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Researching complex projects: Using causal mapping to take a systems perspective

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Abstract

Extant literature has called for researchers to be more pluralistic in their approaches to researching projects. Responding to this call, this paper offers an exposition of a causal mapping technique. In the project management literature, there already exists a small number of articles reporting effective use of causal mapping. However, these are not dedicated to detailed explanation of the technique itself and so lack consideration of its features beyond those relevant to a particular application. Consequently, an exposition of the technique is needed to enable comprehensive understanding of causal mapping to be gained and its suitability for research designs assessed. Specifically, this paper examines causal mapping's theoretical grounding, explores its strengths and weakness, presents example applications, compares alternative causal mapping approaches, and overall, explains how causal mapping can support a systemic perspective on projects. These issues will be of interest to researchers who wish to incorporate causal mapping into their project management research designs.

Keywords: Causal mapping; Project risk management; Project overruns; Systems thinking

1. Introduction

Reports continue of project's having 'failed', running over time and over budget (Love et al., 2012). This suggests that, despite a wealth of research and the availability of project management handbooks (Turner, 2009; Morris and Pinto, 2007), there remain gaps in our knowledge concerning projects. A number of authors have stressed that to attend to these gaps new approaches to research are needed (Turner et al., 2010; Smyth and Morris, 2007; Cicmil et al., 2006; Williams, 2005; Morris, 2002; EURAM Sig). Underpinning these calls is an acknowledgment that the conventional positivist based approach to researching projects is, on its own, insufficient to provide a comprehensive understanding of project phenomena. Williams (2005), for example, highlights that the conventional approach takes only limited account of human factors and intricate relationships between project components and that both these are highly salient in explaining project behavior such as cost and time overrruns.

The need to widen approaches to project management research is echoed by Winter et al. (2006) who, in rethinking project management, call for more research to be undertaken with particular emphasis on Theory ABOUT Practice, Theory FOR Practice, and Theory IN Practice. This reflects a more integrative and potentially systemic approach to research which is in contrast with the atomic, discrete approach of the conventional positivist perspective. The emphases put forward by Winter et al. (2006) are elaborated by Bredillet (2013) who adds three further emphases, namely Theory From Practice, Theorising In Practice and Theorising As Practicing. Additionally, both of these calls reflect project management researchers' growing interest in management research in general, in particular Mode 2 research (Pettigrew, 2001; Tranfield and Starkey, 1998). Mode 2 research combines rigour and relevance to produce research that achieves the dual objectives of applied use (contribution to practice) and advancing fundamental understanding (contribution to theory) (Van De Ven and Johnson, 2006). This widening of research

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emphases in project management resonates with Turner et al.'s (2010) identification of nine schools of project management research.

In response to the above calls for a broadening of approaches to researching projects, this paper proposes a causal mapping technique (Bryson et al., 2004; Eden, 1988). In the project management literature a small number of researchers have already reported effective use of causal mapping (Williams, 2015; Edkins et al., 2007; Maytorena et al., 2004; Williams et al., 1995). However, with few exceptions (Edkins et al. (2007)), these are not dedicated to exploration of the technique itself but rather they concentrate on illuminating features germane to a particular application. Consequently, issues such as the theoretical grounding, strengths and weakness, and alternative ways of applying causal mapping remain under explored in a project management context. If causal mapping is adopted without consideration of these issues, the danger is that methodological confusion might ensue bringing the integrity of the approach and resultant findings into question.

With causal mapping as its sole focus, this paper reveals the technique's theoretical underpinnings, identifies key considerations in its adoption, and examines its value-add to project management research. Importantly, the paper also positions the technique within the methodological debate taking place in contemporary project management concerning the need for new perspectives (Bredillet, 2013; Turner et al., 2010). Finally, limitations and future research possibilities using the technique are examined. The discussion is grounded in the extant literature using sources within and beyond the field of project management, in particular drawing from operational research and strategy making where causal mapping has had greater exposure. The paper aims to provide project management researchers with a point of entry to the technique by attending to important methodological considerations and highlighting what the technique can offer in the way of revealing news insights into projects.

2. Evolution and applications of causal mapping

The causal mapping technique focused upon in this paper originated in the field of Operational Research (OR) and has become strongly associated with a collection of 'soft' OR techniques called Problem Structuring Methods (Rosenhead and Mingers, 2001). Beyond its origins in OR, the technique has been used to support industries and academics in a range of applications. These have included strategy development (Ackermann and Eden, 2011; Bryson et al., 2004; Eden and Ackermann, 1998b), information systems development (Narayanan and Armstrong, 2005), modelling of disruption and delay claims in projects (Williams et al., 2003), and more recently modelling project risk (Ackermann et al., 2014).

Alongside techniques such as repertory grids (Fransella and Bannister, 1977) and influence diagrams (Richardson and Pugh, 1981), causal mapping belongs to a wider collection of techniques referred to as cognitive mapping techniques (Huff, 1990; Axelrod, 1976; Tolman, 1948). Although there are a diverse range of approaches to causal mapping (Narayanan and Armstrong, 2005; Eden and Spender, 1998; Huff, 1990) a particularly salient categorisation is whether they are idiographic or nomothetic in nature (Eden and Ackermann, 1998a) as this imposes different methdological considerations. Idiographic causal mapping is concerned with developing nuanced comprehension of a situation (Cossette and Audet, 1992) whereas nomothetic approaches aim to reveal themes or patterns that can be statistically generalised (Hodgkinson and Clarkson, 2005). As idiographic casual mapping has already begun to demonstrate utility in project management research (e.g. Edkins et al., 2007; Maytorena et al., 2004; Williams et al., 2003) this paper concentrates on this particular type and specifically the approach developed by Eden and colleagues (Bryson et al., 2014; Ackermann and Eden, 2011; Eden, 1988) as this is the form used extensively in the aforementioned applications. In a section describing alternative approaches to causal mapping, the paper also provides a more detailed comparison of nomothetic and idiographic mapping to expose fully their distinguishing features.

The theoretical foundation of Eden's approach is located in psychology (Ackermann and Eden, 2001; Eden, 1988), adopting George Kelly's Personal Construct theory as its fundamental basis (Kelly, 1955). Three of Kelly's corollaries strongly influence the approach. These are individuality (recognising individuals interpret events in unique ways), commonality (the development of a common language through shared understanding of the different interpretations) and sociality (agreement based on a shared understanding towards a common outcome). Placing the corollaries in the context of project management research, Eden's approach enables the creation of causal maps that (i) represent how individual project actors perceive situations (individuality); (ii) can be shared and woven together to form a single interconnected whole (commonality); and, consequently, (iii) provide researchers (and practitioners) with a holistic view of the project that can be used to improve understanding. Moreover, among project actors, the holistic view can be used as a basis for negotiation and reaching shared agreement for action (sociality).

Eden's approach takes into account Weick's work on sensemaking (Weick, 1995), Ackoff and Emery's conceptualisation on problem definition (Ackoff and Emery, 1972), and McHugh's views regarding the sociology of defining situations (McHugh, 1968). To ensure methodological rigour, a set of coding rules (Bryson et al., 2004; Eden, 1988) and methods of analysis (Eden and Ackermann, 1998a) have also been developed and refined over the last 25 years (for a history of the technique's development see Ackermann and Eden (2010b)). With its own coding guidelines, and processes for construction and analysis, causal mapping is a distinct technique. Moreover, it is important to note that there are examples of its incorporation into quantitative modelling techniques like system dynamics (Howick et al., 2009) further illustrating its contribution to project management research.

Causal maps are in essence directed graphs (Fig. 1) representing perceptions of situations as statements (nodes) connected by causal links (Eden, 1992). As representations of perception, the artefacts of causal mapping (the maps) capture subjective data. Causal mapping's acknowledgement and attendance to subjective data enable it to effectively get at mental models and thus take cognisance of 'soft' intangible

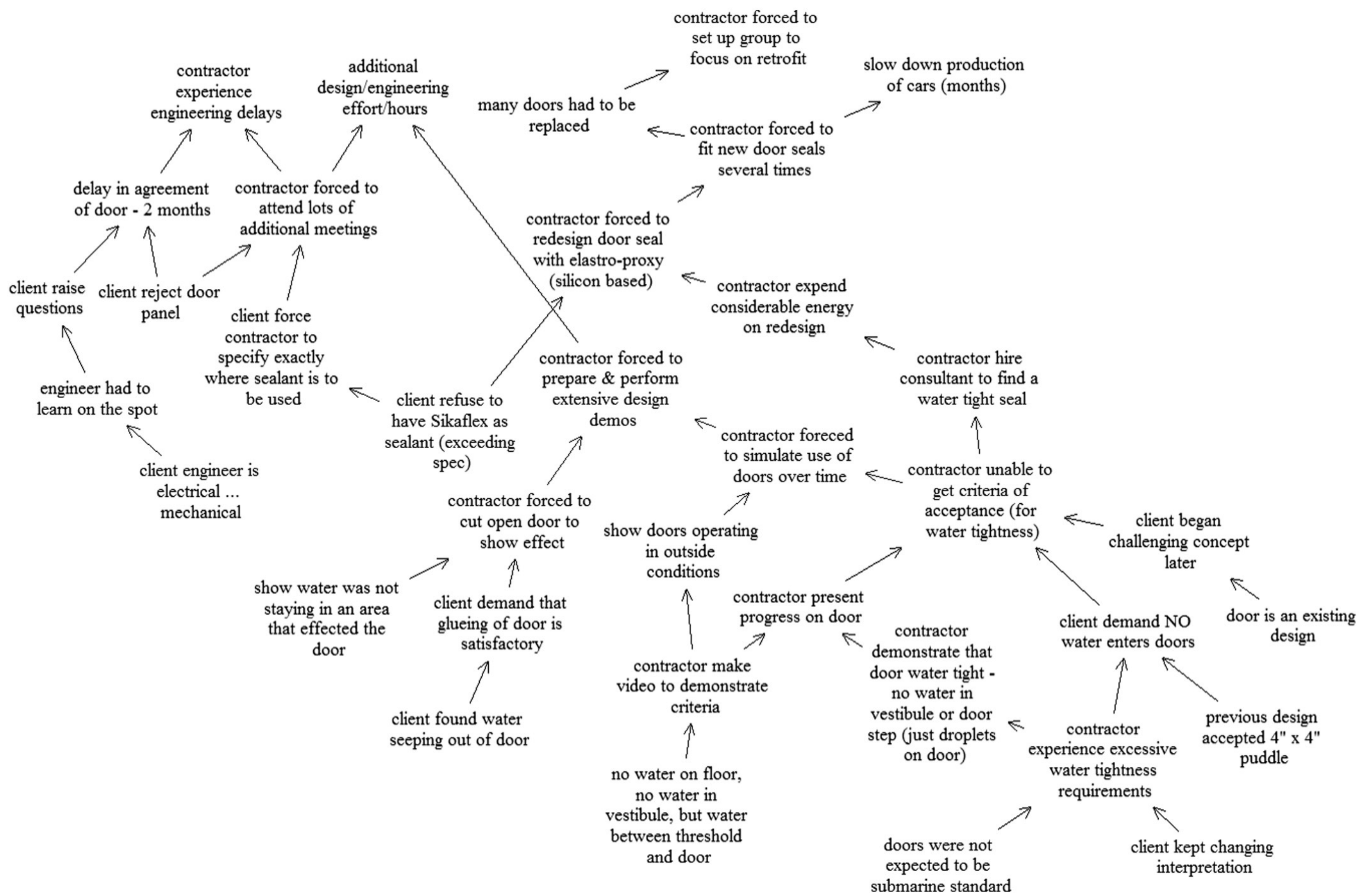

Fig. 1. Example section of a causal map adapted from Howick et al. (2009). Each arrow/link represents causality and thus reveals chains of argument starting from explanations at the bottom of the map through to consequences at the top.

factors such as politics and social issues (Ackermann and Eden, 2011). Although intangible, the influence and ramifications of ‘soft’ factors can be significant. This point is succinctly captured by the seminal work of sociologists Thomas and Thomas (1928, p.572) who noted that ‘If men define situations as real, they are real in their consequences’. The importance of soft factors is also emerging in the context of project management where studies are beginning to reveal their salience in explaining project behaviour such as cost and time overruns (Williams, 2005; Howick and Eden, 2001).

As computing has become ubiquitous and increased in power and graphics, software tools to support causal mapping techniques have been developed. The choice of which software to use is guided by the research design alongside the particular mapping technique that has been adopted. For example, idiographic mapping techniques (Cossette and Audet, 1992) that are concerned with developing nuanced comprehension are supported by software such as *Decision Explorer* (Eden and Ackermann, 1998a) and *Dialogue Mapping* (Conklin, 2006). Nomothetic techniques on the other hand which are concerned with revealing the general themes or characteristics of a situation (Hodgkinson and Clarkson, 2005) can be supported by software tools such as CMAP (Laukkanen, 1998). Given the focus of this paper is an idiographic technique, *Decision Explorer* and *Dialogue Mapping* software packages are therefore packages to concentrate upon. In particular, *Decision Explorer* (DE) ™[1] due to its emerging track record of use in a project management context (Ackermann et al., 2014; Edkins et al., 2007; Maytorena et al., 2004).

In the context of project management, Ackermann et al. (2014) suggest that computer aided analysis using the DE software has benefits in terms of bringing efficiency and accuracy to the analytic process. This is because causal maps can comprise a large number of nodes intricately linked by numerous relationships meaning manual analysis is likely to be time consuming and risks errors. Furthermore, DE has an extension module called *Group Explorer* (Ackermann and Eden, 2011) which enables it to perform as a group support system.

Both pieces of software enable the capture and analysis of causal maps. However, *Group Explorer* enables participants to enter their contributions directly into the software in a group setting (e.g. in a workshop) whereas *Decision Explorer* sees the facilitator capturing the map’s contents. Ackermann and Eden (2005) note that using *Group Explorer* brings benefits in terms of productivity because all participants can input simultaneously and also take advantage of the inbuilt anonymity. These benefits embrace insights from research into group support systems (Jessup and Valacich, 1993). Applying causal mapping in a

[1] Originally called COPE.

workshop setting provides a means for creating detailed networks (causal maps) reflecting the wealth of participant perspectives present at the workshop (Ackermann et al., 2014). Furthermore, the maps support thinking by providing a 'boundary object' (Carlile, 2002) as well as being amenable to analysis. Decision makers are therefore able to manage the complexity and uncertainty surrounding many of the situations facing them as well as develop solutions that are feasible, desirable and sustainable (Ackermann and Eden, 2010a). Allied with the Strategic Options Development and Analysis method (Ackermann and Eden, 2010b) (which explicitly takes account of process and content management considerations), casual mapping facilitates negotiation amongst participants/decision makers, found to be particularly important in the arena of strategy making (Bryson et al., 2004).

Extending from its development in OR and strategy making, causal mapping has also begun to form part of research designs to study projects. A particular application that has been reported in the operational research literature is the role of mapping in modelling projects that have experienced considerable challenge, namely client induced disruptions and delays. For example, Williams et al. (2003) and Ackermann et al. (1997) both illustrate how the technique was used to support litigation claims by developing a deep and systemic understanding of projects that had experienced disruption and delay. The outputs in both studies were maps illustrating a rich network of triggers, consequences, and dynamics taking place in projects. These maps were used to ensure accuracy of understanding and gain clarity over the project's evolution.

Building upon this work, and again reported in the OR literature, Howick et al. (2008) show how causal maps can be used as the basis for developing quantitative system dynamics models by identifying the triggers and dynamics (feedback loops) of disruptions and delays in projects. As well as forensic post mortem analysis of projects, the OR literature also reports use of the technique in a proactive mode for the ongoing management of projects. Examples include the identification and management of risks (Ackermann et al., 2014), identifying scenarios so as to test policy options (Howick and Eden, 2001), and the creation of a risk filter based upon litigation models and in which is embedded systemicity and mapping (Ackermann et al., 2007).

Specifically within the project management literature, Edkins et al. (2007) report the value of the technique along with content analysis in understanding how those involved in projects understand the management of projects. Maytorena et al. (2007) use causal mapping as a data capture tool in their inquiry into the risk identification processes used by project participants. In addition, Williams et al. (1995) applied the technique to reveal the effects of parallel working on projects and, most recently, Williams (2015) used causal mapping to explore the systemicity of success factors in projects.

Despite the growing application of causal mapping in a project management context, the existing articles are not dedicated to exposition of the technique itself but rather illuminating features germane to a particular application. Consequently, matters such as theoretical grounding, coding guidelines, strengths and weakness, and alternative ways of applying causal mapping remain under explored. Lack of attention to these issues could lead to methodological confusion, evidence of which is already beginning to emerge in the project management literature. For example, without exception, current articles use the term 'causal mapping' as though there is only one form. However, there are a wide range of approaches to causal mapping (Narayanan and Armstrong, 2005) and, more often than not, current literature fails to acknowledge these or explain why one approach is used in favour of another. Views are also emerging concerning the perceived weaknesses of the technique. Edkins et al. (2007, p.770), for example, suggest that constructing causal maps is resource intensive and, therefore, 'researchers must find a way of reducing the amount of labour and time that are required to build the maps'. Although some aspects of causal mapping can be resource intensive (Narayanan and Armstrong, 2005) there is considerable evidence in the OR and strategy literature that there are forms of map construction that do not demand intensive resources as the maps are created 'live' in a workshop (either through the facilitator capturing the data or participants using *Group Explorer*) rather than from existing text or interview transcript (as experienced by Edkins). Indeed, within the project management domain, Williams (2004, p.277) highlights that maps can be constructed 'in a few hours, with a few more hours needed to analyse and consider lessons to be drawn'.

In summary, there is a body of work exploring causal mapping as a technique for research particularly in the field of management and specifically with regard to operational research and strategy making (Jenkins, 2002; Eden and Ackermann, 1998b; Langfield-Smith and Wirth, 1992; Bryson et al., 2014). The technique has also begun to extend into project management literature with a small number of studies reporting application of the technique (Edkins et al., 2007; Maytorena et al., 2004; Williams, 2015). However, with few exceptions (e.g. Edkins et al., 2007), there is a lack of detailed exposition of the technique that can be used by project management researchers who wish to consider causal mapping for their particular studies. The preceding discussion has begun to attend to this gap by exposing the technique's theoretical basis as well as offering insight into its evolution within the fields of operational research, strategy making and project management. Below, we continue our exploration of causal mapping explaining how the processes of data elicitation, structuring and analysis can support project management researchers, particularly in managing project complexity. Moreover, we explain how the technique stimulates participant reflection and sense-making (Weick, 1995) and, in turn, how the technique enables participants to go beyond their initial impressions to surface their deep, tacit knowledge about a situation as well as prompting consideration of actions. Finally we explore alternative means of applying causal mapping and future directions for research. To contextualise the concepts in our discussion we call upon two research studies drawn from the OR literature—Ackermann et al. (2014) and Ackermann et al. (1997). Both of the studies use causal mapping in a project management context; the former focusing upon project risk management and the latter on litigation for project disruption and delay. A synopsis of the two papers is provided below followed by rationale for our choices.

2.1. 'NINES Case' (Ackermann et al., 2014)

This paper describes the application of causal mapping to assist project actors in effectively working with the multitude of interlocking risks that are often present in projects (Ackermann et al., 2007). The paper focuses on the development of a new power generation system for the Shetland Islands, a small group of islands at the northern end of Scotland. The purpose of the project was to consider different generation options taking cognisance of i) increasing social and political interest in renewables, ii) meeting legislative demands, iii) ensuring that the 'lights remain on' and iv) doing so in a cost effective manner. Using this real case study project, the paper describes the process of applying causal mapping including its outcomes and implications for the project.

2.2. 'Litigation Case' (Ackermann et al., 1997)

Where the *NINES case* explains the use of causal mapping prior to project execution, the *Litigation Case* illustrates a post-hoc application as part of a litigation claim. The case study focuses on a claim raised by a contractor for the costs of disruption and delay during a major project—the Channel Tunnel. In conjunction with system dynamics modelling, causal mapping was used to enable forensic analysis and improve understanding of the project's unfolding behaviour.

Two reasons underpin our choice of case study papers. Firstly, the project management literature suggests that projects are increasingly complex in nature (Williams, 1997); therefore, selecting case studies that illustrate the utility of causal mapping in managing project complexity is beneficial. The *NINES case* had significant structural complexity in terms of the interdependence between a wide variety of stakeholder objectives, technologies and processes. The *litigation case* exhibits similar complexity but in a different industry arena—transportation rather than energy thus illustrating industry independence. In both cases causal mapping was used to manage project complexity and arrive at improved understanding of projects.

Secondly, the combination of the two papers offer illustration of a range of causal mapping features. For example, two alternative applications of the technique are explained, the *NINES case* focusing on prospective risk management and the *litigation case* focusing on retrospective analysis of a project. A range of data sources for mapping are also illustrated, the *NINES case* explaining the use of workshops and the *litigation case* describing the use of interviews and documentation augmented with workshops. Lastly, both papers discuss how causal mapping can be used in a multi-method research design. In particular, the *litigation case* explains in detail how causal mapping (a qualitative technique) was used in conjunction with system dynamics (a quantitative technique).

3. Managing project complexity in project management research

Williams (1997) suggests that projects are increasingly complex in nature and that complexity comprises two interrelated concepts—structural complexity and uncertainty. Structural complexity concerns the interdependence between elements (Kharbanda and Pinto, 1996), for example, stakeholder objectives, technologies, processes and teams but to name a few. Clearly, as the number of project elements increases, the number of interrelationships and thus structural complexity of the project are also likely to increase (Cooke-Davies et al., 2011; Baccarini, 1996). The second concept of project complexity is uncertainty (Williams, 1997) concerning, for example, project objectives and the methods to achieve those objectives (Turner and Cochrane, 1993). As clarity of objectives and methods emerge through progressive elaboration, it may become necessary to add new elements to the project leading to yet more interrelationships and further structural complexity (Williams, 1997). It seems reasonable to deduce that if projects are becoming increasingly complex, there is utility in understanding complexity when researching projects. In the following discussion we show how causal mapping assists in managing complexity through its processes of data elicitation, structuring, and analysis.

3.1. Data elicitation

Casual mapping allows for the capture, exploration and management of very large amounts of qualitative data in the form of a causal map. Data can be elicited from a variety of sources such as interviews (Bryson et al., 2004) and documents (Eden and Ackermann, 2004) but as with any technique the sources that can be called upon are informed by the context in which the research takes place. For example, in cases where research takes place across disperse geographies, one to one interviews augmented by documentary materials can offer a feasible way to proceed. This is illustrated in the *litigation case* where key stakeholders were scattered across the globe (France, Belgium and Canada). In the *NINES case*, on the other hand, stakeholders were in closer geographic proximity opening the opportunity for workshops to elicit project risks as well as build a shared stakeholder commitment to the project and its outcomes.

Each source of data used to construct a causal map portrays the project as viewed from a particular perspective. In the *NINES case*, for example, the perspectives captured included those of project managers, local councilors, wind farm owners and the local community and thus a broader ranging, more holistic view of the project was gained which unlocked a series of benefits. In particular, the range of project objectives across stakeholders was made explicit, enabling different stakeholders to create a vision for the project that was shared rather than based upon assumptions (Eden and Ackermann, 2013). Furthermore, potential conflicts and confusions among viewpoints were identified, and means for determining resolutions subsequently explored. In short, by eliciting and capturing multiple stakeholder perspectives, causal mapping enabled a comprehensive consideration of concerns and opportunities across a project to be achieved.

Each stakeholder's perspective will comprise various elements of data, for example, what the key issues are, what the risks are, and how these various elements of data relate to one another. To elicit this data, causal mapping uses the process of laddering

(Vygotsky, 1978)—continuously asking questions regarding both consequences (laddering up to goals or objectives) and explanations (laddering down to options, constraints, triggers). This process reveals data and the causal relationships that link them, therefore acknowledging and addressing Andriani and Mckelvey's (2007) concerns regarding research practice.

3.2. Structuring data

Capturing the breadth of perspectives (statements and relationships) in a causal map enables the often substantial amount of qualitative data to be structured and revealed as interconnected 'chains of argument' (elements linked by causal relationships) in its entirety. As such the map enables a holistic and systemic view of the project particularly when in electronic form. Using the software enables the 'whole' to be viewed alongside detailed exploration of specific parts thus helping ensure that multiple ramifications can be explored and alternative options assessed. Among others, Senge (1990) and Checkland (1999) have comprehensively discussed how a systemic view offers improved understanding of complex systems (like projects), particularly in explaining why and how phenomena are brought about—useful therefore when the aim of research is explanation building.

3.3. Reflection and sense making

Inquiry using causal mapping seeks to go beyond a participant's initial impressions of a situation to surface their deep, tacit knowledge. This is enabled by the process of laddering described earlier but also by using the visual presentation of the causal map to take advantage of sense-making concepts (Weick, 1995). Laddering encourages participants to reflect upon, and drill into, 'why' and 'how' events are brought about. What emerges is knowledge comprising the various elements of the situation (e.g. issues, options, constraints) as well as how they impact upon one another (causal relationships). Presenting this data graphically enables participants to visually inspect, reflect upon, and thus clarify the logic of the chains of argument. In other words, participant interaction with the map reflects a sense-making perspective of 'how do I know what I think until I see what I say' (Eden and Ackermann, 1998a, p.94 adatped from Weick, 1979). Moreover, as new elements of data emerge, they can be examined in full view of the existing data captured on the map potentially revealing new relationships between data that might otherwise have been overlooked. The visual display therefore facilitates looping between the emergence of data (through teasing out richness and nuance) exploring how this information relates to other data (personal, organisational, established wisdom), and revealing insights into the situation as patterns are detected, and assumptions questioned.

By utilising the processes of reflection and sense making, causal mapping enables participants to go beyond their immediate, sometimes superficial, perceptions of a situation to arrive at more nuanced and subtle understandings. The effectiveness of causal mapping in this regard is illustrated in both the *litigation case* and the *NINES case*. In the *litigation case*, causal maps were developed on the basis of interview data, integrated into a single map and subsequently presented back to participants who then spent 'a great deal of time debating the structure of the map' which provided the researchers with 'extra information and validated the model with much more precision' (Ackermann et al., 1997, p.53).

3.4. Triggering thinking about action

The ability to tease out the relationships between statements (risks, issues, etc) not only facilitates data structuring and enhanced understanding but also naturally triggers thinking about actions to improve the situation (Eden and Ackermann, 2010). These can be woven into the map enabling them to be assessed in terms of their efficacy while also revealing undesirable consequences. This benefit is illustrated in the *NINES case study* where, during the workshops, proposed actions were debated and shaped using the causal map to support discussion of efficacy and potential ramifications. By encouraging comprehensive consideration of ramifications, the map supported managers in taking a systemic rather than a discrete approach to their decision making. Actions were therefore arrived at through a process of interaction between participants and the map. In short, participants were able to 'read, absorb and work with' the emerging causal map, the value of which is articulated in the following participant feedback comments (Ackermann et al., 2014, p.296):

- 'got the big picture…rather than looking only at your own area of responsibility'
- 'the cross links [between risks] were interesting. I was interested in links that come into my area'.

These positive comments suggest that, as well as being valuable to researchers, causal mapping is valuable to participants. This is of benefit if researchers are to develop Theory ABOUT Practice, Theory FOR Practice, and Theory IN Practice (Winter et al., 2006). Research that has practical value is clearly powerful as it gains validity through utility, as well as encouraging further openness and engagement. This helps in understanding the nuanced life of a project—and through the co-production of knowledge and its usage, taps into a more praxis oriented approach enabling project managers to act more wisely. As a result Bredillet's (2013) request for a more phronesis oriented form of project management research is put into action as multiple consequences and ramifications can be viewed and assessed.

3.5. Computer aided analysis

It is not uncommon for causal maps to comprise many hundreds of intricately linked nodes and in the case of group maps in particular, Ackermann and Eden (2001, p. 160) suggest the number can reach 'up to 1000 nodes'. Consequently, although causal maps are amenable to visual analysis, computer-aided analysis brings productivity gains and accuracy (Ackermann and Eden, 2005). With the aid of the *Decision Explorer* computer software, analysis can take place on the basis of both content and structure. In terms of content, statements with common content can be arranged into clusters (in a similar manner to content analysis (Miles and Huberman, 1994)) revealing emergent themes in the data. DE also enables these clusters of statements to be labelled facilitating their retrieval during the analytic process.

Various structural analysis techniques are also available including domain and loop analysis (Eden et al., 1992). Using domain analysis, *Decision Explorer* calculates the number of links in and out of each statement in the map. Statements with a high count (i.e. a large number of 'ins' and/or 'outs') indicate potential key issues due to their high connectivity on the map. For example, in Fig. 1 the statement 'contractor unable to get criteria of acceptance (for water tightness)' has 3 links in and 2 links out giving a total of 5 links. As the statement with the highest number of links on the map, this statement would warrant further exploration.

Using loop analysis, DE can detect feedback loops within the structure of a map which Ackermann and Eden (2010b) and Eden et al. (1992) suggest can offer a number of benefits. To illustrate these in a project management context we draw upon an output of loop analysis reported in the *NINES case* (illustrated in Fig. 2 below). For ease of referencing during our discussion, we have numbered the statements in Fig. 2. The first benefit centres on whether the loop is legitimate or not. Examining the causal relationships connecting each statement in a loop reveals whether the chain of argument comprising the loop is logically coherent and thus legitimate (as opposed to the result of a mapping error). Tracing a chain of argument in Fig. 2 helps illustrate this process. Fig. 2 explains that insufficient skills and knowledge (2) caused by a shortage of engineering staff (1) may negatively affect the contractor's ability to successfully operate the project (3, 4) and thus demonstrate to the regulator its competency in delivering special projects like *NINES* (5). Without demonstrating such competency, the contractor may be less likely to win new bids (6) meaning less funding will be available (7), causing the firm to become too hide bound (8) and thus less attractive to new high flying staff (9). This outcome, in turn, may lead to a shortage of engineering staff (1) and so the chain returns to its start completing the loop. Reviewing the foregoing explanation, the logic of the feedback loop appears to be coherent and therefore legitimate.

A second benefit can be derived from determining whether the loop is positive (generative) or negative (control). This is achieved by counting the number of negative links in the loop. An even number of links indicates positive feedback and an odd number negative feedback. In the case of positive feedback, examination of the loop will give indication as to whether the loop is vicious or virtuous (Eden, 1992) which in turn provides insight into whether action should be taken to eradicate (for vicious loops) or enhance (for virtuous loops) this dynamic. Revisiting Fig. 2, the loop from statement (1) through (9) contains an even number of negative links indicating it is a generative loop. Furthermore, the description of this loop provided earlier indicates that the loop is vicious—i.e. it reinforces an undesirable outcome. Thus the insight gained is that management action should be taken to eradicate or mitigate this dynamic.

A final benefit that can be gained from loop analysis is an indication of where management efforts should focus when attending to nested feedback loops i.e. structures with multiple interconnected loops. This type of structure is illustrated in Fig. 2 which contains 4 feedback loops, these are listed below and can be traced around Fig. 2:

- Loop 1 beginning (1) through (9) and back to (1)
- Loop 2 beginning (1) through (6) to (9) and back to (1)
- Loop 3 beginning (1) through (4) to (9) and back to (1)
- Loop 4 beginning (1) through (2) to (4), through (6) to (9) and back to (1)

In Fig. 2, both the west and east elements of the map comprise two routes suggesting management attention takes place at either the north or south of the loop i.e. actions to address the shortage of engineers (1) or actions to attend to the

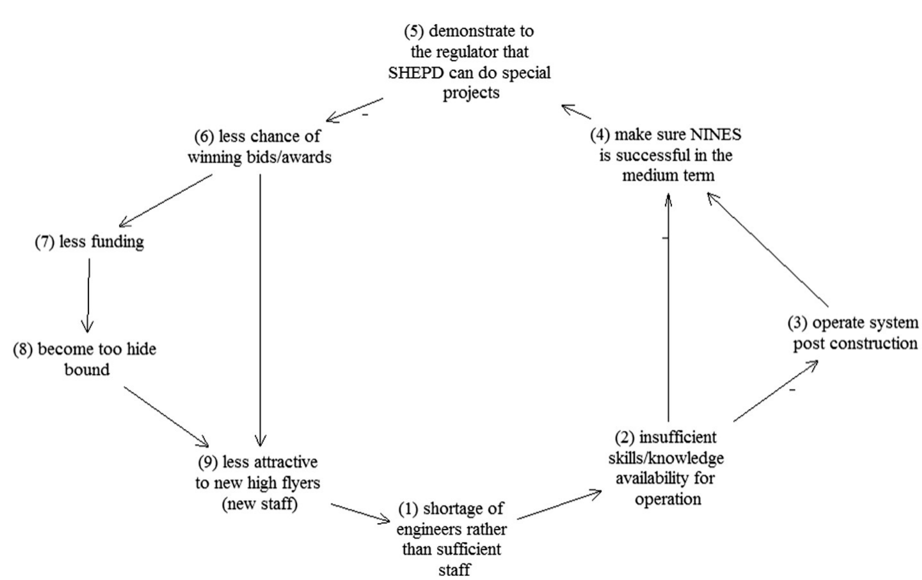

Fig. 2. Illustration of feedback, Ackermann et al., 2014.

ability to demonstrate competency in delivering special projects (5). The focus on these two issues is driven by the fact that attending to either will break the chain of argument effectively eradicating all of the feedback loops in one action.

3.6. Causal mapping's contribution to research design

Causal mapping is not restricted to a particular research design as illustrated through the two examples detailing both forensic and proactive usage. The technique can also be used to complement quantitative designs (Howick et al., 2009; Belton et al., 1997). The *litigation case* provides a good example of this in practice where causal mapping was combined with system dynamics modelling to support quantitative analysis. Howick et al. (2008, 2009) go further and provide a detailed discussion on the benefits of a mixed method approach as well as a conceptual model of how the transition between causal mapping and system dynamics modelling can be achieved. The authors explain that a mixed method approach makes it possible to capitalise on the benefits of both. Qualitative methods enable a high degree of equivocality, necessary when eliciting participant views on what has/or is to come on a project because there will be no single universal 'truth', instead a shared understanding among participants needs to be arrived at in order to move ahead effectively. As such qualitative maps can provide the structure upon which a quantitative model can be constructed. In turn, quantitative methods through their demand for data (in order to run) may reveal inconsistencies between the data held by the organisation, and the structure provided by the qualitative map. As such it becomes important to return to the qualitative map to allow for further exploration to tease out subtle and yet significant structural features of the project. As such a cycle of convergence and divergence takes place until a robust understanding and quantifiable outcome is achieved.

3.7. Alternative approaches to causal mapping

As noted earlier there are two forms of causal mapping—nomothetic and idiographic. Although the two types of causal mapping can be distinguished along a number of lines, their differences are driven by their contrasting aims. As discussed already, the aim of idiographic techniques is to arrive at detailed understanding of phenomena. Nomothetic approaches on the other hand are concerned with revealing patterns in data that can be statistically analysed (Hodgkinson and Clarkson, 2005). These contrasting aims drive two distinct research approaches. Aspects of an idiographic approach have already been discussed in this paper; however, these are briefly revisited for the benefit of comparison with nomothetic approaches.

To surface detail, an idiographic research approach necessarily focuses on small 'n' sample sizes coupled with a semi-structured approach to data elicitation (Bryson et al., 2004). Using this approach, the researcher can tease out details about the situation while also allowing opportunities for the participant to offer data outside of the arenas identified a priori by the researcher. Novel insights can thus be revealed. The product of this type of approach is very rich raw data of the sort illustrated in Fig. 1; beneficial when subtle understanding of phenomenon is the aim. Analysis is conducted directly on the raw data rather than using coding as a preparatory step; consequently, richness of data and depth of understanding are not lost as a result of the analytic processes in idiographic mapping.

An altogether different approach is needed when the aim of research is to reveal statistically generalisable patterns (Miles and Huberman, 1994). In order to achieve statistical significance of findings, a large 'n' sample size is desirable. Highly structured data elicitation is also valuable, as is data coding, both of which help reduce variation and thus volume of data in preparation for analysis. These are features often found in nomothetic approaches to causal mapping (Narayanan and Armstrong, 2005).

What emerges from idiographic and nomothetic research approaches are two distinctly different maps. To fully illustrate this difference, consider the following portion of map created following a nomothetic approach (Fig. 3) in comparison to the portion of idiographic map from the *NINES case* (Fig. 4).

As can be seen, using a nomothetic approach, the resultant map tends to contain a) briefer (fewer words), b) a smaller number of statements and c) fewer relationships linking the nodes. In short, data tend to be far less abundant in a nomothetic map than in an idiographic map. As a consequence, meaning and thus clarity of understanding are impeded. (Eden and Ackermann, 1998a). For example, in Fig. 3 the meaning of 'building capacity' is ambiguous; it is not clear whose capacity is being referred to or what type of capacity is being considered. While the researcher might deduce meaning from these statements, this might not accurately match the meaning intended by the participant. The ambiguity, therefore, leaves the researcher with a less accurate comprehension of the situation.

While the lack of detail in nomothetic maps negatively impacts comprehension, the rich detail contained in idiographic maps has its own challenge. This challenge centres on the sheer volume of data meaning analysis of maps can be resource intensive, a feature considered by some to be 'a major drawback' of an idiographic approach (Hodgkinson and Clarkson, 2005, p.54). This 'drawback', however, is not particular to idiographic mapping but rather a trait of 'thick' qualitative data in general (Miles and Huberman, 1994, p.56). Moreover, the analytic routines offered by *Decision Explorer* discussed earlier help to alleviate the demands inherent in analysing idiographic maps.

The contrasting aims and features of nomothetic and idiographic mapping mean there is no value in attempting to justify one as being superior to the other. All that can reasonably

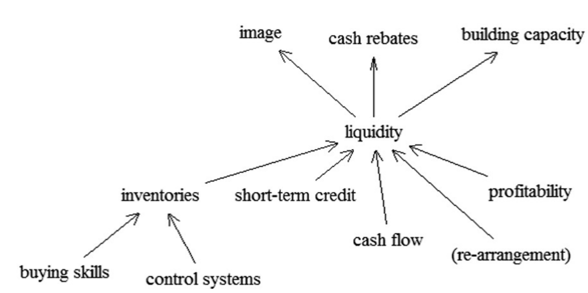

Fig. 3. A portion of a map created using a nomothetic approach (adapted from Laukkanen (1998, p.181)).

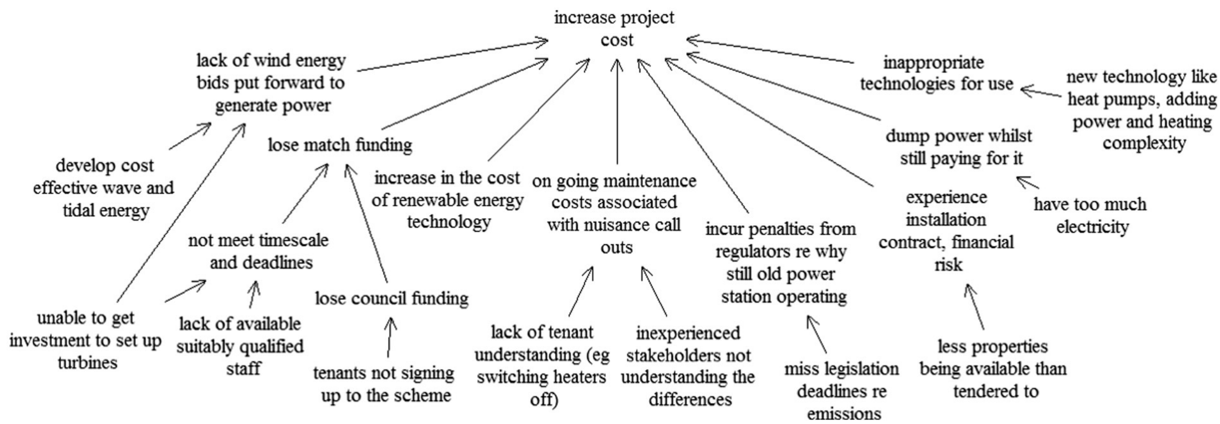

Fig. 4. A portion of idiographic map of project risks drawn from the *NINE Case* (Ackermann et al. (2014, p.293)).

be argued is that for researchers whose objective is to gain detailed understanding of situations, an idiographic approach may be appropriate. For those interested in statistically generalisable patterns, nomothetic approaches may provide benefit.

4. Reflections and discussion

Despite their contribution to the field traditional approaches to project management are increasingly recognised as being insufficient, on their own, for understanding and thus improving the management of projects. Their limitations include an inability to attend to important characteristics of projects such as intricate relationships between project components and the role of human factors in project behaviour (Williams, 2005).

In the preceding sections we have sought to reveal how causal mapping can address these limitations with a view to extending knowledge in the field of project management. We gave prominence to number of considerations that will be of relevance to researchers wishing to use causal mapping in their research designs. Beginning with the technique's theoretical foundation, we examined the aims of idiographic causal mapping exploring how the aims shape the research design in relation to the processes of data collection, analysis and mixing methods. Using two case study papers, we sought to illuminate how these processes can benefit project management research. In particular, the reflective nature of the data elicitation process in causal mapping can provide deep insights into the complex structures of interrelated components that constitute projects. Furthermore, the technique can allow for a broad range of perspectives to be captured in a single map thus providing breadth as well as depth. Project data can often be highly complex in terms of number and interrelationships, for example in the *litigation case* there were 750 statements and 900 relationships. Using causal mapping to structure, visualise and analyse data, allows for complex data to be explored in a systematic way such that emergent properties, that might otherwise be difficult to discern, can be revealed and examined. By attending to the foregoing points we have sought to provide the project management research community with a point of entry to causal mapping.

4.1. Moving forward with causal mapping

Despite the potential benefits of causal mapping to project management research, adoption of the technique is not without challenge. Learning the technique is a particular issue, especially for new researchers who have had limited exposure to the complexities of real world problems and are thus without the necessary background with which to contextualise the use of the technique (Ackermann, 2011). Moreover, proficiency in causal mapping is the result of intense formal training and mentorship, both of which have been argued to be in short supply (Morrill, 2007; Robinson, 2007). Putting these barriers to entry to one side, however, this paper has highlighted that causal mapping can provide a valuable return to project management researchers willing to invest the time needed to develop the necessary skills.

The remaining question is where might future research focus its attention? Applying the technique in a longitudinal study is one such area (Jenkins, 2002). Causal maps created at a particular point in time could be compared with those of a later time period thus enabling longitudinal analysis of projects, allowing for shifting patterns of behaviour to be explored. Projects could be mapped during their life cycle providing a nuanced understanding of the issues faced at bid, design, construction and commissioning phases as well as across different projects, industries and organisations. A further innovative development currently being explored by the authors of this paper is mapping in 3 dimensions harnessing new developments in graphics and visualisation to better support exploration of emergent properties and in particular longitudinal analysis of projects.

To date, application of causal mapping in projects has been researcher led (for example Williams, 2004; Maytorena et al., 2004). There appears to be no examples of practitioner-led application. For the benefits of causal mapping to be extended to main stream project management, rather than restricted to specialist use in complex projects, practitioner application will be necessary. Thus, another avenue for research concerns finding mechanisms to encourage the application of the approach by project management practitioners.

From a methodological perspective, opportunities exist to mix causal mapping with other approaches. Causal mapping need not be seen as distinct from traditional approaches to researching projects. For example, causal mapping could be used prior to a survey as a means of surfacing and structuring knowledge to help frame the questionnaire. Alternatively, mapping could be used post-survey to delve deeper into the topic such that a more nuanced understanding of survey results can be achieved. Causal mapping could also augment traditional content analysis through providing new insights but also through triangulation, validating those properties already identified. Mapping might also help when undertaking Critical Incident Analysis (Flanagan, 1954) as the incidents are able to be explored in detail (for an example see Bryson et al., 1996). Augmenting traditional approaches with causal mapping creates a synergistic relationship whereby the strengths of one approach offset the limitations of the other.

Conclusions

There is a growing recognition within the project management community of the need for pluralism of approaches in order to create broader ranging perspectives on projects and thus improve our understandings of them.

In response, this paper has offered an exposition of causal mapping as one alternative to typical project management approaches. Causal mapping is well grounded within academic research having been applied widely in other disciplines, particularly management, yielding a variety of benefits. It has been suggested in this paper that these benefits offer value in the field of project management. The benefits discussed include elicitation, structuring, management and analysis of complex qualitative data gathered across participants, projects, organisations and other project stakeholders.

While the technique is emerging within project management, the paper has suggested further avenues for research in which the technique could offer additional insights for both project management theory and practice. These included practitioner-led application of the technique, longitudinal analysis of projects and mixing the technique with more typical methods such as the survey design. Causal mapping is collaborative, engaged, draws on multiple perspectives and enables application—four of the key points demanded by Bredillet (2013) in project management.

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