A CRITICAL SYSTEMS APPROACH TO BUSINESS INTELLIGENCE SYSTEM DEVELOPMENT

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ABSTRACT

Business intelligence is becoming increasingly important in organisations. Business intelligence systems are very expensive to implement. Unfortunately these systems often fail to realise business benefits, even when they are technically very good. Traditional development approaches enable developers to develop technically good systems. However, a business intelligence system is a social artefact as well as a technical artefact; it should aim to improve the organisational context of its users rather than merely automate existing business processes. Yet, traditional development approaches do not enable developers to incorporate these social and organisational dimensions into their artefacts. Methodologies in the critical systems thinking paradigm aim to also explore the relevant social dimensions of a problem context in order to provide richer and more meaningful solutions. This paper describes an action research study whereby critical systems thinking principles (operationalised by critical systems heuristics) were applied as part of a business intelligence development project; the principles were applied during the business requirements analysis phase. The aim was to emancipate participants to explore: what is relevant; who needs to be involved in determining what is relevant; and how to handle conflicting views regarding the new business intelligence system.

Keywords: Action research, Business intelligence, Critical systems thinking, Critical systems heuristics, Business intelligence system development

INTRODUCTION

Business intelligence is an important enabler for organisational decision making. It improves organisational decision making capabilities, and ultimately organisational performance and competiveness (Popovič *et al*., 2012). Hence, business intelligence is a focus area for many organisations (Işik *et al*., 2013). The implementation of a business intelligence system is a complex and expensive intervention; it must be planned judiciously to ensure success (Yeoh and Koronios, 2010). Unfortunately, business intelligence systems approaches lack people orientation; human, social and organisational aspects are often not sufficiently taken into account when developing these systems (Işik *et al*., 2013; Popovič *et al*., 2012; Yeoh and Koronios, 2010). Consequently, business intelligence systems often do not realise intended business benefits (Dresner Advisory Services, 2012; Gartner, 2011; Hwang and Hongjiang, 2007) even though the systems may be technically appropriate (Clegg and Shaw, 2008; Avison and Fitzgerald, 2006).

Critical systems thinking aims to facilitate social improvement; it is founded in: critical and social awareness; methodological complementarism; and a dedication to human emancipation (Jackson, 1991). Critical systems thinking aims to emancipate the oppressed by exploring

supressing societal structures, and then intervene to remove them. For this study the business users with unrealised business benefits are viewed as the oppressed; non-people oriented business intelligence system development approaches are viewed as the supressing structures.

This paper describes an action research study, i.e. a business intelligence system development project, which was guided by the critical systems heuristics strand of critical systems thinking. This study explores the application of critical systems heuristics as part of development approach to allow for human, social and organisational aspects to be taken into account more effectively; hence, it results in a business intelligence development approach that are more people oriented and ultimately in an artefact that are both technically feasible and realise expected business benefits to meet users' requirements.

This paper is structured as follows: Firstly, it motivates the study. Secondly, it includes a literature study that: discusses traditional BI system development and critical systems thinking; it positions critical systems heuristics as an approach that can improve business intelligence system development. Thirdly, this paper discusses action research as the research methodology followed. Lastly, it discusses the research intervention in terms of: the diagnosis; action planning; intervention; specification of learning; and reflection on the learning.

MOTIVATION FOR THE STUDY

Business intelligence (BI) is a business differentiator; it improves an organisation's decision making capabilities and operational efficiency (Marinela and Anca, 2009). BI provides "a single version of the truth" to act upon (Inmon, 2005). Well-informed decisions improve organisational planning; enable organisations to swiftly react to changing business climates; and ultimately improve organisations' economic results and value (De Leon *et al*., 2012). It is thus not surprising that 59% of organisations intended to improve their decision making capabilities and invest in business intelligence in 2014 (Gartner, 2013b).

Business intelligence systems are very complex and expensive to design and implement (Yeoh and Koronios, 2010). Unfortunately, BI systems often fail to realise intended business benefits; failure rates that ranged between 30% and 59% were reported in the literature between 2007 and 2012 (Dresner Advisory Services, 2012; Gartner, 2011; Hwang and Hongjiang, 2007). Given the potential value addition that BI brings to an organisation, versus the complex and expensive nature of such an intervention, it becomes crucial to improve the success rates thereof.

Software artefacts, such as BI systems, are often technically good but still fail as a result of low user acceptance. The majority of unsuccessful software artefacts do not fail based on technical feasibility; rather, unsuccessful software artefacts fail due to neglect of relevant human, social and organisational factors (Avison and Fitzgerald, 2006; Clegg and Shaw, 2008; Warren and Adman, 1999). User's requirements inevitably change during the development process of a software artefact (Sommerville, 1996). However, traditional (sequential) approaches, which delivers the most robust artefacts, is rigid and does not allow developers to easily accommodate these changing requirements (Hijazi *et al*., 2012). As a consequence, development approaches are not people-oriented; the human, organisational and social aspects are often neglected and not incorporated in software development approaches and as part of requirements collection (Avison and Fitzgerald, 2006).

The complexity and importance of BI system development necessitates a critical approach to successfully develop technically appropriate as well as usable (people-oriented) BI systems that meet user needs. It has therefore been argued that critical systems thinking (CST) may add value to the design and development processes of software artefacts, such as BI systems, to improve their success rates (Warren and Adman, 1999; Bentley *et al*., 2013). This study explores the use of critical systems methodologies to include the human, social and organisational dimensions of the system, and hence improve the development of BI systems.

THEORETICAL UNDERPINNINGS OF THE INTERVENTION

Critical social research that aims to intervene in a problematical social context, such as action research, is guided by theory (Myers and Klein, 2011; Baskerville, 1999). Therefore, this literature study discusses the theoretical underpinnings of the concepts that are central in this study. Firstly, it discusses traditional BI system development approaches. Secondly, it discusses CST and critical systems heuristics (CSH). CSH is a strand of CST.

Traditional business intelligence system development

Business intelligence systems are typically developed using traditional BI development approaches such as the Kimball lifecycle approach (Kimball and Ross, 2010), Inmon's Corporate Information Factory (Inmon *et al*., 2001), or Linstedts' data vault model (Linstedt, 2002). Traditional BI development approaches are heavily influenced by the paradigm within which traditional information systems/software development (ISD) approaches emerged. Traditional ISD approaches stem from the post-World War II era, when computers were originally widely adopted for commercial use. This era was dominated by deterministic problem solving methodologies such as operational research and systems engineering; these types of methodologies stem from the hard systems thinking paradigm and focus on optimisation and design of problems with well-defined (given) objectives (Checkland, 1985; Checkland, 2011).

When these newly adopted computers required new software, formal sequenced software development activities emerged and subsequently evolved in this paradigm. The traditional sequenced software development lifecycle (SDLC) stems from systems engineering; it is (still) widely adopted since its publication in 1970 (Royce, 1970). The philosophical underpinning of these approaches is that "computer systems are usually good solutions to organizational problems and processing" (Avison and Fitzgerald, 2006). Adoption of these engineering type approaches "was probably historically inevitable, given that early computers were large machines…the initial importation of thinking from the world of engineering projects was not foolish" (Checkland and Scholes, 1990). Thus, traditional BI development approaches, such as the Kimball lifecycle approach, also follow a similar sequenced approach to: gather business requirements; design the relevant BI applications; develop the relevant BI applications; deploy the relevant BI applications; and lastly maintain all the applications (Kimball and Ross, 2010).

However, software artefacts, such as BI systems that aim to *improve* an organisational context, are social artefacts; hence, the development process is a social process (Córdoba, 2009). Applying only approaches from the hard systems perspective is potentially a disregard of social facets in favour of elements that are more easily modelled using reductionist methods (Ezell and Crowther, 2007). These approaches deliver good technical artefacts (such as the DW); however, they fail to enable users to actively explore and discover *new* business requirements that will lead to organisational *improvement* once implemented.

These approaches successfully develop robust data warehouses. The data warehouse (DW) is the technological infrastructure that enables BI; it is a technical component that is crucial for BI. However, successful BI entails more than a single analytical tool. BI entails a range of processes and systems applied to create intelligible information that can *enhance* organisational decisions; it must ultimately *improve* an organisation (Inmon, 2005).

When designing a new BI system, business users often restrict themselves within the performance limitations of their current (known) systems; hence, they only use current information and fail to explore new and improved key performance indicators that can *enhance* their decisions (Gardner, 1998). BI users "operate in a mode of discovery...cannot tell what the information needs are until they see the possibilities" (Inmon, 2005). Traditional BI development approaches focus on the development of the technical artefact (DW); they do not guide developers to enable users to reflect in such a mode of discovery prior to or during the development of the BI system. A BI development approach thus require reflective practices to enable (emancipate) users to become aware of business requirements that will enable the development of a BI system that will *improve* the organisation by *enhancing* their decisions.

Critical systems thinking

Critical systems thinking (CST) is a systems thinking paradigm that emerged in the 1980s, whereby problem solvers aim to intervene in order to improve problematical social situations (Flood and Jackson, 1991; Ulrich, 1983). CST is derived from systems thinking and social theory (Jackson, 2001). It combines the concepts of holism and social intervention in order to holistically improve problematic social contexts. The CST paradigm does not render other paradigms, such as the hard systems thinking paradigm where BI development approached emerged, invalid. Rather, within the CST paradigm the epistemological debate moved from the question of selecting a single problem solving method, to recognising the value of combining different methods from different paradigms (Mingers and White, 2010). Critical systems thinkers view the world as conflicting, contradictory, and in need of intervention (Flood and Jackson, 1991).

Critical systems thinking is operationalised by methodologies such as critical systems heuristics (CSH). CSH is a strand of CST that provides a conceptual framework for critical practice and awareness; CSH provides a philosophical foundation and practical (discursive) framework for CST (Ulrich, 2003). CSH enables a problem solver to critically determine: *what* is relevant; *who* should assist to determine it; and *how* to handle conflicting views amongst relevant stakeholders (Ulrich, 1983). CSH is discussed in the next section.

Critical systems heuristics

The methodological core principle of CSH is boundary critique; it enables problems solvers to systematically and critically deal with *boundary judgements* of a problem situation (Ulrich, 1983). CSH consists of a checklist of boundary questions to be asked in the 'is' and the 'ought to' mode to determine: *what* aspects of a situation are to be considered relevant; *who* should be involved in determining it; and *how* should conflicts be handled amongst relevant stakeholders (Ulrich, 1983). CSH considers four basic categories to describe the normative content of systems, i.e. the basis of *motivation*; the basis of *power/control*; the basis of *knowledge/expertise*; and the basis of *legitimacy* – these are defined below (Ulrich, 1983).

- The basis of motivation indicates the clients that motivates that the system should be designed; they are involved during the design process, concerned with the system's purpose, and interested in possible improvements by means of the system.
- The basis of power/control indicates the decision makers that control the system; they are involved during the design process to determine sources of control within (components) and beyond (environment); and they account for the way in which the system's improvements depends on the components and the environment.
- The basis of knowledge/expertise indicates the planners/designers that are the sources of knowledge, experience, and/or skill; they implement the systems and should aim to guarantee its success.
- The basis of legitimacy indicates the witness that are affected by the system; they would not usually be involved during the design and/or implementation of the systems; however, they hold the three above mentioned stakeholder groups ethically responsible (they may have conflicting world views amongst them that needs to be reconciled).

The checklist of boundary questions to be asked in the 'is' mode determines the actual situation, i.e. the actual mapping; and the boundary question to be asked in the 'ought to' mode determines the ideal situation, i.e. the ideal mapping. Ulrich (2005) phrases the questions as follows:

- "Who is (ought to be) the **client** or beneficiary? That is, whose interests are (should be) served?"
- "What is (ought to be) the **purpose**? That is, what are (should be) the consequences?"
- "What is (ought to be) the **measure of improvement** or measure of success? That is, how can (should) we determine the consequences, taken together, constitute an improvement?"
- "Who is (ought to be) the **decision maker**? That is, who is (should be) in a position to change the measure of improvement?"
- "What **resources** and other conditions of success are (ought to be) controlled by the decision maker? That is, what conditions of success can (should) those involved control?"
- "What conditions of success are (ought to be) part of the **decision environment**? That is, what conditions can (should) the decision-maker *not* control (e.g. from the viewpoint of those not involved)?"
- "Who is (ought to be) considered a **professional** or further **expert**? That is, who (should be) involved as competent provider of experience and expertise?"
- "What kind of **expertise** is (ought to be) consulted? That is, what counts (should count) as relevant knowledge?"
- "What or who is (ought to be) assumed to be the ***guarantor*** of success? That is, where do (should) those involved seek some guarantee that improvement will be achieved – for example, consensus among experts, the involvement of stakeholders, the experience and intuition of those involved, political support?"
- "Who is (ought to be) **witness** to the interests of those affected but not involved? That is, who is (should be) treated as a legitimate stakeholder, and who argues (should argue) the

case of stakeholders who cannot speak for themselves, including future generations and non-humans?"

- "What secures (ought to secure) the **emancipation** of those affected from the premises/promises of those involved? That is, where does (should) legitimacy lie?"
- "What **worldview** is (ought to be) determining? That is, what different visions of 'improvement' are (should be) considered and how are they (should they be) reconciled?"

This study applied the twelve boundary questions to define the boundary judgements of a problem (the real business requirements of a BI system to be developed) in terms of: the relevant aspects to consider; the stakeholders that should be involved in determining the relevant aspects; and how to handle conflicting views amongst stakeholders by determining where relevant motivation, power, knowledge, and legitimacy lies.

RESEARCH METHODOLOGY: ACTION RESEARCH

This study intervened in an organisational context; it aimed to improve the development of a BI system so that the system realises envisaged business benefits. Therefore, it applied action research (AR) as a critical social research approach. Baskerville and Wood-Harper (1996) say that AR "is empirical, yet interpretive…experimental, yet multivariate…observational, yet interventionist." AR developed out of the believe that social phenomenon could be best understood by attempting to change it in a real-life situation since changing it would reveal its underlying dynamics (Lewin, 1946). AR is a cyclical approach that encapsulates the following principles: it questions taken-for-granted assumptions and extends the scope of the research from the organisational to the societal level to include the social dimension as well; it embraces fundamental criticism and allows questionable social and/or human conditions to be surfaced; it enables intervention in the real world; and the inclusion of organisational and social dimensions add richer meanings to results (Myers and Klein, 2011).

Baskerville (1999) describes the (cyclical) AR phases as follows: Firstly, the diagnosis phase involves the identification of the primary reason(s) that necessitates changes, holistic interpretation of the problem situation and the development of theoretical assumptions about the problem context. Secondly, the action planning phase includes determining the actions to relieve the problem, including the approach for change. Thirdly, the planned actions are implemented in the action taking phase. Fourthly, the outcomes of the implemented actions and the extent to which the problem was resolved are assessed in the evaluation phase. Lastly, the specification of learning phase is concerned with the recognition of new knowledge gained.

Checkland and Holwell (1998) argue that the action researcher intervenes in a social context: enters the problem situation (i.e. an area of concern); takes part in change process; performs the research based on the establishment of roles as well as a declared-in-advance methodology and intellectual framework of ideas; and exits the research situation whilst reflecting on the experience and recording learning in relation to the framework of ideas, methodology as well as the area of concern (i.e. the problem area where the researcher intervened). **Error! Reference source not found.** below illustrates the approach by Checkland and Holwell (1998) that includes the elements relevant to research, i.e. its declared methodology (M), framework of ideas (F) and the area of concern (A).

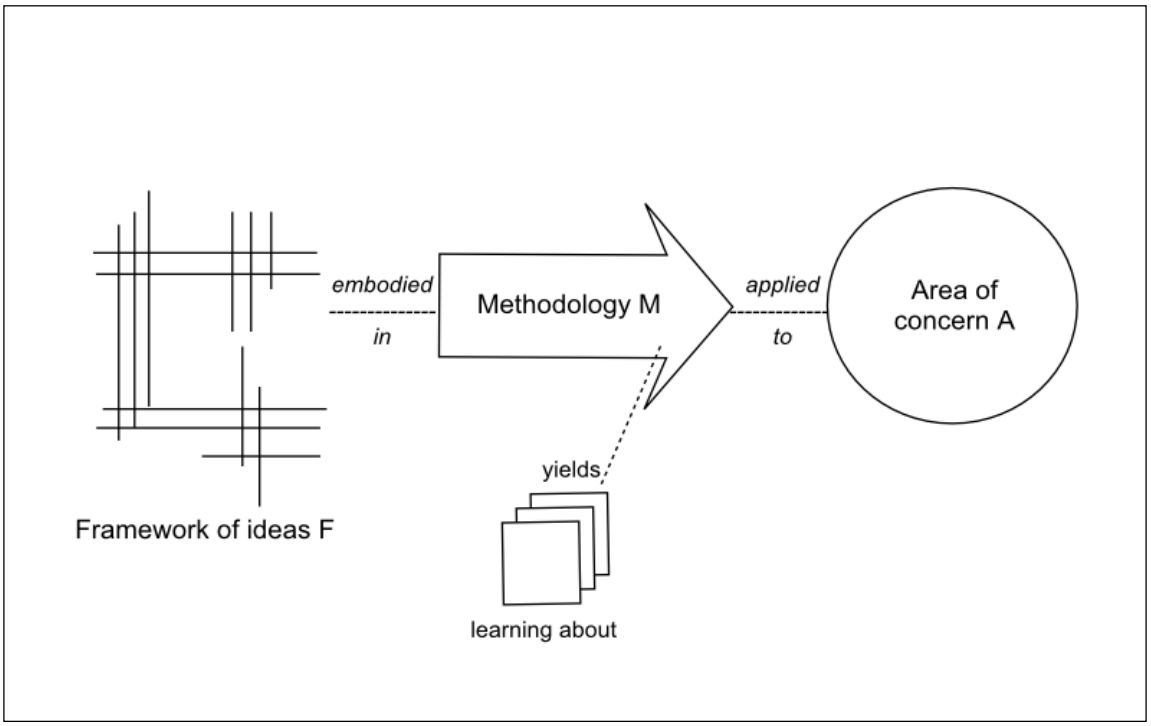

Figure 1. Elements relevant to research (adapted from Checkland and Holwell, 1998)

For this study, the area of concern is a BI system to be developed; this BI system should realise business benefits. The approach followed should thus be people oriented to ensure that users are enabled to discover their real requirements prior to the development of the artefact. For this purpose, the development approach was enriched with the critical systems heuristics (CSH) methodology; CSH was applied to enable users to reflect upon the boundaries of the BI system to be developed in terms of: the basis of motivation; the basis of power; the basis of knowledge; and the basis of legitimacy. The framework of ideas that underpins this research was thus the philosophical notions of the critical systems thinking (CST) paradigm and, more specifically, Ulrich's CSH strand of CST.

THE RESEARCH PROJECT

This action research intervention aimed to intervene in a BI system development project. The focus was on the requirements analysis phase of the development approach. CSH was applied as part of the business requirements analysis phase in the Kimball lifecycle approach to define the boundaries, i.e. the real business requirements that would constitute improvement in the organisation, of the BI system being developed.

The BI system was then developed according to the traditional development approach. Lastly, the BI system was evaluated in terms of user acceptance. The next sections discuss the project in terms of the phases according to Baskerville (1999), i.e. diagnosis, action planning, intervention, specification of learning, and evaluation. The researchers then reflect on the study in terms of the extent to which the area of concern has been resolved; the methodology applied; and the framework of ideas that guided the study.

DIAGNOSIS

The aim of the diagnosis phase of action research is to understand the problem environment. For this study, the problem environment is an organisation that requires a BI system; they need an artefact that realises business benefits. The next section provides background to the organisation where the study was conducted as well as background to the development project.

Background to the organisation

This study was done in the technology division of a large South African based petrochemical organisation. The organisation has an international footprint with operations in 37 countries. The organisation continually sustains, improves and grows its asset base to remain competitive within its industry; sustenance, improvement and growth activities are undertaken in its local as well as its international operations. The organisation's sustainability and growth – locally and internationally – therefore depends largely upon its ability to execute sustainability and growth projects effectively and efficiently. These projects are resource intensive in terms of both capital and human resources. Thus, to accelerate sustainable growth the organisation strives towards world-class project planning and execution processes and systems. Some of the key strategic drivers that were recently identified within the organisation were cost optimisation, simplicity and reduced bureaucracy; yet, projects still ought to be executed and delivered within budget and on schedule whilst consistently adhering to quality standards.

The organisation required a BI system to inform strategic (project-related) investment decisions. This study entailed the analysis of root causes of the perceived inefficiency of decision support software that the organisation applied to inform investment decisions. The objective was to specifically focus on improving the supporting technology that enables decisions related to the organisation's project planning and execution performance.

This business process entailed the following: The organisation's sustainability and growth projects are planned and executed according to a standardised project management methodology. It has been customised for the organisation; yet, it is still fundamentally based on the project lifecycle approach prescribed by the Project Management Body of Knowledge of the Project Management Institute (PMI, 2013). Accordingly, the organisation's projects are planned and executed using a stage-gated approach; projects are evaluated at three pre-defined evaluation points ("gates") during planning phases; the objective of these evaluations are to determine the project's health/performance relative to its phase in the project's lifecycle in order to inform project investment decisions. The organisation refers to the decision points at the end of each stage as "gates" or "gate decisions". Thus, each project's lifecycle consists of a number of phases with fixed decision points where strategic (investment) decisions are informed based on the outcome of the "gate" evaluation; at these decision points senior investment managers decide whether to allocate resources to continue to the next phase of the project. This process is formally applied to all projects that adhere to minimum criteria in terms of probable complexity and cost.

Investment managers use these outcomes to inform further investment decisions, i.e. decisions to allocate human and monetary resources to the projects so that they can be developed and refined further. The outcomes of these gate evaluations are one of the following: continue the project as-is and hence allocate resources (positive recommendation); recycle the project, i.e. do more work prior to continuation, so resource allocation is delayed

(negative recommendation); or terminate (stop and/or shelve) the project due to lack of maturity and/or viability (negative recommendation). This business process is governed by an organisational department called the project management office.

This process was supported by BI systems, which had to be improved upon. The investment managers (decision makers on these capital projects) became increasingly uncomfortable with the quality of information that stemmed from the system. They started to question whether it accurately informed their investment decisions. Doubt was instilled particularly when an independent (external) benchmarking company benchmarked the organisation's overall project planning and execution performance and found it to be sub-optimal when compared to the organisation's typical peers/competitors in terms of schedule competitiveness and cost competitiveness.

The benchmarking company indicated that the organisation's gate keeping process (and the associated decision support software) may have been ineffective. Hence, they argued that the business process and supporting software was insufficient; they concluded that insufficiently developed projects were recommended for continuation at the gate decision points. As a result, the benchmarking company found that projects were not planned effectively and efficiently; as a result, re-work during execution phases lead to an estimated loss of 6.3% internal rate of return (IRR) and, on average, schedule overruns of 23% across its portfolio of projects. Investment managers (the decision makers) therefore requested that this decision support software be improved and that business intelligence (BI) capabilities be added to it.

ACTION PLANNING

In order to plan this intervention, this study applied the core philosophical concepts from the work of Ulrich (1983). Ulrich (1983) asserts that reflective practice necessitates the inclusion of practices (i.e. *heuristic procedures)* to identify and explore relevant assumptions/questions about the problem context; this is necessary to determine the extent of the problem to be resolved, as well as the kind of change required to constitute improvement. Therefore, the twelve CSH boundary questions was used to define the boundary judgements of the problem (the real business requirements of the BI system to be developed) in terms of: the relevant aspects; stakeholders that should be involved in determining relevant aspects; and how to handle conflicting views amongst stakeholders by determining where relevant motivation, power, knowledge, and legitimacy lies. The twelve CSH boundary questions were used to reflect on the required *improvement* that should be established by the BI system to be developed. These questions were asked in the "is" mode to determine the actual situation in the organisation (prior to improvement); and also in the "ought to" mode to determine the ideal situation in the organisation (how it should look once improved by the BI system).

A small focus group was used to gather data. The focus group: two senior managers from the project management office group in the following roles, i.e. participant 1 (P1) and participant 2 (P2); as well as two users of the system, i.e. participant 3 (P3) and participant 4 (P4). Participant 2 (P2) was the executive sponsor of this project, whilst participant 1 (P1) was the executive manager accountable to ensure that investment managers receive relevant decision support information. The participants' views are summarised in Table 1 below.

Table 1. Data gathered from participants

Question	P1	P2	P3	P4
Who is the client?	Project management teams; they have to use the tool to provide management with reporting information.	Project management teams. They provide input so that we can make decisions.	Project managers. Their projects are measured by this. It is yet another bureaucratic tool.	Project management groups are being assessed. They're being checked – bureaucracy!!
Who ought to be the client?	Senior management are must receive decision support information that can be trusted: strategic, forward looking information to improve project execution performance.	We need information to make the right investment decisions. For money and resource allocations. And to do trend analyses – what are consistently bad.	Is it necessary? We edit the reports in any case.	Probably the investment decision makers?
What is the purpose?	Confirm benchmarking information.	Show where project teams must improve / focus more when they plan.	Assess project readiness and get resources.	To get money and people allocated to my projects for further work.
What ought to be the purpose?	We need 'independent' information that we can trust – in line with that from benchmarks.	Factual information – are projects really ready to continue? Complete information!!!	It is unnecessary – we get good scores on all our projects in any case.	We don't need a software tool to tell us we did our job; we do it well. Look at the scores.
What is the measure of improvement or success?	I don't think what we currently have works well enough.	Our current system is not successful.	When we pass the 'test'; get a good score from the software.	When we can continue – get good score rating.
What ought to be the measure of improvement or success?	Recommend only projects that developed sufficiently. So that we don't waste any more resources.	Un-manipulated information for decision making!	We get good scores so it should stay the same.	When we can continue to the next phase.
Who is the decision maker?	Governance group.	Governance group.	We give inputs to governance group to update measures.	We occasionally update measures when governance team asks us to.
Who ought to be the decision maker?	Somebody like the benchmarking companies should ratify measures.	Measures should be determined by industry best practice.	I think it works so don't change it.	The measures are fine as is.
What resources are controlled by the decision maker?	The information that we get is wrong according to benchmarks; we need you to investigate why.	I don't think the software has the right KPIs but we need an expert to look at it in detail.	The governance group control the elements and their weightings.	We give inputs to the governance team.

Question	P1	P2	P3	P4
What resources ought to be controlled by the decision maker?	If we know what is wrong we can change it. The reports are very lengthy and sometimes don't say much.	Let industry experts ratify the KPIs. And give us information that is easy to interpret.	It is very complicated to understand so I don't know how they determine the weightings. It can maybe be made easier?	The governance team asks us but I don't know how they interpret the weightings and work out the scores.
What conditions of success is part of the decision environment?	We don't get the information that we need.	We apparently get wrong information. So no success??	The interface that we work with is difficult. The whole system is just bureaucratic.	It is very difficult and just another bureaucracy! It does not really inform decisions!
What conditions of success ought to be part of the decision environment?	If we get good unbiased information that is usable it will be great!	Information must be accurate and supplied when we need it.	If we have to use the system please make it easier.	Make it less complex please?
Who is considered an expert?	I don't know who designed the original system.	It was designed 16 years ago by engineers from civil, chemical, electrical and mechanical.	Probably the governance group? Project teams know better what works for them.	I think the project managers know what should be included in measures.
Who ought to be considered an expert?	The software must be developed by IT people. Get BI people involved as well. Get business people to design the KPIs.	IT must develop the system but business and BI people must be involved for the KPIs.	Industry experts?	Probably industry benchmarking expertise.
What kind of expertise is consulted?	We receive inaccurate information – refer to benchmark reports.	The benchmarks show that we don't get the right information.	There is nothing wrong with the scoring – we do well.	We don't get bad scoring so it should be all good.
What kind of expertise ought to be consulted?	Refer to the question regarding the experts.	The right people from the right groups must give input.	Nothing wrong…	It is good.
What/who is (ought to be) the guarantor of success?				
Who is witness to the affected?	No comment.	We did not have a business analyst before when the original system was designed. IT was not involved in building it.	I am not sure.	I don't really know?
Who ought to be witness to the affected?	No comment.	Get the right people involved for the different aspects of the system!	I am not sure.	I don't know.
What secures emancipation of those affected?	Users are not emancipated.	No emancipation in current system!	This is not applicable.	Nothing.

Question	P1	P2	P3	P4
What ought to secure emancipation of the affected?	Do proper stakeholder analysis and requirements analysis. Give us a system that we can trust in terms of information.	Analyse requirements from all stakeholders appropriately. Built integrity into the system.	Nothing to comment.	Nothing.

The gathered data indicated that the two stakeholder groups represented by the participants had diverse (conflicting) views of the BI system. This is discussed in the next sections; the outcomes are discussed in terms of the four categories as proposed by CSH:

The basis of motivation

The question regarding the client highlighted conflicting views between the users (those that populate the source data) and the senior managers in the organisation (the recipients of the output, i.e. the decision support information). The managers P1 and P2 required information, whilst the users P3 and P4 viewed the process as bureaucratic; these conflicts had to be resolved to ensure that the system is accepted by both stakeholder groups. The questions about the purpose and measures of success/improvement of the system revealed some root causes of the bias and lack of integrity in the organisation's source data and decision support information; it also exposed a gap between the input data and output information where decision support information were manually edited to fill the gap and decisions were thus indirectly manipulated.

The basis of power

The decision maps highlighted inadequacies in the key performance metrics applied to transform source data into decision support information; it highlighted that the performance metrics were controlled by the 'wrong' stakeholder group. The data capturers controlled the performance metrics; they adjusted performance metrics to manipulate output information to reflect favourably on their work. The resources and conditions maps provided a platform whereby to analyse the inherent flaws of the historical decision support system in terms of its embedded key performance metrics; it also showed that this system was difficult and cumbersome to use and therefore revealed some root causes of the perceived bureaucracy of this system and the process supported by it. Knowing what did *not* work and *why* it did not work in the previous system gave the design team a starting point to design towards *improvement* rather than mere automation.

The basis of knowledge

The questions about the experts and expertise to be consulted and included during the design process highlighted shortcomings in the design team of the historical decision support system; it also indicated who to involve in the design of the new BI system. It made explicit the required expertise for the new BI system. These analyses clearly highlighted the need for both business and technical experts to be included in the design team. It also showed deficiencies in the actual development process of the historical decision support system, to be provided for during the development of the new BI system so that the team do not 'repeat mistakes'. These concerns could be addressed in the design of the new system; the designers

of the new BI system recognised that they had to design the system in such a manner that it prevents possible reappearance of these organisational issues.

The purpose of the question regarding the guarantor is to determine where do (should) those involved seek some guarantee that improvement will be achieved (Ulrich, 2005). For example, it may include consensus among experts, the involvement of stakeholders, the experience and intuition of those involved or political support (Ulrich, 1983). However, according to Ulrich (1983) the "appropriate ideal might be to free ourselves from the need for a guarantor"; it may thus be better to accept the lack of a guarantor rather than attempt to find a guarantor as the ideal guarantor may only be found when the need for a guarantor disappeared. Therefore, this question was asked to the participants.

The basis of legitimation

The ideal emancipation map confirmed the purposes that the new BI system ought to achieve for its identified clients. The BI system was developed according to these business requirements and the identified clients responded positively to it. The world view question was not included in the questionnaire. The organisation where the research was conducted has a very strong sense of culture and promotes a "one-way" of business operations; participants were thus hesitant to answer this question.

THE INTERVENTION

This research study focused on the requirements analysis portion of the development process; effective requirements analysis improved the development of the BI system. The application of the twelve boundary questions enabled users to reflect on the system in terms of what are relevant, who needs to be involved in determining the relevant aspects, and how to handle conflicting views amongst those stakeholders. It highlighted the diverse perspectives of the data capturers (executers of the business process) vs. the decision makers (recipients/clients of the business process), which base their decisions on the information stemming from the data captured in the data warehouse. CSH was effectively applied as part of the Kimball lifecycle (Kimball and Ross, 2010). The twelve CSH boundary questions were incorporated in this process as per Figure 1 below.

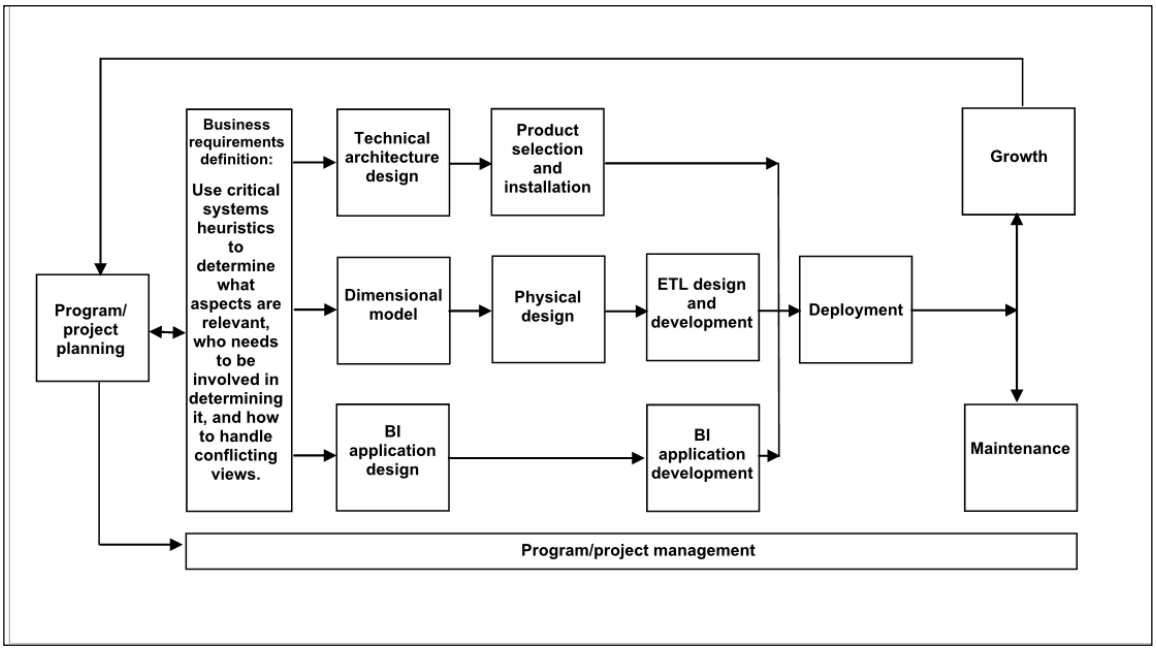

Figure 1. The use of CSH as part of the Kimball lifecycle

The application of CSH resulted in the following benefits: Firstly, the associated business processes was simplified; it was automated as far as possible to ensure integrity of the captured data. Secondly, in developing the new BI system, the front-end (data capturing portion) of the system was designed for ease-of-use; yet, it still included all the required elements for which data had to be gathered. Thirdly, the data warehouse was redesigned and dimensionally modelled around the business process – refer to Figure 2 below.

	Date dim	Project profile dim	Sponsor profile dim	Project team profile dim	Engineering team profile dim	Business team profile dim	Review team profile dim	Facts
Create project profile	X	X						• One project per portfolio per cluster per tier
Sponsor evaluation	X		X				X	• One outstanding action per project per sponsor track
Project evaluation	X		X	X			X	• One outstanding action per project per project track
Engineering evaluation	X		X		X		X	• One outstanding action per project per engineering track
Business evaluation	X		X			X	X	• One outstanding action per project per business track
Gate readiness review and assessment process	X	X	X	X	X	X	X	• One score per project per track per gate • One outstanding action per track per project • Scorecard snapshot • Scorecard accumulation
Document governance process	X	X	X	X	X	X	X	• One review per project per gate per tier

Figure 2. The data warehouse bus matrix

User's feedbacks are captured in the next section that reflects on the intervention.

EVALUATION OF THE RESEARCH INTERVENTION

The next sections evaluate the research and reflect on the experience. It firstly evaluates whether the area of concern has been resolved. It then reflects on the applied methodology and its underpinning framework of ideas.

Reflection on the intervention (area of concern)

The CSH boundary questions gave insight into the objective versus the normative dimensions of the as-is (historical) system as well as the to-be requirements of the new BI system being developed. Upon completion of the project the identified stakeholders responded positively to the new system. For example, an informal survey indicated that they agreed that the system achieved its purpose to: "inform the relevant decisions as per its intended purpose"; "bring focus and a clear indication of where 'burning platforms' exist by means of the associated criticality assessment". Users felt emancipated by the BI system; they stated that it "enables the user to decrease the time spent to execute a gate keeping session"; it also "supports the gate keeping process without adding unnecessarily to the work lead of its users"; and "increases productivity". Users also asserted that the BI system improved the way that they worked, for example "removing the scoring and weighting was a major improvement as it provided a false sense of compliance and it shadowed focus on potentially

critical shortfalls" and "the [BI system] provides great management info". Data capturers said that the application of the new BI system is "a major improvement" and it is also "easy to use". It can thus be said that the intervention was successful.

Reflection on the methodology

The insight gained in applying the CSH boundary questions enabled the team to complete conceptual design and workflow in a very short space of time. The BI system was also designed within a (short) period of four months. CSH aimed to emancipate system users; thus, the *philosophical notions* of the intervention and emancipation embedded in this critical systems methodology were also achieved. In reflecting on the boundary questions, the business analyst did not only consider and therefore enabled automation of the as-is scenario; rather, it enabled the business analyst to create *improvement* in the organisational context. She could determine what the important aspects to consider were as well as who had to be involved in determining it. CSH thus successfully enabled intervention and emancipation.

Methodological complementarism was also achieved; the traditional development approach was enhanced by including the CSH boundary questions as part of the business requirements analysis phase of this project. Application of CSH gave insight into the root causes for failure of the historical decision support system; it also highlighted organisational concerns that had to be resolved prior to designing the new BI system to ensure positive adoption rates and success. Conflicting views amongst stakeholders were also identified and could be resolved.

Reflection on the framework of ideas

When reflecting on the framework of ideas the researcher realised that: even though the application of CSH enhanced the development of this BI system, the researchers spent a significant amount of time explaining the *intent* of the boundary questions during interactions with the rest of the team. The boundary questions may thus be refined so that they are applicable specifically for a BI context.

SUMMARY

The aim of this paper is to discuss an action research project where the development of a BI system was guided by CST. The traditional BI development approach was enriched by the application of the CSH strand of CST. The CSH boundary questions gave insight into the actual and ideal situations relating to the boundaries of the BI system. The developer therefore gained an understanding of the required improvement that the organisation required. The users were emancipated to explore their real business requirements prior to the system being developed. The user's feedback was positive; the outcome was a successful BI system that realised business benefits.

Critical systems heuristics can thus be effectively applied as part of a traditional BI development approach – in this case it was applied as part of the Kimball lifecycle. The twelve boundary questions can be used during the business requirements analysis phase to define the boundaries of the BI system to be developed; CSH then enables users to reflect on the system in terms of relevant aspects as well as conflicting views amongst stakeholders that needs to be resolved prior to the development of the system.

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