DOI: 10.1002/sres.2813

RESEARCH PAPER

SYSTEMS and BEHAVIORAL RESEARCH SCIENCE WILEY

Sustainable business intelligence systems: Modelling for the future

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Abstract

Business intelligence systems are used in support of strategic decision-making in organisations. Strategic decisions in support of the sustainable development goals require accurate and accessible data. Of equal importance is the sustainability of the business information systems themselves. Not only should they be sensitive to resource consumption but they should also be designed for the future needs of the organisation. We argue that sustainable business intelligence systems should represent as many perspectives in the organisation as possible supported by the available data. In order to achieve this, a critical (Kantian) systems perspective is suggested that foster appreciation of different perspectives in the organisation. Prevailing belief in the business intelligence system industry is that a key business problem should drive development of the system. Our position is more future oriented in that we argue that inclusion of all available perspectives on business problems will prolong the life of the system, thereby making it more sustainable. This is not an idealistic requirement when a data vault is used for the data model of the system. Contrary to the more common dimensional modelling, data vault modelling does not require restrictive decisions to be made on the scope of the system. In fact, the worst-case scenario is addressed in the initial model. The paper provides a conceptual discussion of how a business intelligence system should be designed and developed to ensure that it is sustainable. Since the right system should be developed in the right way, we incorporate known success factors into our discussion. We argue that the critical (Kantian) systems perspective can lead to the right system and that data vault modelling in context of lessons from identified success factors is the right way to develop the business intelligence system.

KEYWORDS

business intelligence systems, critical systems thinking, data vault modelling, key success factors, sustainable information systems

1 | INTRODUCTION

Business Intelligence Systems (BISs) are specialised information systems used to support strategic decision making and therefore also support the achievement of sustainable development goals in organisations (El-Gayar & Fritz, 2006). They are however not only a means to an end in achieving sustainable development; BISs

themselves should be sustainable. Huang (2009) argues that sustainable information systems development is only possible when sustainability is part of every phase of the software development lifecycle. Huang (2009) rightfully focuses on energy consumption during the *design phase* and storage space, and execution time during the *implementation phase* of the software development lifecycle. The argument of this paper is that the modelling technique is another key aspect of designing sustainable BISs, which is overlooked in current literature. The paper justifies the use of the later versions of Data Vault modelling (Linstedt & Olschimke, 2015) from a critical systems thinking perspective as a modelling technique for BIS.

We argue that sustainable BIS is more than reducing hardware use and energy consumption; it is designing systems that are from their inception accommodative of various and changing perspectives in the problem situation. Ulrich (1983) explains the benefit of embracing multiple perspectives based on the work of the philosopher Immanuel Kant (1724–1804). His critical systems heuristics (Ulrich, 1983) is often used as methodology for stakeholder involvement to articulate different perspectives. Stakeholder involvement is central to sustainable information system development (Hosman & Fife, 2008; Ziemba, 2013). Our discussion is supportive of the holistic model for sustainable information systems (IS) of Ziemba (2013) that identifies, among others, stakeholder involvement and success factors as instrumental in sustainable IS.

The theoretical perspective of the paper starts with a brief introduction of the model for sustainable IS by Ziemba (2013) in Section 1. This is followed by a discussion of applicable ideas of Ulrich's work on critical systems thinking in Section 2 and a review of success factors in BIS, presented in Section 3. A brief nontechnical introduction to data vault modelling is provided in Section 4 to conclude the literature review.

The main contribution of the paper (Section 3) is a conceptual view of a sustainable BIS designed using Ulrich (1983)'s critical systems perspective, implemented using Linstedt and Olschimke (2015)'s data vault model sensitive to known BIS success factors.

Although the paper hides the technical detail of data vault modelling, it should be clear to the systems practitioner that a critical analysis of the implementation phase of the systems development lifecycle may lead to systems which accommodate future perspectives from their inception.

2 | THEORETICAL PERSPECTIVES

2.1 | Sustainable information systems development

In this paper the definition of sustainability of the Brundtland Commission (WCED, 1987) is used: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Sustainable information societies require reforms on many different levels of general computer use, such as number of physical computers (to reduce material), energy consumption, temperature management, data usage (to reduce cloud storage

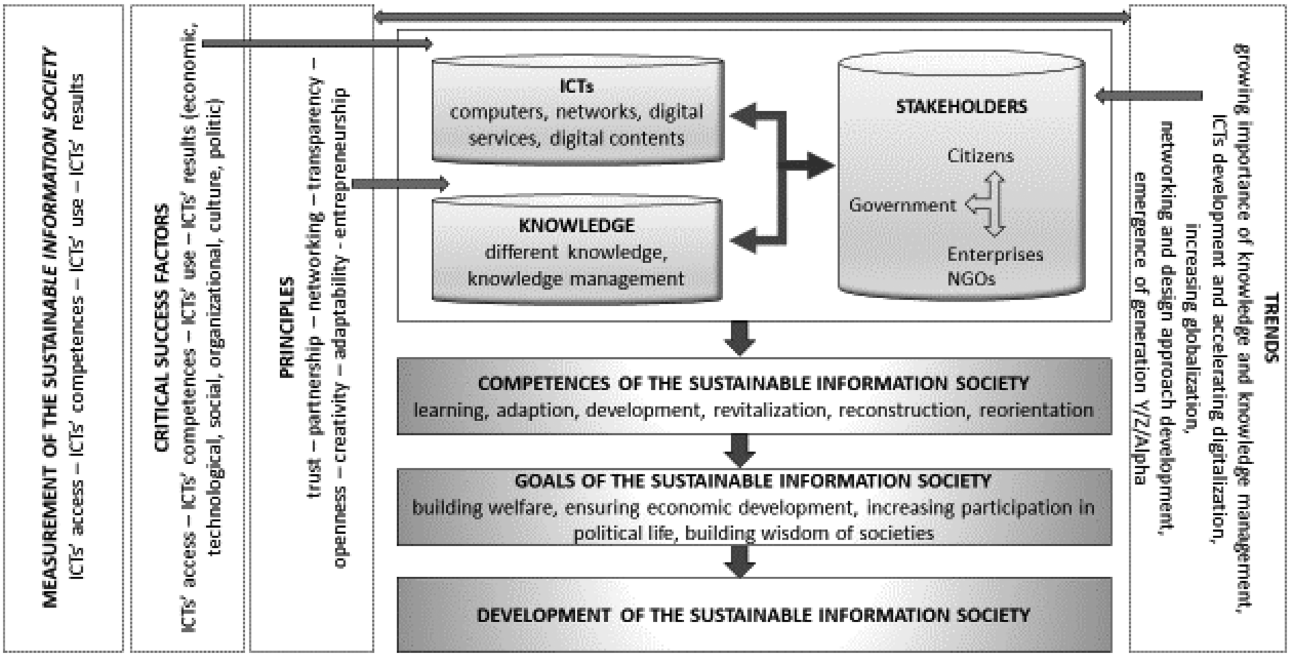

FIGURE 1 The conceptual model of the sustainable information society adapted from Ziemba (2013)

infrastructure) and even effective algorithm development (to reduce running times) (Huang, 2009; Schmidt et al., 2009). In order to develop sustainable IS solutions one should evaluate each phase of the software development lifecycle in terms of sustainability (Huang, 2009). The phases are Planning, Analysis, Design, Implementation, Maintenance, and Disposal. Ziemba (2013) models a wider perspective on sustainable information systems as part of sustainable information societies as depicted in Figure 1.

In a BIS, which is the concern of this paper, the three central components of Ziemba's model, namely, knowledge, ICTs and stakeholders are especially prominent. Business decisions are supported from historical data stored in support of multiple stakeholder perspectives. The identified principle of adaptability ensures longer service-life of information systems, leading to fewer resources required to maintain and replace the system. We argue that adaptability should not only imply that the system may be adapted later, but it should also mean that the original design should incorporate possible future perspectives. When an organisation is able to develop sustainable information systems, their development cost is reduced, which in turn improves the sustainability of their business (Schmidt et al., 2009). The role of critical success factors in systems development (discussed later in the paper) is also evident from the model. The argument presented in this paper, and supported from the model in Figure 1, is that when a BIS is designed in a way that accommodates various perspectives and implemented using techniques which are able to support future changes, it improves the sustainability of the organization. The sustainability is increased if the system itself is successful in terms of its stated purpose. BIS success factors are discussed in Section 2.3.

2.2 | A critical (Kantian) systems perspective on business intelligence systems

In this research project, our ontological position (inspired by the philosopher Immanuel Kant (1724–1804) and Ulrich (1983)) is that our experiences condition our view of reality and each of us has a different perspective or view of reality (we call these perspectives "conditioned realities"). Furthermore, although it is impossible to achieve an objective understanding based on the totality of these subjective perspectives (conditioned realities), striving towards understanding all conditioned realities leads to an improved understanding of the phenomenon under investigation. It is necessary to uncover the moral and political-institutional presuppositions that condition our understanding of a phenomenon such as the business intelligence system and its role to support business decisions. This is in contrast with positivism that elevates the empirical–analytic experience to be the origin of knowledge while denying the possibility of a transcendental reflection on the conditions and meaning of knowledge.

We cannot use a philosophical position without being aware of its shortcomings. The transcendental reflection of Kant has long been criticised. According to Habermas (1971), Hegel argues that "reflection is dependent on something prior and given, which it takes as its object while simultaneously originating in it." In effect, Hegel challenges Kant's transcendental reflection because of its lack of an absolute starting point. We assume the position of Habermas (1971) on this matter and omit the detail thereof.

Although our focus is not on the critical systems heuristic methodology developed by Ulrich (1983), our systems concept is best described by a quotation from his work. "Like the concept of totality, the systems concept refers to the critical idea of a whole of relevant conditions, a whole that we cannot possibly know, although we can and must nevertheless think it. But unlike the concept of totality with its implication of an unconditioned, transcendent reality (the totality of conditions is always itself unconditioned), the systems concept has the advantage of reminding us of the relative character of every system of which we can meaningfully speak. It does so because it is clear that what belongs to the "whole system" is entirely a matter of the enquirer's choice of the conceptual boundary that separates the "system" from its "environment" (Ulrich, 1983).

As business intelligence systems practitioners, we can contextualise this position as: different users have different perceptions and expectations of the system and will use it for different gains. These perspectives are based on the experiences and motivations of the different users. We should strive to understand as many of these perspectives as possible before we design the system; better yet, we should strive to design a system that can accommodate different perspectives not even considered by ourselves.

2.3 | Business intelligence systems: Critical success factors

Business intelligence is an umbrella term for all legal and ethical methods used in an organisation aimed at making better strategic decisions based on information (Vedder et al., 1999). In this study, we adopt the definition of BIS as "a system comprised of both technical and organizational elements that presents its users with historical

information for analysis to enable effective decision making and management support, with the overall purpose of increasing organizational performance" (Işık et al., 2013). A data warehouse is typically the artefact used to support the business intelligence process (Inmon, 2005; Kimball et al., 2011). In this paper, a data warehouse is viewed as a component of the BIS used to provide the information technology support to management. The BIS is viewed as the wider system that includes the people, processes, and the artefact. Grover et al. (2018) provide examples how the use of appropriate data in decision making can create business value in different areas such as process improvement, innovation (products and service) customer service and market research all leading to overall improved organizational performance and reputation.

Data warehousing development methodologies were developed in the 1990s. Inmon (1996) defines a data warehouse (DW) as "a subject oriented integrated, non-volatile, and time variant collection of data in support of management decisions." Data in the data warehouse represent more than one source system or online-transactional processing system (OLTP) (Kimball et al., 2011). OLTP systems are the everyday information systems we encounter in banks, supermarkets etc. that capture transactional data. The principles guiding the development of OLTP systems differ from those guiding DW systems since DW are optimised to provide quick responses to queries. OLTP systems are designed to provide accurate input methods and to store data according to the relational database normalisation principles developed by Codd (1972).

In DW development, different data models are used such as a relaxed relational data store (Inmon, 1996), a dimensional model (Kimball et al., 2011) or a data vault model (Lindstedt & Graziano, 2011). The aim of these models is to integrate data from different source systems and to provide management decision makers with fast, reliable answers to support their decisions. Results from OLTP systems are well-structured reports that are typically provided to the same people month after month while data requirements from DWs are more diverse and provided to key decision makers in organisations (Kimball et al., 2011). In a recent comprehensive study comprising of an analysis of empirical studies on effects of strategic management systems, Yoshikuni and Albertin (2018) reports on specific conditions where strategic information systems are of great value. They refer specifically to the positive impact when strategic information systems are used in support of innovation in turbulent economic times.

Unfortunately, BISs are not always successful. A study by Dresner Advisory Services, L. (2012) showed that only 41% of the 859 organisation involved in the study, rated their own BI projects as successful. Lack of business involvement, lack of user involvement, lack of funding and organizational politics are listed as some of the causes of BIS failures (Wixom & Watson, 2001). The established model of Wixom and Watson (2001) published in MISQ in 2001 is often used as basis for empirical studies in BIS/DW critical success factors (to name a few: Arnott, 2008; Dawson & Van Belle, 2013; Hawking & Sellitto, 2010; Hayen et al., 2007; Mungree et al., 2013; Shin, 2003). Each of these empirical reports provides detail of the participants, methodologies used and statistical rigorous findings. Recently, a substantial number of papers are published on success factors in BIS such as Ain et al. (2019), Zaied et al. (2018), Alali et al. (2019) and Shapouri and Lotfollah (2020). These authors all conducted a literature reviews on recent papers with strong empirical evidence on critical success factors (CFSs) on BIS and identified similar factors. We summarise the commonly identified factors in Table 1.

Kimpel and Morris (2013) summarise their recipe for success: "In summary, for a data warehouse to succeed, it must provide data, information, and knowledge that allow a user to solve their business problems. More important than building the system right (i.e. CSFs for data warehousing implementation), is building the right system (i.e. providing a solution to the business problem). To solve a user's business problem, the IT analyst must understand the problem. To understand the business problem, the analyst must engage the user, elicit their problem, and agree together on the solution."

2.4 | Data vault modelling

A stated earlier, a data warehouse (the data store of the BIS) can be modelled using different techniques, namely relaxed relational data store (Inmon, 1996), a dimensional model (Kimball et al., 2011) or a data vault model (Lindstedt & Graziano, 2011). The first two models are more common than the data vault, mainly due to perceived complexity of data vaults.

Dimensional modelling developed by Kimball et al. (2011) is very popular in DW design (Sen & Sinha, 2005). Without going into the details of dimensional modelling, it requires a decision regarding the granularity of the data in the data warehouse. This refers to the level of detail of entries storing basic measurements (facts). Transactions representing events are loaded in a central fact table with dimension tables linked to the fact table in order to provide context to the data. The granularity of the facts should be defined in such a way that there is a one-to-many relation between

TABLE 1 BI/DW success factors from literature

Category	Identified success factors
Source data and technology aspects: When discussing technological readiness for a BI/DW systems many authors refer to both the technology used for the source systems and the technology required for the BI/DW system. It proved very difficult to distinguish between "appropriate technology" in terms of source systems, development technology, and usage technology. Many authors referred to technology in conjunction with source data quality. This factor for appropriate development is repeated in the third category on development aspects.	1. Good source systems (source data quality); 2. Appropriate technology (sophistication of IT infrastructure, technical capability; heterogeneity of IT infrastructure; proper development technology; flexible and appropriate technological framework; tools and technology to enhance BI use; business-driven, scalable and flexible technical framework); 3. Data quality and management (ongoing organisational consolidation of structures, processes, and data; identification and access to required data sources; combine different data sets; high data quality; data security and privacy).
Requirements and participation aspects: This category combines the requirements of the BI/DW system with management support. Although these two aspects are separable, the result of the requirements analysis phase is influenced by the level of top management support and user involvement. These factors are not all supported by empirical investigation in different studies. It is not always easy to distinguish between the factors listed as "clear link to business objectives" and "strategic value".	1. Management support (committed management support and sponsorship); 2. User participation (user involvement; user support; user expectations); 3. Champion (executive sponsorship; operational sponsorship); 4. Organisational impacts (perceived benefits, organisational resistance; organisational politics, measurable business benefit, governance; legislation, ongoing organisational consolidation of structures, processes and data; business process improvement); 5. Clear link to business objectives (align BI strategy with business objectives); 6. Strategic value (provide benefits statement; identification of key performance indicators; corporate strategy; business case; business content); 7. User oriented change management; 8. Other: Organisational management (organisational culture; literacy; management method; organisational size); market dynamics (degree of competition, product range, competitor's BI capability); IT's influence on business strategy.
Development and project aspects: This category focusses on the work of the BI development team. The item "user participation" in the previous category may have an impact in this category. Source literature is not always clear on the extent of "user participation".	1. Evolutionary development and methodology (deliver first iteration quickly; visualisation; virtualisation; interactive process model); 2. Development technology (repeated from category 1); 3. Resources (adequate funding, cloud based-solutions); 4. Team performance (appropriate IS staff; multi-disciplinary teams; analytical skillset; technical skillset); 5. Project management and scope control (clear and manageable project scope; clear project goal with deadline); 6. Change management (user oriented change management); 7. Testing; 8. Other: Time restrictions; process automation; integration of new solutions.
BI/DW usage aspects: The factors in this category can be viewed as both an influence and a result of BI/DW success. Many of the items listed are basic requirements or well-designed BI/DW systems. These factors are included since they are sometimes present in studies on BI/DW success factors as indicated in literature.	1. Information quality (accurate information; concise information; access to external data; trend analysis); 2. Use (minimal or no training; adaptable interface; exception reporting; performance; reporting strategy) 3. User satisfaction (improved efficiency); 4. IS service quality.

the fact table and the dimension tables. The moment business rules change, or another perspective requires a different granularity, substantial changes need to be made to the data model.

Data vault modelling is an alternative though less used strategy to dimensional modelling. In contrast to dimensional modelling, data vault models implement many-to-many relationships from the beginning between

all hub entities. This means that the "worst"-case scenario is supported from the inception of the data warehouse (Lindstedt & Graziano, 2011). Typical changes in user requirements or new perspectives lead to either a change in granularity, or a change in the one-to-many nature of the relationships. Such changes require substantial effort when a dimensional model is used, while minimal, if any, changes are required to an equivalent data vault model.

Due to the flexibility inherent in the data vault design it provides better technical ability to model different perspectives in an organisation than traditional dimensional modelling. By using a data vault model, one system can incorporate different user's perspectives!

Another advantage of data vault modelling is the ability to reconstruct all source data from the data vault because it contains audit data. Data is not "cleaned" in the load processes such as the case in dimensional modelling. The validity and correctness of the data is much more traceable than in other data models.

It is outside the scope of this paper to explore the technical detail of data vault modelling. *The most important distinguishing characteristic of the data vault is that it makes provision for all possible relationships between entities in the initial model*. One may view this as modelling for all possibilities of interactions between data, even those not required by the current business specification document. Proponents of data vaults, Giebler et al. (2019) highlight the fact that data are stored in its raw format which improves the auditability of results and flexibility of the system for future adaptability of requirements. The popularity of data vault modelling is increasing and clear principles for the implementation of BISs using data vaults have been developed by industry role players (Stroo & Broekmans, 2018).

3 | SUSTAINABLE BUSINESS INTELLIGENCE SYSTEMS FROM A CRITICAL (KANTIAN) SYSTEMS PERSPECTIVE

Now, we state our own perspective of best practices for the BIS development lifecycle in order to develop a sustainable system as part of a sustainable information society.

Similar to Kimball et al. (2011), we view BIS as inclusive of the artefact (the DW) per se as well as support structures that provide the data support for decision making in an organisation. This includes different types of decisions as discussed in Işık et al. (2013) on different levels of the organisation. The phenomenon under investigation (for which we want to understand the conditioned perspectives) is data-driven decision making in an organisation and therefore we take a wider view of DWs as typically described by DW definitions. We define the DW as:

A system that stores integrated data from multiple sources and provides fast, easy access to a diverse user community in order to empower them to use available data in support of a variety of decisions in an organisation.

This definition follows from our philosophical point of view that different users will have different perspectives on the activities of the organisation, and consequently want to use the DW/BIS in support of decisions made from their unique and valuable perspectives. Users need a system that is easy and convenient to use, and that enables them to justify their perspective on a specific issue in the organisation from available data. Inherent to the empowerment of all users is an assumption that a variety of perspectives in business improves understanding and that all perspectives are welcome in an organisation, provided that they can be justified. The BIS provides a means for such justification. Such an openness to multiple perspectives, includes future perspectives, not currently observed. The topics that guide the rest of this reflection is not directly related to the categories of success factors in the previous section since our view of the BIS facilitates a more integrated perspective than one solely based on success factors.

3.1 | Clear vision and well-defined information and systems requirements

A large number of studies indicate that a strong business case or business justification is crucial to BIS success. We want to challenge this argument from our philosophical position. If a user (respondent) is asked in an empirical questionnaire about the importance of the BIS in support of a clearly defined business case, he/she reflects both on the BIS and the perceived business case from his/her conditioned perspective. It is most likely that the current BIS was developed in support of some perspective of a key business problem which might be different from the respondent's perspective. Since there is then a lack of alignment from the perspective of this respondent, he/she might argue that alignment is crucial, due to the current lack of alignment. Since this alignment is only possible for a small group of users who succeeded in controlling the BIS development, many other participants in the survey might also respond that alignment is key. Alignment between a business case and the BIS is then identified as a key success factor, but is rather a symptom of the problem of trying to align the BIS to a specific perspective of the

business case, to the exclusion of other perspectives. From our perspective, such a specific alignment is a fallacy when diversity is not accommodated in the BIS.

The formulation of well-defined information systems requirements belongs to the traditional functionalist information systems development strategy and the problems associated with it has been identified many times (Clegg & Shaw, 2008). William Inmon, known as the "father of data warehousing", promotes the idea that the data warehousing team should load all available data into a central data repository without any focus on business requirements. Business analysts will then, after the completion of the data store, assist business users to access the data in support of their decisions (Inmon, 1996). From our perspective this argument is also flawed in that the business users should be empowered to access the data themselves. The integration effort required to incorporate all the data is often too complex (therefore time consuming and expensive) to make this a practical strategy.

A final more pragmatic problem with having a strong business case or problem as justification for the DW is the sustained use of the DW in a changing business environment. What happens to the DW if the "well-defined" business problem has been "solved" or has become irrelevant?

From our perspective a change of attitude away from "well-defined information systems requirements" is necessary. We argue that requirements collection is still the most important phase in BIS development. The aim of requirements collection from a Kantian systems perspective is to document different perspectives in the problem situation. Each perspective serves to enrich the understanding of the business analysis team and should be embraced. Tools from OLTP systems development such as use case diagrams can assist the requirements collection team to represent different perspectives. The resulting data models will then support different views of the problem situation as discussed later in the paper.

The soft systems methodology (SSM) developed by (Checkland, 1981) has been successfully used to represent different perspectives, and is listed as an excepted OLTP methodology (Iivari et al., 2000). The SSM however does not have an explicit critical nature in terms of identifying underlying oppressive structures in an environment (Jackson, 2003). We have successfully used critical systems methodologies from the proposed Kantian systems perspective to understand high level requirements of a BIS (Venter & Goede, 2017). Total systems intervention developed by Flood and Jackson (1991) suggests different strategies for different types of problems. One such strategy is critical systems heuristics developed by Ulrich (Ulrich, 1983) who provides a list of boundary questions to aid the articulation of different perspectives as discussed earlier in the paper.

The aim of business requirements collection in a BIS should be to incorporate as many as possible conditioned views in the initial description of the BIS's requirements. Since we presuppose that we cannot know all possible perspectives the design of the BIS requires flexibility and evolutionary development as discussed later in this section.

3.2 | Management support

From our perspective of striving towards understanding the totality of conditioned perspectives, management has a particularly important role to play. A well-designed BIS will change the way decisions are made in an organization, and such change requires top management support. When the BIS is used as intended from our perspective, all users should have equal opportunity to use data in order to justify their perspectives on organisational improvements or to prove deception in other perspectives. This is only possible when members of top management support this extensive use of the available data in the organisation. Widespread management support is also required to enable user involvement in the development of the BIS to ensure availability of data and good access tools. When management supports the Kantian systems perspective of striving towards the totality of conditioned perspectives, they will be able to assist in the identification of users to involve, who are representative of different perspectives.

When management develops an understanding of the benefits of multiple perspectives, they will encourage evolutionary systems development methods to enable multiple user input in the early phases of the implementation of user requirements.

3.3 | User involvement

User involvement is non-negotiable in the process of developing a BIS that supports different perspectives in an organisation. The development team cannot properly understand what the users want without the support of a large group of diverse users. We agree with Andrew Liberale (quoted in the previous section) that ownership must be transferred from the IT department to the end-users. A group of users should be involved in order to become super users later, who may inspire other users.

The selection of the participating users should be clearly thought through. Since the super users have to inspire other users, they should be representative of different management levels. Care should be taken to create an environment where power differences are set

aside (Checkland & Poulter, 2006). Checkland and Poulter (2006) identify roles played by individuals in organisation. Some people are advocates for change while others are conservative and minimise risks. The more diverse the involved user community is, the larger the number of conditioned perspectives represented by the BIS design.

Aside from general requirements, user input is required mainly in two aspects of the BIS design, namely what source data to include in the design, and the development of user access tools. We first discuss user access tools before we consider source data.

3.4 | Quality of user access tools

The ultimate success criterion of the BIS from our perspective is whether it is widely used in an organisation to support decision making. The test is not whether it is used by executives who majored in IT or had specialised SQL training, for such requirements reinforce power struggles in the organisation. "Ease of use of the user access tools" is the factor that enables widespread use of the BIS. The user interface should not require knowledge of technical terms and table names or queries written in SQL but should enable every user easy access as described by the Mantillion organisation (Anon, 2016).

Such ease of access can only be achieved when novice and experience users are involved in the design of flexible user access tools. Once again, it is a case of involving different perspectives in order to design tools flexible enough to support diverse users in a variety of decisions.

Often additional requirements are frowned upon by system developers. From the Kantian systems perspective, additional requirements are an indication of success of the user access tools. Users are using the system and want to use it even more. Additional requirements may also represent a new perspective on the data. Flexibility in the data model to incorporate additional requirements is key to a successful well-used BIS, as discussed later in the paper.

3.5 | Fast, accurate data from reliable sources

The BIS will not be used if the data cannot be trusted or if it takes hours to obtain the required data. In the theoretical discussion the role of data quality as factor or dimension of BIS success was not always supported by empirical data analysis. From our perspective it is crucial. Users use data to support their perspectives on organisational decisions, and thus data should be accurate. This is easier said than done, since data are integrated from more than one source system and duplicate data exist in these systems. User involvement in the technical integration is not always possible but users may be able to suggest procedures to verify the quality of the data. Users may also have different perspectives on the level of quality of specific data.

High quality source system data is of utmost importance, and if widespread management support is achieved, top management can intervene to increase source data capture quality. High quality of data should be an organisational goal and cannot be achieved alone by the data warehouse development team.

3.6 | Flexibility and performance of the data model

All of the above may sound like a utopian system: a system that supports more than one perspective, and produce fast and accurate data. It need not be if the data model of the DW is designed to support multiple perspectives from its inception. It might seem strange that a high level philosophical argument focuses on low level data modelling, but it is indeed this technical issue that allows best for the implementation of our proposal.

Van Schalkwyk (2014) empirically investigates the impact of changes to user requirements on a data warehouse implemented with a data vault compared to one implemented with a dimensional model. He shows that when the level of detail stored in the dimensional data warehouse is changed, major redesign is required, whereas the data vault caters from its inception for the lowest level of detail, and therefor needs no change at all. A key hypothesis tested and supported by Van Schalkwyk's (2014) experiments is that the number of existing queries that need to be changed when changes are made to the data model is less for a data vault than for a dimensional model. Therefore, a data vault is more resilient to future changes, making it more sustainable.

In order to provide fast accurate data access to a diverse user community representative of multiple perspectives, we promote the use of a data vault as data model and evolutionary development. Evolutionary development is possible using data vaults and provides user data for the access tools development early in the project lifecycle.

3.7 | Quality team with sufficient resources

Resulting from our discussion on the other factors of a BIS, we are now ready to discuss the data warehouse

development team. None of the ideas presented above is possible without a skilled data warehouse team with sufficient resources to implement them. The most important requirement of the team should be that all the team members embrace the diversity of organisational perspectives that the BIS should support. If team members have a functionalist approach to user requirements conflict will be unavoidable! Team members should have good communication skills and an open mind. Good software development skills are required to provide easy to use user access tools. Data modellers should be skilled in data vault modelling to develop a robust data warehouse.

The advantages of a champion have been supported by the empirical studies reviewed in the previous section. We advise that the role of the champion should be filled either by somebody that is exceptionally aware of different perspectives in the organisation or by more than one person in order to represent different perspectives in the organisation. It is advantageous if the champion is not a skilled computer user in order to highlight the need for good flexible user access tools that support a diverse user community. The higher the rank of the champion(s) in the organisation, the easier it will be to obtain the required resources for the BIS team.

As indicated by Mungree et al. (2013) and the Mantillion organisation (Anon, 2016) the data warehouse requires extensive, continuous support and development. This is due to changes in available data and changes in the business environment. These changes are handled better by the original BIS team than by a new maintenance team since the original team already has an understanding of the different perspectives supported by the BIS. The same argument can be used to promote in-house BIS development teams.

3.8 | Other success factors

Although our discussion was guided by a specific subset of known success factors, the role of other success factors can also be reflected upon in terms of their ability to enable the development of a BIS that support a variety of decisions by a diverse user community. We argue (like we did with a specific business motivation) that many of these success factors are symptoms of a core problem, namely the inability of the BIS to support different perspectives in the organisation.

4 | CONCLUSION

The aim of this paper is to provide guidance for developing business intelligence systems for the future. Our philosophical position is described based on the transformed transcendental ideas of Habermas and the Kantian systems ideas of Ulrich. Different people have different perspectives on a phenomenon and the phenomenon is better understood if one is able to understand many different perspectives. We refer to this as striving towards an unconditioned totality of conditioned perspectives. It is "striving towards" because it is indeed impossible to gain an understanding of all the different perspectives on a phenomenon. We argue that users of a BIS have different perspectives on organisational matters. Not only should the BIS support these different perspectives, but it should also motivate people to support their perspectives from available data. A new way of decision making is proposed by using the BIS.

We present success factors from literature to show that certain factors are highlighted over and over again. Some factors indicated have a more organisational context while others are more technical. We argue that the known success factors are well researched and need no further investigation as such. Our contribution is to provide a new perspective on these accepted factors. We agree that is not only about building the system right, but also about building the right system.

In our reflection on the success factors from a Kantian systems perspective, we strongly argue against alignment of the BIS with a too narrow business case or business problem. The "right system" will then be only "right" for a small group of people. In fact, our focus on the totality of the conditioned perspectives motivates us to include terms like "diverse user community" and "a variety of decisions" in a refined version of existing data warehouse definitions.

We can only succeed in developing a single system that enables decisions from multiple perspectives if we involve different users, representative of a variety of perspectives, in our design process. For this we need widespread management support. Users must guide the development team to develop user access tools that provide easy access to the data to all users. Furthermore, they should assist in solving data quality issues.

We promote the use of data vault modelling for the data model of the data warehouse. Data vaults are more flexible and accommodate different business perspectives due to the many-to-many relationships in the model. Thus, although many studies on success factors divide the factors in more technical and more organisational groups, we argue that the technical data model is key to the success of the DW to accommodate different organisational perspectives and changing business environments.

In conclusion, we argue that "the right" system is not a system aimed at solving a well-defined business

problem. It is a system which is "right" for a diverse group of users and that they can use to provide data support for their diverse views on organisational matters. A system, designed to handle diversity, will withstand organisational change better than a traditional data warehouse built to answer well-defined business questions.

Our future work will entail the evaluation of successful and unsuccessful BI systems in relation to our philosophical perspective.

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How to cite this article: Goede, R. (2021). Sustainable business intelligence systems: Modelling for the future. *Systems Research and Behavioral Science*, *38*(5), 685–695. https://doi.org/10.1002/sres.2813