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Published by *Project Management Research and Practice*

Citation: Shalbafan, S., Leigh, E., Pollack, J. and Sankaran, S. 2017. Decision-making in project portfolio management: using the Cynefin framework to understand the impact of complexity. *International Research Network on Organizing by Projects (IRNOP) 2017*, UTS ePRESS, Sydney: NSW, pp. 1-20. https://doi.org/10.5130/pmrp.irnop2017.5775

Published by UTS ePRESS | http://pmrp.epress.lib.uts.edu.au

CONFERENCE PAPER

Decision-making in project portfolio management: using the Cynefin framework to understand the impact of complexity

Saeed Shalbafan[1]*, Elyssebeth Leigh[2], Julien Pollack[3], Shankar Sankaran[4]

[1] University of Technology Sydney. 11201338@student.uts.edu.au
[2] University of Technology Sydney. elyssebeth.leigh@icloud.com
[3] University of Sydney. julien.pollack@sydney.edu.au
[4] University of Technology Sydney. Shankar.Sankaran@uts.edu.au

***Corresponding author:** Saeed Shalbafan, University of Technology Sydney. 11201338@student.uts.edu.au

Name: International Research Network on Organizing by Projects (IRNOP) 2017

Location: Boston University, United States

Dates: 11-14 June 2017

Host Organisation: Metropolitan College at Boston University

DOI: https://doi.org/10.5130/pmrp.irnop2017.5775
Published: 14/05/2018

Synopsis

The majority of project portfolio management tools are not flexible and responsive to complex and dynamic environments. This can result in business losses when management does not effectively adjust project portfolios to meet organizational and contextual needs. This paper concentrates on the impact of individual decision-making, perceptions of decision processes and the influence of uncertainty on effective decision-making in project portfolio management.

Relevance for practice and education

This research explores the impact of real-time events on managers during decision-making processes for project portfolio management, using a purpose-built simulation. The simulation development was informed by the Cynefin framework. The Cynefin framework emphasizes

DECLARATION OF CONFLICTING INTEREST The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. **FUNDING** The author(s) received no financial support for the research, authorship, and/or publication of this article.

the importance of applying different leadership styles and decision-making approaches depending upon the complexity of the situation.

Research design

A multi-method, abductive research process was used to collect and analyse the data. Data collection involved four complete iterations of a purpose-built simulation, resulting in 66 datasets of individuals' perspectives of the project portfolio management decision-making process, under varying levels of complexity. The research data were focused on participants' perceptions of their efforts to manage key decision turning points through two "real-time" events, simulating project cancellations and organizational change.

Main findings

Participants were found to use different approaches to decision-making, depending on the complexity of the situation. The findings show that participants' roles in the simulation, participants' experience, decision makers' feeling, the maturity of team cognition, and diversity of participants are key considerations that influence the success of decision-making under uncertainty in PPM contexts.

Research implications

The findings in this study build on previous research in a number of ways. They demonstrate the effectiveness of simulation as a data collection technique in project management, an approach which has hereto been rarely used. This research also develops our understanding of portfolio decision-making by directing attention from rationalist approaches to the consideration of emotion, real-time events and individuals' decision-making styles, reflecting something closer to the lived experience of project portfolio management.

Keywords

Project Portfolio Management, Decision-making, Cynefin, Simulation, Complexity

Introduction

Project portfolio management (PPM) has been developed to assist in the management of interrelated groups of projects and programs; aid in the selection of projects within a portfolio, and their alignment to organizational intent; and to facilitate communication amongst internal and external stakeholders with regard to decision-making on clusters of interrelated projects. PPM is particularly vital in contexts where complex decisions need to be made involving groups of stakeholders within, and external to, organizations. The dominant trend in decision-making during the planning and implementation of multiple projects is driven by a rationalist perspective, emphasizing financial analysis. Optimization methods apply linear and stable assumptions to create decision trajectories for portfolio roadmaps (Belaid, 2011; Ghasemzadeh, Archer, & Iyogun, 1999; Project Management Institute, 2012). However, in many cases, the environment is changing so quickly that changes are not captured effectively by the decision makers working on project portfolios. Further investigation of decision-making process in PPM contexts is needed if organizations are to account for sudden changes. Management of the process for identifying and controlling uncertainty affecting project portfolios is a key challenge for project practitioners and researchers. However, understanding the perceptions of individual decision makers in connection with their decision-making is not yet subject to much research.

This research explores how real-time events affect decision makers in a PPM context. This paper discusses the use of a novel approach to research, data generation and analysis to create recommendations for consideration by practitioners and researchers. The research problem being explored is:

What is the impact of real-time events on managers during PPM decision-making?

This paper extends the previous work of authors (Robert Gravlin Cooper, Edgett, & Kleinschmidt, 2001); (Killen, Jugdev, Drouin, & Petit, 2012; Martinsuo, Korhonen, & Laine, 2014; Y. Petit & Hobbs, 2012) and other researchers (Kurtz & Snowden, 2003; Leigh & Kinder, 2001; Remington & Pollack, 2007) into the management of uncertainty and decision-making for project portfolios. The research reported in this paper included the development of a simulation (Hooshmand-1) for replicating scenarios involving unexpected change and complex PPM decision-making contexts. The Cynefin model of Domains of Knowledge (Kurtz & Snowden, 2003) informed the development of the simulation and provided the research framework for this study. Data generation and analysis made use of SenseMaker software to provide insight into the types of actions and strategies required when facing unanticipated change during decision-making in the context of PPM.

Literature review

Project portfolio management is a multidisciplinary response to aligning corporate strategy with the specific tasks of choosing and executing the right projects. Project portfolio management is defined as the management of projects and programs to achieve strategic goals as set out in a corporate strategic plan (PMI, 2006). The three key goals for implementing PPM across a corporation have been identified as (i) maximizing the value of the portfolio; (ii) achieving the right balance and mix of projects; and (iii) linking the portfolio to the strategy of the business through implementation of PPM (Robert G. Cooper, Edgett, & Kleinschmidt, 1997a, 1997b). Corporations with multi-project structures challenge top management teams, as these practices begin with competing resources for projects at the same time, and the maturity of organizations to establish PPM as a key functional responsibility for senior managers. Engwall and Jerbrant (2003) stated that a multi-projects corporation carries out the majority of its business operations through the execution of projects. The standard of portfolio management (Project Management Institute, 2012) concerns common sense for the implementation of PPM across organizations. This standard discusses definitions and concepts aimed at achieving a balance among key goals for profitability, strategic alignment and resource utilization.

Several models and frameworks discuss various perspectives to the alignment processes between corporate strategy and projects. Archer and Ghasemzadeh (1999) proposed an integrated framework for decision-making on projects selected for portfolios. The strategic implications of project selections are complex, as they depend on internal and external factors (Archer & Ghasemzadeh, 1999). Connecting strategic management and PPM as a relevant capability for corporates to plan and implement strategically and effectively are proven for the PPM context (Killen et al., 2012). Kodukula (2014) described the funnel model as a good guide for practice to combine tactical and strategic views for PPM planning and implementation. The funnel model uses three gates: (i) initiation, (ii) development and (iii) production (Kodukula S., 2014). The production gate is when the delivery of project values commences. Furthermore, a strategic framework was introduced to lay out the sustainable decision criteria and fuzzy-based decision-making models for decisions on project portfolio selection and evaluation (K. Khalili-Damghani & S. Sadi-Nezhad, 2013). K. Khalili-Damghani and S. Sadi-Nezhad (2013) argued that the framework use of Balanced Score Card (Kaplan & Norton, 2001) provides feedback to evaluation and assessment processes.

Complexity in project portfolio management processes is inherent and contingent. Complexity is inherent in the process because of the multifactor and multi-stakeholder process of analytic and rational decision-making for project selection., prioritization and authorization of projects (Gemünden, Kock, Kopmann, & Schulz, 2015). The complexity of the processes is concerned with key determinants for the number of elements, the degree of interdependencies between elements, and the predictability and magnitude of changes to these elements and their interdependencies (Daft, 1992; Dietrich, 2007; Dooley & van de Ven, 1999; Levinthal & Warglien, 1999; Ribbers & Schoo, 2002; Teller, Unger, Kock, & Gemünden, 2012). Changes in the elements and interdependencies can happen because of internal and external factors (Martinsuo et al., 2014).

A wide variety of advanced, computerized, and formalized processes exist for aiding project selection, prioritization and decision-making (Archer & Ghasemzadeh, 1999; Gemünden et al., 2015). Several quantitative models and frameworks have been developed to aid with the complexity of multidimensional problems for PPM. Financial and non-financial indicators at the project level could assist the decision-making process. According to Costantino, Di Gravio and Nonino (2015), deciding on project critical success factors is an important criterion for PPM, as decision makers deal with probable causes of failures during project selection processes. These authors argued that using artificial neutral networks provides a simpler approach for top manager engagement in the decision-making, facilitating communication loops between project managers and project portfolio managers to assess the riskiness of project success based on the project managers' past experience (Costantino et al., 2015). Maged (2008) describes a multiple criteria decision-making (MCDM) model to find the optimized solutions for R&D projects where resources dependencies pose constraints on the decision-making process for project selection. MCDM is also used to measure the performance of project portfolios to make decisions on strategic changes to and use a variety of criteria, which are required for the decision maker to reprioritize the projects based on their performance (Rogério Tadeu de Oliveira, Ensslin, & Sandra Rolim, 2011).

Arguably, companies are struggling with sub-optimization and irrational decision-making processes (Martinsuo, 2013). Müller, Martinsuo and Blomquist (2008) challenged the contribution of several tools and quantitative methods for project portfolio optimization to the performance of project portfolio management. Kaiser, El Arbi and Ahlemann (2015)) emphasized that despite developments in project selection models for decision-making, the key to successful implementation of PPM is the organization structure and its alignment with decision-making criteria.

Some have argued that project portfolio management methods are not mature enough to support organizations during uncertain conditions because of its focus on rational decision-making (Arlt, 2010; Martinsuo et al., 2014). In parallel with methods and processes, competencies the top management team who use the methods for decision-making is at a great attention. Martinsuo stated that skills and competencies for managing project portfolios should extend to the project management teams. Furthermore, senior managers need to support the development of dynamic capabilities across organizations to overcome uncertain and changing environments (Yvan Petit, 2012).

Uncertainties are beyond the analysts' ability to predict events and cannot be reduced to the risk level (Quade, 1989). The quick-changing environment is a reality of the business environment. The changes influence decision makers' perceptions for choosing processes and decision criteria. Christiansen and Varnes (2008) suggested that decision makers have to deal with multiple criteria and, sometimes, conflicting interests. Thus, decision makers move away from traditional rational thinking and try to adopt a sub-optimal problem-solving approach. Martinsuo et al. (2014) asserted that external uncertainty could be related to factors such as competitors' actions, customers' needs or changes to macroeconomic conditions.

Korhonen, Laine, and Martinsuo (2013) asserted that managers cannot stick to their rational decision-making approach when facing uncertain or unknown conditions. Furthermore, there is a need for further research into how to manage uncertainty in PPM (Korhonen et al., 2013; Yvan Petit, 2012). The extended framework for managing uncertainty offers categorization of uncertainty based on the sources of uncertainty – external context, organizational context and single project changes – in which managers can identify and prepare a contingency plan to overcome those events (Martinsuo et al., 2014).

Facilitation of decision-making in a project portfolio committee through a crafted framework might provide top managers with a mechanism to manage unexpected events during decision-making for project portfolio decision processes. Yahaya and Abu-Bakar (2007) argued that group decision-making is across all decision-making processes and is used as a powerful mechanism to overcome factors of uncertainties during a decision-making event for project portfolios of new product development. Group decision-making is known as a tactic for strategic planning, where decision makers have to overcome uncertainties. Strategic decision-making and project selection and termination processes can benefit from group decision-making to mitigate risks or uncertainties (Kaveh Khalili-Damghani & Soheil Sadi-Nezhad, 2013; Shepherd & Rudd, 2014).

Decision-making in a PPM context is a complex process. The research discussed above demonstrates the need to account for individual contributions to decision-making, group decision-making and a changing and uncertain context. Although many tools and applications exist to assist in this process, the literature suggests that the ability of these approaches to deal with complex environments has been constrained by an underlying rationalist perspective.

FRAMEWORK FOR ANALYSIS

Complexity and uncertainty are being recognized as creating fundamental difficulties for decision makers, especially when senior managers have to make decisions without sufficient information (Gorzen-Mitka & Okreglicka, 2014). Remington and Pollack (2008)) categorized four types of project complexity: structural, technical, directional and temporal. For example, the physical size of projects or the extent of technical interdependencies can result in complexity for decision-making (Remington & Pollack, 2008).

Seeking to make sense of complexity leads to a more proactive identification of sources of uncertainty and for early signs of failure (Kappelman, McKeeman, & Zhang, 2006). Weick (1995) argued that people apply sense-making as a tool to overcome ambiguity and associated interpretation to that condition. Shrivastava (1987) stated that individuals engage in sense-making to find out what to do next, as well as a way of dealing with the anxiety and fear in complex conditions that may accompany the disastrous experiences. Hence, a framework of making sense of complex situations can be a mechanism to manage uncertainty for top management decision-making.

Cynefin, a Welsh word that means "habitat" (Kurtz & Snowden, 2003), is used for knowledge exchange and as a framework that helps decision makers making sense of complexity through relaxing boundaries and assumptions deriving from existing theory, belief or practices (Krems, 1995; Sardon & Wong, 2010). According to Kurtz and Snowden (2003), there are five domains for the Cynefin framework: simple, complicated, complex, chaos and unordered.

The Cynefin framework has been used in collective sense-making to enable emerging understanding through the discourses of group decision-making (Tomasini, 2013). According to Kurtz and Snowden (2003), the Cynefin model provides ways to open up discussions, identify barriers, stimulate attractors, encourage dissent and diversity, manage starting conditions and monitor for emergence in order to manage complexity and stabilize uncertain conditions. Application of the Cynefin framework to boost project managers with their decision-making capabilities is evident with the Legos (Tomasini, 2013).

The application of the Cynefin framework for creating simulation scenarios in complex and complicated domains and a reflection framework for participants in the simulation is discussed in the next sections.

Research methodology

This research involved two main research methods: the design of an original simulation (Hooshmand-1) for generation and collection of data and the use of the SenseMaker software to collect and analyse data. Each is discussed here in turn.

SIMULATION

Simulation is 'the abstraction of reality for a purpose" (Leigh 2013, p. 200). It has been in use for thousands of years for many different purposes and in various modes such as war games and board games (A.J. Faria, Hutchinson, Wellington, & Gold, 2009).

Simulation has diverse uses for research and practice, and is an attractive tool for training and education where "what-if" questions can be explored through the use of different scenarios, helping learners by providing experience-based activities (Aldrich, 2005; Banks, Carson, & Nelson, 1996). Training for performance improvement in risk-oriented contexts, such as those experienced by emergency medical crews, firefighters, and in surgery and nursing, is often conducted via simulation, which provides relatively safe environments for learning while avoiding adverse real-life consequences (Okuda, 2009; Rosen, 2008; Sa. Silva, Pedrosa, Trigo, & Varajao, 2011).

Simulation, as a research and exploration tool, is found in technical disciplines including crisis management (Walker, GIddings, & Armstrong, 2011) and operations management (Zee & Slomp, 2009). Simulation is also recognized in the human sciences as a means of building formally arranged structures that become temporary knowledge transmission spaces, allowing researchers to explore specific aspects of human behaviour (Sá Silva et al. 2011). The context in which specific simulations are applied greatly influences their design, for example entrepreneurship education using simulation as a method for teaching complex business interrelationships applying concepts unique to that context (Huebscher & Lendner, 2010).

Use of simulations in project management is growing. While computational simulations are being used for "discrete event simulation" where the complex systems can be simplified to sequence of pre-defined events (Hengst, Vreede, & Maghnouji, 2007), role-play simulations are being used for strategic decision-making and also the study of decision-making on project portfolios as well as other educational purposes (Culpin & Scott, 2012; A. J. Faria & Wellington, 2004; Hussein, 2007; Keys & Wolfe, 1990; Leigh & Kinder, 2001). Simulations are also used to improve understanding of the nature of complexity (Killen, 2013; Leigh, 2013).

Role-play-based simulation has many applications for the education of both adults and children and has a long history of use (Leigh & Kinder, 2001). Role-play is "a technique (used in games and simulations) in which participants act out the parts of other persons or categories of persons" (Leigh & Kinder, 2001, p. 10). Role-play simulation is used for close-to-reality settings that engage participants in experientially based events to help them enhance their skill and capabilities (Clapper, 2010).

The design of a simulation is intimately connected to the features of the context being represented and is shaped by the nature of the intended research or learning objectives. Stainton, Johnson, and Borodzicz (2010) identify three principles that contribute to a viable simulation design as being representation, content and implementation. Each of these is elaborated on here.

To be effective, e a simulation must provide a realistic representation of the real environment (Duffy & Cunningham, 1996; Elgood, 1993). Shalbafan, Leigh, Pollack, and Sankaran (2015) argued that a viable model for simulation must replicate known conditions. To be effective, a simulated representation must address complex and challenging situations without unnecessarily confusing participants (Leigh, 2013).

Content is the second important principle in each simulation design. This includes the rules, materials, venue, processes and support tools, all of which must be true to the context of the simulation (de Caluwé, Geurts, & Kleinlugtenbelt, 2012). Well-developed content needs to be challenging for participants and present a framework for generating knowledge (Shalbafan et al., 2015).

Implementation refers to the facilitation processes that guide and manage the performance of the simulation. Timing is a key factor. A simulation must include time for sufficient analysis afterwards as well as allowing time for players' decision-making, reflection and discussion within the activity (Hall, 2004). The facilitator needs to be a knowledgeable person in order to provide technical assistance to participants (Hall, 2004; Wolfe, 1997).

The use of simulation has grown to include training, education, decision-making and crisis management for many groups including middle and senior managers (A.J. Faria et al., 2009). The use of simulation for project management has helped students in postgraduate courses to understand the complexity that can occur during construction projects. For instance, BoBs Building is simulation software that covers subjects such as planning and controls, network analysis, risk management, earned value for training and education (Hussein, 2007). Other business simulations support learning about organizational changes and decision-making on strategic matters (A.J. Faria et al., 2009; Joldersma & Geurts, 1998).

Simulations are also increasingly being used for research projects, demonstrating advantages such as allowing for participants' subject expertise, motivation and opportunity for group discussions (Elgood, 1997). Simulations can also address communications, critical thinking and emotions as research factors, as well as providing participants with learning opportunities (Clapper, 2010). Finally, simulations offer researchers opportunities to compare qualitative and quantitative data at the same time (de Caluwé et al., 2012). Simulations enable researchers to study decisions and activities that are extraordinary, dangerous, risky and obscure organizational environments (de Caluwé et al., 2012).

Simulation Hooshmand-1 was created to expose participants to two predefined scenarios. In each scenario, participants adopted a role and contributed to group decision-making about items on a list of project portfolios. In the second scenario, two real-time events were introduced to assess participants' capability for coherent decision-making after receiving news of unanticipated but predictable events.

The simulation process follows these steps:

1. Briefing
2. First scenario
3. Reflection on the first scenario
4. Second scenario
5. Reflection on the second scenario
6. Debriefing

The two scenarios were developed using data from a case study of IT companies in Canada (Yvan Petit, 2012). Both scenarios are set in the Sydney headquarters of a fictional international IT company. The context is a meeting of the project portfolio committee chaired by the director of product development unit (PDU) based in Sydney and attended by heads of the application development (AD), and integration and verification (IV) divisions. The scenarios are dynamic and competitive, including sources of instability related to product content, unstable standards and unclear customer requirements about products.

Narratives are a commonly used sense-making tool for interpreting how people make sense of uncertain conditions or complex problems. Rituals, belief and experience are all ways that people make sense of events, and thus they respond to organizational shocks, such as mergers, layoffs and expansions, using very different perspectives (Mills, Thurlow, & Mills, 2010). Narratives (Weick 1995; Weick 2005) are active lenses to monitor individual behaviour, as participants' stories discuss who said what to whom with what effect (Mills et al., 2010; Weick, 1995, 2005).

Narrative research can assist the research subjects to make sense of a complex situation, and that contributes to data analyses with less researcher bias as a reliable research method (Browning & Boudès, 2005). Storytelling (Callahan, Rixon, & Schenk, 2006), games and simulations (Leigh & Kinder, 2001) are known tools to make sense of complexity. Stories are richer research instruments than conventional questionnaires and interviews because they bring the subjects' opinion directly into the research field (Berry, 2001; Boudes & Laroche, 2009; A.D. Brown, 2004; A.D. Brown & Jones, 2000). SenseMaker software was introduced to narrative research, which enables visual presentation and analysis (GORZEŃ-MITKA & OKRĘGLICKA, 2014) of stories collected in narrative research.

SenseMaker software, associated with the Cynefin framework, can be used to support decision-making and metadata analysis when used with large numbers of participants. This software is becoming widely used for making sense of complex problems (Gorzen-Mitka & Okreglicka, 2014; Snowden & Boone, 2007). Sardon and Wong (2010, p. 5&6) have described the key benefits of using SenseMaker as follows:

- Allows distribution of the analysis load across participants and makes it possible to analyse the stories in a relatively short time

- Reduces the authors' bias that might be introduced in the interpretation of the stories. In doing so, each story contributor makes sense of one's story
- Engages the participants and positively prepares them for the next steps. Involvement is a key success factor for the long-term success of any intervention.

Sixteen attributes were selected as indicators of features relevant to understanding the research questions (Table 1). A questionnaire using the SenseMaker software was developed to collect data from participants as they made sense of their experience in each scenario.

Table 1 Attributes of simulation and codes in the sense-making framework

No.	Attribute Description	Code	Scenario
1	Participants' feeling	Q9	SC1
2	Criteria of decision-making	T1	SC1
3	Drivers for individual decision-making	T2	SC1
4	Sources of uncertainty	T3	SC1
5	Perception of final group decision	T4	SC1
6	Group adaptation to decision-making Process	T5	SC1
7	The focus of task on team vs. individual	Q11	SC1
8	Participants' feeling	Q14	SC2
9	Perception of impact on decision makers for the first real-time event	Q16	SC2
10	Perception of impact on decision makers for the second real-time event	Q17	SC2
11	Drivers for individual decision-making	T6	SC2
12	Shift of criteria for decision-making because of real-time events	T7, T8 &T9	SC2
13	Group adaptation to decision-making Process	T10	SC2
14	Individual perception for factors to overcome changes on decision-making process	T11	SC2
15	Sources of uncertainty	T12	SC2
16	Perception of final group decision	T13	SC2

SenseMaker provided measuring mechanisms, including distribution diagrams, to support the analysis of qualitative data, and it proved to be an efficient tool for data collection and data analysis for this research. SenseMaker allows the provision of a variety of data collection techniques, including dyads, triads, micro narratives and multiple-choice questions. A dyad is a two-dimensional signifier that assesses the subjects' perception in a range between 0 and 100. A triad is a three-dimensional signifier and assessment tool. Respondents are asked to balance the relative significance of three signifiers by placing a point within the area of a triangle. Micro narratives are respondents' short stories, images, videos or audios that they use to make sense of a complex situation.

To collect the data, participants responded to questions by writing a micro narrative or a short story to describe their experience at the end of each simulation scenario. Participants were asked to describe key turning points during each. They were also asked to describe aspects of the simulation experience by positioning response points on a selection of triads, indicating their perception of the significance of a variety of factors.

Four simulations were conducted using the SenseMaker software to collect data from participants. After each simulation scenario, participants underwent a reflection through listing turning points from the end to the beginning of the scenario, and they wrote a short fragment or micro narrative on their experience for each turning point, followed by signifying their stories in a questionnaire. There were 33 participants, generating 66 data sets from two scenarios in each experiment. A standardized process of facilitation – simulation protocol – was used to minimize variations of facilitator's performance between simulation sessions with different groups of participants.

The participant selection process was tailored depending on the type of volunteers and the context of each simulation. Participants were recruited from professional and postgraduate research students.

Data analysis

Micro narrative analysis and the Cynefin framework were used to assess participants' perceptions about key turning points. The micro narrative stories were considered in relation to three parameters (i) Cynefin domains of knowledge used for decision-making, (ii) experience of real-time events and (iii) turning points within those events. These fragments were assessed and led to the identification of three distinct clusters of participants (see Table 2).

Cluster 1 – These six participants were people who identified real-time events and noted the influence they have on decision-making processes in their micro narratives

"Before the cancellation of program 4, we had a list of potential projects that we wanted to choose for this exercise." This was taken to indicate the simple domain of known information on the Cynefin framework. "After briefing the CEO and explaining the situation to them, we came to a disagreement." This was taken to indicate the disordered domain on the Cynefin framework.

Cluster 2 – These 12 participants were people who identified turning points other than real-time events and named their impacts on the decision-making process.

"Initially it *was not clear* for me that the first thing we needed to do was to calculate the total number." This was assessed as indicating the chaos domain. Or, "We could go easier with the second-year project." This references the complicated domain.

Cluster 3 – These three participants were people who identified turning points other than real-time events, but did not indicate that these have any impact on the decision process.

"Interpreting the data and the interdependencies on the spreadsheet was most difficult." Or we have focused the scheduling of programs with high NPV, ENPV and resource fit." These were understood to indicate the complicated domain on the Cynefin framework.

Shifts and movements between Cynefin domains are considered significant as they affect the decision-making process. Participants whose responses contribute to the first cluster were able to recognize that events occurring during the simulation had impacts on the decision-making. This was concluded after analysing all responses to the first prompt question for listing turning points. Participants, depending on their background, had shown very different approaches to identify real-time events in the simulation as a key change factor for decision-making that

Table 2 Participants in three clusters

Code: Either Number or Pseudonym	Group Colour	Role	Workshop Number	Cluster
1	White	AD	1	1
2	Green	IV	2	
3	Green	AD	3	
4	White	AD	3	
5	Green	IV	4	
6	Green	PDU	4	
7	White	PDU	1	2
8	Red	IV	1	
9	White	IV	1	
10	Green	IV	2	
11	White	AD	2	
12	Red	PDU	2	
13	Green	IV	3	
14	White	IV	3	
15	Red	AD	4	
16	Green	IV	4	
17	Green	AD	4	
18	Gold	PDU	4	
19	Green	PDU	1	3
20	Red	PDU	3	
21	Green	PDU	4	

their groups made. Those six participants whose responses are included in this cluster described a different sequence of changes in decision-making as a result of real-time events. Although these participants were not aware of the domains in the Cynefin framework, their micro narratives describe the awareness of immediate events and the influence on their own decision-making. The change in how each participant perceived how his or her group made decisions is discussed following, with reference to the Cynefin model. Analyses of each participant in the cluster area are presented as coded in table 2.

SHIFT FROM SIMPLE DOMAIN TO CHAOS

Participant 1 recorded two real-time events in the second scenario of Hooshmand -1. The known situation outlines the Simple domain in the beginning. The cancellation of a project triggers a shift to the Complex domain, where discussions among teammates help raise awareness on the changing situation. The increased understanding moves the team to the complicated domain, where prioritizing techniques help decide outcomes. The second real-time event involved a change of leadership. This shifted team members to the Unordered domain, and agreement was not reached. The team concluded in an endless discussion in the Chaos domain. Figure 1 illustrates this movement.

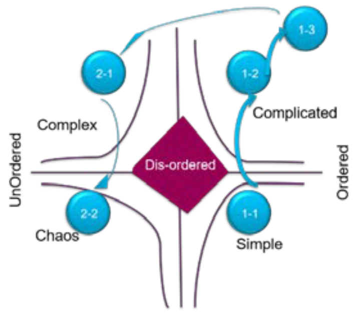

Figure 1 Transition of domains from Familiar to Chaos

SHIFT FROM COMPLICATED DOMAIN TO COMPLEX

Participant 2 identified real-time events in the sequence shown in Figure 2. The first real-time event forced the team to re-evaluate their work because of the emerging situation. The decision-making domain then shifted to Complicated when an analytic approach was adopted. Figure 2 demonstrates the movements in different domains.

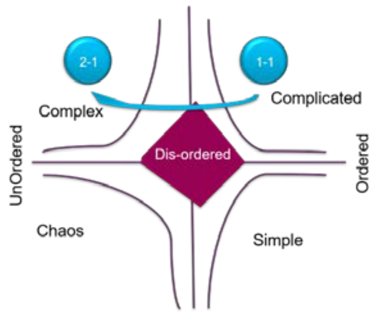

Figure 2 Transition domains from Complicated to Complex

MOVEMENTS BETWEEN COMPLICATED AND COMPLEX DOMAINS

Participant 3 recorded two real-time events. Their group commenced work in the complicated domain, where the expectation from headquarters is known to teammates, and they need to use their analytic expertise to find the solution. The change of team leader shifted the domain to Complex because of the consideration that the new member may have different expectations that could emerge as a new strategy. However, the group shifted back to the Complicated domain through discussion and knowledge sharing. At the cancellation of a project during the second turning point in scenario 2, the group kept their decision-making consistently in the Complicated domain (Figure 3).

FROM CHAOS TO DISORDERED

Participant 4 identified that there were two real-time events and used the future backwards approach (Gorzen-Mitka & Okreglicka, 2014) to list turning points and micro narratives. In the beginning, self-confidence helped this participant to use known facts in the next context; hence, it resembles a simple domain. Upon cancellation of a project as a real-time event, the group wasted times on recalculations, indicating working in the Chaos domain. When the

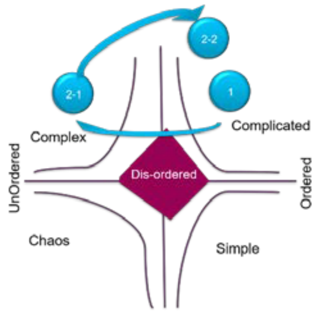

Figure 3 Transition domains between Complicated and Complex

new team leader arrived, team decision-making shifted into Disorder as conflict arose with different perspectives to the solutions, and there was no real agreement about how to proceed; this is what Unordered would mean (Figure 4).

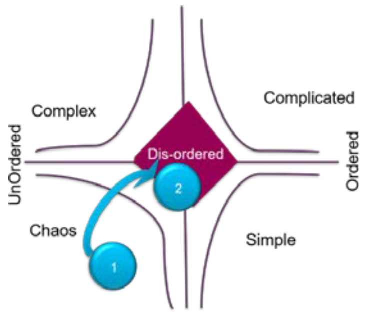

Figure 4 Transition domains from chaos to disorder

SHIFT FROM DISORDERED TO COMPLICATED DOMAINS

Participant 5 recorded two real-time events, but the micro narratives described the impact of only one of the two on the decision process. The cancellation of the project shifted them from Confusion and Conflict on a sideline matter (how to define probability) to a more relevant matter in the simulation. This moved the decision-making from Disorder to the Complicated domain when they started working on known information with analytical tools. Figure 5 illustrates this.

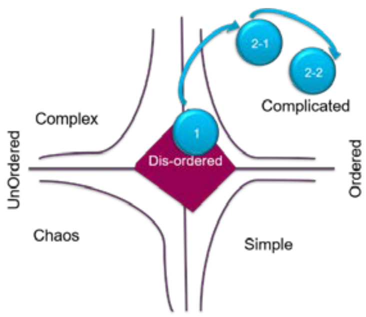

Figure 5 Shift domains from disorder to complicated

MOVEMENTS BETWEEN COMPLICATED AND COMPLEX DOMAINS

Participant 6 reported two real-time events. The future backwards approach was used to write the micro narratives. In this case, the cancellation of a project was treated positively, resulting in no change to the complicated domain to use analysis and expertise to find the best solutions. However, the second real-time event moved the new group into the Complex domain, as one of the participants could not cope with the change properly (Figure 6).

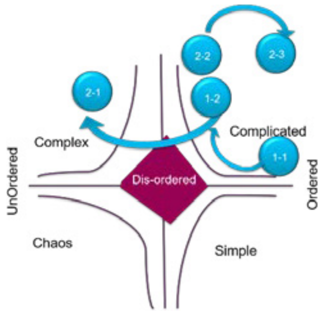

Figure 6 Shift domains between Complicated and Complex

Findings

Key findings in relation to real-time events of the data analysis are listed here:

1. Emotion of decision makers during the simulation Hooshmand-1 scenarios and the real-time event of project cancellation by a client were identified as two impact factors on individual judgement. These impact factors influenced individual perceptions for identifying sources of uncertainty during simulation and decision-making.
2. Organizational changes and decisions by a client to cancel a project were two impact factors on individual judgement for identifying key drivers for final group decision of project portfolios. The factors are influenced by real-time events as per participants' perceptions.
3. Decision-making processes are influenced by real-time events and turning points and decision style of participants
4. Participants adapted to the change to adjust decision-making processes after turning points or real-time events.

This research has resulted in a broad range of findings that can make crafting propositions quite difficult. However, at this stage the results support these two specific propositions.

Proposition 1: A successful model for decision-making of project portfolios in uncertain situations shall consider teamwork, decision makers' feelings and emotions, and the organizational roles as the three key success factors.

Proposition 2: Diversity of decision makers should be encouraged for significant decisions across organizations. This diversity will help counter the unconscious bias of decision makers when selecting criteria and assessing the final quality of decisions.

Three factors were found to affect decision-making:

- The complexity of dealing with unpredicted changes
- Organizational capacity to handle changes
- Individual decision makers' ability to manage decisions in uncertainty

Rational and information-based decision-making strategies that are usual for major projects and strategic initiatives do not effectively deal with significant and unexpected change. This indicates a lack of knowledge about risk management in project portfolio management. Furthermore, poor establishment of information systems and communication in organizations can threaten the success of decision-making for project portfolios if sudden changes are ignored during the process of decision-making. Future research should focus on the "soft factors" techniques and tools which enable decision makers to resolve issues that have their roots in more than one Cynefin domain of knowledge.

Conclusion

As decision makers for project portfolios get exposed to unexpected change events in their decision-making, the importance of research identifying sources of uncertainty and mechanisms to manage them becomes significant. Increased global uncertainty has raised the vulnerability of business leaders to deal with unanticipated change. Project portfolio management has already been a competitive advantage for both service and industries as it facilitates communication of internal and external stakeholders for decision-making on portfolios of projects in a planning time frame. However, previous research into portfolio decision-making has not focused on how decision makers address unexpected change.

This research extends previous researchers' works on increasing the readiness of industry to deal with uncertainty. Mechanisms such as engagement with decision makers' emotions, team works and diversifications were identified as procedures that help practitioners with some guidelines on how to tackle real-time events during decision-making.

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About the Authors

Saeed has over 21 years' work experience in construction, manufacturing and infrastructure projects in private and public sector. He graduated in Bachelor of Industrial Engineering in 1999, and recently finished his PhD degree in project portfolio management in University of Technology Sydney in 2018. He is a PMP certified member of PMI and an active member of PPM specialist group. He is also an academic member in school of built environment, UTS since 2016. As a senior manager, he has led consulting services in program, project and portfolio management in Jacobs for major clients such as Sydney Metro.

Elyssebeth is an academic and consultant. Based in Sydney she specialises in the creation and management of high energy learning environments using action and experiential learning, simulations and games. She is an experienced communicator and learning facilitator, as well as a designer of simulations and games. She works in multi-cultural contexts and publishes books and articles on educational design and theories and uses of simulation. In 2017 she was awarded the Ray Page Award for Lifetime Achievement in Simulation.

Julien is currently an Associate Professor, in the School of Civil Engineering, at the University of Sydney. He started working in project management in the public sector delivering organizational change projects, where he completed an Action Research Ph.D. This research won national and international awards. Following this, he managed telecommunications and heavy engineering projects, before joining academia in 2011. His research has focused on two broad themes: trends in project management research; and developing project management practice to meet the needs of ambiguous and contested projects, drawing on systems thinking, complexity theory, and change management.

Shankar Sankaran is a Professor of Organisational Project Management at the University of Technology Sydney, Australia. He teaches advanced level subjects in a Master of Project Management at his University including Governance, Portfolio and Program Management. His research interests are in organizational project management, systems K?@EB@E>R8E;R8:K@FERI<J<8I:?UR%<RN8JRK?<RGI@E:@G8CRJLG<IM@JFIRF=R!IRO8<<; Shalbafan who used simulation as a research methodology in his investigation of decision making in complex situations in project portfolio management. Shankar is a Fellow of the Action Learning and Action Research Association.R