinn (2005), which categorizes organizational cultures into four types: adhocracy, clan, hierarchy, and market. These types are based on the tensions between flexibility versus stability and internal versus external focus. Goncalves et al. (2020) applied this framework in a qualitative study to explore how cultural values shape organizational agility within the automotive industry, particularly in how companies approach digital innovation. The study revealed two main insights. First, organizational agility is optimized when both Clan and Adhocracy cultures are combined and integrated. The authors referred to this fusion as "Agile culture," emphasizing that the complementary nature of these cultures strengthens agility. Second, they found that the values of Hierarchy and Market cultures oppose those of Clan and Adhocracy, making them incompatible with agile culture and inhibiting innovation. However, a report by the Agile Business Consortium (2017) offers a nuanced view, suggesting that Agile culture is about finding the right balance to achieve organizational goals. It argues that change without stability leads to chaos, and innovation without productivity results in waste. In a similar vein, McKinsey (Aghina et al., 2015) acknowledges the paradox of competing values, emphasizing that genuinely agile organizations master the balance of being both stable while also being dynamic.

Westrum's (1988) typology of cultures—pathological, bureaucratic, and generative—discussed earlier in this paper, is also highly relevant to understanding agile organizational culture. Generative cultures, as identified by Westrum, promote effective collaboration and foster high levels of trust across hierarchical levels (Westrum, 2004), both of which are essential values for agile organizations.

To conclude, for a successful transition to agility, organizations must not only adopt agile practices but also embed a culture of continuous change within their core values. While "agile culture" is a more common term in practitioner circles, scholars have also sought to map various organizational cultural traits to the values, norms, and behaviors that support organizations in their pursuit of agility.

1.3.4. The influence of organizational culture on IT

An important area of research is the relationship between culture and IT, which has garnered significant attention in IS research due to culture's impact on the successful implementation and use of IT. One of the most cited reasons for digital transformation failures is organizations neglecting cultural factors (Kane et al., 2016).

The highly cited research by Leidner & Kayworth's (2006) with their extensive literature analysis revealed that most culture-focused research in IS examines culture's impact on IT (Hoffman & Klepper, 2006; Bradley et al., 2006), some studies investigate IT's impact on culture (Cabrera et al. 2001; Doherty & Doig, 2003; Grover et al., 2022), and only few explore the notion of an IT culture itself (Walsh et al., 2010). Another research interest is the "fit" between IT and culture, recognizing that even effective technology can be sabotaged if it conflicts with established social network values (Martinsons & Chong, 1999).

Researchers found it useful to examine IT and culture linkage through a values-based approach, considering IT values and individual or group values expressed through IT-related behaviors and assumptions. Leidner & Kayworth (2006) developed propositions concerning three types of cultural conflict and the results of these conflicts. Ultimately, the theory suggests that the reconciliation of these conflicts results in a reorientation of values. Conflicts between these values can impact system adoption and usage in companies (Leidner & Kayworth, 2006). Resolving these conflicts involve reorienting values; otherwise, the system may be rejected or modified to align with the existing culture (Cooper, 1994).

Several studies highlight the critical role of organizational culture in deriving business value from BI and analytics (Bordeleau et al., 2019; Oesterreich et al., 2022). Research suggests that improvements in information flow facilitated by analytics technologies can even modify organizational culture, promoting data-driven decision-making over intuition and "gut feelings"-based decisions (Watson & Wixom, 2007), aiding in organizational culture reengineering (Doherty & Doig, 2003).

Despite significant research interest in the relationship between IT and culture, the study of cultural effects within the BI context remains fragmented. Therefore, it is essential to maintain a focus on the human element in BI research, as human involvement is crucial for shaping analyses to address the right questions, communicating findings, and making decisions, especially at tactical and strategic levels.

1.4. Conceptual framework and hypothesis development

1.4.1. Conceptual model

The research model of this study, encompassing both the dimensions of the BI agility construct and the hypotheses to be tested, is presented in Figure 10.

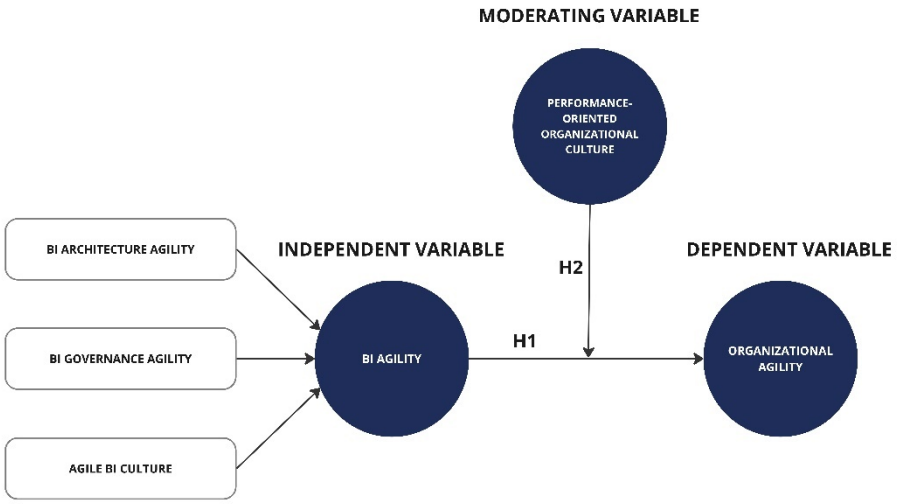

Figure 10. Research model (prepared by the author)

1.4.2. Hypothesis development

1.4.2.1. The relationship between Business Intelligence agility and organizational agility

Today's organizations invest heavily in developing and acquiring BI and analytics assets to support data-driven decision-making. The strategic role of BI and analytics in enhancing organizational agility is widely recognized in the literature (Chen & Siau, 2020). Scholars generally agree that leveraging data through BI and analytics technologies helps improve an organization's

sensing, decision-making, and acting agility, making firms more responsive to changes in the business environment (Park et al., 2017). Data technologies, including descriptive, predictive, and prescriptive analytics, enable organizations to gain valuable insights through real-time monitoring, pattern recognition, and scenario modeling (Overby et al., 2006). These technologies enhance firms' sensing capabilities by providing high-quality information on current business conditions, forecasting potential trends, and guiding action plans—thus helping organizations not only sense but also respond effectively to emerging opportunities and threats. Research consistently shows that BI enhances organizational agility by improving information quality, facilitating easy access to data, enabling data-driven decision-making, and fostering widespread information sharing across business units (Baars & Kemper, 2008; Chen & Siau, 2011; Ashrafi et al., 2019). These capabilities are critical in providing real-time insights into business opportunities and challenges, thereby enhancing organizational responsiveness and agility.

However, the mere presence of BI within an organization does not automatically lead to the expected outcome of increased organizational agility. Research has established that IT, by itself, does not inherently boost agility and, in some cases, can even impede it (Overby et al., 2006; Seo et al., 2006; Van Oosterhout et al., 2006). According to Overby et al. (2006), the effectiveness of IT in enhancing agility depends on its deployment and management, as inadequate investment or poor management can hinder agility by limiting response options (e.g., through monolithic IT architectures) and restricting information visibility (e.g., storing data in ways that are difficult to retrieve and interpret). Similarly, Van Oosterhout et al. (2006) found that many enterprises are constrained by complex, inflexible legacy systems with hard-coded business processes, intricate inter-application links, and isolated technology silos from various vendors, which collectively act as significant barriers to business agility. Seo et al. (2006) identify several challenges - referred to as the “dark sides” of IS - that can impair organizational agility, especially in data-driven systems like BI. Key issues include:

- Data overload, where critical insights are lost amid vast data volumes.
- Lack of integration, with fragmented or duplicated data leading to inefficiencies and missed insights.
- Data inconsistency, as varied formats from different sources require time-consuming standardization, delaying action.
- Rigid IS architecture, which can lead to missed emerging signals in unexplored areas.

- Inaccurate data, where poor data quality risks faulty analysis and misguided responses.
- Decision-maker overload with information, where decision-makers become bottlenecks delaying timely responses.

Scholars have thus emphasized the importance of IS agility, which refers to the ability of information systems to quickly adapt to evolving business environments. This capability is crucial as systems become more integrated and complex (Goodhue et al., 2009; Lu & Ramamurthy, 2011). This principle applies to BI, where BI agility - the capacity for BI systems to adapt rapidly - becomes a critical enabler of organizational agility.

As organizational agility is often defined as the ability to sense and respond to environmental changes effectively and efficiently, BI agility—encompassing both technical flexibility and human-centered adaptability—is vital for supporting such responsiveness. For organizations to fully realize the value of their BI investments, BI systems must be capable of quickly adjusting to evolving business needs and market conditions (Zimmer et al., 2012; Knabke & Olbrich, 2013). However, as BI is a socio-technical system, it is not enough to focus solely on technical adaptability. The human dimensions - including governance and culture - play a decisive role in enabling BI agility. This includes ensuring alignment between BI teams and broader business functions, so the insights generated by BI are not only technically sound but also actionable and strategically relevant (Popovič et al., 2012).

In conclusion, while BI is an enabler of organizational agility, the agility of the BI system itself - comprising both technical and human-centered factors - is crucial for BI to make a meaningful contribution to organizational agility. This leads to the following hypothesis:

H1: An organization's BI agility, encompassing both technical and human factors, positively influences its organizational agility.

1.4.2.2. The role of organizational culture in the contexts of agility and Business Intelligence

Organizational culture theory has been instrumental in explaining various organizational behaviors and outcomes, including organizational agility (Crocitto & Youssef, 2003; Felipe et al., 2017) and the successful implementation of IT (Leidner & Kayworth, 2006). An effective organizational culture provides the foundation for executing key strategies,

such as the agile and digital transformation initiatives that are essential for modern businesses (Heskett, 2022).

Although the role of culture in promoting agility is extensively covered in practitioner literature, there is a notable gap in academic research on this subject. Human-centered factors, such as organizational culture, represent enduring characteristics that are rooted in shared beliefs, values, norms, and priorities (Schein, 2017), making them difficult to research, quantify, and change. To better understand organizational culture and its role in agility, scholars have proposed frameworks such as the Competing Values Framework (Cameron & Quinn, 2005) and Westrum's typology (1988). These frameworks help identify cultural types that are conducive to organizational agility, with agility-supporting cultures characterized by values such as collaboration, team building, empowerment, continuous learning, flexibility, and innovation (Goncalves et al., 2020). As a result, organizations increasingly view cultural transformation as critical to improving agility.

In the field of IS, culture is recognized as a key factor in the success or failure of IT adoption (Leidner & Kayworth, 2006). Studies have shown that when the values of IT systems conflict with organizational culture, adoption is hindered (Martinsons & Chong, 1999). Thus, aligning culture with technology is crucial for deriving value from technology investments. Numerous studies emphasize the importance of organizational culture in deriving business value from BI and analytics (Bordeleau et al., 2019; Oesterreich et al., 2022). Since an organization's culture has a significant impact on information flow (Westrum, 2004), BI systems, which rely heavily on data and information flow, are particularly sensitive to cultural factors. However, there is a lack of empirical research exploring how culture shapes the role of BI in enhancing organizational agility. To date, no studies have specifically examined how culture influences BI agility and its effect on organizational agility.

Given that BI is critical for sensing and responding to changes in business environment, understanding how organizational culture moderates the impact of BI agility on organizational agility is essential. This understanding could help organizations more effectively maximize the value of their BI investments. Therefore, this study aims to fill this gap by exploring how organizational culture influence BI agility in driving organizational agility. Based on this, the following hypothesis is proposed:

H2: Performance-oriented organizational culture moderates the relationship between an organization's BI agility and its organizational agility.

2. QUALITATIVE EXPLORATION AND ITEM GENERATION FOR BI AGILITY SCALE

2.1. Interview design and data collection

The study conducted 15 interviews with professionals and leaders in the BI field, using purposive and snowball sampling techniques to select interviewees with the aim of gathering diverse perspectives and experiences on BI agility factors and indicators. This approach ensured representation from organizations of various sizes and sectors operating in Lithuania. The details of the interviewees are presented in Table 4.

Table 4. Demographic details of the interviewees

Participant	**Position**	**Industry**	**Number of employees**	**Company yearly income, EUR**
1	Head of data and analytics	Telecommunications	2000	400 M
2	Team manager in customer data development unit	Banking	15000	7 B
3	Architect in group BI unit	Banking	15000	7 B
4	COO	IT services	10	0,5 - 1 M
5	CEO	IT services	10	0,5 - 1 M
6	Finance director	Manufacturing	160	50 - 100 M
7	Analyst in data management unit	Retail	410	90 M
8	Head of data science, AI and analytics	Telecommunications	2000	400 M
9	Head of financial planning & analysis	Logistics	17000	1,3 B
10	Brand marketing manager	Financial services	980	20 M

Participant	Position	Industry	Number of employees	Company yearly income, EUR
11	BI product manager	IT services	10	0,5 M
12	Chief data & analytics officer	Financial services	210	15 M
13	Department manager	Manufacturing	200	22 M
14	Unit manager	Financial services	2000	100 M
15	Unit manager	Financial services	2000	100 M

The interviews were conducted using MS Teams in 2021-2022, employing a semi-structured protocol. The duration of interviews ranged from 1 to 1,5 hours. The questions addressed diverse aspects of business intelligence, encompassing changes in BI (both smooth and challenging), reasons behind challenges and successes, factors constraining and enabling BI agility, organizational support for BI agility, actions taken to enhance BI agility, and the required resources for such improvements.

2.2. Data analysis method

In this study, interview data was transcribed and analyzed using ATLAS.ti version 22 software to identify repeated patterns across the dataset. The thematic analysis method was employed to analyze key themes that are relevant to the research subject. Following established qualitative research principles (Boyatzis, 1998; Braun & Clarke, 2006), the process involved iterative data reading, coding and theme searching, refining, and naming for the presentation of results.

The use of ATLAS.ti software facilitated the evaluation of the groundedness of each code, indicating the number of quotations linked. During the analysis process, the software's features enabled the manual linkage of quotations from the transcripts to specific codes. This linkage was based on mentions of related words, synonyms, or other phrases relevant to the meaning of the specific code.

2.3. Data analysis and key insights

2.3.1. Overview of analysis results

The analysis findings were organized into three primary themes, as identified during the conceptualization stage: BI Architecture Agility, BI Governance Agility and Agile BI Culture. The use of ATLAS.ti software aided in the evaluation of the groundedness of each code, which was based on the number of linked quotations (presented in Table 5).

Table 5. Interview codes and their groundedness

BI Architecture Agility	**49**	**BI Governance Agility**	**68**	**Agile BI Culture**	**72**
Data acquisition agility	18	Competence development	14	BI use for decisions	31
BI content agility	16	Business and IT collaboration	11	Employees eager to use data	24
Reporting & analysis functional agility	13	Unified terms and language	8	Sharing of BI insights	10
Data storage agility	13	Business change communication	7	Encouragement for experimentation with data	10
Un-siloed data architectures	12	Defined data ownership	7	BI community	8
Sandboxes	6	Data quality processes	5	Feedback on the impact of BI on business	6
Data acquisition scalability	5	Rapid decision making	5	Trust in insights derived from BI	6
Data storage scalability	4	Value based prioritization	5	Courage to “rock the boat”	5
Scalable reporting & analysis	2	Innovation processes	4	Collaboration in analysis	4
Data storage functional agility	1	Self-organized teams	4	Sharing of lessons learned	3
ETL functional agility	1	BI content renewal	3	Tolerance for mistakes	2
		Interdisciplinary teams	3	Cross-validated analysis	1
		Iterative process	3		
		Lessons learned processes	2		

The results indicate that interviewees mentioned factors associated with agile BI culture and BI governance agility more frequently than those related to BI architecture agility. This underscores the significance of human-centered factors in the perception of BI agility among respondents.

The following figure (Figure 11) offers an overview of the dominant drivers within BI agility dimensions and representative quotations illustrating the respondents' thinking.

Figure 11. Most prominent themes from interviews and representative quotations (prepared by the author)

It is also noteworthy that factors related to BI governance agility and agile BI culture were frequently mentioned in the same quotations, indicating a strong interrelationship between process-oriented and culture-related factors, highlighting their shared human-centered nature.

2.3.2. Key themes and insights

2.3.2.1. Theme 1: BI architecture agility

Within the realm of BI Agility, eleven interviewees underscored the importance of BI architecture and technology-related factors. Within this thematic domain, the following key elements associated with technology emerge as the most prominent.

New data acquisition, storage, and availability for reporting and analysis were frequently mentioned factors that underscored the speed and complexity of efforts in making new data available in BI. Several respondents noted that BI systems failing to deliver on these factors led users to resort to alternative methods, such as gathering data and performing analysis in Excel. Interviewee 1 aptly summarized this situation: "*The sluggishness of BI in implementing changes and updates often compels users dealing with urgent matters to resort to operational reporting and subsequently carry out analysis using Excel. This, in turn, gives rise to a parallel reporting world, commonly referred to as shadow BI.*"

Reporting and analysis functionality plays a pivotal role in empowering end users of BI. The interviewees emphasized the importance of having flexible, user-friendly BI tools that satisfy users' functional needs, enabling them to perform effective data analysis. Moreover, they expressed expectations for future capabilities, such as those related to AI and machine learning, as highlighted by Interviewee 6: "*Three years ago, we opted for a highly regarded tool by Gartner, and currently utilize it for manual data analysis and visualization. However, going forward, we are keen on integrating AI and machine learning capabilities into our data analysis processes.*"

Un-siloed data architectures was another frequently mentioned theme associated with BI Agility. While such implementations may take longer due to the complexity of aligning and integrating data from various domains and sources, they ultimately act as an agility enabler, as noted by Interviewee 5: "*In my opinion, a unified system provides agility because it already has integrated data, making it simple to generate new reports, modify dimensions, and analyze from different perspectives. However, if the data is spread across separate applications, it becomes difficult to integrate and transform.*"

2.3.2.2. Theme 2: BI governance agility

The data analysis revealed that all of the interviewees acknowledged the pivotal role of governance-related factors in enhancing BI Agility. The following sections offer a more in-depth exploration of the dominant themes within governance.

Competence development was identified as a significant factor in establishing effective governance of BI to enhance agility. Interviewees emphasized the importance of competence in BI technology, business, and agile methodologies. Fostering competence in BI technology enables self-service analytics and empowers business functions to leverage data in their daily operations. As one interviewee commented, the goal is to create a platform where everyone is encouraged to be an analyst for their relevant area, and where decentralized analytics can replace the outdated model where only a few analysts and finance department were responsible for data and analysis. Continuous competence development and business expertise are crucial for maintaining BI Agility, while employee turnover poses challenges due to lost knowledge and onboarding time. Several interviewees also indicated that companies are investing in training programs to educate employees about agile methods and their application in BI-related processes, underscoring the role of agile proficiency in enabling BI Agility. When discussing the competence of BI specialists, interviewees recognized that possessing technological proficiency alone is insufficient, as a crucial competency also involves having a comprehension of the business domain and context.

Business and IT collaboration was another dominant theme that emerged during discussions on governance-related factors. This was perceived as a two-way street, with BI specialists displaying an interest in understanding the business to facilitate better insights with the assistance of BI, and business specialists being highly involved in the implementation of BI solutions, which also aids IT in comprehending the business context. As interviewee 11 stated: "*Business engagement to BI implementation is critical condition for success. Without such collaboration even the most technically advanced BI solutions won't be valuable if there will be lack of trust and not met business needs*".

Unified terms and language were highlighted by the interviewees as a critical need in order to secure consistency of analysis results. They identified the absence of such alignment as a major obstacle to achieving BI Agility, as it limits the ability to perform analyses and may result in multiple versions of truth if analyses cannot be performed within a single BI tool. Interviewee 1 emphasized: "*During implementation it was very clear that we lack*

conceptual model and unified terms. We have 150 systems where customer data is being stored so such alignment was crucial."

2.3.2.3. Theme 3: agile BI culture

According to the analysis results, the interviewees reported the agile BI culture-related factors with the highest frequency. This finding suggests a significant association between culture factors and BI Agility, highlighting the challenges that companies face in leveraging data to increase value while contending with cultural barriers. The following cultural traits were identified as core drivers of BI Agility.

BI use for decisions was highlighted nearly by all interviewees, as they firmly believed that it serves as a key cultural trait in leveraging BI and driving BI Agility. Companies that possess a high level of maturity in their data-driven culture recognize the value and consequences of delayed information, which in turn drives the demand for agility in BI architecture. As Interviewee 13 noted: "*Time is a critical factor in every business. Without access to the necessary information at the right time, decision-making is delayed, which can be detrimental to business outcomes.*" Interviewees also noted that businesses implement processes to facilitate well-informed and prompt decisions, thereby reinforcing their data-driven culture and highlighting the strong connection between culture and governance.

Employees eager to use data, and incorporate it in their daily tasks, was another frequently cited cultural attribute. This trait is closely linked to the importance of empowering a wide range of BI users and fulfilling their data needs, rather than concentrating BI solely on a small group of data analysts. As Interviewee 7 elaborated: "*The most effective way to achieve agile business intelligence is to enable the users who utilize the tool to influence the BI dynamics. Merely having a highly skilled analyst is insufficient. While analysts can assist in cultivating an analytics culture, they cannot manage the entire analytics scope*." One interviewee recounted a lesson learned from an organization where the implementation of BI failed since it was driven by the implementation of a new accounting system rather than the demands originating from employees, as driven by strategy, processes, culture and community. Nevertheless, numerous interviewees mentioned positive examples where employees not only utilized the data available in BI but also demonstrated initiative in acquiring new data or adding new metrics to track.

Communication and sharing of information was identified as another cultural characteristic that several interviewees emphasized as an enabler of BI Agility. The interviewees described how this capability is being fostered

through the introduction of recurring ceremonies and meetings aimed at examining key performance indicators (KPIs), which trigger discussions and lead to effective decision-making. This underscores the interdependence between cultural and governance traits. One interviewee highlighted the importance of having a unified BI solution in order to facilitate seamless communication and exchange of information, which ultimately enhances the quality of communication within the company.

Encouragement for experimentation, including a tolerance for mistakes, emerged as another theme highly associated with BI Agility. This trait could be linked to the innovativeness of the company. As one interviewee stated, "*People who drive agility should be innovators. Often, innovations are forgotten, especially when employees are too busy with operational activities and do not have time to think about new ideas. This is a common problem in many companies which relates to how they perceive efficiency*." Companies that interviewees regarded as proficient in using data were also viewed as those that are constantly seeking new ways to analyze data and have frequent demands to add new data.

2.4. Item generation for BI agility scale

The objective of the item generation process was to create a comprehensive set of items (including indicators and formulated statements for a measurement instrument) that encompass essential aspects of the BI agility construct's domain. This process was informed by the outcomes of the literature review, as summarized in Figure 1, and augmented with insights from interviews, as detailed in Table 2 and in Figure 3. In most cases, the literature review provided a foundation in higher-level theoretical concepts of the items, while interviews offered practical insights into how these concepts manifest within organizations. Due to the multidimensional nature of BI agility, this process entailed developing distinct sets of items for each dimension: BI architecture agility, BI governance agility, and agile BI culture. As a result of this process, a total of 59 items were generated, drawing from the findings of the literature review and interviews.

For the evaluation of the developed list of items, the research engaged a panel of six experts, comprising both BI practitioners and academics. These experts had not been involved as interviewees in the earlier phase of the research, ensuring that their assessments remained unbiased. Based on the feedback from this panel, statements were refined, simplified, and reduced to a final set of 37 items, detailed in the Appendix B.

2.5. Initial measurement model specification

The next step was to specify a measurement model that determine the expected relationships between the indicators, the dimensions they are intended to represent and the target construct. Based on the insights derived from this study, the hypothesis is proposed that the multidimensional second-order construct of BI agility comprises three reflectively measured first-order constructs: BI architecture agility, BI governance agility, and agile BI culture. The first-order constructs employ a reflective measurement model, whereas the second-order construct BI agility is a composite formed by the first-order constructs. Thus, the measurement model is identified as reflective-formative. A visual representation of the BI agility construct is depicted in Figure 12.

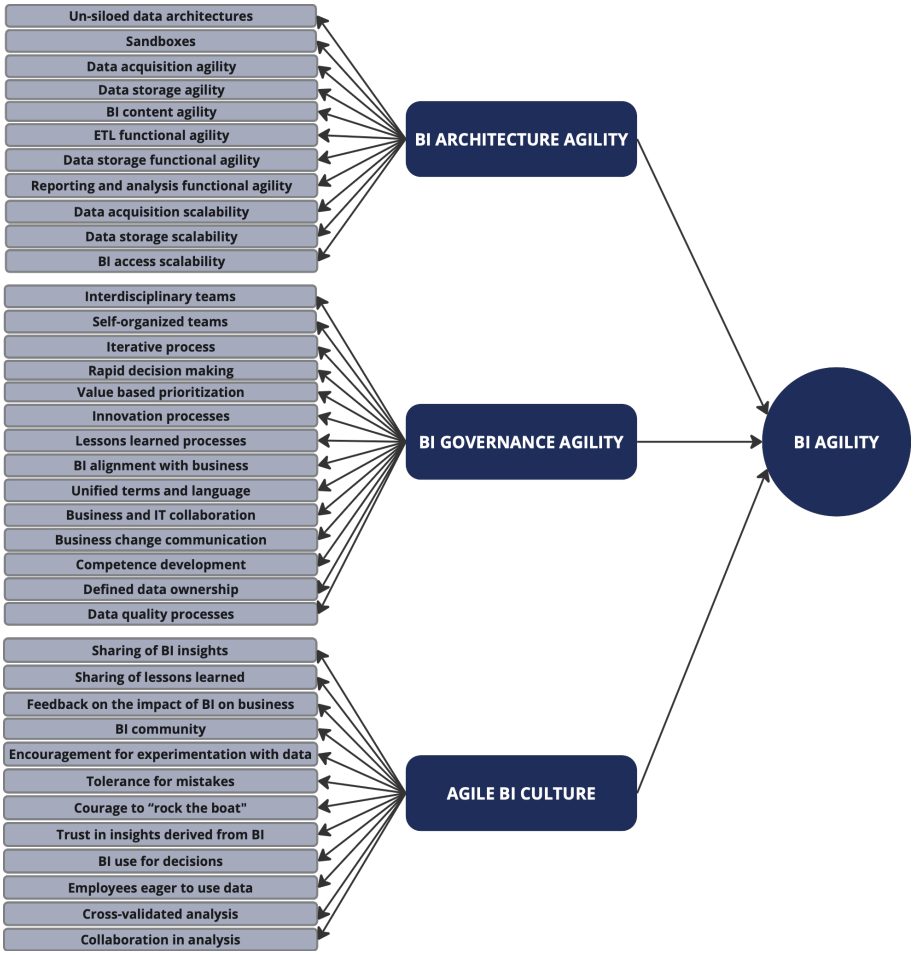

Figure 12. The reflective-formative model of BI agility construct (prepared by the author)

In the reflective-formative model, which has become widely adopted by researchers in the social sciences due to the availability of suitable modeling software (Crocetta et al., 2021), the lower-order constructs are reflectively measured and not connected causally but instead form a general concept (Chin, 1998). This aligns with our hypothesis that BI architecture agility, BI governance agility, and agile BI culture serve as fundamental building blocks of BI agility.

The evaluation and refinement of the proposed scale through quantitative methods, along with the validation of the suggested measurement model, extend beyond the scope of this publication. Nevertheless, these steps are essential, and future studies should undertake exploratory factor analysis and confirmatory factor analysis before utilizing the scale in their research endeavors.

2.6. Discussion and conclusions

This research extends the concept of BI agility by introducing a holistic approach that encompasses BI architecture agility, BI governance agility, and agile BI culture, and operationalizes it through a scale for measuring BI agility. Our findings emphasize the critical role of human-centered factors, particularly cultural aspects, as evidenced by our series of interviews and insufficiently addressed in previous studies on BI agility.

Unlike architecture and governance agility, which can be guided by rules, culture necessitates human-centric approaches that nurture specific values, norms and behaviors. In this study the culture is recognized as a catalyst for BI agility that, if overlooked, could compromise organizational efforts in the realms of architecture and governance. While initiatives in architecture and governance might yield fast and visible results, agility is not about one-time changes, it necessitates the development of human driven capabilities for continuous renewal. Therefore, organizations aspiring to achieve sustained BI agility should prioritize the development of a BI-positive culture. This strategic focus could enhance the utilization of BI, potentially positioning it at the core of organizational information and decision-making processes.

The proposed BI agility scale offers a practical instrument for organizations to assess their BI agility, identifying strengths and opportunities for further action to enhance their agility in this area. The recommendation is to employ this scale in a survey format, utilizing a Likert scale, and inviting employees to evaluate their organization's BI agility across all three dimensions. Although the scale is comprehensive, it utilizes a reflective measurement model for the lower-order constructs, wherein items within such a model can be used interchangeably, and adding or removing an item does

not alter the conceptual domain of the construct (Coltman et al., 2008). Consequently, there may be additional relevant indicators outside this scale's scope that could offer further insights into an organization's BI agility.

Emerging recognition of BI culture underscores the need to expand research perspectives to understand how organizational values, norms, and beliefs shape and are shaped by BI practices, thereby influencing BI agility and overall organizational agility. Thus, the developed scale, following further quantitative evaluation and refinement, could be utilized in empirical studies aiming to test hypothesis related to BI agility.

3. QUANTITATIVE REFINEMENT AND VALIDATION OF THE BI AGILITY SCALE

3.1. Survey design and data collection

3.1.1. Purpose of the survey

After developing the BI Agility Scale in the earlier stage of this research, the next step was to evaluate and refine the scale using statistical factor analysis, specifically exploratory factor analysis (EFA), followed by validation through confirmatory factor analysis (CFA). This required conducting a survey to collect the necessary data. Therefore, an online survey was designed and executed for this purpose.

Since the overall research involved two surveys for clarity, this survey is designated as Survey No. 1.

3.1.2. Survey sample and process

Given the limited number of individuals who use BI systems in their job roles, the sample population was characterized as hard-to-reach, necessitating creative strategies to engage respondents. To address this challenge, the study employed several approaches. Initially, the survey was distributed via email and private messages on social platforms to the professional network of the research group. Subsequently, it was shared on LinkedIn, which is particularly effective for reaching hard-to-reach populations (Baltar & Brunet, 2012; McCormick et al., 2012). The survey targeted individuals who listed 'Business Intelligence,' 'Analytics,' or 'Data' as interests or job titles in their profiles, with a specific focus on respondents located in Lithuania. This strategy helped identify individuals who met the target criteria and overcame access barriers. No compensation was provided to participants for their involvement.

Demographic information was collected, including the sector of the participants' organizations, the number of employees, their job positions, country of employment, and years of experience in BI. The survey, conducted from Q4 2021 to Q2 2022, received a total of 100 responses, primarily from individuals employed in Lithuania. Factor analysis literature emphasizes that larger sample sizes yield more reliable results. Gorsuch (1983) and Kline (1994) suggest 100 as the minimum sample size, with Kline recommending a 2:1 ratio of responses to variables. Thus, a sample size of 100 is considered acceptable for factor analysis. The demographic breakdown of the survey sample is presented in Table 6.

Table 6. Demographic breakdown of a survey No. 1 sample

Demographic item	Survey No. 1	
	Responses	**N (%)**
Sector	Software & Services	21%
	Banks	18%
	Diversified Financials	7%
	Retailing	6%
	Telecommunication Services	6%
	Other	42%
Number of employees	5001 and more	19%
	1001 - 5000	20%
	501 - 1000	16%
	251 - 500	15%
	7 - 250	26%
	1 - 6	4%
Position	Data analyst	42%
	Manager	15%
	Executive	9%
	BI analyst	6%
	Business analyst	6%
	Other	22%
Country of employment	Lithuania	91%
	Other	9%
Years of experience within BI	1 - 3	35%
	4 - 5	26%
	6 - 10	17%
	more than 10	22%

Analysis of the demographic data revealed that the majority of respondents were employed in organizations with a presence in Lithuania, while a few participants belonged to organizations in other countries. The software and services sector constituted the largest segment of respondents' organizations, followed by banks and other financial institutions. The distribution of employees across respondent companies varied, indicating representation from organizations of different sizes.

A significant proportion of respondents identified themselves as occupying data analyst positions. The results indicated a range of BI experience levels among the participants, spanning from those with 1-3 years of experience to individuals with more than 10 years of experience.

3.1.3. Survey instrument

As described in an earlier section, a rigorous approach was employed, incorporating a literature review and interview methods to identify items that could assist in measuring BI Agility. Consultations with both BI practitioners and academics further validated these items. This comprehensive process ensured the validity and reliability of the items, which were used to create a measurement instrument designed to assess the level of BI Agility within organizations.

The BI Agility Scale used in the survey encompassed a total of 37 items, distributed across three first-order scales: BI Architecture Agility, BI Governance Agility, and Agile BI Culture. Participants were asked to indicate the extent to which they agreed with statements related to BI Agility, using a seven-point Likert scale ranging from 1 (Strongly Disagree) to 7 (Strongly Agree). The survey instrument is provided in Appendix C.

3.1.4. Analysis method

To explore the underlying latent factor structure in the dataset (n=100) from Survey No. 1 and identify a set of meaningful and strong indicators for the BI Agility construct, this study employed EFA using IBM SPSS (version 29). Subsequently, to evaluate whether the data fit the hypothesized measurement model, CFA was performed using JASP (version 0.19.3).

3.2. Data analysis and scale refinement

3.2.1. Data quality checks

The sample size (n=100) from Survey No. 1 met the minimum recommended threshold for conducting EFA (Gorsuch, 1983; Kline, 1994). This study assessed data quality through frequency distribution analysis, ensuring completeness with no incomplete responses detected.

The descriptive statistics analysis of the study data (presented in Table 7) provides key insights into the dataset. The variability across items, with standard deviations ranging from 0.97 to 1.73, indicates sufficient differentiation in responses, which is essential for identifying underlying factors. The full observed scale range (1–7) across all items confirms the scale's capability to capture diverse perceptions. Slightly negative skewness (e.g., BIC9, skewness = -1.341) reflects a tendency toward agreement, while balanced skewness (e.g., BIG6, skewness = -0.113) suggests that such items are well-distributed and likely to contribute strongly to factor loadings. Excess

kurtosis values range from peaked distributions (e.g., BIC9, kurtosis = 1.987) to flatter ones (e.g., BIG10, kurtosis = -1.251), highlighting diverse response patterns that are beneficial for identifying distinct dimensions of BI Agility. Overall, the data exhibits sufficient variability, a full range of responses, and no missing values, which enhance the reliability of factor extraction and effectively support the scale development process.

Table 7. Descriptive statistics of survey items

Name	Mean	Median	Observed min	Observed max	Standard deviation	Excess kurtosis	Skewness
BIA1	4.320	5.000	1.000	7.000	1.636	-1.175	-0.251
BIA2	5.050	6.000	1.000	7.000	1.445	0.490	-1.119
BIA3	4.620	5.000	1.000	7.000	1.573	-0.851	-0.616
BIA4	4.030	4.000	1.000	7.000	1.670	-1.120	-0.100
BIA5	4.820	5.000	1.000	7.000	1.381	0.127	-0.849
BIA6	4.650	5.000	1.000	7.000	1.472	-0.448	-0.634
BIA7	4.840	5.000	1.000	7.000	1.481	-0.107	-0.807
BIA8	4.780	5.000	1.000	7.000	1.432	-0.103	-0.745
BIA9	4.590	5.000	1.000	7.000	1.394	-0.051	-0.718
BIA10	4.530	5.000	1.000	7.000	1.452	-0.222	-0.667
BIA11	3.950	4.000	2.000	7.000	1.512	-1.108	0.262
BIG1	4.920	6.000	1.000	7.000	1.617	0.005	-1.022
BIG2	4.960	6.000	1.000	7.000	1.562	0.129	-1.069
BIG3	4.790	5.000	1.000	7.000	1.275	0.627	-1.007
BIG4	4.380	5.000	1.000	7.000	1.554	-0.689	-0.478
BIG5	4.850	5.000	1.000	7.000	1.424	1.090	-1.166
BIG6	4.140	4.000	1.000	7.000	1.594	-1.002	-0.113
BIG7	4.120	5.000	1.000	7.000	1.614	-0.865	-0.415
BIG8	4.600	5.000	1.000	7.000	1.442	-0.531	-0.609
BIG9	5.170	6.000	1.000	7.000	1.241	1.934	-1.380
BIG10	4.120	4.000	1.000	7.000	1.728	-1.251	-0.011
BIG11	4.900	5.000	1.000	7.000	1.253	0.636	-0.861
BIG12	4.290	4.000	1.000	7.000	1.505	-0.444	-0.454
BIG13	5.060	5.000	1.000	7.000	1.248	1.628	-1.276
BIG14	4.550	5.000	1.000	7.000	1.627	-0.552	-0.699
BIG15	4.540	5.000	1.000	7.000	1.486	-0.948	-0.394
BIC1	5.100	5.000	1.000	7.000	1.187	1.364	-1.106
BIC2	4.710	5.000	1.000	7.000	1.381	-0.261	-0.759
BIC3	4.410	5.000	1.000	7.000	1.450	-0.640	-0.508
BIC4	4.440	5.000	1.000	7.000	1.409	-0.368	-0.583
BIC5	4.660	5.000	1.000	7.000	1.416	-0.498	-0.643
BIC6	5.110	5.000	1.000	7.000	1.182	1.631	-1.212
BIC7	5.150	6.000	1.000	7.000	1.602	-0.563	-0.664
BIC8	5.230	5.000	2.000	7.000	0.968	0.195	-0.748
BIC9	5.540	6.000	2.000	7.000	1.099	1.987	-1.341
BIC10	4.860	5.000	1.000	7.000	1.257	0.424	-0.896
BIC11	4.480	5.000	1.000	7.000	1.432	-0.365	-0.624
BIC12	5.320	6.000	2.000	7.000	1.067	0.606	-0.824

Specific to EFA, Bartlett's test of sphericity confirmed the suitability of the correlation matrix for factor analysis, and the Kaiser-Meyer-Olkin (KMO) test yielded a value of 0.858, surpassing the minimum standard (Table 8).

Table 8. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.858**
Bartlett's Test of Sphericity	Approx. Chi-Square	2227.664
	df	666
	Sig.	<.001

Furthermore, anti-image matrices that rely on the decomposition of the two variances were used for evaluating whether individual variables should be included in the factor analysis (Table 9). Anti-image matrices led to the exclusion of two variables, BI access scalability (BIA11) and Innovation processes (BIG6), due to low sampling adequacy measures.

Table 9. Anti-image correlation and MSA

		BIA1	BIA2	BIA3	BIA4	BIA5	BIA6	BIA7	BIA8	BIA9	BIA10	BIA11	BIG1	BIG2	BIG3	BIG4	BIG5	BIG6	BIG7	BIG8	BIG9	BIG10	BIG11	BIG12	BIG13	BIG14	BIC1	BIC2	BIC3	BIC4	BIC5	BIC6	BIC7	BIC8	BIC9	BIC10	BIC11	BIC12
Anti-image Correlation	BIA1	.864[a]	-.036	-.328	.073	-.102	-.141	-.117	-.050	.111	-.056	.281	-.029	.023	-.055	-.209	-.172	-.060	-.258	.167	.114	-.045	-.182	.321	-.150	.214	-.110	.066	-.017	.175	-.043	-.024	-.108	-.017	-.132	.074	.055	-.063
	BIA2	-.036	.789[a]	-.394	-.005	-.101	-.066	-.172	.179	-.030	-.095	-.083	.130	-.210	.122	.284	-.065	-.084	-.139	-.010	-.097	.022	.116	-.158	-.078	.261	.216	.151	-.169	-.221	.020	.025	-.024	-.024	-.153	-.053	.043	-.060
	BIA3	-.328	-.394	.859[a]	-.121	-.184	.116	.175	-.205	-.137	-.049	.035	-.120	.039	.157	-.175	.129	.065	.240	.063	-.004	.042	-.024	-.138	.023	-.131	-.009	-.191	-.050	.127	.083	-.095	-.045	-.082	.160	-.038	.110	.033
	BIA4	.073	-.005	-.121	.852[a]	-.209	-.188	-.238	-.040	.017	-.082	.255	-.005	-.019	-.193	-.090	-.193	.033	-.051	.001	.127	-.006	.032	.204	-.090	.287	.138	-.223	-.112	.003	-.047	.082	-.183	-.011	.100	-.036	.215	-.147
	BIA5	-.102	-.101	-.184	-.209	.857[a]	-.241	.134	-.121	.133	-.089	-.153	.082	.045	.053	-.129	.121	-.092	.107	-.154	-.002	.028	-.067	.029	.061	-.046	-.298	.114	.094	-.045	.058	.064	.123	.205	-.108	.223	-.180	.076
	BIA6	-.141	-.066	.116	-.188	-.241	.888[a]	-.226	-.329	-.105	.168	-.129	.059	.088	.103	.107	.170	.171	.158	-.119	.132	-.059	.074	-.154	.034	-.110	.085	-.118	.119	-.013	-.051	-.073	.025	-.154	.006	-.173	-.187	.202
	BIA7	-.117	-.172	.175	-.238	.134	-.226	.857[a]	-.191	.101	-.151	.022	-.299	.182	.085	-.189	-.059	-.195	.106	.050	-.032	-.190	-.156	-.025	-.061	-.109	-.114	.042	.255	.142	-.024	-.103	.176	-.131	.240	.197	-.097	-.033
	BIA8	-.050	.179	-.205	-.040	-.121	-.329	-.191	.918[a]	-.083	-.144	-.074	-.031	-.092	.081	.061	-.048	-.027	-.084	.015	-.082	.195	-.105	.050	-.026	-.023	.098	.066	-.207	-.134	-.100	-.260	-.027	.148	.034	-.069	.235	-.054
	BIA9	.111	-.030	-.137	.017	.133	-.105	.101	-.083	.826[a]	-.695	.276	.034	.004	.002	-.052	-.183	-.126	-.087	.193	.015	-.198	.036	.206	-.252	-.055	-.078	.071	.151	.002	-.089	-.119	.228	.145	.019	.172	-.156	-.036
	BIA10	-.056	-.095	-.049	-.082	-.089	.168	-.151	-.144	-.695	.830[a]	-.162	-.021	-.024	-.222	-.030	.042	.102	.068	-.096	.006	.043	.115	-.088	.241	-.196	.028	-.058	.127	-.027	.043	.270	-.121	-.171	-.034	-.209	.055	.049
	BIA11	.281	-.083	.035	.255	-.153	-.129	.022	-.074	.276	-.162	.253[a]	-.139	-.117	-.135	-.112	-.395	-.242	.010	.378	.027	-.123	-.008	.228	-.233	.121	.116	-.030	.070	.034	-.016	-.113	-.097	-.031	.030	-.029	.076	-.064
	BIG1	-.029	.130	-.120	-.005	.082	.059	-.299	-.031	.034	-.021	-.139	.825[a]	-.279	-.078	.012	-.028	-.083	-.129	-.139	.277	.001	.096	.159	.119	.059	.238	-.191	-.019	-.265	.157	.169	-.094	.107	-.354	-.124	-.211	.134
	BIG2	.023	-.210	.039	-.019	.045	.088	.182	-.092	.004	-.024	-.117	-.279	.753[a]	-.240	-.126	.099	.034	.115	-.168	.047	-.099	-.127	.041	-.183	.060	-.384	-.103	.389	.022	-.217	-.069	.055	.023	.165	.094	-.096	.231
	BIG3	-.055	.122	.157	-.193	.053	.103	.085	.081	.002	-.222	-.135	-.078	-.240	.791[a]	-.111	.058	.006	.109	-.036	-.015	.038	-.079	-.180	.030	-.009	.191	-.061	-.282	.117	.123	-.183	-.008	-.101	.036	.013	.184	-.225
	BIG4	-.209	.284	-.175	-.090	-.129	.107	-.189	.061	-.052	-.030	-.112	.012	-.126	-.111	.890[a]	.051	.026	-.038	-.031	-.168	-.017	.203	-.375	.013	-.002	.241	.242	-.214	-.185	.016	-.048	-.013	-.081	-.093	-.159	-.053	.029
	BIG5	-.172	-.065	.129	-.193	.121	.170	-.059	-.048	-.183	.042	-.395	-.028	.099	.058	.051	.871[a]	.276	-.018	-.348	-.040	.170	-.139	-.294	.131	.036	-.218	.163	-.167	.001	.118	.004	.008	-.005	-.155	.104	-.153	.042
	BIG6	-.060	-.084	.065	.033	-.092	.171	-.195	-.027	-.126	.102	-.242	-.083	.034	.006	.026	.276	.362[a]	-.053	-.201	-.142	.071	-.190	-.048	.149	-.122	-.006	-.068	-.109	.095	-.038	.066	-.042	-.044	.093	.140	.027	-.027
	BIG7	-.258	-.139	.240	-.051	.107	.158	.106	-.084	-.087	.068	.010	-.129	.115	.109	-.038	-.018	-.053	.865[a]	-.072	.032	.046	-.056	-.197	.101	-.306	-.042	-.317	.111	.016	-.002	-.210	-.026	.082	.053	.031	.030	.036
	BIG8	.167	-.010	.063	.001	-.154	-.119	.050	.015	.193	-.096	.378	-.139	-.168	-.036	-.031	-.348	-.201	-.072	.885[a]	-.133	-.138	.122	-.014	-.166	-.070	-.040	.097	.035	-.099	-.083	-.160	.089	-.040	-.075	-.014	.034	.177
	BIG9	.114	-.097	-.004	.127	-.002	.132	-.032	-.082	.015	.006	.027	.277	.047	-.015	-.168	-.040	-.142	.032	-.133	.836[a]	-.128	-.052	.319	.097	.249	.149	-.361	.065	.090	.010	-.039	-.241	-.051	-.142	-.055	-.023	.067
	BIG10	-.045	.022	.042	-.006	.028	-.059	-.190	.195	-.198	.043	-.123	.001	-.099	.038	-.017	.170	.071	.046	-.138	-.128	.779[a]	-.085	-.100	.068	.081	-.230	.143	-.364	-.061	.197	.076	-.035	.169	-.204	.036	.151	-.103
	BIG11	-.182	.116	-.024	.032	-.067	.074	-.156	-.105	.036	.115	-.008	.096	-.127	-.079	.203	-.139	-.190	-.056	.122	-.052	-.085	.903[a]	-.150	-.203	-.022	.139	.078	-.024	-.172	-.091	.138	-.046	-.051	-.113	-.191	-.058	.017
	BIG12	.321	-.158	-.138	.204	.029	-.154	-.025	.050	.206	-.088	.228	.159	.041	-.180	-.375	-.294	-.048	-.197	-.014	.319	-.100	-.150	.867[a]	-.095	.158	.004	-.314	.118	-.124	-.146	-.036	.035	.096	-.006	.094	-.058	-.022
	BIG13	-.150	-.078	.023	-.090	.061	.034	-.061	-.026	-.252	.241	-.233	.119	-.183	.030	.013	.131	.149	.101	-.166	.097	.068	-.203	-.095	.912[a]	-.256	.066	-.044	-.133	-.010	.080	.125	.004	.016	-.157	-.038	-.040	-.052
	BIG14	.214	.261	-.131	.287	-.046	-.110	-.109	-.023	-.055	-.196	.121	.059	.060	-.009	-.002	.036	-.122	-.306	-.070	.249	.081	-.022	.158	-.256	.858[a]	.000	-.014	-.255	-.085	.103	.052	-.251	-.075	-.169	.141	-.119	-.088
	BIC1	-.110	.216	-.009	.138	-.298	.085	-.114	.098	-.078	.028	.116	.238	-.384	.191	.241	-.218	-.006	-.042	-.040	.149	-.230	.139	.004	.066	.000	.832[a]	-.340	-.145	-.138	.061	.048	-.072	-.247	.011	-.335	.132	-.213
	BIC2	.066	.151	-.191	-.223	.114	-.118	.042	.066	.071	-.058	-.030	-.191	-.103	-.061	.242	.163	-.068	-.317	.097	-.361	.143	.078	-.314	-.044	-.014	-.340	.822[a]	-.222	.020	.007	.024	.028	.048	-.072	.037	-.070	-.035
	BIC3	-.017	-.169	-.050	-.112	.094	.119	.255	-.207	.151	.127	.070	-.019	.389	-.282	-.214	-.167	-.109	.111	.035	.065	-.364	-.024	.118	-.133	-.255	-.145	-.222	.786[a]	.019	-.344	.037	.194	.076	.082	-.152	-.272	.312
	BIC4	.175	-.221	.127	.003	-.045	-.013	.142	-.134	.002	-.027	.034	-.265	.022	.117	-.185	.001	.095	.016	-.099	.090	-.061	-.172	-.124	-.010	-.085	-.138	.020	.019	.941[a]	-.089	-.070	-.014	-.086	.046	.022	.164	-.145
	BIC5	-.043	.020	.083	-.047	.058	-.051	-.024	-.100	-.089	.043	-.016	.157	-.217	.123	.016	.118	-.038	-.002	-.083	.010	.197	-.091	-.146	.080	.103	.061	.007	-.344	-.089	.916[a]	-.105	-.159	.004	-.129	-.037	.020	-.179
	BIC6	-.024	.025	-.095	.082	.064	-.073	-.103	-.260	-.119	.270	-.113	.169	-.069	-.183	-.048	.004	.066	-.210	-.160	-.039	.076	.138	-.036	.125	.052	-.048	.024	.037	-.070	-.105	.914[a]	.073	-.012	-.030	-.109	-.013	-.275
	BIC7	-.108	-.024	-.045	-.183	.123	.025	.176	-.027	.228	-.121	-.097	-.094	.055	-.008	-.013	.008	-.042	-.026	.089	-.241	-.035	-.046	.035	.004	-.251	-.072	.028	.194	-.014	-.159	.073	.796[a]	.082	.203	.120	-.137	.057
	BIC8	-.017	-.024	-.082	-.011	.205	-.154	-.131	.148	.145	-.171	-.031	.107	.023	-.101	-.081	-.005	-.044	.082	-.040	-.051	.169	-.051	.096	.016	-.075	-.247	.048	.076	-.086	.004	-.012	.082	.902[a]	-.276	.046	-.024	-.111
	BIC9	-.132	-.153	.160	.100	-.108	.006	.240	.034	.019	-.034	.030	-.354	.165	.036	-.093	-.155	.093	.053	-.075	-.142	-.204	-.113	-.006	-.157	-.169	.011	-.072	.082	.046	-.129	-.030	.203	-.276	.908[a]	-.045	.023	-.109
	BIC10	.074	-.053	-.038	-.036	.223	-.173	.197	-.069	.172	-.209	-.029	-.124	.094	.013	-.159	.104	.140	.031	-.014	-.055	.036	-.191	.094	-.038	.141	-.335	.037	-.152	.022	-.037	-.109	.120	.046	-.045	.879[a]	-.203	.091
	BIC11	.055	.043	.110	.215	-.180	-.187	-.097	.235	-.156	.055	.076	-.211	-.096	.184	-.053	-.153	.027	.030	.034	-.023	.151	-.058	-.058	-.040	-.119	.132	-.070	-.272	.164	.020	-.013	-.137	-.024	.023	-.203	.860[a]	-.419
	BIC12	-.063	-.060	.033	-.147	.076	.202	-.033	-.054	-.036	.049	-.064	.134	.231	-.225	.029	.042	-.027	.036	.177	.067	-.103	.017	-.022	-.052	-.088	-.213	-.035	.312	-.145	-.179	-.275	.057	-.111	-.109	.091	-.419	.856[a]

a. Measures of Sampling Adequacy (MSA)

A communalities analysis was conducted to identify statements with low communalities (<0.32). The analysis revealed that all statements surpassed the established threshold, indicating an adequate level of shared value. The results of the communalities analysis are presented in Table 10.

Table 10. Communalities of statements before EFA

	Initial	Extraction
BIA1	1.000	.649
BIA2	1.000	.506
BIA3	1.000	.766
BIA4	1.000	.674
BIA5	1.000	.656
BIA6	1.000	.729
BIA7	1.000	.657
BIA8	1.000	.792
BIA9	1.000	.779
BIA10	1.000	.846
BIG1	1.000	.720
BIG2	1.000	.692
BIG3	1.000	.818
BIG4	1.000	.696
BIG5	1.000	.587
BIG7	1.000	.673
BIG8	1.000	.655
BIG9	1.000	.583
BIG10	1.000	.614
BIG11	1.000	.522
BIG12	1.000	.706
BIG13	1.000	.598
BIG14	1.000	.797
BIC1	1.000	.815
BIC2	1.000	.772
BIC3	1.000	.800
BIC4	1.000	.678
BIC5	1.000	.651
BIC6	1.000	.761
BIC7	1.000	.583
BIC8	1.000	.581
BIC9	1.000	.718
BIC10	1.000	.546
BIC11	1.000	.652
BIC12	1.000	.772

The findings from the data quality checks indicate that the collected data possesses a high level of quality. Additionally, specific checks conducted for factor analysis confirm the suitability of the data to proceed with further factor analysis.

3.2.2. Exploratory factor analysis

As a next step, EFA analysis applied in conjunction with principal component analysis for dimensionality reduction. The initial component analysis did not yield an easily interpretable solution (Table 8). The factor loadings were not readily identifiable due to variables loading on few components with weights above 0,4, which is a considered stable score (Guadagnoli & Velicer, 1988; Raubenheimer, 2004). Furthermore, indicators that conceptually belong to different dimensions of BI Agility were observed to load onto the same component. The presence of negative loadings indicates that the interpretation of the corresponding question needs to be reversed in relation to that particular factor.

To facilitate factor differentiation and support interpretation, an orthogonal rotation procedure was employed. Various rotation methods were tested, and it was determined that the Equamax rotation yielded the clearest solution. This particular rotation procedure aids in minimizing the number of variables that exhibit high loadings on a single factor, as well as reducing the number of factors required to explain a given variable. By applying Equamax rotation, the analysis aimed to achieve a more distinct and meaningful factor structure.

The fixed number of factors was set to three, reflecting the proposed conceptual model of BI Agility. These factors accounted for 50.9% of the total variance in the dataset (Table 11). Furthermore, the Scree plot depicted in Figure 13 also supports the selection of three factors for the analysis.

Table 11. Total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.918	36.909	36.909	12.918	36.909	36.909	6.344	18.126	18.126
2	3.251	9.288	46.197	3.251	9.288	46.197	6.071	17.346	35.472
3	1.647	4.705	50.902	1.647	4.705	50.902	5.401	15.430	50.902
4	1.464	4.183	55.085						
5	1.359	3.883	58.969						
6	1.236	3.530	62.499						
7	1.101	3.146	65.645						
8	1.070	3.057	68.702						
9	.938	2.680	71.382						
10	.821	2.345	73.727						
11	.788	2.251	75.978						
12	.753	2.151	78.129						
13	.669	1.911	80.040						
14	.607	1.735	81.775						
15	.605	1.727	83.502						
16	.559	1.598	85.100						
17	.549	1.568	86.667						
18	.516	1.476	88.143						
19	.453	1.293	89.436						
20	.430	1.228	90.664						
21	.415	1.186	91.851						
22	.366	1.047	92.898						
23	.337	.963	93.860						
24	.309	.883	94.744						
25	.268	.767	95.510						
26	.248	.709	96.219						

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
27	.234	.669	96.888						
28	.192	.549	97.437						
29	.180	.514	97.952						
30	.153	.438	98.390						
31	.135	.385	98.775						
32	.134	.382	99.156						
33	.117	.333	99.489						
34	.093	.266	99.755						
35	.086	.245	100.000						

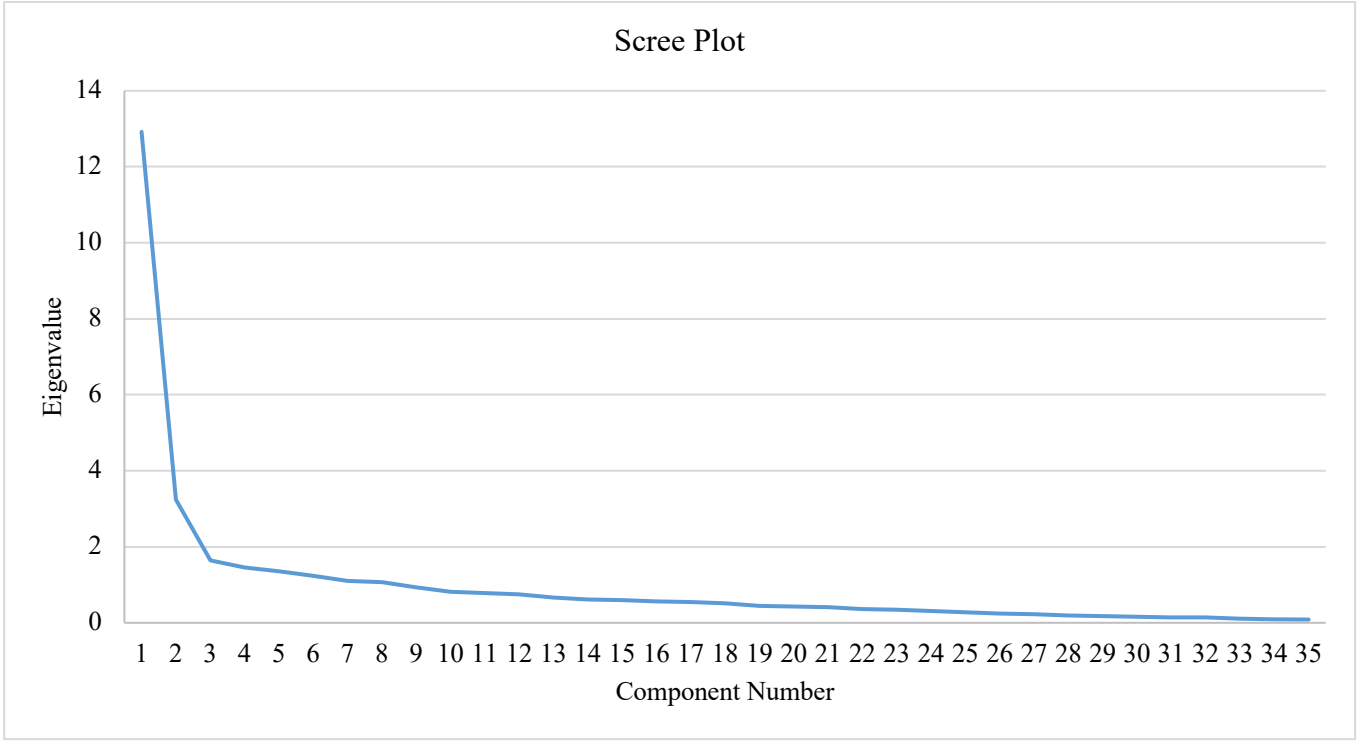

Figure 13. Plot chart

Table 12. Component matrix with factor loadings

	Component		
	1	**2**	**3**
BIA1	.609	.422	
BIA2	.452	.431	
BIA3	.562	.593	
BIA4	.525	.551	
BIA5	.519	.502	
BIA6	.674		
BIA7	.626	.425	
BIA8	.734	.428	
BIA9	.631		-.419
BIA10	.604	.457	
BIG1	.578		
BIG2	.458		
BIG3	.420		
BIG4	.712		
BIG5	.706		
BIG7	.545		
BIG8	.653		
BIG9	-.532		
BIG10	.418		
BIG11	.608		
BIG12	.733		
BIG13	.704		
BIG14	.625		-.484
BIC1	.655		
BIC2	.556		
BIC3	.592		
BIC4	.768		
BIC5	.644		
BIC6	.673		
BIC7			
BIC8	.578		
BIC9	.724		
BIC10	.589		
BIC11	.607		
BIC12	.606		

Table 13. Rotated component matrix with factor loadings

	Component		
	1	**2**	**3**
BIA3		.820	
BIA4		.771	
BIA8		.760	
BIA5		.731	
BIA1		.687	
BIA6		.682	
BIA7		.650	.447
BIA2		.646	
BIA10		.640	.536
BIA9		.559	.619
BIG14			.784
BIG13	.448		.489
BIG7	.437		.479
BIG5	.550		.444
BIG1			.422
BIG9			-.541
BIG12	.681		
BIG8	.639		
BIG11	.502		
BIG10	.466		
BIG4	.408	.508	
BIG2			
BIG3			
BIC3	.738		
BIC10	.666		
BIC5	.624		
BIC1	.623		
BIC2	.611		
BIC9	.570		.531
BIC4	.569		.428
BIC6	.517		
BIC11	.418		.630
BIC12			.676
BIC8			.567
BIC7			

To organize indicators belonging to the same conceptually defined dimension, they were sorted based on their highest loading values. This approach facilitated the identification of indicators with the greatest potential

for measuring the corresponding derived factor, considering their conceptual relevance. In this analysis, indicators related to BI architecture agility exhibited strong loadings on the second factor, while indicators of BI governance agility demonstrated the strongest loadings on the third factor. Indicators associated with Agile BI culture displayed the highest loadings on the first factor.

3.2.3. Refined BI agility scale

The analysis identified nine indicators across three factors, collectively accounting for 69% of the variance in the dataset. According to Hair et al. (2019), factors accounting for 60% of the total variance are considered satisfactory. Table 14 summarizes the results, including factor loadings, communalities, and the variances explained.

Table 14. Final results of EFA

Variable			**BI architecture agility**	**Agile BI culture**	**BI governance agility**	**h^2**
Code	**Name**	**Statement**				
BIA3	Data acquisition agility	In our organization it is relatively quick to integrate new data sources or data elements to our BI application	.834			.736
BIA4	Data storage agility	In our organization it is relatively quick to implement changes in data storage	.864			.764
BIA8	Reporting and analysis functional agility	In our organization we have sufficient and flexible functionality to satisfy the analysis needs of BI users	.752			.769
BIG14	Data quality processes	In our organization we have processes to maintain the quality of our data			.767	.689

Variable			BI architecture agility	Agile BI culture	BI governance agility	h^2
Code	**Name**	**Statement**				
BIG1	Interdisciplinary teams	In our organization we have BI implementation teams consisting of specialists with business and IT competences			.668	.534
BIG9	Unified terms and language	In our organization we do not have unified understanding of business terms and measurements across organization			-.796	.662
BIC3	Feedback on the impact of BI on business	In our organization BI specialists get feedback on the effect of decisions that were based on insights from BI		.834		.755
BIC5	Encouragement for experimentation with data	In our organization we feel encouraged to experiment with data in BI and accept that not all experiments are successful		.739		.632
BIC10	Employees eager to use data	In our organization employees are eager to use and apply new BI data services within their roles		.775		.646
% of Variance			24.420	23.335	20.973	

The extraction method was principal component analysis with a Equamax (with Kaiser Normalization) rotation;
h^2 – communality coefficient.

Three items loaded onto the first factor (0.752-0.864), accounting for 24% of the variance. These items were data acquisition agility, data storage agility, and reporting and analysis functional agility. This factor was named 'BI architecture agility' as the variables pertained to architectural or technical aspects of BI. Three items loaded onto the second factor (0.739-0.834), accounting for 23% of the variance. These items were feedback on the impact of BI on business, encouragement for experimentation with data, and employees eager to use data. Since these indicators measure culture-related aspects of BI, this factor was labelled 'agile BI culture'. The final three items loaded onto the third factor (0.668-0.796) and included interdisciplinary teams, unified terms and language, and data quality processes. This factor was named 'BI governance agility' and accounted for 21% of the variance.

BI Agility model with indicators derived from EFA is presented in Figure 14.

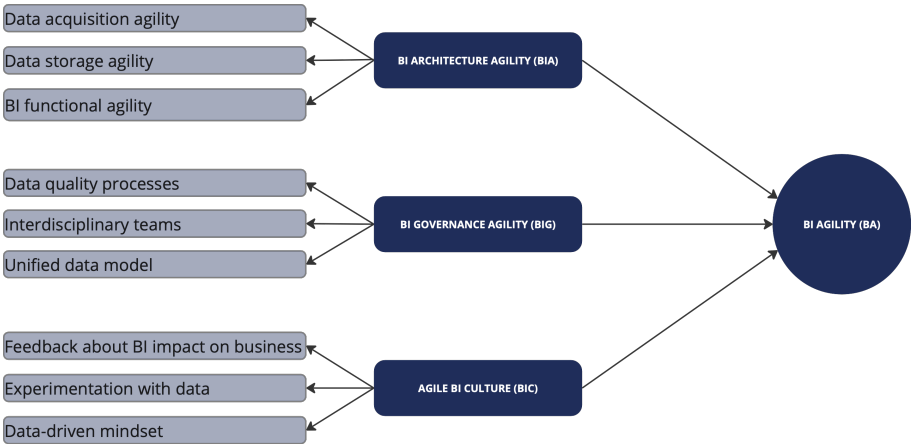

Figure 14. Refined BI agility conceptual model (prepared by the author)

Through the application of EFA, this study developed an instrument capable of measuring distinct dimensions of BI agility, as well as providing an overall assessment of BI agility. This measurement instrument was further utilized in the hypothesis testing stage.

3.2.4. Confirmatory factor analysis

CFA was conducted to validate the measurement model by assessing the relationships between observed variables (indicators) and their corresponding latent constructs—BI Architecture Agility, BI Governance Agility, and Agile BI Culture. This analysis is critical for establishing the reliability and validity

of the constructs. The model fit indices suggest an acceptable fit, as presented in Table 15.

Table 15. Model fit indices

Fit Index	Value	Threshold	Interpretation
Chi-Square (χ^2)	37.168	-	Indicates a difference; commonly significant in large samples
Degrees of Freedom (df)	24	-	Used to calculate χ^2
p-value	0.042	> 0.05	Significant; additional indices should be examined
CFI	0.977	> 0.95	Excellent fit
TLI	0.965	> 0.90	Good fit
PNFI	0.654	> 0.50	Acceptable balance between fit and simplicity
RMSEA	0.074	< 0.08	Acceptable model fit
RMSEA 90% CI	0.014–0.119	-	Confidence interval supports model fit
RMSEA p-value	0.188	> 0.05	Error of approximation is acceptable

The Chi-Square value for the model was significant, $\chi^2(24) = 37.168$, $p = 0.042$, indicating a difference between the observed and expected covariance matrices. However, this result is commonly observed in models with large sample sizes. To provide a comprehensive evaluation, additional fit indices were analyzed.

The Comparative Fit Index (CFI) was 0.977, exceeding the threshold of 0.95, which indicates excellent model fit. Similarly, the Tucker-Lewis Index (TLI) value of 0.965 surpasses the recommended minimum of 0.90, reflecting strong model adequacy. The Parsimony Normed Fit Index (PNFI) value of 0.654, although lower than other indices, demonstrates a reasonable balance between model fit and simplicity.

The Root Mean Square Error of Approximation (RMSEA) value was 0.074, with a 90% confidence interval of 0.014 to 0.119, and a p-value of 0.188. These results indicate that the model fits well in terms of error approximation.

Overall, these indices confirm the validity of the three latent constructs in capturing the dimensions of BI agility: BI Architecture Agility, BI Governance Agility, and Agile BI Culture. These results provide strong evidence supporting the reliability and construct validity of the measurement model.

3.3. Discussion and conclusion

3.3.1. Discussion

This stage of the study aimed to establish a robust measurement instrument for assessing BI Agility within organizational contexts, facilitating further research into its impact on various organizational characteristics. Through a comprehensive methodology that included literature review, interviews (in earlier stages), and survey (this stage), the findings provide empirically grounded insights that expand the traditional notion of BI Agility beyond technical factors to include human and managerial elements. This results in three distinct dimensions that constitute BI Agility: BI Architecture Agility, BI Governance Agility, and Agile BI Culture. By recognizing culture, governance, and architecture as critical building blocks, this approach empowers organizations to develop comprehensive strategies that enhance their ability to navigate the complexities of the modern business landscape more effectively.

Furthermore, the EFA conducted in this study helped identify the most effective indicators for measuring BI Agility across its underlying dimensions. Previous research has not adequately addressed the need for a valid measurement tool to assess the extent of BI Agility in various organizations, leaving this area underexplored in quantitative research. Consequently, little attention has been given to how BI Agility impacts other organizational traits, such as organizational agility. The EFA findings provided valuable insights into the most effective indicators for measuring BI Agility and its dimensions.

The EFA revealed several key insights into the construct of BI Agility. BI Architecture Agility can be quantified through indicators such as data acquisition agility, data storage agility, and BI functional agility. For BI Governance Agility, critical metrics include the presence of interdisciplinary teams, the establishment of a unified data model, and the implementation of robust data quality processes. Lastly, Agile BI Culture is best captured by indicators such as feedback mechanisms to assess BI's business impact, a propensity for data-driven experimentation, and the promotion of a data-centric mindset. Together, these dimensions offer a more comprehensive and actionable way to assess BI Agility.

Another important finding from this study is the consistent association observed between BI Governance and BI Culture factors, as supported by both the interview responses and the EFA results. This suggests that efforts to enhance Agile BI Culture often coincide with the design of processes and the implementation of governance practices that foster agility.

Furthermore, the evaluation of measurement models using CFA confirmed the validity and reliability of the constructs. The model fit indices demonstrated that the three latent constructs—BI Architecture Agility, BI Governance Agility, and Agile BI Culture—effectively capture the dimensions of BI Agility. This validation enhances the robustness of the measurement model, providing a foundation for future research and practical applications in assessing and improving BI Agility.

3.3.2. Theoretical and practical implications

This study contributes to the literature on BI by developing a multidimensional second-order scale for BI Agility, which addresses a significant research gap by providing a measurement tool to assess both BI Agility and its dimensions. This instrument serves as a valuable resource for researchers interested in exploring BI Agility and its impact on various organizational traits, such as organizational agility. By utilizing this scale, researchers can collect data to further investigate the relationships and dynamics of BI Agility within organizations.

From a practical standpoint, the findings of this study provide valuable insights for organizations seeking to enhance the value of their BI functions by improving BI Agility. The study identified key dimensions—architecture, governance, and culture—emphasizing the importance of adopting effective practices in these areas. The refined scale also delivers a list of factors highly associated with BI Agility in organizations. By addressing these areas, organizations can increase their chances of improving BI Agility.

This study serves as a reminder to organizational leaders that effectively leveraging BI as an enabler requires more than just a technical BI platform; it necessitates implementing robust processes and cultivating the right culture. Organizations can utilize these findings to guide their efforts in designing and implementing effective architecture, governance structures, and cultural initiatives that foster BI Agility. This, in turn, can enhance the organization's ability to sense and respond to changing business conditions, maximizing the full potential of their BI capabilities.

3.3.3. Limitations and future research

The present study has several limitations that warrant consideration and can guide future research endeavors. Firstly, it is important to acknowledge that this study relied on convenience sampling and snowball sampling techniques, which resulted in an extended data collection period and limited access to

professionals for survey participation. Despite these challenges, diligent efforts were made to obtain a sufficient number of respondents within the available accessibility. Additionally, this study focused on respondents in Lithuania; a multinational approach could enhance the generalizability of the findings. By broadening the sample to include a wider and more diverse population, researchers could strengthen the applicability of the results.

3.3.4. Conclusions

An extended definition of BI Agility, informed by the insights gained from this study, provides a more comprehensive perspective that encompasses not only technical aspects but also human and managerial dimensions, including architecture, governance, and culture. This expanded definition, along with the developed BI Agility Scale, offers a valuable opportunity to measure BI Agility and enhance our understanding of its role within the organizational context. This stage of the research has produced a scale that can be used to measure BI Agility and further explore its effects on other organizational capabilities and outcomes.

4. HYPOTHESIS TESTING

4.1. Survey design and data collection

4.1.1. Purpose of the survey

The survey conducted in this stage of the research aimed to test the hypotheses derived from this study. It employed the BI Agility instrument developed in the earlier stages, along with other measurement instruments adapted from prior literature. The primary objective of this survey was to test the hypotheses formulated in the research model.

4.1.2. Survey sample and process

The sample population for this research is characterized as hard-to-reach due to the limited number of individuals who use BI systems in their job roles. To address this challenge, the study employed a strategy of reaching members of this population through their social networks (Baltar & Brunet, 2012; McCormick et al., 2012). The LinkedIn platform was selected to source and personally invite respondents to participate in the survey via a link generated through the online survey platform Qualtrics. LinkedIn was particularly relevant for this study due to its focus on professional networking and its widespread use among professionals worldwide, including in the Baltic and Nordic regions that were targeted. This approach facilitated the identification of individuals who met the target profile, overcame access barriers, and expanded the geographic scope of the survey.

The survey was distributed to individuals on LinkedIn who listed 'Business Intelligence,' 'Analytics,' or 'Data' as interests or job titles in their profiles. Another criterion was location: while the first survey targeted respondents located in Lithuania, this second survey broadened the geographic scope to include other Baltic and Scandinavian countries to avoid sample overlap and ensure a more diverse sample.

Conducted from Q4 2023 to Q1 2024, the survey received 103 responses from individuals working in the Baltic and Scandinavian countries. A widely used method for estimating minimum sample size for PLS-SEM is the “10-times rule” (Hair et al., 2022), which suggests that the sample size should exceed 10 times the maximum number of inner or outer model links to any latent variable. In this study, the sample size meets this criterion, with the maximum number of paths being 3. SmartPLS, the software used in this study, is recognized for achieving high statistical power even with small sample

sizes. For example, Knabke and Olbrich (2018) conducted a BI agility study using SmartPLS with a sample size of 110.The demographic breakdown of the sample from this survey is presented in Table 16.

Table 16. Demographic breakdown of a survey No. 2 sample

Demographic item	**Survey No. 2**	
	Responses	**N (%)**
Sector	Software & Services	20%
	Financial Services	16%
	Pharmaceuticals, Biotechnology & Life Sciences	14%
	Telecommunication Services	9%
	Energy	6%
	Other	37%
Number of employees	5001 and more	27%
	1001 - 5000	32%
	501 - 1000	13%
	251 - 500	7%
	7 - 250	18%
	1 - 6	3%
Position	Data Analyst	25%
	BI Analyst	13%
	Manager	10%
	Data engineer	9%
	BI developer	9%
	Other	35%
Country of employment	Lithuania	51%
	Estonia	21%
	Sweden	15%
	Norway	8%
	Other	5%
Years of experience within BI	1 - 3	33%
	4 - 5	27%
	6 - 10	26%
	more than 10	14%

4.1.3. Survey instrument development

The scales for the constructs were adapted from prior literature. For Organizational Agility and Organizational Culture, this study utilized validated measurement scales. However, for BI Agility, no validated scales

existed for the conceptual definition used in this study, so the scale developed in the earlier stages of this research was employed.

BI agility

To operationalize BI Agility, this study followed the measurement model specification established in previous stages of this research, where the multidimensional second-order construct of BI Agility comprises three reflectively measured first-order constructs: BI Architecture Agility, BI Governance Agility, and Agile BI Culture. This measurement approach was selected to capture the nuanced and holistic nature of BI Agility, as it involves technical and human-centered dimensions. The scale was initially developed using qualitative methods, including a literature review and expert interviews, and was refined through exploratory factor analysis (EFA) and validated using confirmatory factor analysis (CFA), ensuring its reliability and construct validity. The validated scale was subsequently used to test the hypotheses in the research model.

Organizational agility

Organizational Agility is commonly defined as an organization's ability to sense and quickly respond to changes in the business environment (Overby et al., 2006). However, the value of the sensing capability, highly impacted by BI, can only be significant for agility if the organization is able to respond and adapt effectively. This involves efficiently redeploying or redirecting resources toward value-creating, value-protecting, and value-capturing activities (Teece et al., 2016). Thus, to measure the Organizational Agility construct, this study adopted an established measurement scale from the literature that focuses on the response aspect of agility. The scale developed and tested by Tallon and Pinsonneault (2011) was chosen because it aligns with this objective. This reflectively measured scale evaluates a firm's ability to adapt quickly in three key areas:

- Customer Agility: assesses responsiveness to changes in demand, innovation, and pricing.
- Business Partnering Agility: evaluates adaptability within supplier networks.
- Operations Agility: measures response times to new product launches by competitors, market expansions, changes in product mix, and the adoption of new production technologies.

This comprehensive scale effectively captures the response dimension of organizational agility, making it suitable for this research.

Organizational culture (moderator)

For Organizational Culture measurement, this study sought to utilize a scale established in the literature that connects to an organization's data, information, and knowledge management contexts, given the study's focus on BI. Westrum's (1988, 2004) typology of organizational culture, which compare how organizations manage information flow, was found to be particularly relevant. Westrum identified three types of cultures: pathological, bureaucratic, and generative. Among these, generative culture is regarded as performance-oriented and highly effective in fostering positive information flow within organizations.

Westrum's typology has been widely applied in both academic research and industry-driven studies. One prominent example is its adoption in IT context, particularly in the State of DevOps reports (Forsgren et al., 2018; DORA, 2024). DORA's research demonstrates that Westrum's generative (or performance-oriented) culture predicts software delivery and organizational performance in technology.

This study employed survey items developed for the State of DevOps report (DORA, 2024) to reflectively measure organizational culture, with a focus on Westrum's generative (or performance-oriented) culture. The generative culture scale includes items that measure six specific aspects of culture: high cooperation, trained messengers, shared risks, encouraged bridging, failure leading to inquiry, and implemented novelty. These dimensions closely align with the study's focus of BI and agility.

All constructs in this study were measured using a seven-point Likert scale, ranging from "Strongly disagree" to "Strongly agree." This approach was selected to capture the intensity of participants' perceptions and ensure consistency across different constructs. The seven-point scale offers a balance between granularity and ease of response, providing sufficient variability for statistical analysis without overwhelming respondents.

Appendix C includes the full survey instrument, detailing the scales and survey items used in this study.

4.1.4. Analysis method

The data analysis for the Survey No. 2 dataset (n=103) was conducted using SmartPLS version 4.1 software, employing the Partial Least Squares

Structural Equation Modeling (PLS-SEM) algorithm, bootstrapping procedure and PLSpredict algorithm. First, an evaluation of the measurement models was performed, and then the final structural model between the three latent variables was tested.

4.2. Results of data analysis and hypothesis testing

4.2.1. Descriptive statistics of research data

The data analysis started from the verification of the descriptive statistics measures of the research data collected for this study, focusing on three primary constructs: BI Agility (BIA), Organizational Agility (OA), and Organizational Culture (OC). The analysis provides insights into the central tendencies, variability, and distribution characteristics of the survey items used in the study, the details presented in Table 17.

Table 17. Descriptive statistics of survey items

Name	Mean	Median	Observed min	Observed max	Standard deviation	Excess kurtosis	Skewness
BIA1	4.835	5.000	1.000	7.000	1.514	-0.506	-0.549
BIA2	4.427	5.000	1.000	7.000	1.549	-0.560	-0.331
BIA3	4.913	5.000	1.000	7.000	1.394	-0.152	-0.780
BIA4	4.903	5.000	1.000	7.000	1.704	-0.336	-0.790
BIA5	4.612	5.000	1.000	7.000	1.470	-0.559	-0.344
BIA6	4.961	5.000	1.000	7.000	1.494	0.022	-0.766
BIA7	4.408	5.000	1.000	7.000	1.523	-1.045	-0.199
BIA8	5.078	6.000	1.000	7.000	1.531	-0.436	-0.709
BIA9	4.893	5.000	2.000	7.000	1.379	-0.531	-0.391
OA1	5.058	5.000	2.000	7.000	1.096	0.007	-0.522
OA2	4.728	5.000	1.000	7.000	1.496	-0.143	-0.707
OA3	4.447	4.000	1.000	7.000	1.399	-0.135	-0.105
OA4	4.456	4.000	1.000	7.000	1.392	-0.056	-0.380
OA5	4.515	5.000	1.000	7.000	1.654	-0.560	-0.379
OA6	4.592	5.000	1.000	7.000	1.383	-0.110	-0.418
OA7	4.767	5.000	1.000	7.000	1.553	-0.512	-0.503
OA8	4.175	4.000	1.000	7.000	1.410	-0.387	-0.253
OC1	5.466	6.000	1.000	7.000	1.122	2.628	-1.296
OC2	5.515	6.000	2.000	7.000	1.299	0.543	-1.031
OC3	5.301	6.000	1.000	7.000	1.313	1.366	-1.123
OC4	5.515	6.000	2.000	7.000	1.042	0.746	-0.798
OC5	4.301	4.000	2.000	7.000	1.328	-0.541	-0.092
OC6	5.903	6.000	2.000	7.000	1.119	1.410	-1.197

The dataset comprises responses from participants across all survey items, with no missing data reported for any variable. This ensures the reliability of subsequent analyses and avoids potential biases arising from incomplete data.

The BI Agility construct includes nine items (BIA1–BIA9) designed to measure three dimensions of agility related to BI. The mean values for BIA items range from 4.408 (BIA7) to 5.078 (BIA8) on a Likert scale of 1 to 7, suggesting a generally positive perception of BI Agility among respondents. Standard deviations range from 1.379 (BIA9) to 1.704 (BIA4), reflecting moderate variation in responses. Skewness values for most BIA items are negative, indicating a slight tendency toward higher response categories. Kurtosis values are close to zero for most items, suggesting flatter distributions.

The Organizational Agility construct comprises eight items (OA1–OA8), assessing the organization's ability to respond and adapt effectively to environmental changes. Means range between 4.175 (OA8) and 5.058 (OA1), reflecting moderately positive responses about organizational agility. Standard deviations fall within 1.096 (OA1) to 1.654 (OA5), suggesting consistent variability across items. Slight left-skewness is observed across items, with skewness values ranging from -0.707 (OA2) to -0.105 (OA3). Kurtosis values close to zero indicate near-normal distributions.

The Organizational Culture construct uses six items (OC1–OC6) to measure cultural characteristics based on Westrum’s typology. Higher mean values, ranging from 4.301 (OC5) to 5.903 (OC6), suggest positive perceptions of organizational culture. Standard deviations range from 1.042 (OC4) to 1.328 (OC5), indicating relatively low variation compared to other constructs. Skewness values for OC items are largely negative (e.g., -1.296 for OC1), reflecting a tendency toward agreement. Kurtosis values vary, with higher positive values for some items (e.g., 2.628 for OC1), indicating peaked distributions.

To sum up, the data indicate generally positive perceptions across all constructs, with moderate variability suggesting consistent responses within the sample. Skewness and kurtosis metrics reveal slight deviations from normality. These descriptive statistics confirm the dataset's suitability for hypothesis testing and structural modeling. The absence of missing data and the consistency of responses enhance the reliability of the findings, while the non-normal distributions justify the use of robust analytical methods like PLS-SEM.

4.2.2. Evaluation of measurement models

To evaluate the robustness of the scales for the survey constructs, including the BI Agility scale developed through EFA and validated through CFA, as well as other scales adopted from the literature, an evaluation of the measurement models was performed on the Survey No. 2 data in SmartPLS. Given that BI Agility is modelled as a second-order reflective formative construct, firstly was assessed the reliability and validity of the lower-order constructs (LOC)—BI Architecture Agility, BI Governance Agility, Agile BI Culture—and the regular constructs—Organizational Agility and Organizational Culture. Next, the higher-order construct (HOC), BI Agility, was evaluated.

LOC validation

The reliability of constructs was assessed using Composite Reliability (CR) and Cronbach's Alpha (CA), and convergent validity using Average Variance Extracted (AVE). All constructs demonstrated satisfactory reliability with CR values greater than 0.70. Cronbach's Alpha values were above 0.70 for all constructs, indicating high instrument reliability, except for Agile BI Culture, which had an acceptable reliability of 0.621. The AVE values for the three BI Agility constructs exceeded 0.50, indicating adequate convergent validity, while Organizational Agility and Organizational Culture had marginally acceptable convergent validity with AVE values slightly below 0.50.

Indicator reliability was confirmed with outer loadings above 0.70 for BI Agility constructs. In Organizational Agility, some loadings were below 0.70, and one indicator in Organizational Culture was significantly below the threshold. Removing low-loading indicator 'failure handling' (OC5) improved AVE value for Organizational Culture above 0.50. The results of the construct reliability analysis are presented in Table 18.

Table 18. Reliability of constructs

Construct	Loadings	Average Variance Extracted (AVE)	Composite Reliability	Cronbach's Alpha
BI Architecture Agility		0.747	0.898	0.831
BIA1	0.915			
BIA2	0.881			
BIA3	0.792			
BI Governance Agility		0.642	0.843	0.721
BIA4	0.726			
BIA5	0.822			

Construct	Loadings	Average Variance Extracted (AVE)	Composite Reliability	Cronbach's Alpha
BIA6	0.850			
Agile BI Culture		0.567	0.797	0.621
BIA7	0.782			
BIA8	0.779			
BIA9	0.695			
Organizational Agility		0.496	0.886	0.852
Organizational Agility after removing OA5		0.531	0.887	0.852
OA1	0.650			
OA2	0.651			
OA3	0.851			
OA4	0.634			
OA5	0.560			
OA6	0.768			
OA7	0.771			
OA8	0.706			
Organizational Culture		0.480	0.834	0.752
Organizational Culture after removing OC5		0.580	0.873	0.822
OC1	0.739			
OC2	0.817			
OC3	0.746			
OC4	0.703			
OC5	0.196			
OC6	0.759			

Discriminant validity was evaluated using the Fornell-Larcker criterion and the HTMT ratio. The Fornell-Larcker criterion showed adequate discriminant validity, as the square root of the AVE for each construct was greater than its correlations with other constructs (Table 19).

Table 19. Fornell-Larcker Criterion

	Agile BI Culture	BI Architecture Agility	BI Governance Agility	Organizational Agility	Organizational Culture
Agile BI Culture	0.753				
BI Architecture Agility	0.378	0.864			
BI Governance Agility	0.505	0.496	0.801		

	Agile BI Culture	BI Architecture Agility	BI Governance Agility	Organizational Agility	Organizational Culture
Organizational Agility	0.506	0.446	0.401	0.704	
Organizational Culture	0.622	0.329	0.504	0.513	0.761

HTMT values were mostly below 0.85, which is considered ideal for discriminant validity (Henseler et al., 2015). The HTMT value for Organizational Culture <-> Agile BI Culture was slightly above the ideal value at 0.858, which is still considered acceptable. HTMT analysis results presented in Table 20.

Table 20. Heterotrait-Monotrait Ratio (HTMT)

	Original sample (O)
BI Architecture Agility <-> Agile BI Culture	0.535
BI Governance Agility <-> Agile BI Culture	0.757
BI Governance Agility <-> BI Architecture Agility	0.647
Organizational Agility <-> Agile BI Culture	0.676
Organizational Agility <-> BI Architecture Agility	0.501
Organizational Agility <-> BI Governance Agility	0.495
Organizational Culture <-> Agile BI Culture	0.858
Organizational Culture <-> BI Architecture Agility	0.408
Organizational Culture <-> BI Governance Agility	0.660
Organizational Culture <-> Organizational Agility	0.570

The collinearity was assessed using the Variance Inflation Factor (VIF). All VIF values were below 5.0, indicating no collinearity issues (Hair et al., 2014), as shown in Table 21.

Table 21. Collinearity statistics

	VIF
BIA1	2.550
BIA1	2.371
BIA2	2.643
BIA2	2.256
BIA3	1.862
BIA3	1.596

	VIF
BIA4	1.530
BIA4	1.301
BIA5	1.735
BIA5	1.486
BIA6	1.996
BIA6	1.563
BIA7	1.209
BIA7	1.355
BIA8	1.331
BIA8	1.574
BIA9	1.205
BIA9	1.301
OA1	1.413
OA2	1.456
OA3	2.668
OA4	1.671
OA6	1.907
OA7	2.268
OA8	1.842
OC1	1.479
OC2	1.972
OC3	2.070
OC4	1.670
OC6	1.785

HOC validation

To assess the formative relationship between the HOC BI agility and its reflectively measured LOCs, a disjoint two-stage approach was used (Hair et al., 2024). In the first stage, the model was estimated using the LOCs without the HOC. In the second stage, the LOCs were replaced with the HOC, measured using the construct scores of BI Architecture Agility, BI Governance Agility, and Agile BI Culture from the first stage (Figures 15 and 16).

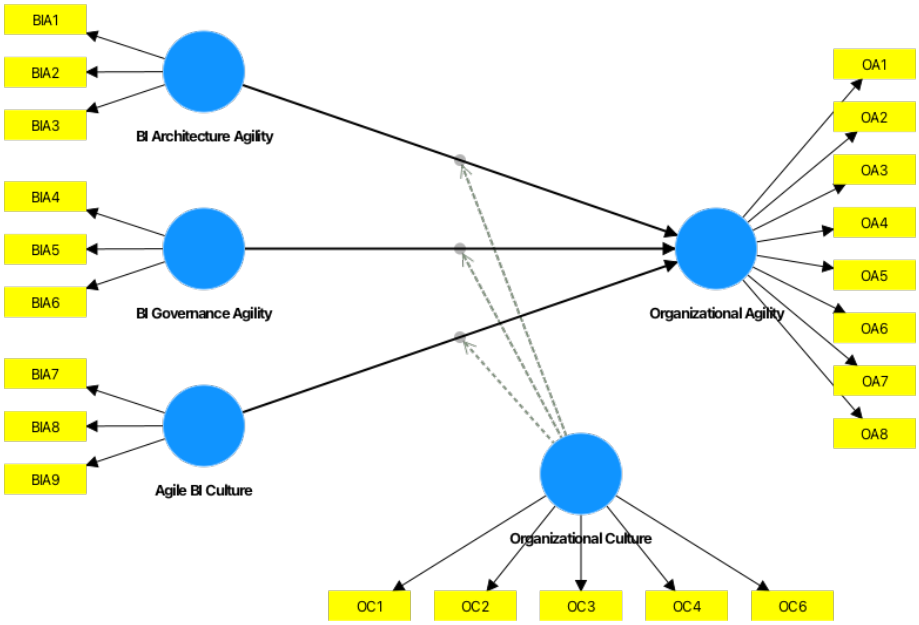

Figure 15. Stage 1 of HOC validation

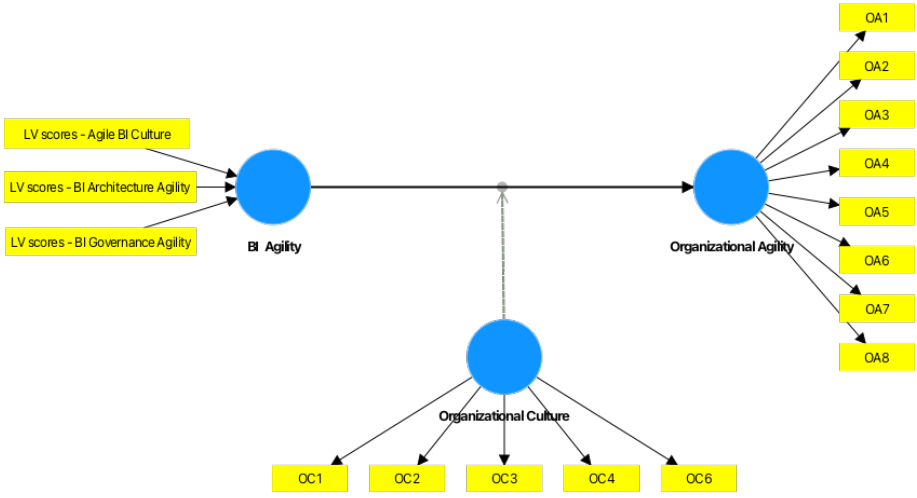

Figure 16. Stage 2 of HOC validation

The check was conducted for potential collinearity among the LOCs where it was found the VIF values considerably below the threshold of 3, providing support that collinearity is not a critical issue. The results presented in Table 22.

Table 12. Collinearity statistics of LOCs

	VIF
LV scores - Agile BI Culture	1.383
LV scores - BI Architecture Agility	1.365
LV scores - BI Governance Agility	1.571

To evaluate the contribution of each formative indicator, outer weights were examined. The outer weights for Agile BI Culture and BI Architecture Agility to BI Agility were found to be significant. Since the outer weight for BI Governance Agility to BI Agility was not significant, the outer loadings of the LOCs were examined. All outer loadings were above 0.5 and significant, confirming the reliability of the BI Agility construct. The results for outer weights and outer loadings are presented in Tables 23 and 24.

Table 23. Outer weights

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Agile BI Culture -> BI Agility	0.626	0.615	0.160	3.905	0.000
BI Architecture Agility -> BI Agility	0.456	0.432	0.194	2.358	0.018
BI Governance Agility -> BI Agility	0.149	0.157	0.192	0.776	0.438

Table 24. Outer loadings

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Agile BI Culture -> BI Agility	0.874	0.856	0.075	11.664	0.000
BI Architecture Agility -> BI Agility	0.767	0.737	0.128	5.971	0.000
BI Governance Agility -> BI Agility	0.691	0.671	0.126	5.467	0.000

With these validations in place, the next step was to evaluate the structural model.

4.2.3. Evaluation of structural model

The structural model was run to examine the research hypotheses of the model. The study used SmartPLS to perform this evaluation, focusing on path coefficients, R^2 values, f^2 effect sizes, Q^2 predictive relevance, and overall model fit.

Before assessing the structural relationships, collinearity was examined to make sure it does not bias the regression results. All VIF values were found to be below 3, indicating that collinearity is not a problem (Table 25).

Table 25. Collinearity statistics

	VIF
LV scores - Agile BI Culture	1.383
LV scores - BI Architecture Agility	1.365
LV scores - BI Governance Agility	1.571
OA1	1.414
OA2	1.462
OA3	2.829
OA4	1.672
OA5	1.349
OA6	1.992
OA7	2.291
OA8	1.842
OC1	1.479
OC2	1.972
OC3	2.070
OC4	1.670
OC6	1.785
Organizational Culture x BI Agility	1.000

In the next step the R^2 value of the endogenous construct was examined. The R^2 value for Organizational Agility was 0.442, indicating that 44% of the variance in Organizational Agility is explained by the combined effect of BI Agility and Organizational Culture. This level of explained variance suggests a moderate to strong explanatory power – the relationship between the predictors (BI Agility and Organizational Culture) and the outcome variable (Organizational Agility).

The effect sizes were calculated to determine how the removal of a certain predictor construct affects an endogenous construct's R2 value. BI Agility had a medium effect ($f^2 = 0.160$), Organizational Culture had a

medium effect ($f^2 = 0.145$), and the interaction term had a small effect ($f^2 = 0.117$).

The PLS path model's predictive accuracy was assessed by calculating the Q^2 value. The Q^2 value for Organizational Agility was 0.333, obtained through the PLSpredict procedure with 10 replications and 10 holdout cases. Q^2_predict values greater than 0 indicate that the model has predictive relevance for the endogenous constructs (Shmueli et al., 2016) and Q^2 value 0.333 show medium predictive relevance of the PLS-path model. This indicates that the exogenous constructs (BI Agility and Organizational Culture) are useful in predicting the endogenous construct (Organizational Agility).

Table 26. Explanatory power

Predictors	**Outcome**	**R^2**	**f^2**	**Q^2**
BI Agility	Organizational Agility	0.442	0.160	0.333
Organizational Culture			0.145	
Organizational Culture x BI Agility			0.117	

The goodness-of-fit of the structural model was evaluated using the Standardized Root Mean Square Residual (SRMR). In our analysis, the SRMR value was found to be 0.088 which provides evidence for an acceptable model fit (Schermelleh-Engel et al., 2003). SRMR results presented in Table 27.

Table 27. SRMR

	Original sample (O)	**Sample mean (M)**	**95%**	**99%**
Saturated model	0.088	0.068	0.081	0.087
Estimated model	0.089	0.068	0.081	0.088

The path coefficients and their significance were examined using the bootstrapping procedure with 5,000 resamples. All hypothesized paths were found to be significant ($p < 0.05$), indicating strong support for our theoretical model (Table 28). Figure 17 displays the path coefficients and R^2.

Table 28. Path Coefficients and Significance Levels

	Path coefficients	T statistics (|O/STDEV|)	P values	Results
BI Agility -> Organizational Agility	0.383	3.051	0.002	H1 supported
Organizational Culture -> Organizational Agility	0.393	2.820	0.005	
Organizational Culture x BI Agility -> Organizational Agility	0.220	2.540	0.011	H2 supported

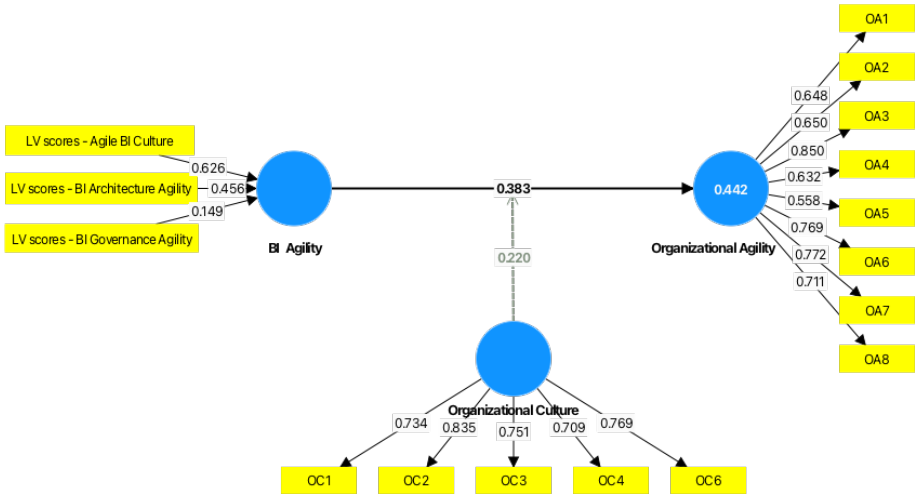

Figure 17. Estimated model

The interaction term's coefficient (0.220) was significant ($t = 2.540$, $p < 0.05$), indicating that performance-oriented Organizational Culture positively moderates the relationship between BI Agility and Organizational Agility. This suggests that the impact of BI Agility on Organizational Agility is stronger in organizations with a supportive culture. To further illustrate the moderation effect, the relationship between BI Agility and organizational agility was plotted (Figure 18) at high and low levels of organizational culture (±1 standard deviation from the mean).

Figure 18. Moderation effect of performance-oriented organizational culture on the relationship between BI agility and organizational agility

The plot shows three lines representing different levels of Organizational Culture:

- High performance-oriented Organizational Culture (+1 SD): Represented by the green line, this scenario shows the steepest slope, indicating the strongest positive relationship between BI Agility and Organizational Agility.
- Mean performance-oriented Organizational Culture: Represented by the blue line, this scenario shows a moderate positive relationship.
- Low performance-oriented Organizational Culture (-1 SD): Represented by the red line, this scenario shows the weakest positive relationship.

The results indicate that research model possesses explanatory power, with BI Agility being statistically significant in explaining Organizational Agility. Additionally, the moderating effect of performance-oriented Organizational Culture on the relationship between BI Agility and Organizational Agility is statistically significant. Consequently, both Hypotheses H1 and H2 are supported.

4.3. Discussion and conclusions

4.3.1. Discussion

Although BI agility is not a new concept and earlier studies recognized the necessity for organizations to strive for BI agility to better meet the demands of changing environments, previous research primarily focused on the technical aspects of BI agility, overlooking the socio-technical nature of BI. BI is inherently a socio-technical system, so human-centered aspects must be considered to achieve and sustain agility. This framework presents the multidimensional nature of BI agility, encompassing both technical (BI architecture agility) and human-centered perspectives (BI governance agility and agile BI culture), with clear indicators that effectively represent these dimensions. This framework can help organizational leaders assess and position their organizations on BI agility dimensions. Without considering the human-centered aspects, the alignment of BI specialists' and users' attitudes and behaviors with BI and agility values, organizations may not fully realize the potential gains from BI in enhancing organizational agility.

It is well recognized that an organization's culture has a powerful impact on its outcomes, largely due to its effects on information flow (Westrum, 2004). BI systems are highly reliant on data and information flow, making them particularly sensitive to cultural factors. Additionally, the literature highlights the significant role of culture in promoting agility. Evaluating agile BI culture, one of the BI agility dimensions in our model, provides insights into how well the organizational workforce’s attitudes and values align with BI and agility values. This alignment can be measured through indicators such as feedback on the impact of BI on business, encouragement for experimentation with data, and employees' eagerness to use data. It is important for organizations to evaluate these indicators, as culture shapes actions. While agile BI culture is important, it is BI-specific and does not fully capture the broader organizational context. To address this, an assessment of overall organizational culture was included in our study, considering the entire workforce, not just BI specialists and users.

Our empirical findings provide data-backed insights showing that organizational culture can enhance the impact of BI agility on organizational agility. Organizations that foster a 'generative' culture, identified by Westrum (2004) as one where people focus on mission accomplishment, can better leverage BI agility to achieve greater organizational agility. This suggests that the influence of culture on the relationship between BI agility and organizational agility extends beyond the culture of BI specialists and users—

something many leaders might overlook. The overall organizational culture is affecting workers at the forefront of BI. Companies seeking to maximize BI-fueled agility gains must focus not only on BI personnel but also address potential cultural conflicts between the broader workforce's values and those essential for a BI- and agility-supportive environment.

This study also found that at higher levels of BI agility, organizational culture has a stronger impact on organizational agility. This suggests that if BI agility is low, a great organizational culture alone cannot compensate for it. However, at high levels of BI agility, a supportive organizational culture provides additional leverage to achieve even greater levels of organizational agility with BI.

4.3.2. Theoretical and practical implications

While previous studies represent BI agility as a technology-driven concept, this study included human-centered dimensions and, through EFA and CFA, developed a validated holistic BI agility measurement scale that includes both the technical perspective (BI architecture agility) and human-centered perspectives (BI governance agility and agile BI culture). Scholars can use this measurement scale in their empirical research.

With the validation of both hypotheses, the research model found strong support from the data on the linkage between BI agility and organizational agility, as well as the moderating effect of organizational culture. The results are novel in the IS literature and provide insights not available from existing research. Research indicates that organizational agility benefits from a culture that encompass agility values and that culture matters to BI success; the results of this research provide empirical evidence to confirm this relationship.

This study provides empirical, research-backed insights and guidance for organizational leaders striving to enhance their enterprises' agility through BI. In order to successfully use BI as enabler for organizational agility, leaders have to understand the competitive advantage they can gain when they consider both BI agility and broader organizational context highly impacted by organizational culture.

Firstly, leaders can utilize the BI agility scale that was refined and validated in this research to assess their organization’s BI agility across three dimensions: BI architecture agility, BI governance agility, and agile BI culture. By identifying gaps in these areas, leaders can take targeted actions to enhance their BI agility.

Secondly, our empirical evidence on the linkage between BI agility and organizational culture highlights the importance of the broader organizational

context. Leaders should ensure that the values embedded in the organizational culture support a fluent information flow and align with BI and agility values. This alignment would accelerate the effects of BI agility on organizational agility. A BI- and agility-friendly organizational culture is characterized by high cooperation, trained messengers, shared risks, encouraged bridging, and implemented novelty, as opposed to a culture marked by low cooperation, "shot" messengers, shirked responsibilities, discouraged bridging, and crushed novelty.

4.3.3. Limitations and future research

The author acknowledges several limitations of this study to provide clearer context for findings and suggest avenues for future research.

Firstly, although data was collected from over 200 BI users and specialists and aimed for diversity, the sample may not fully represent all industries, organization sizes, or geographic regions. The focus on the Baltic and Scandinavian regions may introduce context-specific biases related to local business practices and cultural norms. Future research should include a larger and more diverse sample across various regions and countries to enhance generalizability. Additionally, our sample predominantly includes large organizations with established BI practices, so the applicability of the findings to small and medium-sized enterprises (SMEs) warrants further investigation.

Secondly, the reliance on self-reported measures may introduce biases such as social desirability or respondent fatigue. Future research could mitigate this by employing a mixed-methods approach, integrating qualitative methods such as interviews, focus groups, and case studies to corroborate self-reported data. Longitudinal study designs would also be beneficial to track changes over time, identify patterns, and reduce the impact of transient biases. These studies can also observe how BI agility and organizational culture evolve over time and impact organizational agility.

Thirdly, although this study developed and validated a comprehensive BI Agility measurement scale, there may be additional indicators that were not captured in this research. Future research should explore and validate other potential factors of BI agility.

This study aims to encourage future research to further investigate the dynamics of human-centered aspects, particularly culture, in the context of BI and fast-changing environments. This will aid in developing explanatory theories and provide practical guidance for organizations aiming to enhance their agility with BI.

4.3.4. Conclusions

The BI literature consistently recognizes that BI is crucial for achieving and sustaining organizational agility. This study provides initial empirical evidence to better understand how organizations could better utilize BI to enable organizational agility by enhancing the agility of BI itself and fostering a BI- and agility-friendly organizational culture. This study empirically validated the BI agility concept, encompassing both technological and human-centered dimensions, and used it to measure the impact of BI agility on organizational agility, considering the moderating role of organizational culture. Our findings suggest that BI agility is an important enabler of organizational agility, and that in organizations where the culture is focused on mission accomplishment, the positive joint effect is strongest. This research aims to open up the discussion and encourage further studies to advance the theory, transforming the elusive concept of culture in the context of BI into a tangible form for academics and practitioners. This could provide valuable guidance for organizations navigating challenges in agility-demanding environments.

5. EXPERT GROUP INSIGHTS

5.1. Focus group design

5.1.1. Purpose of the focus group discussion

The final phase of this study involved a focus group discussion. The purpose of using the focus group method was to engage a selected group of experts in a facilitated discussion, aimed at generating insights that would validate, interpret, and enrich the findings from the earlier stages of the research. This discussion sought to capture the personal experiences, beliefs, and perceptions of the participants, with the objective not only to gather opinions and narratives but also to identify practical, actionable strategies for organizations seeking to enhance their organizational agility through BI.

The focus group method was selected for its distinct advantages in qualitative research, particularly when exploring complex phenomena such as organizational culture, BI agility, and organizational agility. This approach provides a platform for collecting in-depth qualitative data through group interaction, encouraging participants to share and elaborate on their perspectives. Such interaction often leads to the generation of richer and more nuanced insights than those obtained through individual interviews (Krueger & Casey, 2015). Additionally, group dynamics can stimulate memories, trigger deeper insights through discussion, and facilitate comparisons of experiences, thereby enhancing collective problem-solving (Morgan, 1997). Another benefit of the focus group method is its ability to reveal shared norms, attitudes, and values, which are valuable for understanding how a group collectively perceives or interacts with an issue (Kitzinger, 1994). This method was also chosen for its efficiency, as it allows for the simultaneous collection of data from multiple participants in a relatively short time frame (Bryman, 2016).

5.1.2. Participants

The participants for the focus group were selected based on their expertise and experience in fields directly related to BI, analytics, and leading cultural transformations within organizations. The selection criteria emphasized diversity in industry backgrounds, with representation from sectors such as telecommunications, banking, insurance, retail, e-commerce, logistics, and IT consulting. This approach ensured that a wide range of perspectives on BI

agility, its impact on organizational agility, and the role of organizational culture could be captured.

The group comprised senior leaders with extensive experience in data management, analytics, and digital transformation, along with an expert in organizational culture and behavioral science. Participants held positions such as Heads of Data, BI & Analytics leaders, Chief Technology Officers (CTO), and Organizational Culture and Change Specialist. This diverse mix of technical, managerial, and cultural expertise was instrumental in providing a comprehensive understanding of how BI and organizational culture interact to influence organizational agility. A detailed overview of participants' backgrounds and relevance to the study is presented in Table 29.

Table 29. Overview of focus group participants and their expertise

Participant	**Background and relevance to the study**
Participant A	A seasoned executive with extensive experience in the retail and telecom sectors. Former Head of Data Management and Analytics at a leading telecom company in the Baltics and Nordics. An expert in data analytics, passionate about utilizing data-driven insights to drive business growth and operational efficiency.
Participant B	Senior leader with over 15 years of experience in building high-impact analytics teams and leading digital transformation initiatives. Former Head of BI & Analytics in banking and telecom industries, now Head of Data at an insurance firm. Skilled in leveraging big data, statistical modeling, machine learning, and AI for profitable decision-making.
Participant C	Senior executive with a diverse background in banking, telecom, and software engineering. Currently the CTO of a tech firm, previously held roles as Head of Enterprise Reporting and Data Partner. Expertise in bridging technology and business insights through data.
Participant D	Over 10 years of experience leading analytics teams across e-commerce, retail, logistics, and SaaS sectors. Currently the Business Analytics Team Lead at a fast-growing cybersecurity company, focused on making

Participant	Background and relevance to the study
	data-driven decision-making a core aspect of business strategy.
Participant E	ERP, CRM, and BI systems expert, Managing Director at an IT consulting firm. Extensive experience implementing BI and analytics solutions across various organizations, helping drive data-enabled business strategies.
Participant F	Organizational psychologist specializing in behavioral science and cultural transformation. Currently Culture and Change Specialist at a leading bank, also works as an independent organizational behavioral consultant. Expert in applying psychological insights to drive organizational change and foster agile cultures.

5.1.3. Focus group format and process

The focus group session took place on March 27th, 2024, and lasted for two hours. It was a moderated session in which participants' insights were gathered and recorded for transcription purposes. The session was held in a comfortable conference room at the university, equipped with a round table and a large screen to facilitate both in-person and remote participation. All participants and facilitators attended on-site, except for one expert who joined remotely via the MS Teams platform.

The moderation team consisted of two members from the research group. One moderator guided the session, while the other contributed ad hoc questions based on the ongoing discussion, ensuring that the conversation remained relevant and thorough. The Miro online service was used throughout the session, displayed on the screen for all participants. The Miro board contained a backlog of questions categorized by themes, which were systematically moved from the "Backlog" section to "Ongoing Discussion" and finally to "Discussion Completed" as the conversation progressed. Major insights were noted in real-time to capture key points and maintain a continuous flow.

The focus group session followed this agenda:

16:00 – 16:10: Welcome & Introduction
16:10 – 17:00: Discussion
17:00 – 17:10: Break
17:10 – 17:50: Discussion
17:50 – 18:00: Closing & Check-out

The session began with an introduction, followed by an ice-breaker question to help participants get acquainted and foster a comfortable atmosphere for discussion. The facilitators provided a brief overview of the research objectives, key concepts, and terms to align the group's understanding. Ground rules were established to encourage active participation, attentive listening, and a focused dialogue. The discussion was divided into two segments, separated by a short break. The session concluded with a check-out, during which participants shared their final thoughts, and facilitators outlined the next steps in the research process.

5.1.4. Themes and questions

The goal of this focus group was to explore the interplay between BI agility and organizational agility, with a specific focus on the influence of culture. Through in-depth discussions across 3 themes such as BI & Organizational Agility, BI Agility, Culture and BI, this focus group aimed to gather insights, perspectives, and experiences from an array of participants to validate, interpret and complement the findings from the earlier stages of this research.

The questions for this discussion derived from earlier stages of this research and covered such topics as:

- Gather different perspectives on the BI mission and its challenges in the changing dynamic environment.
- Discuss BI-empowered agility - the current state in today's organizations, the desired state and the gap to be closed.
- Obtain insights on expectations for the agility of BI itself, whether and where organizations are making effort to establish an agile BI function, observed successes and failures.
- Clarify the role associated with technological factors and human-centred factors in cultivating BI agility.
- Discuss the influence of culture in building an agile BI function that enables organizational agility.
- Investigate cultural traits having a positive or negative impact on the agility of the BI function and explore how those relate to organizational culture, information culture, or BI culture.
- Gain insights on cultivating a BI-positive and agility-positive culture, including core values, mindsets, and behaviours.
- Discuss actionable strategies for embedding a BI-positive culture within an organization and the practical steps to operationalize these strategies.

Detailed questions backlog provided in Appendix E. Important to note that due to limited time not all questions were covered in the session. Questions to discuss from backlog were chosen by facilitator based on the dynamics and flow of the discussion.

5.2. Data analysis method

The analysis began with the preparation of data, where focus group discussion was transcribed. This transcript was then imported into Atlas.ti for analysis. The thematic analysis method was selected as it is straightforward and provides a structured process for identifying, analyzing, and reporting patterns (themes) within qualitative data. The thematic analysis process followed the guidelines outlined by Braun and Clarke (2006), which provide a systematic approach to qualitative data analysis. The detailed steps of this process are presented in Table 30.

Table 30. Phases of thematic analysis of focus group followed in this research (based on Braun and Clarke, 2006)

Phase	Description of the process
Familiarizing with the data	The process began with thoroughly reading the transcript to gain a deep understanding of the content and identify key ideas discussed by the participants. This helped to recognize patterns and potential themes in the data.
Generating initial codes	The next step involved systematically segmenting the data into meaningful units through coding. Using Atlas.ti, these segments were coded based on recurring concepts, phrases, or ideas.
Searching for themes	After coding, the data was grouped into broader themes by identifying patterns and connections among the codes. Atlas.ti's tools were used to visualize and cluster these themes.
Reviewing themes	The identified themes were reviewed for coherence and accuracy in representing the data. Overlapping or redundant themes were merged, and those without enough data support were refined or discarded.
Defining and naming themes	Once the themes were finalized, they were defined and named according to the core concepts they represented, ensuring clarity and alignment with the research objectives.
Producing the report	The final stage involved interpreting the themes in relation to the research questions. Atlas.ti was used to visualize the relationships between themes, and the results were reported to tell the story revealed by the focus group discussion.

The thematic analysis method, supported by Atlas.ti software, facilitated a rigorous and systematic examination of the focus group data. This approach enabled the identification of key patterns, offering valuable insights into how industry experts perceive BI agility, its relationship to organizational agility, and the influence of organizational culture.

5.3. Summary of discussion – key themes and insights

The focus group discussion provided valuable insights into the interplay between BI agility, organizational agility, and the influence of organizational culture. This section summarizes the key themes, insights, and divergent views that emerged during the focus group.

5.3.1. Theme 1: expectations on BI and its role in organizational agility

The focus group discussion began by exploring the mission of BI in organizations operating in dynamic and fast-changing environments. Among the most frequently discussed topics were supporting decision-making, promoting organizational alignment through BI, driving business growth, and providing real-time data and insights. The full list of topics under this theme, along with the number of associated quotations, is presented in Table 31.

Table 31. Focus group codes on expectations for BI in dynamic business environment

Code	Number of quotations
Supporting decision-making	11
Aligning entire organization	5
Driving business growth	4
Real-time data and insights	4
Empowering business through BI	3
Enabling use of new technologies (AI)	3
Promoting transparency via BI	3
Single source of truth	3
Democratization of data / Open access	2
Rapid feedback loop	2
Sensing threats through data	2
Enabling predictive & prescriptive analytics	1
Ensuring data quality	1

Unsurprisingly, all participants emphasized the critical role of BI in supporting decision-making, describing it as a tool to understand current

situations and determine future directions, as well as to sense signals that require attention. The importance of decision-making support was a recurring theme throughout the discussion. However, Participant B offered a slightly different perspective, arguing that BI alone is insufficient for decision-making and that more advanced analytics capabilities are required to turn data into actionable decisions: *"I don't fully agree because BI is just one function, but decision science and decision-making represent the next level of maturity. BI is the first step, but to make decisions, we need to analyze alternatives and scenarios. BI provides the foundation by giving us the facts, but we need the right capabilities and skills to transform those facts into decisions. In my opinion, the data analyst community should focus on translating facts into decisions. The complexity starts when we have certain data, certain assumptions, and then incorporate those into future decision-making. Often, there's a mental gap here. BI is not always enough for decision-making."*

Another recurring theme was the critical role of BI in aligning the organization. Participants discussed the growing pressure on BI to serve as a central function that not only provides answers to all questions but also coordinates and aligns the entire organization. This shift reflects BI's evolving role from a mere reporting tool to a key driver of business operations. However, this transformation also brings new demands on the BI function and its personnel, requiring strong soft skills to facilitate coordination, cooperation, and change management. As participant B noted: *"I hear more frequently about the need for quality and how the BI function is viewed as a central hub with answers to all questions, expected to coordinate and align all functions. Soft skills have become super important for effective stakeholder communication. BI has truly become the center of everything."*

The focus group participants discussed the evolving role and growing importance of BI in organizations, emphasizing its emergence as a key driver of business growth. While BI was previously used primarily for descriptive analytics, helping to understand historical data, there is now increasing demand for predictive and prescriptive analytics. This shift largely depends on the organization's analytics maturity. One participant shared a case where organization shifted focus from implementing new systems to advancing their data platforms, making BI central to their operations. As Participant A explained: *"A major new trend is that just a few years ago, BI solutions were at the end of the value stream—strategy, tactics, execution, and reporting. Now, BI has moved to the start of the value stream, as everything depends on how well BI prepares data for decision-making."*

Focus group participants emphasized the importance of obtaining real-time data and insights from BI. They noted that businesses want to be alerted

to issues or red flags as soon as possible, enabling immediate action without waiting for feedback from clients. As participant A observed, *"Managers understand that if they're not getting real-time data to make decisions, they feel blind. Everyone wants at least basic numbers. Some even choose to pay twice and get an additional BI tool if the centralized one doesn't meet their needs."*

The focus group agreed that fulfilling the identified expectations for BI would positively influence organizational agility.

5.3.2. Theme 2: BI agility and its drivers

This theme, prompted by questions to the focus group about the agility expected from the BI function in creating value, explored how organizations can achieve BI agility. The discussions helped identify key expectations for BI agility, factors influencing it, and emphasized the critical role of BI, analytics, and data teams in building and sustaining BI agility.

The list of expectations for BI agility presented in Table 32.

Table 32. Focus group codes on expectations for BI agility

Code	Number of quotations
Speed of getting data insights	7
BI aligned to business changes	6
Responsiveness of BI	3
Seamless data integration	3
Flexibility in BI	2
BI aligned to technological changes	1

The focus group unanimously agreed that the speed of obtaining relevant data insights for timely decision-making is the most critical feature of agile BI. Participant A shared: *"I worked in one organization with a flexible BI model where we could ask crazy questions, raise various hypotheses, and get the needed data quickly. In another organization, I was told to wait a week for the data. That's agility—in one place, you get answers in 20 minutes, while in another, you wait a week."* Another participant emphasized the distinction between the speed of implementing changes in BI and the speed of delivering insights once BI is in place. While both aspects are crucial for BI agility, the group noted that rushing implementation might sometimes compromise quality and long-term benefits.

The ability of BI to adapt to business changes was also discussed as a key expectation. BI specialists must stay informed about organizational changes

and proactively implement relevant adjustments to maintain alignment. As Participant D noted, *"It is expected that BI will move at the same speed as the business."*

The group then transitioned to discussing what it takes to create an agile BI function, considering both technological and human factors. This part of the discussion focused on identifying factors that either enable or restrict BI agility. Key restricting factors that emerged included a deficiency in data literacy and a gap between BI and decision-making. On the enabling side, topics such as the alignment of common language and terms, effective change management, and cross-functional cooperation/teamwork were frequently mentioned. A comprehensive list of these factors is presented in Table 33.

Table 33. Focus group codes on factors impacting BI agility

Code	Number of quotations
Deficiency in data literacy	10
Common definitions and terms aligned	9
Gap between BI and decision-making	9
Cross-functional cooperation/teamwork	8
Data-driven decision making	8
Effective change management	8
Business competence of data staff	7
Challenges of decentralization/silos	6
Data professionals' soft skills	5
Leadership's role in supporting BI agility	5
Business ownership of data	3
Dependencies impacting BI	3
Analytics maturity as a driver	2
Curiosity in exploring data	2
Experimentation with data	2
Increasing complexity of data environment	2
Resistance of BI adoption	2
Technical debt as a constraint	2
Agile BI architecture	1
Cost-efficient data storage	1

Deficiency in data literacy among employees was a recurring topic in the discussion. Participants shared experiences where, during the BI implementation phase, gathering requirements proved challenging because stakeholders lacked understanding of their own data or didn't know the right questions to ask. Another issue raised was that when BI specialists or data analysts presented more advanced calculations, management often struggled

to grasp them, leading to their rejection. Thus, a key success factor is to work closely with stakeholders and educate them. Participant D noted: *"In earlier times, accountants were responsible for BI data, so the demand for data literacy across the organization beyond data teams is relatively new. When organizations change processes or products, they often overlook data. As an example, our team gave a data award for a situation where certain data was deemed unsuitable for analytics because, during the introduction of a new product, no consideration was given to how the data should be structured for future use."*

The necessity of having a commonly aligned language and terms was another topic highlighted by several participants. Achieving this requires the entire organization to align, with key stakeholders sitting together to reach common ground. An important point mentioned was that these common definitions need to be periodically reviewed and updated to stay relevant and reflect the current situation. Participant D shared: *"The challenges we faced were that different departments were not communicating and were creating their own silos, making alignment difficult. So, we invited representatives from each domain, locked them in a meeting room, and told them not to leave until they had agreed on common terms and definitions. It took several meetings, but in the end, we had those definitions. To maintain them, we introduced a process where any change in definition required the relevant stakeholders to gather and agree. This way, we engaged business people."*

The gap between BI and decision-making was another recurring theme that impacts BI agility. BI is only as valuable to the organization as it is used for decision-making. Participants highlighted instances where, due to deficiencies in data literacy or other factors, decision-makers were not utilizing the available BI tools. Participant D noted: *"Simply having BI tools doesn't automatically lead to insights. There's a gap that needs to be bridged between BI and decision-making. While presenting numbers is a step forward, understanding what those numbers mean and what actions to take is the next critical step."* The focus group emphasized not only the need for data literacy education for decision-makers but also placed expectations for BI and data specialists to help bridge this gap.

The expectations for BI and data professionals are outlined in Table 34.

Table 34. Collinearity statistics

Code	Number of quotations
Growing responsibilities for data staff	6
Responsibilities beyond technical	6

Communication and other soft skills	5
Proactive collaboration with business	5
Business competence is a must	4
Self-leadership	1

The focus group noted a growing trend in the increasing expectations and responsibilities placed on data professionals over time. This shift can be attributed to the rising importance and strategic role of BI and data platforms, as they become central functions for aligning the entire organization. Data professionals are now expected to oversee the entire data architecture, drive change, and actively collaborate with business units to ensure BI and data systems remain aligned with business objectives and support decision-making. Effective communication, collaboration skills, and self-leadership were highlighted as essential competencies for BI and data specialists. Participants also mentioned the introduction of business analysts into data teams to bring in more business acumen and enhance collaboration with business stakeholders.

5.3.3. Theme 3: culture‘s influence on BI agility

The theme of culture emerged consistently throughout the discussion, and the final part of the focus group focused specifically on how organizational culture affects BI and the agility of the BI function. The discussion explored the values, mindsets, and behaviors that are critical for BI success in dynamic environments. Additionally, participants shared insights into situations where not only does culture influence BI, but BI can also have an impact on shaping organizational culture.

The complete list of cultural factors identified by the focus group as influencing BI agility is presented in Table 35.

Table 35. Focus group codes on cultural impact on BI agility

Code	**Number of quotations**
Fear of transparency	7
Psychological safety	5
Hierarchical culture's impact	4
Business pressure for speed	3
Courage to challenge the status quo	3
Punishment culture (messenger shot)	3
Manipulation of data for personal gains	3
Curiosity and learning culture	2
Organizational climate	2

Code	Number of quotations
Scapegoating	2
Speed and urgency as cultural traits	2
Cultural history affecting BI adoption	1
Data for risk mitigation	1
Leadership's culture	1
Openness and candor	1
Openness to change	1
Personal needs vs common needs	1
Shared accountability	1

When discussing the cultural impact on BI agility, a recurring topic was the fear of transparently sharing data, as individuals may worry that the data will reveal uncomfortable truths that could have negative consequences for themselves, their peers, or managers. This fear was often attributed to a lack of psychological safety, where employees feel hesitant to share openly. This issue tends to be more pronounced in organizations with hierarchical structures and autocratic leadership. As participant E noted: *"One of the key factors encouraging agility is openness. We talk about transparency, but I want to emphasize personal openness within teams, departments, organizations, and cross-functional settings. This is deeply connected to culture. If openness exists and is promoted, we have a sharing culture. Another critical aspect is the courage to speak up. Often, we see situations where business people recognize that something isn't working, but the failing idea originated from C-level leadership. Overcoming the fear to say 'this isn't working, we need to stop' is essential."*

The impact of BI on organizational culture was another theme that emerged during the focus group discussion (Table 36).

Table 36. Focus group codes on BI impact on culture

Code	Number of quotations
Encouraging curiosity and questioning	3
Fostering a collaboration-driven culture	3
Encouraging experimentation with data	2

Participants shared examples of how BI projects foster curiosity and promote the practice of asking questions. Participant E remarked, *"BI pushes people to think differently. It promotes intelligence—not just by showing results but by encouraging the asking of more questions."* The same participant noted that in organizations just beginning their BI implementations, people often don't know what to ask, but once shown the

data, curiosity is sparked. The group also discussed another cultural shift that occurs in organizations with an established BI function—employees feel empowered to experiment with data, without fear of asking any questions or proposing unconventional hypotheses.

The focus group also highlighted how BI acts as a catalyst for increased collaboration within organizations, prompting individuals to talk, share data, and engage in discussions together. This collaboration is driven by the goal of establishing a BI platform as a single source of truth that is aligned across departments and teams—an alignment that cannot be achieved without strong cross-functional collaboration.

5.3.4. Theme 4: paradoxes and contradictions

The analysis of the focus group transcript also revealed several paradoxes and contradictions that emerged during the discussion, highlighting the complexities organizations face. These contradictions indicate that not everything is straightforward and emphasize the challenges organizations encounter in their BI and agility efforts. Key topics included tensions between centralization and decentralization and the gap between declared values and actual behaviors (see Table 37 for the full list).

Table 37. Focus group codes on paradoxes and contradictions

Code	Number of quotations
Centralization vs. decentralization tensions	8
Declared values vs. actual behaviours	4
BI staff culture vs. stakeholder culture	1
Real-time data desires vs. business value	1
Speed of implementation vs. data access speed	1

The focus group participants discussed observed market scenarios where companies or individual departments and teams are shifting from centralized BI and analytics platforms to siloed solutions. While centralized systems play a crucial role in aligning the organization and providing a single source of truth, they can sometimes hinder speed and agility. On the other hand, decentralized or siloed BI solutions may address immediate needs more quickly but often lead to increased complexity, limited strategic decision-making, and reduced agility in the long term.

Participant B illustrated this trade-off: *"Due to siloed solutions, decision quality can suffer. While this approach might seem to improve agility at the business unit level, I see signs that decision-making is becoming slower*

company-wide. Individual units might solve operational issues faster, but for strategic decisions, it's much slower because the information is fragmented and unaligned. This lack of alignment paralyzes the organization. In isolated areas, it might be faster, but making strategic decisions and long-term plans becomes really challenging."

The group expressed skepticism about siloed solutions, acknowledging their specific benefits but noting the overall cost to the organization. Participant D shared: *"One of our subsidiaries took this path, and it seemed to work well initially, providing more agility. But when we needed to merge across silos, it became a bottleneck. If you don't plan ahead, it gets really challenging because we end up with different stacks, cultures, and definitions. Fixing that technical debt becomes an organizational bottleneck."*

Participant A further highlighted the drawbacks of siloed BI solutions: *"A centralized solution helps build holistic competence and enables understanding of the end-to-end data flow. But with decentralization, this competence narrows, and in the long term, people lose sight of the broader organizational context."* The group agreed that strategic decision-making tends to suffer in favor of operational agility in departments using siloed BI systems. While acknowledging the value of siloed solutions, the group emphasized the importance of planning ahead to mitigate associated risks.

Another contradiction discussed was the cultural factors affecting BI and its agility. Participants shared examples where leaders declared support for BI but behaved in ways that contradicted these statements. Participant F explained: *"It's important how BI is introduced in an organization. If leaders claim that BI will help monitor problems or control bad results, there won't be much enthusiasm or curiosity. People may try to hide or remain silent. But if it's introduced as a positive tool that helps improve teamwork, people will react differently. The tone of introduction, what we expect from it, and how we use it daily are crucial."* Other participants echoed this sentiment, adding that if leaders declare BI as a tool for improvement but use it to justify negative outcomes, such as employee terminations, it undermines trust. The group agreed that for BI to be effective, declared values must align with actions, creating a safe environment for employees to leverage BI for meaningful improvements.

5.3.5. Theme 5: actionable insights and leadership's role in BI agility

As this study aims to gather not only experiences and perspectives on BI agility and its role in supporting organizational agility but also to provide actionable insights, the focus group was guided by questions on practical

solutions. Participants shared both solutions they have seen successfully implemented in organizations and those they believe would be beneficial. The most frequently mentioned solutions for addressing BI agility and enhancing BI utilization to improve organizational agility were: involving data professionals in business changes, focusing on change management in BI initiatives, expanding data literacy beyond data teams, leveraging business analysts to drive BI initiatives, introducing a common terms and definitions dictionary, and taking actions to bridge the gap between BI and decision-making. A comprehensive list of these solutions is presented in Table 38.

Table 38. Focus group codes on actionable insights for BI agility

Code	Number of quotations
Involve data professionals in business changes	9
Attention to change management in BI initiatives	7
Grow data literacy beyond data teams	6
Leverage business analysts to drive BI initiatives	6
Introduce a common terms and definitions dictionary	5
Take actions to bridge the gap between BI and decision making	5
Appoint change champions for BI initiatives	4
Attention to data people soft-skills development	4
Establish governance for siloed BI solutions	4
Implement data-driven performance management	4
Provide continuous education and coaching for business	4
Act based on price of not having data	3
Assign business ownership for specific data	3
Foster a BI-friendly organizational culture	2
Appoint change owners	1
Balance centralized and silos solutions	1

The leadership role and its impact on the successful utilization of BI insights for decision-making, as well as the influence on the BI function itself, were recurring themes throughout the discussion. The focus group unanimously agreed that leaders set the tone and can either cultivate or undermine the culture in which BI can thrive. Insights derived from the focus group transcript analysis, detailed in Table 39, highlight how leaders can more effectively contribute to BI and improved agility.

Table 39. Focus group codes on leadership impact

Code	Number of quotations

Actively drive culture change	9
Enhance management's data literacy competence	5
Align BI-related communication with actions	4
Set a strategic vision for making analytics a business driver	4
Strengthen positive manager-employee relationships	3

These insights emphasize the importance of leaders actively driving cultural change to prevent dysfunctional or even toxic behaviors and instead promote attitudes and behaviors that support BI initiatives. Another key area is the need for leaders to prioritize data literacy within the management team, ensuring that data insights are well understood and used to guide decision-making. Additionally, leaders must avoid the disconnect between promoting BI as a positive tool for the organization and employees while contradicting this with their actions. Leadership's role in understanding the critical business-driving benefits of BI and championing this vision emerged as a crucial point. Lastly, the importance of positive manager-employee relationships was highlighted as essential for fostering psychological safety, which, in turn, encourages employees to ask questions and experiment with data, ultimately leading to better decision-making.

5.4. Results and findings

5.4.1. Summary of key findings

Many themes that emerged from the focus group discussion align with existing literature on Organizational Agility, BI Agility, Organizational culture and their interconnection. While these themes conceptually relate to the academic discourse, the focus group discussion offered a more operational understanding and surfaced actionable insights that were not fully explored in the literature. Although some of these insights echo practitioner-oriented literature, the academic literature appears to fall short in providing sufficient guidance for organizations seeking to leverage BI to enhance their organizational agility.

A summary of the key insights from the focus group is provided in Table 40.

Table 40. Key focus group insights

Theme	Sub-theme	Insights from focus group
Expectations on BI in dynamic business environment	Supporting decision-making	BI is a tool to understand current situations and determine future directions, as well as to sense signals that require attention.
	Aligning entire organization	BI should serve as a central function that not only provides answers to all questions but also coordinates and aligns the entire organization.
	Driving business growth	BI should meet the increasing demand for predictive and prescriptive analytics that drive business growth.
	Real-time data and insights	BI should ensure that business is alerted to issues or red flags as soon as possible, enabling immediate action without waiting for feedback from clients.
Expectations for BI agility	Speed of getting data insights	The speed of obtaining relevant data insights for timely decision-making is the most critical feature of agile BI. Important to distinct between the speed of implementing changes in BI and the speed of delivering insights once BI is in place - rushing implementation might sometimes compromise quality and long-term benefits.
	BI aligned to business changes	BI specialists must stay informed about organizational changes and proactively implement relevant adjustments to maintain alignment.
Factors impacting BI agility	Deficiency in data literacy	Stakeholders often lack understanding of their own data or don’t know the right questions to ask. When BI specialists or data analysts present more advanced calculations, management often struggled to grasp them, leading to their rejection.
	Common definitions and terms aligned	Achieving common definitions and term requires the entire organization to align, with key stakeholders sitting together to reach common ground. These common definitions need to be periodically reviewed and updated to stay relevant and reflect the current situation.

Theme	Sub-theme	Insights from focus group
	Gap between BI and decision-making	Due to deficiencies in data literacy or other factors, decision-makers are not utilizing the available BI tools. Decision-makers need more data literacy education. Also BI and data specialists are expected to help bridge this gap.
Expectations on BI/data specialists	Growing responsibilities for data staff	Data professionals are now expected to oversee the entire data architecture, drive change, and actively collaborate with business units to ensure BI and data systems remain aligned with business objectives and support decision-making. Effective communication, collaboration skills, and self-leadership are essential competencies for BI and data specialists. The introduction of business analysts into data teams is a solution to bring in more business acumen and enhance collaboration with business stakeholders.
Cultural impact on BI agility	Fear of transparency	Concerns about revealing uncomfortable truths hinder BI adoption.
	Psychological safety	Employees may hesitate to share openly due to fear of negative consequences.
	Hierarchical culture's impact	Hierarchical structures exacerbate resistance to BI adoption.
BI impact on culture	Encouraging curiosity and questioning	BI projects foster curiosity and promote the practice of asking questions.
	Fostering a collaboration-driven culture	BI acts as a catalyst for increased collaboration within organizations, prompting individuals to talk, share data, and engage in discussions together. This collaboration is driven by the goal of establishing a BI platform as a single source of truth that is aligned across departments and teams—an alignment that cannot be achieved without strong cross-functional collaboration.
	Encouraging experimentation with data	Employees feel empowered to experiment with data, without fear of asking any questions or proposing unconventional hypotheses.

Theme	Sub-theme	Insights from focus group
Paradoxes and contradictions	Centralization vs. decentralization tensions	While centralized systems play a crucial role in aligning the organization and providing a single source of truth, they can sometimes hinder speed and agility. On the other hand, decentralized or siloed BI solutions may address immediate needs more quickly but often lead to increased complexity, limited strategic decision-making, and reduced agility in the long term.
	Declared values vs. actual behaviours	In some cases leaders may declare support for BI but behaved in ways that contradicted these statements. E.g. if leaders declare BI as a tool for improvement but use it to justify negative outcomes, such as employee terminations, it undermines trust. For BI to be effective, declared values must align with actions, creating a safe environment for employees to leverage BI for meaningful improvements.

5.4.2. Validation of hypothesis

The focus group discussion also provided valuable insights for validating the BI agility construct and the hypotheses formed and empirically tested in earlier stages of this research.

Firstly, regarding the BI agility construct, which was conceptualized in this study as a composite of three dimensions: BI architecture agility, BI governance agility, and agile BI culture, the focus group discussions revealed strong alignment with this framework. Participants predominantly emphasized factors related to people and organizational practices, covering both governance and cultural aspects, while also recognizing the importance of technical and architectural elements of BI solutions and the broader data environment.

The focus group insights on factors influencing BI agility and their alignment with the dimensions of the conceptualized BI agility construct are detailed in Table 41.

Table 41. Mapping of focus group insights to BI agility construct dimensions

BI agility construct dimensions	**Factors impacting BI agility derived from focus group discussion**
BI architecture agility	Challenges of decentralization/silos
	Negative effects of centralization
	Technical debt as a constraint
	Agile BI architecture
	Cost-efficient data storage
	Dependencies impacting BI
	Increasing complexity of data environment
	Self-service capabilities
BI governance agility	Common language and terms aligned
	Cross-functional cooperation/teamwork
	Effective change management
	Business ownership of data
	Ensured data quality
	Business competence of data staff
	Data staff soft skills
Agile BI culture	Curiosity in exploring data
	Experimentation with data
	Resistance of BI adoption
	Data-driven decision making
	Fast feedback loop
N/A	Gap between BI and decision-making
	Leadership's role in supporting BI agility
	Deficiency in data literacy

While the focus group confirmed that BI architecture, BI governance, and BI culture are foundational for establishing an agile BI function capable of supporting organizational agility, it also introduced new insights that do not directly map to these dimensions. These include the gap between BI and decision-making, leadership's role in supporting BI agility, and deficiencies in data literacy. Although not part of the original construct, these insights could be considered influential factors for BI agility and warrant further investigation in future research.

Secondly, regarding the hypotheses tested in earlier stages of this research, the focus group provided valuable insights that not only support but also expand on them in more detail.

For hypothesis H1: *An organization's BI agility, encompassing both technical and human factors, positively influences its organizational agility*, the focus group offered perspectives on BI expectations (Table 31). If these

expectations are met, they can help organizations thrive in dynamic, fast-changing environments.

For hypothesis H2: *Organizational culture moderates the relationship between an organization's BI agility and its organizational agility*, the focus group highlighted mindsets and behaviors that strongly influence both BI agility and organizational agility. Some of these cultural traits are specific to the BI function and can be considered part of BI culture. However, many other mentioned traits exist at the overall organizational level, significantly impacting BI-related behaviors and decisions.

5.4.3. Practical implications

In addition to advancing the theoretical understanding of BI agility, its role in organizational agility, and the impact of cultural factors, the focus group discussion also provides practical insights for organizations. A key objective of this research was to offer actionable guidance for organizations seeking to derive more value from their BI systems. The insights gathered from the focus group have been organized into a visual framework, which can serve as a blueprint for organizational leaders and business consultants aiming to enhance organizational agility through BI. This framework is presented in Figure 19.

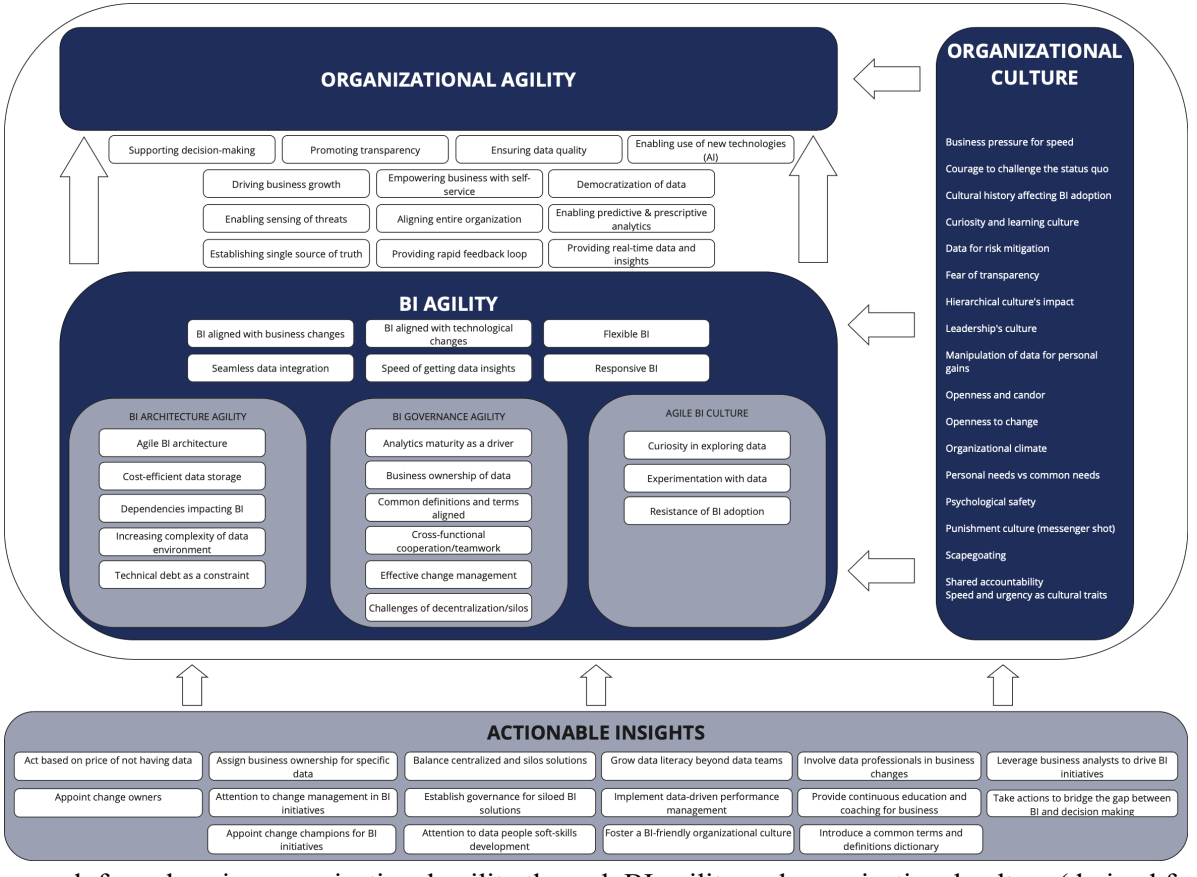

Figure 19. Framework for enhancing organizational agility through BI agility and organizational culture (derived from focus group insights)

This framework is designed to help organizations understand not only the general relationships between BI agility, organizational agility, and organizational culture, but also the forces that influence these relationships. Starting from the bottom, the framework highlights actionable insights, which, if implemented, are expected to positively impact BI agility, organizational culture, and ultimately, organizational agility.

The model presents the three dimensions of BI agility—BI architecture agility, BI governance agility, and Agile BI culture—along with the factors that specifically affect each of these dimensions. It also outlines what is expected from an agile BI function, such as alignment with business and technological changes, seamless data integration, and speed in delivering insights.

Moving from BI agility to organizational agility, the framework shows how BI agility supports specific capabilities that shape organizational agility, such as decision-making support, promoting transparency, and enabling the use of new technologies like AI. On the side, organizational culture is presented, along with the cultural traits that strongly influence both BI agility and organizational agility, demonstrating how culture can either enable or constrain the relationship between the two.

5.5. Discussion and conclusions

This focus group study provided valuable insights into the role of BI agility in enhancing organizational agility and the impact of organizational culture on this relationship. The discussions with industry experts not only confirmed several theoretical perspectives but also revealed practical and actionable insights that go beyond existing literature, contributing to a more operational understanding of how BI agility can be leveraged within organizations.

One of the key findings is the growing expectation for BI systems to move as fast as business operations and provide real-time data insights to support decision-making in dynamic and fast-changing environments. Participants emphasized the importance of BI agility, not just from a technological perspective, but also from a governance and cultural standpoint. These findings validate the BI agility construct proposed in this research, which includes BI architecture agility, BI governance agility, and an agile BI culture. The experts also highlighted the critical role of data literacy and leadership in fostering an agile BI function that effectively supports organizational agility.

The focus group discussions reinforced the hypothesis that BI agility positively influences organizational agility, particularly when BI systems are

aligned with business needs, able to integrate data seamlessly, and offer timely, actionable insights. Participants provided examples of how organizations that have agile BI systems are better equipped to sense and respond to market changes, thereby enhancing their overall agility. However, the discussions also revealed potential barriers to BI agility, such as decentralized or siloed BI solutions, gaps between BI and decision-making, and a lack of data literacy among decision-makers. These insights suggest that while BI agility is a crucial enabler of organizational agility, its effectiveness can be hampered if these barriers are not addressed.

The role of organizational culture in moderating the relationship between BI agility and organizational agility was also a central theme in the discussions. Participants pointed out that cultural factors, such as transparency and openness, psychological safety, and a data-driven mindset, are essential for fostering an environment where BI can thrive and contribute to organizational agility. Moreover, the focus group highlighted a potential paradox where organizations may declare positive values around BI use for the organization and employees, yet fail to align these declarations with their actions. This cultural misalignment can ultimately hinder BI adoption and agility.

In conclusion, this study offers both theoretical and practical contributions. The focus group discussions have validated the BI agility construct and confirmed its importance in enhancing organizational agility. Moreover, the findings underscore the critical role of organizational culture in shaping BI agility and its impact on agility outcomes. Organizations seeking to improve their agility through BI must not only focus on the technical aspects of BI but also invest in fostering a supportive cultural environment that promotes data literacy, collaboration, and openness. The actionable insights derived from this research offer a practical blueprint for organizations to leverage BI in enhancing their agility, helping them navigate an increasingly competitive and dynamic business landscape.

Future research could further explore the specific challenges and solutions identified in this study, particularly in addressing the gaps between BI and decision-making, as well as the leadership's role in driving cultural change to support BI agility. Additionally, longitudinal studies could examine how these factors evolve over time and their long-term impact on organizational performance and agility.

CONCLUSIONS

Enhancing organizational agility to strengthen economies and improve competitiveness in fast-paced markets is a topic of undeniable importance to both academic researchers and practitioners. In an era characterized by exponential data growth and rapid technological advancements, organizations that effectively leverage BI technologies to sense and respond to environmental changes gain a significant competitive advantage. This dissertation investigated two critical conditions – BI agility and organizational culture – and their roles in enabling organizations to achieve greater agility. While this research advances the understanding of these factors, it is essential to acknowledge additional influences, such as IT infrastructure flexibility (Chen & Siau, 2020), technological and market turbulence (Ashrafi et al., 2019; Zhang et al., 2024), data-driven organizational learning (Zhang et al., 2024), entrepreneurial orientation (Al-Darras & Tanova, 2022), information quality, innovative capability (Ashrafi et al., 2019), and managerial skills (Zhang et al., 2024), which were beyond the scope of this study.

This research addresses a critical gap by refining and extending the concept of BI agility to align with the socio-technical nature of BI systems. Previous studies largely focused on BI agility as a technical feature, but this dissertation reconceptualizes it as a multidimensional construct encompassing human-centered factors (BI governance agility and agile BI culture) alongside technical factors (BI architecture agility). This socio-technical perspective highlights BI agility as a capability to adapt to dynamic environments. A comprehensive measurement scale was developed to assess not only BI's technical readiness for change and ability to meet business demands but also the readiness of BI governance and BI culture to sustain long-term agility. Key BI agility dimensions and their strongest indicators include:

- BI Architecture Agility: data acquisition agility, data storage agility, and BI functional agility.
- BI Governance Agility: data quality processes, interdisciplinary teams, and a unified data model.
- Agile BI Culture: feedback on BI impact, experimentation with data, and a data-driven mindset.

The findings confirm that BI agility, when framed as a multidimensional construct, significantly influences organizational agility. Moreover, this study empirically demonstrates that a performance-oriented organizational culture moderates the relationship between BI agility and organizational agility. Organizations that cultivate such a culture – characterized by high

cooperation, trained messengers, shared risks, encouraged bridging, and implemented novelty (Westrum, 1988, 2004) – are better positioned to leverage BI capabilities for enhanced agility. Importantly, the supportive effect of culture is amplified at higher levels of BI agility.

While the study highlights the critical role of culture, it also acknowledges its complexity. Culture, shaped by deeply rooted shared beliefs, values, norms, and priorities (Schein, 2017), is challenging to research, quantify, and change. Organizational culture is rarely monolithic or unitary; instead, it is often fragmented or differentiated, with subcultures existing at various levels (Meyerson & Martin, 1987; Howard-Grenville, 2006). These subcultures, with potentially competing sets of values, can influence the extent to which BI agility translates into organizational agility. For example, while certain subcultures may exhibit stronger results, the overall effect at the organizational level may depend on the dominant cultural values.

Recognizing the limitations of quantitative methods in capturing human-centered and cultural complexities, this study complemented its findings with qualitative insights from a focus group discussion with industry experts. The participants validated and enriched the results, confirmed the multidimensional nature of BI agility, which extends beyond technology to include governance and cultural aspects. They highlighted the critical role of data literacy and leadership in fostering an agile BI function that supports organizational agility while identifying cultural barriers such as fear of transparency, lack of psychological safety, and rigid hierarchies that limit BI's potential. Actionable insights from the discussion include addressing gaps in data literacy, aligning common definitions and terms, and ensuring stronger integration between BI and decision-making.

In conclusion, this dissertation advances the understanding of BI agility and organizational culture as critical enablers of organizational agility. By developing a BI agility measurement instrument, empirically testing key relationships, and incorporating insights from industry experts, this research provides valuable guidance for both academia and practitioners.

THEORETICAL CONTRIBUTIONS

This research contributes to science in several keyways:

1. *BI agility conceptualization aligned with its socio-technical nature*. The existing literature predominantly conceptualizes BI agility as a technical feature (Zimmer et al., 2012; Knabke & Olbrich, 2013; Baars & Zimmer, 2013; Baars et al., 2014; Knabke & Olbrich, 2017), neglecting the socio-technical nature of BI systems. This perspective has primarily addressed the "what" of BI agility, focusing on BI's technical responsiveness and adaptability to changing business requirements and demands. However, it has not adequately explained the "how" — the human-driven factors and organizational actions critical to achieving BI agility. Although Krawatzeck and Dinter (2015) attempted to bridge this gap by providing more actionable insights, their study remained largely centered on technical aspects, with limited attention to human-centered dimensions. This research challenges the prevailing notion of BI agility as solely a technical feature and offers a redefined and extended conceptualization grounded in a socio-technical perspective. In socio-technical systems, human factors are as critical as technological factors, and focusing only on technical factors cannot ensure the desired outcomes. This study highlights the significance of human-centered dimensions (Agile BI culture and BI governance agility) alongside technical aspects (BI architecture agility), supported by evidence gathered in this study. Additionally, it provides a comprehensive overview of the factors that contribute to each of these three BI agility dimensions, addressing gaps in the academic literature and providing actionable insights for achieving BI agility.
2. *Introduced new measurement scale for BI agility.* This study introduces a novel measurement scale for operationalizing the BI agility construct, integrating both technical and human-centered dimensions. Previously, Knabke and Olbrich (2017) attempted to quantitatively measure BI agility by assessing extrinsic characteristics such as BI change behavior, perceived customer value, and the adequacy of architecture, data models, and infrastructure. While these characteristics capture the state of BI agility at a specific moment, they fail to encompass the capability to adapt to changing environments over time. To address this limitation, this study developed a comprehensive scale that assesses not only BI's technical readiness for change and ability to meet business demands but also

the readiness of BI governance and BI culture to sustain long-term BI agility. The scale was developed using a combination of qualitative methods (literature review and interviews) and empirically refined and validated through statistical techniques, including Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). This measurement scale offers scholars a robust tool for future empirical research.

3. *Empirical results supporting the proposed research model.* The research model proposed in this study received strong empirical support, validating both hypotheses regarding the relationship between BI agility and organizational agility, as well as the moderating effect of organizational culture – both demonstrating positive results. While prior studies have examined the effect of BI on organizational agility through constructs such as BI use (Chen & Siau, 2011, 2012), BI technologies (Park et al., 2017), BA use (Chen & Siau, 2020), BA capabilities (Ashrafi et al., 2019), BDA technologies (Corte-Real et al., 2017), BDA capabilities (Xie et al., 2022; Al-Darras & Tanova, 2022), and BDA use (Hyun et al., 2020), none have explored the specific impact of BI agility on organizational agility. This research provides robust evidence that higher levels of BI agility result in a stronger positive impact on organizational agility. Furthermore, while existing academic literature suggests that organizational agility benefits from a culture embracing agility values and highlights the importance of culture for BI success (Popovič et al., 2012; Dubey et al., 2019; Wong & Ngai, 2023; Thanabalan et al., 2024; Wamba et al., 2024), this study offers empirical confirmation of these relationships. It identifies specific organizational culture traits based on Westrum's (1988, 2004) framework critical for fostering an environment conducive to both BI agility and organizational agility. Notably, the research reveals that the supportive effect of organizational culture on the relationship between BI agility and organizational agility is amplified when BI agility is high. These findings are novel contributions to the academic literature, advancing the understanding of the interplay between BI agility, organizational agility, and organizational culture.

PRACTICAL IMPLICATIONS

This study provides research-backed insights and guidance for organizational leaders striving to enhance their enterprises' agility through BI, as well as for management consultants advising organizations. The key practical implications derived from the study are as follows:

1. *Raising awareness of the role of BI agility and organizational culture*. Organizations can leverage the insights from this research to capture leadership's attention on the benefits of fostering BI agility and cultivating a BI- and agility-friendly culture. These research-backed insights can inspire strategic decisions and initiatives that enhance BI agility and it's enabling role in organizational agility, ultimately strengthening competitive positioning in the market.
2. *Utilization of the BI agility scale.* Leaders can utilize the validated BI agility scale to assess their organization's current BI capabilities across three dimensions: BI Architecture Agility, BI Governance Agility, and Agile BI Culture. By identifying specific strengths and weaknesses within these areas, organizations can prioritize initiatives that enhance their BI functions. Regular assessments using this scale can help track progress over time and adapt strategies as needed.
3. *Cultural assessment and alignment.* Using Westrum's (1988, 2004) culture framework based measurement scale combined with cultural traits identified by industry experts in focus group, organizations can conduct a thorough assessment of their current culture against the traits identified in the research. This assessment can help leaders identify cultural gaps that may hinder both BI agility and overall organizational agility. A BI- and agility-friendly organizational culture is characterized by high cooperation, trained messengers, shared risks, encouraged bridging, and implemented novelty, as opposed to a culture marked by low cooperation, “shot” messengers, shirked responsibilities, discouraged bridging, and crushed novelty. The culture assessment could motivate organizational leaders to initiate cultural transformation if they find that the current culture in their organization conflicts with these essential values.
4. *Actionable insights and best practices derived from industry experts.* Insights from the focus group discussions confirm that the challenges addressed in this research are highly relevant to practice. Many organizations struggle with both building and maintaining an agile BI function and using BI to achieve the desired level of organizational agility. The experiences shared by the expert group have potential to

resonate with the realities of other organizations, and the identified improvement opportunities may inspire leaders to take necessary actions toward building a more agile BI function.

RECOMMENDATIONS FOR FUTURE RESEARCH

Building on the findings of this dissertation, several avenues for future research are suggested to further explore and deepen the understanding of BI agility, its impact on organizational agility, and the role of organizational culture:

1. *Exploration of more cultural dimensions.* While this dissertation highlights the importance of organizational culture, it primarily utilized Westrum's (1998, 2004) culture framework in empirical research. Incorporating additional frameworks, such as those by Cameron and Quinn (2005) or Hofstede et al. (1990), could provide a more comprehensive overview of cultural influences on BI agility and it's role in organizational agility.
2. *BI agility scale utilization in empirical studies.* The BI agility measurement instrument developed in this research can be applied in empirical studies to validate hypotheses on the relationship between BI agility and other organizational traits, such as organizational resilience or performance. Additionally, new insights could be gained by exploring the relationship between BI agility and BI maturity – a topic of interest to practitioners, as higher levels of BI maturity might come at the cost of reduced BI agility. Future studies could use this scale in diverse organizational settings to assess its reliability and validity across various contexts. This would also enhance the scale's applicability and facilitate broader empirical research on BI agility.
3. *Investigating the role of emerging technologies.* Future research should examine the impact of emerging technologies, such as AI, ML, DL on BI Agility. Understanding how these technologies influence data processing, decision-making, and ultimately organizational agility could offer new perspectives on the evolving role of BI.
4. *Summarizing and integrating human-centered knowledge in BI research.* This study highlights the critical importance of human-centered aspects, particularly the role of BI culture in BI agility and the broader impact of organizational culture on BI agility. The literature review identified a fragmented body of research addressing human factors in the BI field. Future studies should focus on systematically reviewing the evidence at the intersection of BI and culture, integrating existing knowledge to provide cohesive insights that inform practitioners and guide further scholarly exploration.

By pursuing these recommendations, future research can further advance the field of BI, its agility, cultural influences, and its impact on organizational outcomes, ultimately equipping organizations with insights and strategies for leveraging BI in dynamic environments.

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APPENDIXES

APPENDIX A. Studies on the relationship between BI and agility

Authors	Year	Research type	Independent variable	Mediator and/ or Moderators	Dependent variable	Key findings
Chen & Siau	2011, 2012	Empirical	BI use; IT infrastructure flexibility	-	Organizational agility	BI and IT infrastructure flexibility are significant antecedents of organizational agility.
Kuilboer et al.	2016	Conceptual	-	-	-	BI capabilities enable organizations to achieve the three particular types of agility: operational, portfolio, and strategic agility, thus leading to their short-term and long-term performance.
Park et al.	2017	Empirical	BI technologies; Communication technologies	-	Organizational agility (Sensing agility; Decision-making agility; Acting agility)	In fast, predictable environments, BI technologies are essential for firms to achieve sensing agility, decision making agility, and acting agility.
Ashrafi et al.	2019	Empirical	BA capability	Information quality; Innovative capability; Technological turbulence; Market turbulence	Firm agility; Firm performance	BA capabilities strongly impact a firm's agility through an increase in information quality and innovative capability. Market and technological turbulence moderate the influence of firms' agility on firms' performance.
Corte-Real et al.	2017	Empirical	BDA technologies (endogenous knowledge management,	Organizational agility	Competitive advantage	BDA applications can allow an effective internal and external knowledge management which can help firms to create

Authors	Year	Research type	Independent variable	Mediator and/ or Moderators	Dependent variable	Key findings
			exogenous knowledge management, knowledge sharing patterns)			organizational agility and competitive advantage.
Barlette & Baillette	2020	Narrative literature review	-	-	-	The link between BDA and organizational agility. The renewal of internal and external relationships and the acceleration of the organizational speed required for maximizing the benefits offered by BDA. The importance of organizational culture change and top management support.
Hyun et al.	2020	Empirical	Advanced use of BDA; Basic use of BDA	Organizational culture (Democratization culture, Collectivistic culture)	Organizational agility	BDA use (both advanced and basic) positively relates to organizational agility. Democratization culture helps advanced BDA use translate into agility, but has a negative moderating effect on the link between basic BDA use and agility. The collectivistic culture strengthens the link between basic BDA use and agility.
Chen & Siau	2020	Empirical	BA use;	IT infrastructure flexibility	Organizational agility	BA use and IT flexibility are significantly associated with

Authors	Year	Research type	Independent variable	Mediator and/ or Moderators	Dependent variable	Key findings
			IT infrastructure flexibility			organizational agility, requiring flexible IT infrastructure.
Xie et al.	2022	Empirical	BDA capability	Organizational agility	Organizational performance	Organizational agility mediates the link between BDA capability and performance.
Al-Darras & Tanova	2022	Empirical	BDA capability	Entrepreneurial orientation	Organizational agility	Entrepreneurial orientation mediates the relationship between BDA capabilities and agility.
Hyun et al.	2023	Systematic literature review	-	-	-	BDA enhances agility via inside-out, outside-in, and spanning capabilities, influenced by internal/external moderators such as IT infrastructure flexibility, dynamic capability, intergroup leadership, organizational culture, the fit between an organization and big data analytics, the customer involvement in BDA competency, market turbulence, technological uncertainty.
Zhang et al.	2024	Empirical	BDA managerial skills	Data-driven organizational learning; technological turbulence; market turbulence	Organizational agility	Data-driven learning mediates the link between BDA managerial skills and agility, moderated by technological and market turbulence.

APPENDIX B. Indicators for the BI agility scale

Indicators	Statements
BI ARCHITECTURE AGILITY	
Un-siloed data architectures	In our organization it is quick and easy to get an integrated view of data from different business functions and processes.
Sandboxes	In our organization it is possible to create own BI applications for data exploration, discovery, and what-if analyses.
Data acquisition agility	In our organization it is relatively quick to integrate new data sources or data elements to our BI application.
Data storage agility	In our organization it is relatively quick to implement changes in data storage.
BI content agility	In our organization it is relatively quick to add new facts, dimensions, or attributes into data models accessible for BI users.
ETL functional agility	In our organization we have a sufficient and flexible functionality to perform data extraction, transformation and loading.
Data storage functional agility	In our organization we have a sufficient and flexible functionality to store our data.
Reporting and analysis functional agility	In our organization we have sufficient and flexible functionality to satisfy the analysis needs of BI users.
Data acquisition scalability	In our organization we have scalable and flexible infrastructure to adjust data processing capacity when data load changes.
Data storage scalability	In our organization we have scalable and flexible infrastructure to adjust DW capacity when data volumes change.
BI access scalability	In our organization BI users are not experiencing performance or availability issues when BI workload increases.
BI GOVERNANCE AGILITY	
Interdisciplinary teams	In our organization we have BI implementation teams consisting of specialists with business and IT competences.
Self-organized teams	In our organization BI teams are self-organized, meaning that teams choose how best to accomplish their work, rather than being directed by others outside of the team.
Iterative process	In our organization BI teams produce BI deliverables in small iterations.
Rapid decision-making	In our organization we have rapid decision-making cycles for BI development and maintenance related questions.

Indicators	Statements
Value based prioritization	In our organization BI development priorities are set based on highest expected value.
Innovation processes	In our organization BI teams have dedicated time to experiment and test new solutions.
Lessons learned processes	In our organization we have processes to discuss and review lessons learned in BI initiatives.
BI alignment with business	In our organization we update BI content based on changes in business environment.
Unified terms and language	In our organization we have unified understanding of business terms and measurements across organization.
Business and IT collaboration	In our organization business act as a driver for changes in BI.
Business change communication	In our organization BI responsible persons or teams are informed in timely manner about planned changes on business side that might affect BI.
Competence development	In our organization BI specialists and users are constantly learning and developing their competence.
Defined data ownership	In our organization it is clear who owns and is responsible for specific data meaning takes care of data integrity.
Data quality processes	In our organization we have processes to maintain the quality of our data.
AGILE BI CULTURE	
Sharing of BI insights	In our organization employees share insights from BI with each other permanently, without limits and voluntarily.
Sharing of lessons learned	In our organization we are frequently discussing positive and negative experiences related to BI implementation, usage, and insights creation.
Feedback on the impact of BI on business	In our organization BI specialists get feedback on the effect of decisions that were based on insights from BI.
BI community	In our organization we have strong and respected intelligence and analytics community.
Encouragement for experimentation with data	In our organization we feel encouraged to experiment with data in BI and accept that not all experiments are successful.
Tolerance for mistakes	In our organization we accept mistakes in BI activities as learning opportunities.
Courage to "rock the boat"	In our organization we are not afraid to share insights from BI even if those are "uncomfortable" to some colleagues or units.

Indicators	Statements
Trust in insights derived from BI	In our organization we trust BI insights prepared and presented by other colleagues.
BI use for decisions	In our organization we use BI to receive maximum support by evidence to make better decisions.
Employees eager to use data	In our organization employees are eager to use and apply new BI data services within their roles.
Cross-validated analysis	In our organization we collaborate in insights preparation by updating and/or testing each other's analysis in BI.
Collaboration in analysis	In our organization collaboration increases insight reliability.

APPENDIX C. Survey No. 1 questionnaire for BI agility scale refinement

	Indicators	Statements
BI ARCHITECTURE AGILITY		**Indicate to what extend You agree or disagree with each statement relevant to BI & Analytics architecture:**
BIA1	Un-siloed data architectures	In our organization it is quick and easy to get an integrated view of data from different business functions and processes.
BIA2	Sandboxes	In our organization it is possible to create own BI applications for data exploration, discovery, and what-if analyses.
BIA3	Data acquisition agility	In our organization it is relatively quick to integrate new data sources or data elements to our BI application.
BIA4	Data storage agility	In our organization it is relatively quick to implement changes in data storage.
BIA5	BI content agility	In our organization it is relatively quick to add new facts, dimensions, or attributes into data models accessible for BI users.
BIA6	ETL functional agility	In our organization we have a sufficient and flexible functionality to perform data extraction, transformation and loading.
BIA7	Data storage functional agility	In our organization we have a sufficient and flexible functionality to store our data.
BIA8	Reporting and analysis functional agility	In our organization we have sufficient and flexible functionality to satisfy the analysis needs of BI users.
BIA9	Data acquisition scalability	In our organization we have scalable and flexible infrastructure to adjust data processing capacity when data load changes.
BIA10	Data storage scalability	In our organization we have scalable and flexible infrastructure to adjust DW capacity when data volumes change.
BIA11	BI access scalability	In our organization BI users are not experiencing performance or availability issues when BI workload increases.
BI GOVERNANCE AGILITY		**Indicate to what extend You agree or disagree with each statement relevant to BI & Analytics governance:**
BIG1	Interdisciplinary teams	In our organization we have BI implementation teams consisting of

	Indicators	Statements
		specialists with business and IT competences.
BIG2	Self-organized teams	In our organization BI teams are self-organized, meaning that teams choose how best to accomplish their work, rather than being directed by others outside of the team.
BIG3	Iterative process	In our organization BI teams produce BI deliverables in small iterations.
BIG4	Rapid decision-making	In our organization we have rapid decision-making cycles for BI development and maintenance related questions.
BIG5	Value based prioritization	In our organization BI development priorities are set based on highest expected value.
BIG6	Innovation processes	In our organization BI teams have dedicated time to experiment and test new solutions.
BIG7	Lessons learned processes	In our organization we have processes to discuss and review lessons learned in BI initiatives.
BIG8	BI alignment with business	In our organization we update BI content based on changes in business environment.
BIG9	Unified terms and language	In our organization we have unified understanding of business terms and measurements across organization.
BIG10	Business and IT collaboration	In our organization business act as a driver for changes in BI.
BIG11	Business change communication	In our organization BI responsible persons or teams are informed in timely manner about planned changes on business side that might affect BI.
BIG12	Competence development	In our organization BI specialists and users are constantly learning and developing their competence.
BIG13	Defined data ownership	In our organization it is clear who owns and is responsible for specific data meaning takes care of data integrity.
BIG14	Data quality processes	In our organization we have processes to maintain the quality of our data.
AGILE BI CULTURE		**Indicate to what extend You agree or disagree with each statement relevant to BI & Analytics culture:**

	Indicators	Statements
BIC1	Sharing of BI insights	In our organization employees share insights from BI with each other permanently, without limits and voluntarily.
BIC2	Sharing of lessons learned	In our organization we are frequently discussing positive and negative experiences related to BI implementation, usage, and insights creation.
BIC3	Feedback on the impact of BI on business	In our organization BI specialists get feedback on the effect of decisions that were based on insights from BI.
BIC4	BI community	In our organization we have strong and respected intelligence and analytics community.
BIC5	Encouragement for experimentation with data	In our organization we feel encouraged to experiment with data in BI and accept that not all experiments are successful.
BIC6	Tolerance for mistakes	In our organization we accept mistakes in BI activities as learning opportunities.
BIC7	Courage to “rock the boat”	In our organization we are not afraid to share insights from BI even if those are "uncomfortable" to some colleagues or units.
BIC8	Trust in insights derived from BI	In our organization we trust BI insights prepared and presented by other colleagues.
BIC9	BI use for decisions	In our organization we use BI to receive maximum support by evidence to make better decisions.
BIC10	Employees eager to use data	In our organization employees are eager to use and apply new BI data services within their roles.
BIC11	Cross-validated analysis	In our organization we collaborate in insights preparation by updating and/or testing each other's analysis in BI.
BIC12	Collaboration in analysis	In our organization collaboration increases insight reliability.

APPENDIX D. Survey No. 2 questionnaire for testing hypothesis

Questions	Constructs
In which country do you work? Which industry does your organization belong to? What is the number of employees in your organization? What is your position? How many years of experience do you have working with BI & Analytics?	N/A
Please indicate the extent to which you agree or disagree with each statement concerning BI within your organization: • In our organization it is relatively quick to integrate new data sources or data elements to our BI application. • In our organization it is relatively quick to implement changes in data storage. • In our organization we have sufficient and flexible functionality to satisfy the analysis needs of BI users. • In our organization we have BI implementation teams consisting of business and IT specialists. • In our organization we have unified understanding of business terms and measurements across organization. • In our organization we have processes to maintain the quality of our data. • In our organization BI specialists get feedback on the effect of decisions that were based on insights from BI. • In our organization we feel encouraged to experiment with data in BI and accept that not all experiments are successful. • In our organization employees are eager to use and apply new BI data services within their roles.	**BI Agility**
Please indicate the extent to which you agree or disagree with each statement regarding your organization's ability to easily and quickly perform the following actions: • Respond to changes in aggregate consumer demand. • Customize a product or service to suit an individual customer. • React to new product or service launches by competitors.	**Organizational agility**

• Introduce new pricing schedules in response to changes in competitors' prices. • Expand into new regional or international markets. • Change (i.e., expand or reduce) the variety of products / services available for sale. • Adopt new technologies to produce better, faster and cheaper products and services. • Switch suppliers to avail of lower costs, better quality or improved delivery times.	
Please indicate the extent to which you agree or disagree with each statement: • In my organization, information is actively sought. • In my organization, failures are learning opportunities, and messengers of them are not punished. • In my organization, responsibilities are shared. • In my organization, cross-functional collaboration is encouraged and rewarded. • In my organization, failure causes enquiry. • In my organization, new ideas are welcomed.	**Organizational culture**

APPENDIX E. Focus group question backlog

INFORMATION ABOUT DOCTORAL STUDENT

Justina Valentukevičė is a junior assistant professor at the Faculty of Economics and Business Administration at Vilnius University. She is also a seasoned practitioner with over 18 years of experience in the IT sector, including 7 years dedicated to implementing BI/analytics applications for private and public organizations in Lithuania and the Scandinavian market, as well as more than 7 years leading software engineering teams and contributing to digital transformations in large enterprises, including banking and telecommunications companies. Her research interests encompass BI/analytics agility, BI/analytics culture, the interaction between BI/analytics technology and humans, the effects of BI/analytics and AI on business, and digital transformation. Justina has published in *Journal of Decision Systems*, *Informing Science: The International Journal of an Emerging Transdiscipline*, and *Information Sciences*. Her conference papers have been presented at the *IFIP WG 8.3 Decision Support Open Conference* and the *InSITE: Informing Science + IT Education Conferences*. She teaches *Business Analytics and Decisions* and *Information Systems and Users Interaction* at the Faculty of Economics and Business Administration at Vilnius University.

INFORMACIJA APIE DOKTORANTĄ

Justina Valentukevičė yra jaunesnioji asistentė Vilniaus universiteto Ekonomikos ir verslo administravimo fakultete. Ji taip pat yra patyrusi praktikė, turinti daugiau nei 18 metų patirties IT sektoriuje, įskaitant 7 metus, skirtus verslo analitikos sprendimų diegimui privačioms ir viešosioms organizacijoms Lietuvoje bei Skandinavijos rinkoje, taip pat daugiau nei 7 metus vadovavusi programinės įrangos inžinerijos komandoms ir prisidėjusi prie skaitmeninių transformacijų didelėse įmonėse bankų ir telekomunikacijų sektoriuose. Jos mokslinių tyrimų interesai apima verslo analitikos lankstumą, verslo analitikos kultūrą, sąveiką tarp verslo analitikos technologijų ir žmonių, verslo analitikos ir dirbtinio intelekto poveikį verslui bei skaitmeninę transformaciją. Justina yra publikavusi mokslinius straipsnius žurnaluose „Journal of Decision Systems“, „Informing Science: The International Journal of an Emerging Transdiscipline“ ir „Informacijos mokslai“. Jos konferenciniai pranešimai buvo pristatyti „IFIP WG 8.3 Decision Support Open Conference“ ir „InSITE: Informing Science + IT Education Conferences“ konferencijose. Vilniaus universiteto Ekonomikos ir verslo administravimo fakultete Justina dėsto verslo analitikos ir sprendimų bei informacinių sistemų ir vartotojų sąveikos kursus.

SANTRAUKA

Didėjant rinkos nepastovumui, sparčiai besivystant technologijoms, susiduriant su tvarumo iššūkiais ir veikiant kitiems griaunamiesiems bei evoliuciniams pokyčiams, organizacinis judrumas tampa kritiniu strateginiu tikslu. Siekdamos padidinti judrumą, organizacijos transformuoja savo veiklos modelius paliečiant strategijas, struktūras, procesus, darbuotojus bei technologijas (Aghina ir kt., 2021). Technologijų srityje reikšmingos investicijos skiriamos pažangioms informacinėms sistemoms, tokioms kaip verslo analitika (angl. *Business Intelligence*), kurios padeda organizacijoms tapti dinamiškomis ir prisitaikančiomis prie kintančios aplinkos. Duomenys yra laikomi „pasaulio vertingiausiu resursu“ ir „skaitmeninio amžiaus nafta“ (*The Economist*, 2017; Pasaulio Ekonomikos Forumas, 2019), todėl organizacijos, kurios sėkmingai naudoja verslo analitikos technologijas duomenų analizei, įgyja konkurencinį pranašumą ir taip visų siekiamą judrumą. Tai siejasi su organizacinio judrumo apibrėžimu kaip gebėjimu aptikti pokyčius aplinkoje ir į juos reaguoti (Overby ir kt., 2006), o šiam gebėjimui labai svarbu efektyvus informacijos apdorojimas, kurį užtikrina verslo analitika.

Verslo analitika tapo kritiniu įrankiu organizacijoms, siekiančioms įgyti ir išlaikyti konkurencinį pranašumą per duomenimis grįstą sprendimų priėmimą. Verslo analitika, kuri iš pradžių buvo įrankiu, leidžiančiu organizacijoms geriau suprasti praeities įvykius ir analizuoti istorinius duomenis, evoliucionavo į pažangesnes sistemas. Dabar šios sistemos ne tik padeda žmonėms gauti įžvalgas, svarbias sprendimų priėmimui, bet ir prognozuoja ateitį bei teikia rekomendacijas sprendimams, o tam tikrais atvejais ir visiškai automatizuoja sprendimų priėmimo procesą (Gartner, 2014; White ir Rollings, 2021). Dėl eksponentiškai didėjančių duomenų apimčių ir technologijų pažangos, kuriai didelę įtaką daro dirbtinis intelektas (DI), verslo analitikos svarba vis stiprėja.

Verslo analitikos poveikis organizacijų rezultatams, ypač judrumui, yra reikšminga mokslinių tyrimų sritis (Chen ir Siau, 2012, 2020; Kuilboer ir kt., 2016; Park ir kt., 2017; Xie ir kt., 2022; Barlette ir Bailette, 2022; Hyun ir kt., 2023; Zhang ir kt., 2024). Nors verslo analitika yra matoma kaip judrumo didinimo priemonė, vien jos buvimas nebūtinai garantuoja šį rezultatą. Todėl svarbu identifikuoti papildomas sąlygas, kurios būtinos siekiant padidinti organizacinį judrumą per verslo analitiką. Šioje disertacijoje pristatytame tyrime išskiriamos dvi tam svarbios sąlygos: verslo analitikos judrumas ir organizacinė kultūra.

Šiame tyrime siūloma, kad verslo analitikos skatinamam organizaciniam judrumui yra svarbu užtikrinti, jog verslo analitikos sistemos pačios būtų pakankamai judrios tam, kad padėtų laiku aptikti pokyčius, grėsmes ir galimybes bei efektyviai į juos reaguoti. Organizacijoms vis dažniau reikia realaus laiko įžvalgų, kurios padėtų priimti sprendimus, tačiau sparčiai kintančioje aplinkoje ataskaitos, valdymo skydeliai, prognozavimo modeliai ir kiti analitiniai įrankiai, kurie anksčiau buvo efektyvūs, gali greitai tapti pasenę, prarasti gebėjimą aptikti naujas tendencijas ir palaikyti sprendimų priėmimą (Bieda, 2020). Nepaisant empirinių tyrimų, rodančių teigiamą ryšį tarp investicijų į verslo analitiką ir organizacinio judrumo (Baars ir Kemper, 2008; Chen ir Siau, 2012; Park ir kt., 2017; Ashrafi ir kt., 2019), vis dar trūksta tyrimų, nagrinėjančių, kaip pati verslo analitikos sistema gali būti judri ir prisitaikanti prie dinamiškos aplinkos (Zimmer ir kt., 2012; Knabke ir Olbrich, 2013). Ankstesni verslo analitikos judrumo apibrėžimai buvo orientuoti į techninius aspektus (Zimmer ir kt., 2012; Knabke ir Olbrich, 2013; Baars ir Zimmer, 2013), tačiau svarbu atsižvelgti į naujausias tendencijas sprendimų paramos sistemų tyrimuose, kuriuose pabrėžiama socio-techninė perspektyva, apjungianti žmogaus elgseną ir techninius sprendimus siekiant geresnio sprendimų priėmimo (Storey ir kt., 2024).

Literatūroje pastebimą verslo judrumo sąvokos netikslumą paaiškina trūkumas tyrimų, kuriuose būtų bandoma sukurti verslo analitikos judrumo konstruktą tikslesniam jo apibrėžimui ir vertinimui. Nors Knabke ir Olbrich (2017) reikšmingai prisidėjo prie verslo analitikos judrumo vertinimo, apibrėždami jo dimensijas, susijusias su verslo analitikos sistemų pasiruošimo reagavimui į pokyčius charakteristikomis, jie neatsižvelgė į veiksnius, kurie yra susiję su žmonėmis ir yra kritiškai svarbūs ilgalaikiam judrumui pasiekti ir išlaikyti. Šiame tyrime kuriama nauja verslo analitikos judrumo koncepcija, integruojanti tiek žmogiškąsias, tiek technines dimensijas, taip pat kartu vystomas ir matavimo instrumentas (skalė), skirtas verslo analitikos judrumui vertinti. Šis instrumentas kuriamas siekiant dviejų tikslų: prisidėti prie akademinių tyrimų plėtros ir padėti praktikams vertinti bei tobulinti verslo analitikos judrumą organizacijose.

Šis tyrimas taip pat pabrėžia organizacinės kultūros svarbą verslo analitikos ir organizacinio judrumo kontekste. Nors žmogiškosios verslo analitikos dimensijos yra svarbios siekiant verslo analitikos judrumo, svarbu suprasti, kad verslo analitika nėra izoliuota nuo platesnio organizacinio konteksto, todėl ją veikia ir visoje organizacijoje vyraujanti organizacinė kultūra – tai įsitvirtinę bendri įsitikinimai, vertybės, normos ir prioritetai (Schein, 2017). Šias kultūros savybes yra sudėtinga tirti, kiekybiškai įvertinti ir keisti. Nepaisant šio sudėtingumo, organizacinė kultūra verslo tyrimuose

plačiai pripažįstama kaip svarbus veiksnys, skatinantis organizacinį judrumą (Crocitto ir Youssef, 2003; Felipe ir kt., 2017). Informacinių sistemų (IS) tyrimuose organizacinė kultūra taip pat įvardinama kaip pagrindinis informacinių technologijų (IT) įsisavinimo sėkmės veiksnys (Leidner ir Kayworth, 2006) – tai taip pat galioja ir verslo analitikos sistemoms.

Šiam į verslo analitiką orientuotam tyrimui taip pat svarbu tai, kad mokslininkai pripažino duomenimis pagrįstos kultūros, analitikos kultūros ar didžiųjų duomenų kultūros vaidmenį, gaunant verslo vertę iš verslo analitikos (Popovič ir kt., 2012; Dubey ir kt., 2019; Wong ir Ngai, 2023; Thanabalan ir kt., 2024; Wamba ir kt., 2024), pabrėždami būtinybę organizacijoms puoselėti specifines kultūros savybes, leidžiančias veiksmingai panaudoti duomenis ir analitiką. Be to, tyrimai patvirtino reikšmingą organizacinės kultūros poveikį informacijos judėjimui (Westrum, 2004), o tai ypač aktualu verslo analitikos sistemoms, kurios labai priklauso nuo duomenų ir informacijos judėjimo. Gartner analitikai (James ir Duncan, 2024) prognozuoja, kad iki 2026 metų duomenų ir analitikos vadovų gebėjimas skatinti kultūrinius pokyčius, kartu su duomenų ir DI raštingumo didinimu bei kvalifikuotos darbo jėgos ugdymu bus vienas iš trijų pagrindinių veiksnių, lemiančių verslo strategijos palaikymo sėkmę.

Nors duomenų rinkimas, apdorojimas ir analizė tampa vis labiau automatizuoti, o DI galimybės padeda arba net pakeičia kai kuriuos žmogaus sprendimų priėmimo uždavinius (Edwards ir kt., 2000; Duan ir kt., 2019), šios technologijos dažniausiai papildo ir įgalina, o ne visiškai pakeičia žmogaus vaidmenį duomenų panaudojime, todėl žmogiškieji veiksniai, ypač organizacinė kultūra, išlieka svarbia tyrimų sritimi verslo analitikos kontekste.

Šios įžvalgos kartu su ankstesniais akademiniais tyrimais pabrėžia svarbą kultūros savybių, kurios lemia tai, kad vienos organizacijos sėkmingai panaudoja verslo analitiką organizaciniam judrumui padidinti, o kitoms tai vis dar išlieka sunkiai įveikiama užduotis. Nepaisant pripažinto ryšio tarp verslo analitikos ir organizacinio judrumo, mokslinė literatūra nepakankamai išnagrinėjusi, kaip tam tikros organizacijų kultūros savybės prisideda prie aplinkos, kuri skatina verslo analitikos judrumą ir organizacinį judrumą. Šis tyrimas siekia užpildyti šią spragą, praplėsdamas mokslo žinias ir suteikdamas gaires praktikams, apie organizacinės kultūros vaidmenį, taip stiprinant verslo analitikos judrumo gebėjimą daryti įtaką organizaciniam judrumui.

Apibendrinant, šioje disertacijoje pristatomas tyrimas nagrinėja tarpusavyje susijusius verslo analitikos judrumo, organizacinio judrumo ir organizacinės kultūros ryšius, atliepiant esamos mokslinės literatūros spragas. Vis nepastovesnėje ir dinamiškesnėje aplinkoje verslo analitikos sistemos įgalina duomenimis pagrįstą sprendimų priėmimą ir atlieka svarbų vaidmenį

užtikrinant organizacinį judrumą. Tačiau verslo analitikos sistemos gali tapti kliūtimis, o ne skatinti organizacinį judrumą, jei joms pačioms trūksta lankstumo ir gebėjimo prisitaikyti, reikalingo efektyviam pokyčių aptikimui ir reagavimui į juos. Šiame tyrime pristatoma nauja verslo analitikos judrumo koncepcija, kuri apima tiek žmogiškąsias, tiek technines dimensijas, pabrėžiant socio-techninio suderinamumo svarbą, nepakankamai išnagrinėtą ankstesnėje literatūroje. Be to, tyrime išryškinamas organizacinės kultūros vaidmuo kuriant aplinką, palaikančią tiek verslo analitikos judrumą, tiek organizacinį judrumą. Sukuriant verslo analitikos judrumo matavimo instrumentą, empiriškai ištestuojant hipotezes apie pagrindinius sąryšius tarp kintamųjų ir surenkant įžvalgas iš verslo ekspertų, šis tyrimas pateikia gaires akademinei bendruomenei ir praktikams. Pasiūlytas modelis gali prisidėti prie efektyvesnio verslo analitikos panaudojimo ir užtikrinti ilgalaikį judrumą sparčiai besikeičiančiame pasaulyje.

Disertacijos tyrimo problema

Organizacijos, siekdamos pasinaudoti verslo analitikos galimybėmis organizaciniam judrumui didinti, susiduria su iššūkiais, kuriuos lemia nepakankamas supratimas, kaip efektyviai užtikrinti pačios verslo analitikos judrumą ir dėmesio organizacinei kultūrai trūkumas. Prie šios problemos taip pat prisideda trūkumas tyrimų ir mokslu pagrįstų įžvalgų, kaip verslo analitikos judrumas veikia organizacinį judrumą ir kokia organizacinės kultūros svarba šiam ryšiui. Neįveikus šių spragų, organizacijoms išlieka sudėtinga pasiekti norimą judrumą per verslo analitikos sistemas ir dėl to jos praranda konkurencinį pranašumą.

Disertacijos tyrimo tikslas ir uždaviniai

Šios disertacijos tyrimo tikslas – ištirti daugiapusišką verslo analitikos judrumo reiškinį ir jo poveikį organizaciniam judrumui, ypatingą dėmesį skiriant organizacinės kultūros moderuojančiam vaidmeniui šiame santykyje.

Disertacijos tikslui pasiekti keliami šie uždaviniai:

1. Konceptualizuoti verslo analitikos judrumą, išanalizavus jo techninius, socialinius ir organizacinius aspektus, apjungiant esamos literatūros žinias ir praktikų pateiktas įžvalgas.
2. Operacionalizuoti verslo analitikos judrumą, sukuriant indikatorius matavimo skalei ir užtikrinant šio instrumento aktualumą tiek moksliniams tyrimams, tiek ir praktiniam taikymui organizacijose.

3. Patobulinti ir patvirtinti verslo analitikos matavimo instrumentą, naudojant statistinius metodus, įskaitant tiriamąją faktorinę analizę (EFA) ir patvirtinančiąją faktorinę analizę (CFA).
4. Įvertinti verslo analitikos judrumo ir organizacinio judrumo ryšį bei nustatyti organizacinės kultūros moderuojantį poveikį šiam ryšiui, taikant struktūrinių lygčių modeliavimo (SEM) analizės metodiką.
5. Interpretuoti gautus rezultatus, identifikuoti praktinį jų poveikį ir papildyti veiksmingomis ekspertų įžvalgomis su tikslu pateikti praktines rekomendacijas organizacijoms, norinčioms pagerinti savo organizacinį judrumą pasitelkiant verslo analitiką.

Tyrimo metodologija

Atsižvelgiant į tiriamų reiškinių sudėtingumą ir tarpdisciplininį pobūdį – esantį IS, strateginio valdymo ir organizacinės psichologijos disciplinų sankirtoje – bei ribotą esamų tyrimų skaičių šia tema, vienos metodologijos taikymas būtų nepakankamas siekiant gilesnio supratimo ir naujų teorinių perspektyvų atradimo. Todėl ši disertacija taiko pliuralistinį metodą, derinant su interpretatyvizmu ir pozityvizmu siejamus tyrimo metodus – kokybinius ir kiekybinius.

IS tyrimų srityje mokslininkai atkreipė dėmesį į mišrių metodų studijų trūkumą, nepaisant jų potencialo pateikti turtingesnes įžvalgas apie IS reiškinius, kurie yra socialiniai ir nėra visiškai deterministiniai (Venkatesh ir kt., 2013, 2016). Šio tyrimo metu buvo taikomas mišrių metodų požiūris, leidžiantis atsakyti tiek į tiriamuosius, tiek į patvirtinamuosius klausimus.

Šios disertacijos tyrimas apima penkis pagrindinius etapus:

- **1 etapas: Literatūros apžvalga**. Šiame etape buvo nagrinėjama esama literatūra, siekiant konceptualizuoti verslo analitikos judrumą, organizacinį judrumą ir organizacinę kultūrą bei išsigryninti hipotezes.
- **2 etapas: Interviu**. Šio etapo metu buvo atlikti pusiau struktūruoti interviu su verslo analitikos praktikais, siekiant nustatyti su verslo analitikos judrumu susijusius veiksnius ir patikslinti konceptualųjį modelį. Interviu rezultatai kartu su literatūros apžvalga padėjo sukurti verslo analitikos judrumo matavimo instrumentą.
- **3 etapas: Pirmoji apklausa**. Šio etapo metu apklausos būdu surinkti duomenys, kurių pagrindu atlikta tiriamoji faktorinė analizė ir patvirtinančioji faktorinė analizė.

- **4 etapas: Antroji apklausa**. Šios apklausos metu surinkti duomenys buvo naudojami hipotezių testavimui, vertinant ryšius tarp verslo analitikos judrumo, organizacinio judrumo ir organizacinės kultūros, naudojant struktūrinių lygčių modeliavimą.
- **5 etapas: Fokus grupė**. Tai paskutinis tyrimo etapas, kurio metu buvo surengta fokus grupės diskusija su ekspertais, siekiant patvirtinti tyrimo išvadas ir gauti papildomų įžvalgų. Šis kokybinis metodas leido išgauti praktinių rekomendacijų organizacijoms, siekiančioms pagerinti savo judrumą pasitelkiant verslo analitiką.

Atsižvelgiant į tai, kad verslo analitikos judrumas ir jo ryšys su kitais organizacijos reiškiniais yra pagrindinė šio tyrimo tema, ir kad ankstesnė akademinė literatūra nėra sukūrusi išsamios verslo analitikos judrumo matavimo skalės, apimančios tiek techninius, tiek ir su žmonėmis susijusius aspektus, šiame tyrime buvo siekiama sukurti pagrįstą ir patikimą verslo analitikos judrumo matavimo instrumentą. Šio instrumento tikslas – ne tik pasitarnauti šiame tyrime, bet ir paskatinti tolesnius empirinius tyrimus šioje srityje. Siekiant užtikrinti akademinį pagrįstumą, tyrimas vadovavosi MacKenzie ir kt. (2011) aprašytomis skalės kūrimo proceso gairėmis.

Tyrimo mokslinis naujumas ir indėlis į mokslą

Šios disertacijos tyrimas prisideda prie mokslo naujomis žiniomis, jo pagrindinis indėlis į mokslą apima:

1. *Socio-techninė verslo analitikos judrumo konceptualizacija*. Šis tyrimas meta iššūkį dominuojančiam verslo analitikos judrumo kaip techninės savybės suvokimui (Zimmer ir kt., 2012; Knabke ir Olbrich, 2013; Baars ir Zimmer, 2013; Baars ir kt., 2014; Knabke ir Olbrich, 2017) ir pateikia naują konceptualizaciją, suderintą su socio-techniniu požiūriu, apimant žmogiškuosius veiksnius (judri verslo analitikos kultūra ir verslo analitikos valdymo judrumas) kartu su techniniais aspektais (verslo analitikos architektūros judrumas). Socio-techninių sistemų atveju sėkmingam sistemos diegimui ir naudojimui žmogiškieji veiksniai yra ne mažiau svarbūs nei techniniai. Tyrimas užpildo esamas literatūros spragas pateikiant išsamų, kiekvienai dimensijai svarbių veiksnių, supratimą.
2. *Naujos verslo analitikos judrumo matavimo skalės sukūrimas*. Sukurta nauja matavimo skalė, integruojanti techninius ir su žmonėmis susijusius verslo analitikos judrumo aspektus. Ši skalė išsprendžia ankstesnių tyrimų ribotumus, kurie buvo orientuoti tik į

verslo analitikos judrumo būklės tam tikru momentu charakteristikas (Knabke ir Olbrich, 2017) ir neapėmė gebėjimo prisitaikyti prie besikeičiančios aplinkos ilgalaikėje perspektyvoje, atsižvelgiant į dinaminių gebėjimų teoriją. Skalė, sukurta naudojant kokybinius ir statistinius metodus, yra įrankis būsimiesiems empiriniams tyrimams ir priemonė organizacijoms įvertinti savo verslo analitikos judrumą.

3. *Siūlomas tyrimo modelis patvirtintas empiriniais rezultatais*. Tyrimas empiriškai patvirtino reikšmingą teigiamą verslo analitikos judrumo poveikį organizaciniam judrumui ir į rezultatus orientuotos organizacinės kultūros moderuojantį vaidmenį. Nors ankstesni tyrimai nagrinėjo verslo analitikos poveikį organizaciniam judrumui plačiąją prasme (Chen ir Siau, 2011, 2012, 2020; Corte-Real ir kt., 2017; Park ir kt., 2017; Ashrafi ir kt., 2019; Hyun ir kt., 2020; Xie ir kt., 2022; Al-Darras ir Tanova, 2022), nė vienas iš jų tiesiogiai neanalizavo konkrečiai verslo analitikos judrumo vaidmens šiame ryšyje. Be to, šis tyrimas nustatė svarbius kultūros bruožus, remiantis Westrum (1988, 2004) kultūros modeliu, ir atskleidė, kad organizacinės kultūros stiprinantis poveikis auga didėjant verslo analitikos judrumui – tai taip pat nauja mokslinė įžvalga.

Tyrimo praktinė nauda

Šis tyrimas pateikia moksliškai pagrįstas įžvalgas ir gaires organizacijų vadovams, siekiantiems padidinti savo organizacijų judrumą per verslo analitiką, taip pat ir verslo konsultantams, teikiantiems patarimus organizacijoms. Pagrindinės praktinės tyrimo išvados yra šios:

1. *Atkreipiamas dėmesys į svarbų verslo analitikos judrumo ir organizacinės kultūros vaidmenį*. Organizacijos gali pasinaudoti šio tyrimo įžvalgomis, siekdamos atkreipti vadovybės dėmesį į verslo analitikos judrumo skatinimo ir verslo analitikai bei judrumui palankios kultūros kūrimo naudą. Šios moksliškai pagrįstos įžvalgos gali padėti priimti strateginius sprendimus ir įgyvendinti iniciatyvas, stiprinančias verslo analitikos judrumą ir jo vaidmenį organizaciniam judrumui, taip rezultate stiprinant organizacijos konkurencingumą.
2. *Paruoštas naudoti verslo analitikos judrumo vertinimo instrumentas*. Vadovai gali naudoti patvirtintą verslo analitikos judrumo skalę, siekdami įvertinti savo organizacijos esamus verslo analitikos gebėjimus trijose dimensijose: verslo analitikos architektūros judrumas, verslo analitikos valdymo judrumas ir judri verslo analitikos kultūra. Identifikavus stipriąsias ir silpnąsias vietas šiose srityse, organizacijos gali prioritetizuoti iniciatyvas, kurios stiprintų

verslo analitikos funkcijas. Reguliarus vertinimas pagal šią skalę gali padėti stebėti pažangą laikui bėgant ir, prireikus, koreguoti strategijas.

3. *Gairės organizacijos kultūros vertinimui ir verslo analitikai palankios kultūros kūrimui*. Naudojant Westrum (1988, 2004) kultūros modelio pagrindu sukurtą matavimo skalę kartu su kultūros bruožais, įvardintais ekspertų diskusijose, organizacijos gali atlikti nuodugnų savo dabartinės kultūros vertinimą pagal tyrime pristatytus bruožus. Šis vertinimas gali padėti vadovams nustatyti kultūrinius trūkumus, kurie gali trukdyti tiek verslo analitikos judrumui, tiek bendram organizaciniam judrumui, ir paskatinti inicijuoti kultūros transformaciją, siekiant sukurti verslo analitikai palankią kultūrą stiprinant tokias savybes kaip bendradarbiavimas, atvirumas bet kokioms žinioms, rizikos bendras pasidalinimas, dalinimasis nepaisant hierarchijos ir naujovių įgyvendinimas.
4. *Veiksmingos įžvalgos ir gerosios praktikos iš pramonės ekspertų*. Diskusijos su ekspertų grupe patvirtino, kad tyrime nagrinėjami iššūkiai yra aktualūs praktikai, ir pateikė praktinių įžvalgų apie dažniausiai pasitaikančius sunkumus ir jų sprendimus kuriant judrią verslo analitiką.

Ginamieji disertacijos teiginiai

Šios disertacijos autorė siekia apginti šiuos tyrimo teiginius:

1. Verslo analitikos judrumui pasiekti būtinas požiūris, integruojantis į žmogų orientuotus veiksnius, apimančius verslo analitikos valdymą ir verslo analitikos kultūrą, kartu su techniniais veiksniais.
2. Verslo analitikos judrumas skatina organizacinį judrumą – aukštesnis verslo analitikos judrumas turi stipresnį teigiamą poveikį organizaciniam judrumui.
3. Į veiklos rezultatus orientuota organizacinė kultūra teigiamai moderuoja ryšį tarp verslo analitikos judrumo ir organizacinio judrumo ir šis moderuojantis poveikis dar sustiprėja augant verslo analitikos judrumo lygiui.

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