Using Business Intelligence to Support the Process of Organizational Sensemaking

Morteza Namvar
Deakin University, mnamvar@deakin.edu.au

Jacob L. Cybulski
Deakin University

Luckmika Perera
Deakin University

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Morteza Namvar

Department of Information Systems and Business Analytics
Deakin University
mnamvar@deakin.edu.au

Jacob L. Cybulski

Department of Information Systems and Business
Analytics
Deakin University

Luckmika Perera

Department of Accounting
Deakin University

Abstract:

Making sense of an organization overwhelmed with data becomes a problem for decision makers at all levels of business planning and operation. Although scholars have suggested several technological solutions such as business intelligence as being useful in helping busy executives to make decisions, we still know little about assisting business stakeholders in the process of understanding their organizational complexity before such decisions could even be formulated. In this paper, we investigate the opportunities in using BI technologies to make sense of a business environment. We analyze the views and opinions of developers, analysts, consultants, and users of business intelligence, who are experienced in using the technology beyond decision making to support organizational sensemaking. Our results highlight the need for creating and maintaining individual; and organizational identity and enacting this identity on the business and its environment.

Keywords: Sensemaking, Business Intelligence, Decision Making, Management, Hermeneutic Phenomenology.

1   Introduction

In today's business world, organizations face constant environmental volatility and change, which are responsible for the creation of an enormous amount of corporate data. To master this change and turn it to business advantage, many organizations strive to transform the huge volume of available data into a genuine understanding of business. Consequently, such organizations are able to base their decisions on insights derived from facts—a process called business intelligence (BI). BI comprises several capabilities, such as capturing and storing organizational memory, integrating data, and creating and presenting insights (Sabherwal & Becerra-Fernandez, 2009). Luhn (1958) provides one of the earliest definitions of BI, which emphasizes the ability to understand presented information and to subsequently use it to effectively guide business actions toward desired goals. In a recent definition, however, Wixom and Watson (2010, p. 13) describe BI as "the technologies, applications, and processes for gathering, storing, accessing, and analyzing data to help users make better decisions".

Companies have realized that data is a valuable resource that they should exploit to gain insights into their operation and, thus, arrive at higher-quality decisions and actions. To this end, BI empowers companies by overseeing their processes and allowing them to monitor their activities. Despite BI being one of the most important elements of contemporary decision-support systems (Arnott & Pervan, 2005; Namvar, Khakabimamaghani, & Gholamian, 2011), many researchers observe that decision makers do not use BI to its fullest (Chen, Chiang, & Storey, 2012). For example, Davenport (2010) claims that, while BI systems collect data continuously over extended periods of time, the majority of firms use BI simply to support their short-term decisions. Few published reports, however, identify BI as a tool suitable for gaining long-term understanding of organizational and business issues, which is indispensable in making informed decisions. Indeed, Sabherwal and Becerra-Fernandez (2009) suggest that managers now need a new view of BI capabilities that will enhance their understanding of business, foster organizational learning, and, ultimately, support decision making. In other words, decision makers could more effectively use BI if they were provided with the sustained insight into a broad spectrum of business phenomena and focused on such issues instead of on the short-term processes of choice determination and action planning (Namvar & Cybulski, 2014).

The sequence of business activities leading from understanding to decisions and further to actions is at the crux of organizational sensemaking, a process one can use to better understand a business context and its problems (Weick, 1995). From the BI perspective, a decision maker and sensemaker are often the same person, especially at the strategic level, where quality decisions can happen only after a lengthy and thorough sensemaking process. Sensemaking is an important prerequisite to reaching informed decisions and involving processes that current or future BI technology could support. Although decision making and sensemaking may seem similar and although both are intimately related to the human being as an actor, they have different perspectives on human behavior (Boland, 2008). In the context of organizational behavior, sensemaking is the structured process of dealing with ambiguity and uncertainty in organizational settings to give meaning to objects and events from the past. Decision making, however, focuses on evaluating a range of possible actions and selecting the best alternative. In contrast to sensemaking, a decision maker focuses almost completely and without exception to the future impact of decisions, actions, and their outcomes (Boland, 2008).

One can define sensemaking as an ongoing socio-cognitive activity that organizational actors initiate when seeking to understand and control their environment (Weick, 1993, cited in Lewis, Mathiassen, & Rai, 2011). Organizational researchers claim that sensemaking has been helpful in investigating management practices (Drazin, Glynn, & Kazanjian, 1999; Gioia & Chittipeddi, 1991), supporting decision making processes (Taylor & Bogdan, 1998), implementing information systems (Jensen & Kjaergaard, 2010; Jensen, Kjærgaard, & Svejvig, 2009), understanding communication channels (Cooren, 2004; Manning, 1992), adopting information technology (Lewis et al., 2011; Ramiller & Swanson, 2009; Swanson & Ramiller, 2004), managing processes (Maitlis & Lawrence, 2007; Maitlis & Sonenshein, 2010), and conducting organizational change (Sonenshein, 2010). Sensemaking as a concept arose from the organizational theory context, but it has strong links with information processing and information quality, which have given it credence as an important research topic in information systems. Few studies, however, link BI and organizational sensemaking with BI research, which in its majority focuses on providing support for decision making (Arnott & Pervan, 2005; Bucher, Gericke, & Sigg, 2009; Davenport, 2010; Shim et al., 2002). We address this gap by exploring the following research question:

RQ: How can BI improve decision makers' organizational sensemaking?

Therefore, we explore how BI technologies could assist decision makers to continuously engage in sensemaking to gain insight into their business environment.

This paper proceeds as follows: in Section 2, we introduce sensemaking and compare and contrast its properties with BI tools and capabilities. In Section 3, we discuss hermeneutic phenomenology, which involves a broad range of BI stakeholders, as our research methodology. In Section 4, we present our results to determine BI requirements to support organizational sensemaking. In Section 5, we discuss our findings and reveal the emerging insights into designing a process for BI-driven sensemaking in organizations. Finally, in Section 6, we conclude the paper.

2   Background

Weick (1995) introduced the best known sensemaking model. The model provides the most comprehensive framework for studying and understanding sensemaking in equivocal business situations. Alternative models of sensemaking, which other authors have reported, lack the level of sophistication and completeness of Weick's conceptualization. For example, Russell, Stefik, Pirolli, and Card (1993) focus on the mechanism of organizational learning (via sensemaking); however, they do not consider sensemaking as a concrete organizational process. Pirolli and Card (2005) do not rely on human cognition to capture and process information cues and instead focus on information representation or its flow in an organization. While Weick (1995) established his model in part on cognitive dissonance theory (Festinger, 1962), unlike other theorists such as Dervin (2008), he derived his concepts from business cases and considers sensemaking to be a practical business problem. He sets his focus firmly on people's making sense of their organizations' structural and social complexity, making decisions, and acting in an organizational context, especially when faced with equivocal (or confounding) situations. Finally, Weick's framework provides organizations with the flexibility to address not only individual sensemaking as Klein, Moon, and Hoffman (2006a) and Snowden (2002) do but also organizational sensemaking. As such, Weick's framework subsumes other models' features. Consequently, we adopt Weick's model to investigate BI in support of sensemaking, which we turn to next.

Weick's (1995) model of sensemaking defines an organizational process of continuous insight generation, which he characterizes with seven properties: retrospection, sensemaking as a social phenomenon, cue extraction, plausibility, sensemaking as an ongoing process, enactment, and identity creation. Subsequently, we briefly describe each property and contrast them with the features of various BI technologies, which we do to assess BI's potential to support decision makers in constructing meaning and gaining new insights about their organizations.

1)   Sensemaking is *retrospective*, which means that the sensemaker looks back and reviews events or situations that make sense in respect to the current situation. In a broader view, retrospection is the domain of what is known and what is knowable (Snowden, 2002). Pirolli and Card (2005) and Klein et al. (2006a) consider acquiring data and creating data repositories as essential for referring to past events. Moreover, BI systems are eminently suited to support retrospection because they efficiently process vast amounts of structured data about an organization's past events, transactions, and situations (Wixom et al., 2014). Contemporary BI tools can also employ unstructured data, such as text drawn from websites and social media, to form a retrospective view of an organization and its larger social context (Holsapple, Lee-Post, & Pakath, 2014). Large data volumes generally enhance retrospection, create new opportunities for organizational change and improvement, and facilitate trend predictions (Russom, 2011). Not surprisingly, all such historical accounts can facilitate retrospective views of an organization and may, thus, provide active support for sensemaking.

2)   Sensemaking is a *social phenomenon* such that one never makes sense of their environment alone. Weick (1995) explains that sensemaking is a social activity that deals with communicating organizational "stories", assessing their plausibility, and preserving, retaining, and sharing them. In organizations, sensemaking occurs in the context of self-organizing communities of experts, who engage in the collective processes of learning, knowing, and self-awareness (Snowden, 2002). In the context of BI, access to shared data repositories, which are growing rapidly and continuously, commonly requires a concerted team effort to manage, analyze, and understand (Stoodley, 2012). This situation is especially pronounced in those cases where a large number of BI users or stakeholders across the organization could leverage a broad spectrum of information (Imhoff & White, 2010) and where contemporary BI systems directly facilitate the interactions among BI users, their communications, and their collaborations. Typically, such interactions occur

via the distribution of live and interactive reports for feedback and action, the sharing of comments and opinions on these reports, messaging between contributing parties, and the circulation of reports in and outside the business community (Briggs, 2009; Smietana, 2010).

3) Sensemaking focuses on *cues* extracted from the organizational context to help sensemakers determine current and relevant information. Weick (1995) attaches primacy to a person's ability to plan actions by continuously sensing environmental cues and deriving meaning from their relationships and structures. Moreover, individuals often consider cues in various forms; that is, mismatch, omission and misuse of data or its representation (Russell et al., 1993), or gaps, questions, confusions, muddles, riddles and angst (Dervin, 2008). One can extract cues by searching for evidence, information, and relations (Pirolli & Card, 2005); by probing, sensing, and managing patterns (Snowden, 2002); and by self-reflecting on the fundamental domain concepts and their combinations while trying to track semantic anomalies and detect inconsistencies (Klein et al., 2006a; Klein, Moon, & Hoffman, 2006b). Indeed, BI technology can assist decision makers and other organizational stakeholders in monitoring the flow of business data, alerting users to important changes in their environment, supplying them with relevant information so they can make sense of evolving business situations (which such technologies achieve by automatically generating insights from collected data to identify business problems, strategy gaps, emerging opportunities, or activity patterns), and, ultimately, improving business decisions (Davenport, 2010). BI technology communicates business cues to decision makers in a variety of forms, such as interactive reports, alerts, dashboards or scorecards (Davenport, 2010; Wixom & Watson, 2010).

4) Sensemaking relies on *plausible* rather than accurate observations and predictions. Under normal business conditions, one can never know if management insights and perceptions are accurate; however, decisions based on information derived from merely plausible premises often lead to positive consequences. Most organizational actions are time sensitive, which means that, instead of accuracy, managers favor efficacy and, thus, rely on evidence's and inferences' plausibility. According to Pirolli and Card (2005), organizations prioritize plausibility over truth also because they weigh the cost of information seeking against the cost of its accuracy in the lengthy process of searching for, extracting, and reusing relevant information; subjecting it to detailed analysis; and, eventually, acting on information cues. BI systems can use vast volumes of past data to create reports summarizing historical events, predicting future situations and events useful for considering alternative business scenarios, understanding existing and potential risks, and assessing an organization's future prospects. In all such cases, accuracy of prediction is about the system's ability to identify and evaluate many possible outcomes (Fayyad, Piatetsky-Shapiro, & Smyth, 2008). A combination of mathematical models and machine learning techniques for exploratory, predictive, and optimization purposes (often referred to as advanced analytics) and access to good quality data could assist managers to better evaluate their decision options and, thus, become more effective decision makers (Wixom & Watson, 2010).

5) Sensemaking is an *ongoing process* in which individuals shape and react to the environments they face. Accordingly, real-time BI provides decision makers with ongoing data and analytic support, which offers continuing access to and understanding of changes in the business environment. In many industries such as communications, manufacturing, aviation and defense, decisions' effectiveness hinges on access to real-time data and analytics. In fact, real-time processing plays a critical role in BI systems, especially for operational and process-centric applications (Azvine, Cui, Majeed, & Spott, 2007; Negash & Gray, 2008; Smietana, 2010; Wixom & Watson, 2010). For strategic business objectives, data needs to have a long lifespan and eventually turn into historical data; whereas, for operational objectives, data needs to be live and updated and analyzed on the fly (Strenger, 2008).

6) Sensemaking is about *enactment*. Sensemakers often construct and influence part of the environment they face, which either empowers them or constrains their actions. In turn, the environment shapes the sensemakers' identity and determines their interpretation of situations. By acting on their environment, people shape their organizations by bringing into existence a variety of organizational structures and events, which, in turn, continuously alter their own identity and their understanding of the changing environment. BI systems have a limited repertoire of facilities capable of supporting individuals to directly change their business environment.

7) Finally, sensemaking is grounded in *identity construction*. This key proposition states that sensemaking and, thus, perceived reality depend on how sensemakers describe and perceive

themselves. Weick (1995) claims that enactment is central in how one creates their identity, and he identifies two distinct perspectives on this process; namely, the perspective individuals take and the perspective that results from a concerted effort of an organization's community members. Again, scholars have reported little direct insight on how BI and its analytic capabilities could assist sensemakers in defining and understanding their own role in the organization.

Initially, some theorists (such as Russell et al., 1993) explained sensemaking as a sequential process. Weick (1995), however, notes that feedback loops and simultaneous processing complicate the sequence of sensemaking actions. In other cases, individuals may decide to shorten or omit some of the sensemaking steps or their sequences. Weick et al. (2004, p. 409) further remark on the complexity of this process; they state:

> *Sensemaking involves the ongoing retrospective development of plausible images that rationalize what people are doing. Viewed as a significant process of organizing, sensemaking unfolds as a sequence in which people concerned with identity in the social context of other actors engage ongoing circumstances from which they extract cues and make plausible sense retrospectively, while enacting more or less order into those ongoing circumstances.*
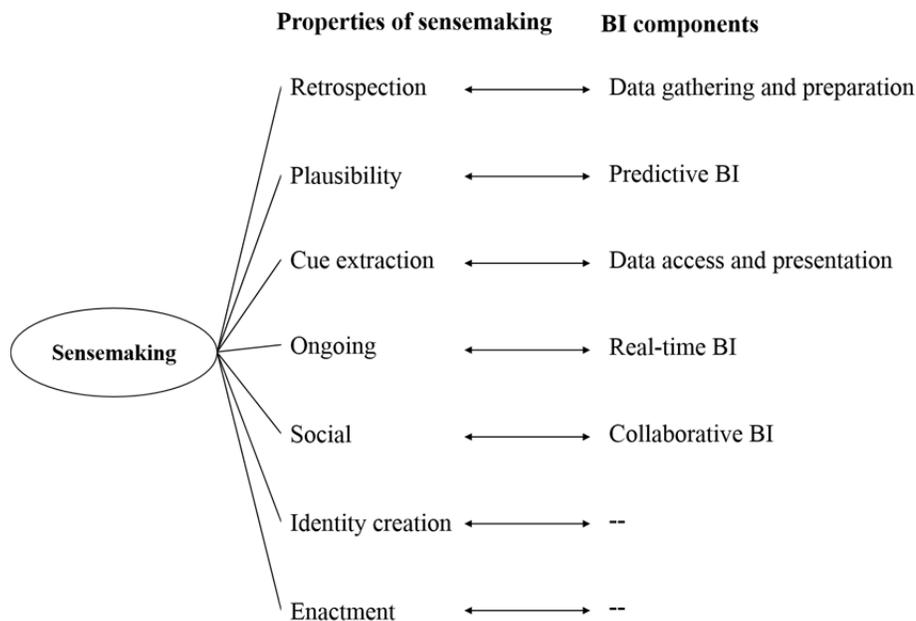

Figure 1. Mapping between BI Components and Properties of Sensemaking

In sum, we can see that many features of contemporary BI and the common properties of organizational sensemaking significantly overlap, intersect, and interweave. As Figure 1 shows, five sensemaking properties (retrospection, plausibility, cue extraction, ongoing processing, and social factors) can be directly mapped into (and be supported by) BI components and their features. However, the extant BI literature provides no obvious answers as to the question of possible relationships between BI, enactment, and identity creation. In search for answers, we turned to BI developers, analysts, consultants, and users, who reflected on their experience in using BI tools to make sense of their organizations.

3   Research Method

We looked at the opportunities presented by BI tools to improve organizational sensemaking, which is necessary to make quality decisions. Because we focused on decision makers' practice and their lived experience with using BI to improve organizational sensemaking, which we needed to untangle from the confounding web of socio-technical context and personal opinions, we chose hermeneutic phenomenology (Van Manen, 1998) as our overarching theoretical perspective and method of inquiry. Considering little prior work in this area, our research is necessarily empirical and exploratory (Crotty, 1998).

Phenomenology describes situations in which one can investigate "phenomena" as they are experienced and reflected on to reinterpret and renew meaning (Husserl, 1931). In general, the phenomenological inquiry process allows the researcher to study highly subjective and complex personal accounts of events and circumstances to gain awareness, understanding, and knowledge of the investigated phenomena (Moustakas, 1994). In this research, our phenomena of interest were individuals' interaction with and adoption and use of BI tools for organizational sensemaking because these tools are imparted with meaning and interconnected with social and business structures that form the fabric of organizational decision makers' lives. Participants included BI users (consultants and decision makers) and developers (in-house analysts and BI vendors). We selected study participants broadly from predominantly large organizations, but they all relied on a set of common practices and used comparable technology in their daily work. We isolated the meanings and experiences that the study participants shared, which we found to span two distinct conceptual dimensions. The first relates to the analytic principles encompassed by the existing BI models for gaining organizational insights, and the second pertains to the business decision-making processes that are constrained and enacted by social and organizational structures (Moreno, 1999).

There are several phenomenological traditions, such as transcendental, existential, and hermeneutical (Van Manen, 1998). We selected hermeneutic phenomenology to guide our research, which was first proposed by Gadamer (2008) in 1960 and reinterpreted by Ricoeur in 1975, practiced by Van Kaam (1966), and refined, formulated, and publicized as a research methodology by Moustakas (1994). Hermeneutics, the theory of interpretation, which was originally conceived to support the in-depth analysis of historical texts, provides a methodical analytic framework for understanding subjective views and opinions in spite of the inquirer's distance in time, place, and culture from the subject matter. Gadamer (2008) asserts that one can understand complex and unexplored phenomena only through a cyclical dialectic process called the hermeneutic circle—an ongoing interpretive oscillation between accumulated understanding and new insights in their rich socio-historical context. By applying the cycles of hermeneutic analysis to phenomena, which are often described with text or some text analogue (such as drawing, music, or film), the researcher can understand invisible and implicit meanings buried in the richness of told and retold narrative (Heidegger, 1962). By adopting hermeneutic analysis to decision makers' accounts of using BI in sensemaking, we explored these experiences from a variety of personal, organizational, and social perspectives by reconciling vastly different views and opinions—what Merleau-Ponty (2004) refers to as arriving at the essence of the investigated phenomena to identify the common core of shared experiences.

According to Weick, Sutcliffe, and Obstfelt (2005, p. 410) "organizational sensemaking is first and foremost about the question: How does something come to be an event for organizational members?". Therefore, the unit of analysis in our study was individuals who used BI tools in their daily work to make decisions. Hence, we conducted 23 in-depth interviews with 27 study participants from 17 separate organizations to identify their personal experience in using BI, making decisions, and making sense of their organizations. Because we focused on study participants' lived experiences, we used other sources of data such as documents or log data only when the participants volunteered them. The majority of interviews were one on one; however, in some cases (on study participants' requests), we conducted the sessions in small groups. Our study participants included the primary organizational users of BI technology such as consultants, decision makers, developers, and analysts who relied on a set of common BI practices in their work portfolios. Because we focused on both individual and organizational identity creation and enactment, we chose participants mainly from large enterprises (including multinationals) each with over 1000 employees where rich organizational settings could support the creation and evolution of such identities. Only five organizations were small BI consulting companies of fewer than 100 employees. The chosen companies were from a variety of different industries including IT, finance and banking, government, healthcare, education, and retail (see Table 1). All study participants used BI tools in their daily life. The most common tools used that participants used were Microsoft SQL Server, IBM Cognos, and TM1. Depending on the company and the level of analytical skills, companies also used other tools from vendors such as SAS, Microsoft (e.g., Excel with BI add-ins), IBM (e.g., SPPS and SPSS Modeler), R, Tableau, Omniscope, Procuretrak, Oracle, Lavastorm, Allesco, MapInfo, Siebel, Manugistics, Maximo, and Unica. The interviews were open ended, and we asked unique questions related to the role of the study participants and their company. Because the study participants were not familiar with the notion of sensemaking, we asked them questions related to those aspects of sensemaking they were familiar with; for instance, how they used BI for understanding business environment and making decisions in complex and ambiguous situations. We also invited participants to

provide examples of how they used BI, the challenges they faced, and benefits they gained (see the interview schedule in the appendix).

We used four methodological data-analysis steps interwoven into the cycles of the hermeneutic circle as adapted from Van Kaam (1966) and Moustakas (1994): epoché, phenomenological reduction, imaginative variation, and synthesis.

Table 1. The Characteristics of the Study Participants

Pseudonym	Position	Industry	Company size
Alfred	Director, data integration and management	IT	Fewer than 100
Andrew	Manager, diagnostic imaging	Healthcare	More than 1000
Arnaldo	Business intelligence developer	Healthcare	More than 1000
Chandler	Director, financial governance and planning	IT	Fewer than 100
Clark	Director, operations	Government	More than 1000
Dale	Data analyst, enterprise intelligence	Finance	More than 1000
Daniel	Data analyst	IT	Fewer than 100
Emily	Senior delivery analyst	Retail	More than 1000
Glenn	Manager, data analysis	Healthcare	More than 1000
Hill	Managing director	IT	Fewer than 20
Ian	Operations manager, diagnostic imaging	Healthcare	More than 1000
Jane	Senior consultant	IT	Fewer than 20
Jeffrey	National manager, financial reporting and analysis	Government	More than 1000
Jordan	Senior data analyst	Education	More than 1000
Madison	Director, enterprise intelligence	Finance	More than 1000
Matt	Manager, business intelligence	Education	More than 1000
Myla	Data analyst	IT	Fewer than 100
Nathan	Director, sales and marketing	IT	Fewer than 100
Rachel	Director, research and analytics	Government	More than 1000
Robert	Channel technical manager	IT	More than 1000
Ross	Founder, data visualization company	IT	Fewer than 100
Roy	Software sales manager	IT	More than 1000
Ruofan	Senior business analyst, data infrastructure	Banking	More than 1000
Sahil	Manager, IT strategy and architecture	Government	More than 1000
Scott	General manager, development	IT	More than 1000
Shane	Technology strategist	IT	More than 1000
Shaun	Executive director	IT	Fewer than 100

In the first step, epoché, we identified and set aside our personal biases and pre-judgments for each hermeneutic cycle. Myers (2008) emphasizes that prejudice or prior knowledge is the initial point that drives researchers' understanding of a phenomenon. Therefore, we initiated our research by explicitly describing our prior experience with BI.

In the second step, phenomenological reduction, we prepared a textural description of each interview. We used the resulting narratives, which comprised 2193 statements, to recognize and identify the discussed issues, the participants' viewpoints, and the meaning of individually experienced phenomena (Moustakas 1994). We analyzed the narrative statements and assigned each one a number of codes to represent and classify their content. Through the open-coding process (Glaser & Strauss, 1967), we identified the aspects of BI use in the organizations that had some importance for study participants. Subsequently, we reviewed the preliminary codes and combined those with similar meaning in the relevant context. As a result, we refined the coding system to comprise only 22 codes, which we applied to all narrative statements, to identify those aspects of BI that, from the perspective of the study participants, had some

relevance to and significance for organizational sensemaking. In the ensuing coding and analysis process, we included the participants' views that were interconnected via the common codes into a shared conceptual structure (horizon of understanding). We reduced other views that we deemed vague, repetitive, or overlapping to their essential parts. We eliminated those views we found not relevant to the subject matter. We then indexed, sorted, and clustered the coded statements into related themes to facilitate easy access to the narratives and their parts and to reference back to them in any future research tasks. In the process, we re-discovered the main themes related to different elements of using BI in the organizations. At the end of this stage, with the codes, their themes, and the emerging conceptual representations of participants' views, we developed a composite textural description of the phenomena to gain new insights into using BI for business sensemaking.

In the third phase, imaginative variation, we determined the structure of the phenomena and their meaning. In this process, we explored the previously identified themes by varying the participants' perspectives and adopting different frames of reference to look for overlaps, confirmation, complementarity, and conflict in the views that the participants held. At the end, we arrived at the composite structural description of the invariant shared experience (Moustakas, 1994). We further contrasted the concepts derived from such invariant experience with the ideas reported in the prior research to explain the shared phenomena from the perspective of Weick's (1995) sensemaking model. We report this analysis in Section 4.

In the final step in the hermeneutic phenomenological process, synthesis, we identified the essence of the study participants' shared experience. We further compared and contrasted such shared views with the extant literature on BI-based organizations and sensemaking. We present the synthesis in Section 5.

4   Results

In this section, we present the outcome of imaginative variation, which includes the textural-structural description of the investigated phenomena. The in-depth knowledge gained after identifying the themes in phenomenological reduction phase helped us to expose the structure of meaning hidden in the stories that participants shared during the interviews. In this study, the process of imaginative variation involved exploring similarities and differences between study participants' views and opinions about BI technologies' (and their properties') strengths and weaknesses and how they support organizational sensemaking's seven properties. To elucidate the connection between BI capabilities and sensemaking properties, we illustrate the properties with statements of personal experience from the study's participants and, when necessary, compare the statements with concepts drawn from the literature. Note that, in the following discussion, for confidentiality reasons, we refer to the interviewees by pseudonyms. We removed the statement IDs, which represent the paragraph numbers of an interview transcript, for readability. We describe the results in Sections 4.1 to 4.3. In Section 4.1, we explain how BI directly supports five of sensemaking's properties and the challenges the sensemakers faced in using the technology. We emphasize that BI in its current technological form is not able to directly support identity creation and enactment. In Sections 4.2 and 4.3, we discuss the importance of stakeholders' ability to interact with BI systems and to create their unique BI identity so that they can use BI for sensemaking in their organizations.

4.1   BI's Direct Support for Five Properties of Sensemaking

By analyzing the participants' experience, we clarified the strengths and weaknesses of using BI to support organizational sensemaking (refer to Figure 1) in the following five areas.

4.1.1   Retrospection

BI systems rely on huge volumes of business data, which represent past transactions, events, and situations. Not surprisingly, all such historical accounts could facilitate retrospective views of an organization and, thus, may provide active support for sensemaking. Ruofan elaborated on the purpose of capturing past events for business and discussed customer data integration with BI predictive tools. Several study participants also found the availability of big data to be important, especially in terms of developing organizational ability to expand their retrospective view into external business environments. However, as Robert observed, to use BI as a lens on retrospective records, one needs to consider data quality as a fundamental aspect of the analytic system. Nathan asserted that committing time and effort in delivering quality insights into organizational processes involves preparing data, which may not have been

collected for specific analytic purposes. Madison added to this view by noting the risks to data quality when using data from multiple sources. In summary, ineffective data integration and poor data quality are the main barriers to effective management of retrospective records, whether generated from within or sourced externally. BI technologists primarily attempt to overcome these problems to provide a "single version of truth" for decision makers.

4.1.2   Social Engagement/Collaboration

Sharing BI reports and relying on decision making partnerships are a form of social engagement in an organizational framework. Robert, for example, noted that BI tools offer facilities capable of supporting face-to-face and virtual meetings, providing access to shared data, aiding circulation, and supporting discussion and annotation of BI reports online—all part of the socio-organizational engagement. Ross, on the other hand, drew our attention to two new BI enablers for collaborative decision making. He mentioned the need for co-located BI collaboration and the large screens and interactive visualizations to support team interaction. He also recognized the way that contemporary BI extends its collaborative functionality to the cloud via cloud-based reporting and access to such reports via mobile devices. Ross further highlighted the trend of combining BI with collaboration systems via messages, emails, and, most importantly, mobile phones and tablets. Apart from BI's facilitating collaborative decision making, some study participants noted the need for BI to actively support communication and experience sharing between data analysts and decision-makers (e.g., Clark). This need is propelled by significant knowledge gaps in both business communities, where the majority of organizational decision makers do not have sufficient technical skills to operate BI tools, and by data analysts, who do not have enough understanding of the business environment.

4.1.3   Cue Extraction

Every organizational decision maker finds identifying significant cues to unfolding business events buried in rapidly changing business data a challenge. Contemporary BI provides some answers to those challenges. For instance, BI can monitor the flow of business data, alert users to important changes in their environment, and supply relevant context so that they could make sense of the evolving business situation. Our study participants identified several cue-extracting tools (namely, dashboards, scorecards, real-time alerts, online KPIs, and starred reports). For example Robert further elaborated on the methods for embedding alerts in dashboards to facilitate cue extraction to support sensemaking. At the same time, drawing on his experience as a manager of business intelligence, Matt cautioned BI adopters from saturating decision makers with signals and alerts in busy organizational environments where they may be subject to warnings constantly competing for their undivided attention, which can lead to disorientation rather than sensemaking. Other study participants noted that skeptical decision makers, who often demand validation of obtained reports, do not readily accept BI-generated cues (e.g., Madison and Andrew). However, Daniel, an experienced data analyst remarked on some decision makers who use interactive self-service reports to drill into data in search of further decision support, clarity, and certainty.

4.1.4   Plausibility

A large part of BI analytics involves considering different business scenarios, understanding existing and potential risks, and making predictions for situations, markets, demands, trends, and business events. Some participants noted that such predictions and modeling can assist managers to better understand a spectrum of business predictions and are capable of providing support for making important strategic decisions, with potentially tremendous impact on company performance (e.g., Sahil). The challenge, however, is to eliminate BI reports' fuzziness, which is often the unwanted consequence of low-quality data. Even though plausibility over accuracy is an important aspect in Weick's (1995) sensemaking model, the inexact nature of business situations described by BI systems often escapes the attention (and moreover comprehension) of many BI end users. Chandler underscored this issue and, from the vantage point of his position as a director of financial governance and planning, discussed the significance of educating business decision makers about the mere plausibility of outcomes predicted by BI systems:

> *We have to give them the story that they were sold, but we also have to open their eyes to the fact that the story that they were sold was based on the perfect world and we don't live in the perfect world.*

4.1.5   Ongoing Access

BI systems commonly acquire and monitor new business data in a continuous cycle of information growth and improvement, which, as our study participants highlighted, creates opportunities for ongoing sensemaking and generation of insights (Jordan, Jeffrey, and Matt). Thus, BI decision makers are equipped with continuous access to up-to-date information capable of supporting the ongoing development of new understandings and fresh insights into their organization. Madison jokingly contrasted BI with other traditional decision support and reporting systems by stating that BI is "a little bit more continuous reporting". Continuous data monitoring and reporting is an integral part of the growing trend to provide decision makers with analytic ubiquity. BI systems must not only provide uninterrupted business status reports and advice quickly, efficiently, and as needed but also deliver such reports and advice to decision makers wherever they are (Robert). Ubiquitous decision support is especially high on the agenda for those executives who operate in dynamic and volatile business environments with multiple information channels and several feedback loops. Such environments change at a pace that no longer permits analytics to take place in the backroom of BI departments or allows reports to be digested at the leisure of a boardroom meeting. However, Clark drew our attention to another aspect of ongoing sensemaking by highlighting the role of continuity in defining the scope of BI and creating a shared understanding: "It is a constantly evolving thing. It's not static, ever. Because if it is—my experience, and a lot of this is that models age quite quickly, particularly in environments where you've got feedback.".

The findings so far clarify that BI can indeed support five out of seven sensemaking properties. BI-captured data allows decision makers to continuously engage with environmental cues via interactive reports, dashboards, and scorecards and, as a result, gain business insights and share them with other decision makers in the organization so that they can make and enact decisions. Table 2 (first column) summarizes BI's strengths and weaknesses in addressing the selected sensemaking properties. The second column shows the tools and services that BI provides that also display various properties of sensemaking as inferred from the literature on BI or from interviews we conducted. The third column, drawn primarily from study participants' viewpoints, highlights BI's weaknesses in supporting sensemaking. In Sections 4.2 and 4.3, we explain the relationship between BI and the two remaining properties of sensemaking (i.e., identity creation and enactment) that BI technology does not support well. In these sections, we clarify their importance and their role in assisting decision makers in understanding their business environment.

Table 2. BI and its Challenges for Supporting Sensemaking Properties

Sensemaking property	BI systems or their features for supporting sensemaking	Challenges identified by study participants
Retrospection	Wide range of data sources and possible reports	Data is not produced for BI purposes
Social engagement/ collaboration	Collaborative BI that facilitates sharing, commenting, and circulating reports and the availability of reports on mobile devices and large screens	Data analysts and decision makers need to interact with data and analytics
Cue extraction	Dashboards, KPIs, and alerts	Information overload and the need for self-service BI
Plausibility	Plausible models are supported by various analytical techniques such as prediction and forecasting	Fuzzy or imprecise data often results from its low quality, the high cost of its processing, or imperfect business models, which decision makers find unacceptable
Ongoing access	Reports that are ubiquitous, and available on mobile devices	The scope of BI and shared understanding should be leveraged in a continuous cycle of growth and improvement

4.2   Identity Creation

While the study participants explained BI's capabilities to support five properties of Weick's (1995) model of sensemaking (namely retrospection, social engagement, cue extraction, plausibility and the ongoing nature of the sensemaking process), they also highlighted the need for organizations and individuals to create the capacity to sustainably use analytical tools to support decision makers in sensemaking;

namely, identity creation. Nathan, with his experience in supporting sales and marketing, elaborated on BI identity's role by contrasting BI and other IT systems and highlighting the need for the culture of discovery:

> *If you put in a CRM system that's new and it requires some business process change, there's going to be some resistance so you need to convince people about the new business process but once you've embedded the process, it's there. Whereas, you know, BI and analytics is probably a more open business process. There are some tied up processes that exist in BI but then, you know, there's a culture of discovery and justifying your position based on evidence which is probably a bit harder than just teaching someone how to generate an invoice differently.*

In the BI context, therefore, to make sense of the larger business environment, organizations need to create BI identity at individual and organizational levels. In both cases, the objectives remain the same. Creating BI identity at the personal level results in individuals' gaining the ability to understand organizational complexity by supporting their sensemaking with data-driven processes, which consequently leads to those individuals' performing more-effective actions in the organization and its environment. Creating BI identity at the organizational level, on the other hand, is about capacity building and modifying organizational elements, which result in a BI-based organization as reflected in its structure, processes, culture, policies, and procedures.

As we show in Sections 4.2.1 to 4.2.2, the importance of BI identity emerged strongly in our interviews with the study participants, who claimed the need for developing and supporting both types of BI identity and enactment of such BI identity in an organization.

4.2.1 Organizational Level

Our study participants identified four principal aspects of BI identity in organizations; namely, clarity of BI scope, alignment of business and BI processes, integration of BI with business rules, and customization of BI tools. The discussions revealed that the clarity of BI scope is one of organizations' first requirements to achieve a shared understanding of analytic reports, which commonly stems from the fact that business information is often valued and analyzed differently across different functional contexts (Davenport, 2010). Our study participants also discussed the implication of process alignment with BI systems. Scott, for instance, cautioned on designing business processes to use BI in an organization:

> *Technology, in my mind, isn't particularly good unless you have a reason for using it and a way of using it, and in that case [BI] organizational process is the most important part. The enabler is the second one. So you need to have your process mapped out and correct first. Then you need someone to automate and enable it to make sure you get a level of rigidity around what the process is supposed to do.*

BI identity can manifest in business rules that integrate with data rules to achieve a "single version of truth" in an organization. Daniel referred to situations where a lack of such integration led to decision makers' skepticism in BI reports and the associated data analysis. He also experienced working with members of the same organization relying on a single data source to produce distinct (and conflicting) calculations and results due to the use of different business rules. To deal with such situations, Roy suggested using consistent data rules across the organization but customizing BI for certain groups of decision makers to assist them in solving their particular issues and provide them with the levels of detail sufficient to understand underlying business problems. At the same time, as a director of enterprise intelligence, Madison expressed his concern about an overly casual approach to analytics for solving problems rather than using the technology as a sustainable approach to managing an organization. This approach may, however, incur time and cost losses to organizations implementing their BI, in which case their management commonly decides on the adoption of vendor best practice with a generic "proven" BI solution, which may result in reducing costs for their organizations but also in copying failures and risks across the entire sector (Hill).

4.2.2 Individual Level

Organizations need to educate individuals and enable them to think and behave in ways that allow them to make sense of their organization with BI. Nathan considered BI as a core competency for contemporary organizations that they should not outsource; therefore, in his organization, instead of undertaking analytic work on behalf of his internal clients, he created an environment where clients could carry out the majority of analytic tasks on their own. Robert added that organizational capacity for using BI effectively includes

every aspect of his organization from its structure to the way people think and make decisions. According to our study participants, however, some situations prevent individuals from using BI effectively, including those involving time constraints, those in which they need to justify decisions and actions, those where other stakeholders are skeptical about BI, and those that involve unskilled users. All such individual characteristics, which promote or hinder BI's use, are the fundamental constituents of BI identity at the individual level.

Decision makers who often face a severe lack of time are unwilling to labor through tables and charts of data or perform complicated data manipulation. During his career, Jeffrey has realized that there are two types of decision makers: "those who are numerically savvy and want tables and data to be able to manipulate information…[and those who are not] interested in diving into the data and…would rather to see the options [to act on]". Nathan further explained that, even if executives have the numerical know-how, they often delegate some of the lower level substantiation of a good decision to their direct reports, and he "would be quite suspicious of a CEO that spends all of his time in spreadsheets" because it was not a good way of using their time.

Having to justify their decisions and action is one reason why some decision makers use BI reports (LaValle, Lesser, Shockley, Hopkins, & Kruschwitz, 2011). In such situations, extensive reports are not effective because decision makers are looking for specific numbers or patterns that they already have in mind (Chandler), and BI systems simply provide decision makers with tools to support what they already know are the possible options.

Decision makers' individual capacity for using BI and, thus, their BI identity could also be reflected through their management style of either trusting data for making fact-based decisions or relying on intuition for making gut-based decisions (MacKrell & van den Boogaard, 2012; Stoodley, 2012). Skepticism toward BI reports hinders intuitive decision makers from using BI. In the study participants' view, skeptical decision makers either feel they may lose their independence (and, ultimately, their power) or they may simply not trust the reports. Madison stated that this issue is even more likely to occur for recommendations models:

> You wouldn't make a recommendation without running it past the client first because every client, even if they have the standard implementation, they are going to do their own things to it and they've got their own quirks about why they do things. So they'll always be a point of validation.

Individuals' analytical skills seem to play an important role in their interactions with BI systems and, subsequently, impact BI systems' effectiveness in helping decision makers understand their organization (Glancy & Yadav, 2011; Shanks & Bekmamedova, 2012). Shane strongly encouraged individuals to develop skills sufficient to use and manipulate BI reports. Ian, responsible for running business operations in his organization, described situations where lack of skill impeded decision makers even from articulating the right questions. At the same time, Dale cautioned against using self-service analytics by unskilled managers acting on BI reports without the presence of an analyst, such as himself, capable of explaining the results and their meanings and how such results should be used in action.

The discussion so far illustrates the necessity for BI identity creation at both the organizational and individual level. We show that creating BI identity will result in organizations with clear BI scope, aligned process, integrated BI and business rules, and customized BI. More importantly, in such organizations, either the culture of discovery already exists between individuals or there is a way to deal with their skepticism, lack of time and skill, and the tendency to justify recommendations and actions while using BI reports. Therefore, in Section 4.3, we elaborate on how decision makers can enact on environment to achieve the desired BI identity at both individual and organizational levels.

4.3   Enactment

When people enact, they bring new events into their environment (Weick, 1995). Enactment is an important element of sensemaking theory in the BI context because it shapes a new environment, which then includes the basic elements for BI-driven sensemaking and, consequently, decision making. Enactment influences both individual and organizational identity (see Figure 2). To enact on BI environments, decision makers need to either rely on self-service BI or communicate with data analysts to create capacity for sustainably using BI tools to support all aspects of sensemaking. Scott observed that few sizeable organizations with people capable of taking an end-to-end view of BI (from data through to its analysis and to decisions and actions) exist. To help such a process to take hold in an organization, he also emphasized the necessity of rich and regular communication between decision makers and data

analysts. Other study participants also commented on this issue and described situations where BI stakeholders needed to communicate clearly to define expectations for BI functionality (e.g., Rachel).
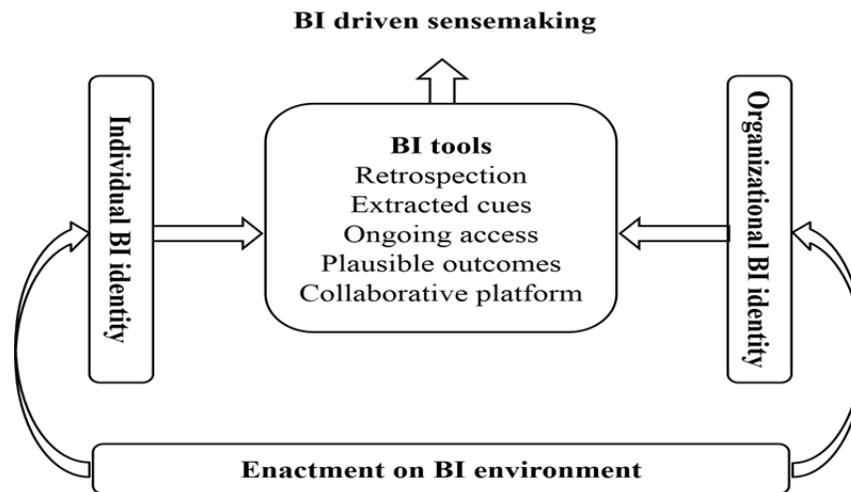

Figure 2. BI-driven Sensemaking

In Sections 4.3.1 and 4.3.2, we elaborate on the role of communication between decision makers and data analysts and on decision-makers' interactions with BI reports. We show the impacts of enacting on a BI environment and its effectiveness on BI in an organization and moving toward sensemaking. Subsequently, in Section 5, we discuss how enactment can address the existing barriers and challenges for creating BI identity.

4.3.1   Communication between Data Analysts and Decision Makers

Individuals' analytical skills influence their interactions with BI systems and, subsequently, impact BI systems' effectiveness in assisting decision makers to understand their organization (Shane, Ian, Dale, Daniel). Madison stated that, in spite of his interest in involving decision makers in exploring reports, BI users still need considerable assistance. Dale also cautioned unskilled managers from acting on reports without the presence of an analyst to explain meanings and how they should be used in action. And yet, Clark identified the lack of proper interaction between data analysts and decision makers as the main barrier to unskilled decision makers using BI reports because "these people do not talk the same language". Madison further highlighted the need for communication with data analysts, which could result in proper presentation of their work and, consequently, assist decision makers in understanding underlying concepts and influence the efficacy of BI reports.

Good communication plays an important role for not only decision makers learning from data analysts about the best way of interacting with BI reports but also for data analysts learning from decision makers about their business environment. Conversation between the two parties has two benefits. First, it educates decision makers on using and interacting with BI and promoting fact-based decision making processes—the main requirement for BI identity creation at an individual level (Ian). Second, data analysts can engage in the process of discovering business rules (Ruofan) and integrating them with the available data (Rachel). Both actions focus on developing a shared understanding between business and technical collaborators (Alfred) and on defining the scope for BI use in an organization (Shaun). Indeed, as Daniel stated, conversation between these two groups ultimately shape the business rules: "There's always some communication with the client and then the next step is to understand, because that conversation creates your business rules.".

The communication between decision makers and data analysts should consider the needs of BI users, their prioritization, and then their validation and verification.

Identifying needs: one of the very first issues of a complex business environment with BI is that decision makers and BI end users are not aware of BI needs. Daniel understood this issue and suggested that many people simply do not know what one can achieve by using BI systems because such people are often "fixed on what they only want to see". In Emily's practice as a senior delivery analyst, since BI users are not aware of BI capabilities, she provides opportunities for them to slowly explore their BI facilities by

staged prototyping of BI solutions. Other study participants such as Ross (an expert in data visualization) used visualization systems for exploring both data and needs. In Ross' view, visualization provides BI-generated insights in the earliest stages of exploring data and problems—well before one employs more traditional BI reporting. Daniel also emphasized the role of visuals in exploring business data: "When the stakeholders are looking at their [visualized] data, they'll see they're standard but then 'Oh, this is new. Let's have a look at this' or 'I want to focus on this particular thing'.".

Prioritizing needs: insufficiently understanding BI capabilities can also result in inefficient reports. As such, several study participants suggested negotiating requirements to prioritize needs. Emily described several situations where BI-related tasks, such as running reports automatically, could not be delivered or understood unless data analysts negotiated with decision makers. She further stated:

> *When you really look into it, you figure out that part of it is never used. So I try not to waste my time and my peoples' development time and the company's money. So we always try to get to the bottom of it. What do you actually need for your work? Not what you had and please replace with that. What you think you want.*

In her view, BI requirement analysis should occur in an evolutionary approach, and one needs prioritization to determine the most critical pieces of information.

Validating and verifying needs: Rachel drew our attention to the need to differentiate between problem statements and stakeholder expectations. She mentioned that, quite often when BI stakeholders defined a problem, their expectations of BI were completely different. In consequence, she routinely undertook an initial interview with BI users to establish their expectation, which she captured in a business understanding report that clearly identified the business's aims and intent. Subsequently, data miners translated the report into a BI model. She stated:

> *It [the communication between analysts and decision makers] wants to show exactly what the aims and intent of the business is and the aims and intent of what a model will deliver, because business aims and intent are different to a model aims and intent. A model is very specific; it will give you a specific outcome, where business will come and say, "We just want to understand the level of compliance".*

4.3.2   Interaction with Reports

Once decision makers start interacting with and validating BI-generated reports, they also start developing trust in such reports (Roy). Consequently, they are likely to undertake more data-driven actions. As a data analyst working closely with BI clients, Daniel added to this view by noting his willingness to anticipate decision makers' needs and provide them with opportunities to customize and tailor their reports. Shaun further suggested that interacting with BI is a constructive way to gain data insights. He indicated that decision makers should find the opportunity to directly interact with reports and answer their own questions since they are the only ones who can actually tell the business story behind the data. Our study participants elaborated on the consequence of interaction with BI systems on BI's effectiveness through the personalization and validation of reports.

Personalization: Rachel explained that there are different types of audiences for BI reports. Therefore, unless she maintains close communication with them, she would not be in the position to prepare and present such reports to their respective clients. She further cautioned against creating reports for decision makers without first identifying and considering their needs and personalities. She strongly asserted that insufficient communication with BI users results from not using BI reports to support important business decisions. Supporting this view, on her approach to delivering BI reports, Emily noted:

> *We work with them [decision makers] and we discuss which way they want the data presented. So in the end, we work in such a way that they understand because that's what they, they are part of the selection process.*

Report validation: in the study participants' view, skepticism toward BI reports hinders intuitive decision makers from using BI (Madison, Rachel, Andrew). To counter this trend, Shaun suggested the need to validate reports by encouraging report users, especially those who are not committed to data-driven decision processes, to actively engage with the reported data via BI-interactive facilities before users understand and act accordingly:

> *[Reports need to be] validated further on down, and by the time it's there, all the questions are out of the way, it's either a yes or no, and we're going to do it.*

As we can see from the presented results, our study emphasizes enactment of individual and organizational BI identity in a BI environment. To this end, data analysts and decision makers need to engage in several important activities. They have to explore and identify requirements of data, analytics, and reports in the enterprise. They should prioritize, verify and review all such requirements. Organizations must aim to increase the level of integration between business rules and data rules across different business functions to create a "single version of truth". A culture of trust toward BI and its outcomes should become the organizational norm, as should a culture of BI self-service and self-improvement so the organization can directly engage with BI-generated insights. BI systems and reports need to be customized and personalized to better support individuals' decisions and actions based on BI-generated data. Our study participants deemed communication between decision makers and data analysts indispensable to develop shared understanding of business and data insights and disseminate such insights in an organization.

5   Discussion

In the context of a traditional (not BI-driven) organization, sensemaking provides a framework for understanding organizational enactment. This framework makes reciprocal exchanges between actors (enactment) and their environments (ecological change) meaningful (selection) and preserves them as lessons learnt (retention). Introduction of BI into this context alters the process of meaning creation and recognizes the primacy of data-based identity for individuals and their collectives (see Figure 3).
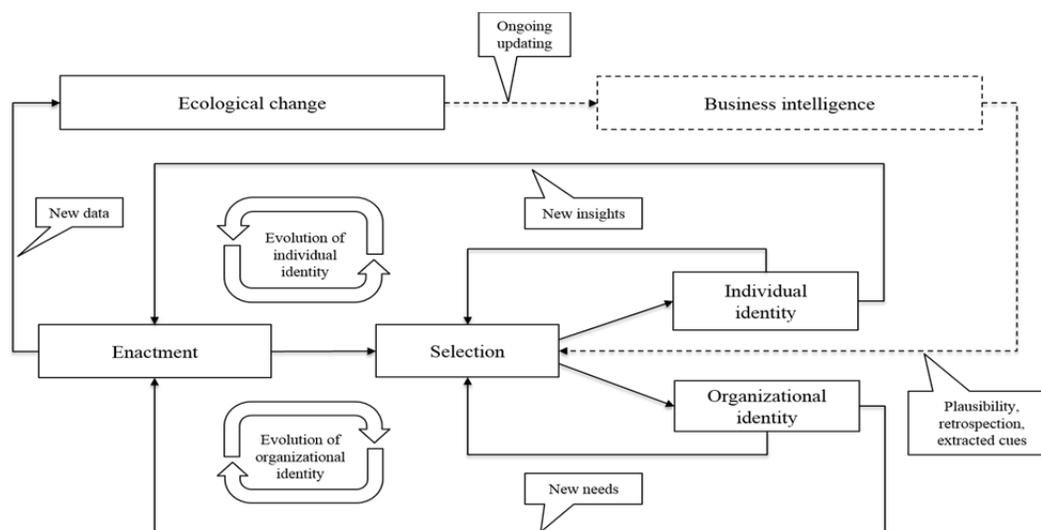

Figure 3. The Revised Enactment Model

The collaboration of BI stakeholders and their interaction with BI tools ultimately evolve BI identity at both individual and organizational levels to support the retaining and sharing of knowledge and individual experience (the "identity", "enactment", and "selection" loops in Figure 3). Through shared knowledge and individual experience, BI can improve decision making processes and indirectly help individuals enact business objectives (feedback from "identity" to "enactment" in Figure 3) on external business environments. In the contemporary digital environment, new data creation and new business activities instigate ecological change (see in Figure 3). At the same time, enactment commences the reflective process of meaning creation ("selection" in Figure 3), which feeds back into improving and strengthening BI identity.

At the organizational level, we can associate the strengthening of BI identity with business process improvement and, in particular, with the development of new requirements for improved BI-related processes ("new needs" in Figure 3). Organizational BI identity helps develop workplace practices and culture. It further leads to refining the scope for BI use, aligning business processes with BI requirements (Marjanovic, 2010), customizing BI tools based on the organization's needs and expectations (Nemati,

Earle, Arekapudi, & Mamani, 2010), and integrating data definition with business rules ("evolution of organizational identity" in Figure 3).

At the individual level, personalized interaction with BI provides opportunities to gain experience, knowledge, attitudes, and skills (Foody, 2009) that will eventually define an individual's role in the organization ("evolution of individual identity" in Figure 3). Via BI self-service, the end users of contemporary BI environments, such as executive decision makers, are able to interact with high-level business reports rather than rely on specialist data analysts to provide the service (Foody, 2009; Stoodley, 2012; Watson, 2008). More personalized reports can be generated at a level relevant to end users, which enables them to view and explore data directly and immediately and, eventually, to generate new insights and turn them into actions effectively and efficiently (Foody, 2009; Hallikainen, Marjanovic, Merisalo-Rantanen, & Syvaniemi, 2012; Smietana, 2010; Steiger, 2010) (see "new insights" in Figure 3).

Decision makers, however, need to clearly communicate with their groups and with data analysts (Imhoff & White, 2010), who may better understand data and its underlying concepts (e.g., its statistical and mathematical grounding). Such communication not only leverages decision makers' BI identity but also educates data analysts about business rules, leads gradually to a shared understanding of BI's business needs and expectations, and helps define BI's scope in an organization.

Upon turning fact-based decisions into action, organizations can collect more data and provide their BI systems with higher-quality data ("ongoing updating" in Figure 3), which assists in their updating data sources, preparing appropriate data for analytics, and improving data quality. Thanks to data-driven meaning creation (link between "BI" and "selection" in Figure 3) and the leveraging of growing experience (link between "identity" and "selection" in Figure 3), decision makers can rely on extracted environmental cues and plausible outcomes to develop retrospective and prospective views of their organization. BI systems that incorporate data for ongoing ecological change allow their users to review and reflect on past data and filter data influx to extract cues via summary reports, KPI charts, and alerts (LaValle et al., 2011). Prediction models and self-service BI motivate skeptical decision makers to interact with the presented information and form and articulate insights that should eventually yield better decisions. Finally, a collaborative BI platform assists decision makers in sharing insights from reports and learn from each other (see the interaction of all feedback loops in Figure 3).

With this paper, we bring two distinct theoretical fields (i.e., sensemaking and enterprise decision making) together and demonstrate how one can put the approaches that these two fields advocate into practice with applications for BI and analytics. From the enterprise decision making vantage point, we identify those BI elements that organizations need for the sensemaking process to succeed. From the sensemaking point of view, our results extend Weick's (1995) sensemaking theory in the context of BI with a particular emphasis on the creation of individual and organizational identity, which can assist contemporary decision makers in making sense of the ongoing changes in their business environment. Most significantly, we advance a continuous process model of organizational sensemaking through the incorporation of BI technologies.

6   Summary and Conclusion

BI can assist not only decision making but also sensemaking. In fact, bridging BI and sensemaking is vital to helping decision makers understand that BI has deeper implications for business than just reporting on its status. BI technology offers ample support for business sensemaking, whether individual or organizational, and, thus, provides management with methods and tools to continuously generate business insights leading to quality and actionable decisions. While BI vendors, analysts, developers, and end users seem to be well aware of BI features and functionality for reporting and decision support, BI-driven sensemaking could provide significantly more opportunities. In this study, we highlight many such opportunities for business decision makers to better use the tools currently in their possession to resolve the challenges around BI and, ultimately, help businesses transform into BI-based organizations.

All the insights we synthesize in this paper represent the views and experience of BI practitioners and, thus, could be of value to the BI community. The results indicate that, for organizations to achieve business environment insights with BI, they need to support their staff in creating and consistently using BI identity at organizational and individual levels. At the organizational level, there is a need for clear BI scope, aligned business and BI processes, BI's integration with business rules, and customized BI tools. Individuals also need to behave in ways that enable them to make sense of their organization with BI. To do so, organizations should develop strategies to overcome situations that prevent individuals from using

BI effectively, such as time constraints, the need to justify decisions and actions, skepticism toward BI, and the involvement of unskilled users.

We found enactment to shape a business environment to support BI-driven sensemaking and, consequently, foster quality decisions. However, decision makers need to be able to independently interact with BI tools and use BI-generated insights to enact their own identity in the process of refining business structures, processes, and data. We found that communication between decision makers (with good understanding of business) and data analysts (with good grasp of data and analytics) to be crucially important for sharing business insights. Sound communication between decision makers and data analysts can ultimately lead to high integrity between business and data rules.

The analysis of insights collected from BI practitioners provides benefits to organizations planning to implement BI systems to support their business decision makers. And yet, as a community of BI researchers, we need to further investigate how enactment on external business environments might be taken to create new data sources for making sense of the organization with BI. Also, we could investigate how one can use prediction models to select plausible meanings in the sensemaking process. Because we conducted our study across different industry sectors and functional areas, we still need to investigate the work patterns and best practice that may emerge for the specific industries.

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Appendix A: Interview Questions

Interview questions include:

A. Please introduce yourself and your organization.
   a. Describe your role in the organization.
   b. Describe your clients and their organization?
   c. Describe the BI technology used in your business and the ways its various components are used by different departments and BI users.
   d. Describe how you use BI in your day-to-day practice.
   e. How frequent do you rely on BI to support your day to day problem solving?
   f. Do you see yourself heavily depending on BI?
   g. How do you perceive the importance and significance of BI in your organization?
B. Please provide examples of complex business situations, which required large amounts of business data, complex data analytics and visualization, to understand the situation and prescribe a plan of action?
   a. Please walk us through these cases by demonstrating the use of BI tools.
C. Explain how BI could assist in understanding business operation.
   a. How do you or other decision makers typically face this situations?
   b. What kind of data is commonly involved in this process?
   c. How can BI help managers in understanding confusing or complex situations?
   d. What analytic tools do you find most useful in this process? How they helped?
   e. Explain how BI could assist in making executive decisions.
   f. Explain how BI could assist in developing action plans.
   g. Explain the role for what-if analysis in decision making.
   h. Explain how BI could assist in strategy planning.
   i. From your perspective, how well (to what extent) does the BI analytics actually support executives in this situations?
D. What data visualization aspects of the BI tool that you use do you find most useful in your work?
   a. What BI visualization do you prefer (or not) and why?
   b. How are executives using the visualization tools?
   c. How could data visualization help in dealing with information overload?
   d. Is personalization of visuals important for decision-makers, why?
   e. If so, can existing systems support ongoing changes to this personal view of analytics?
   f. To what extent do you rely on interactivity of visualized data?
   g. From your perspective, how well (to what extent) does the BI visualization actually support executives in understating business environment?
   h. Do you see any preferences among executives, in terms of the preferences on how insights are presented to them? Which type (charts, cross-tabs, etc.) and why?
E. Please share any stories of you or your clients that fail to utilize insights from BI– how and why did it happen?
   a. How do you overcome the problem when executives are not convinced with the results?
   b. Could you share your experience when you are dealing with executives that are skeptical about using BI and rather rely on their intuition and experience only?
F. Please explain how do you and other BI stakeholders collaborate on the decision-support systems?
   a. What sorts of decisions are involved from both parties during the process?
   b. What sorts of decisions you need to be in charge of by yourself throughout this process?
   c. What sorts of decisions you cannot decide at all but you can only rely others during throughout this process?

       d.   What sorts of decisions should be taken together?

G. How would you rate the capabilities of the results from this collaboration in assisting BI end users in understanding their business?

       a.   What aspects of BI do you think needs to improve in the near future?

       b.   What are the challenges / problems for you in using BI for understanding the organization?

       c.   What kinds of technologies would you like to be available in the future BI tools?

H. What do you think BI would be able to do what is not able to do tomorrow?

About the Authors

Morteza Namvar is a PhD student, sessional lecturer, and a member of Visual Analytics Collaboratory in the Department of Information Systems and Business Analytics at Deakin University (Australia). His research interests includes data visualization, business analytics, and organisational sensemaking. Morteza teaches several units of Master of Business Analytics at Deakin University, including business intelligence and decision modeling for business analytics. Prior to his academic career, he worked as a network engineer and data analyst for more than six years.

Jacob L. Cybulski is a senior academic in the Department of Information Systems and Business Analytics at Deakin University (Australia). He acted as an IT consultant to several organizations and conducted industry research to various clients. Currently, his research interests focus on information systems theory and strategy, business intelligence, data analytics and information visualization. He was instrumental in creating the Australian-first Master's Program in Business Analytics at Deakin University, where he also teaches predictive analytics and business analysis. He is the leader of the Visual Analytics Collaboratory responsible for research and applications in data analytics and visualization. Jacob's past projects range from engineering and telecommunications applications to developing software productivity environments and toolkits. In his free time Jacob engages in the Olympic sport of fencing.

Luckmika Perera is the Director of Teaching in the Department of Accounting within the Deakin Business School. His research interests include social and Environmental Accounting, Earnings Management, Corporate Governance, Critical Perspectives in Accounting, and the Scholarship of Teaching and Learning. He has worked in academia for 10 years. Beforehand, Luckmika worked in industry for several years in consulting roles in middle management in the areas of management accounting, business administration, and information systems.