Visual project mapping of project interdependencies

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Abstract

The research presented in this paper tests a network mapping approach called visual project mapping (VPM) as a tool for managing project portfolio interdependencies. Project portfolio management (PPM) approaches provide a holistic framework for the strategic management of the project portfolio to enhance the return from project investments. However, despite the increasing maturity of the project management (PM) and PPM disciplines, a large percentage of projects still fail and the management of complexity and project interdependencies is not well addressed. The findings of the exploratory study suggest that VPM may provide benefits, however further research is required to better understand whether and how VPM can enhance an organisation's PPM capability, and how VPM representations can be best constructed, interpreted, and used in practice.

Introduction

Project portfolio management (PPM) approaches provide a holistic framework for the strategic management of the project portfolio to enhance the return from project investments. However, despite the increasing maturity of the project management (PM) and PPM disciplines, a large percentage of projects still fail. Research studies regularly report disappointing project success rates of between 30 and 60 per cent (Cooper, Edgett, & Kleinschmidt, 2001; Griffin, 1997; Jenner, 2009; Tidd, Bessant, & Pavitt, 2005). There is significant scope for improved project success rates, and organisations actively seek new methods that may boost the return on their project investments. An identified area of weakness is the management of complex project portfolios with multiple project interdependencies (Elonen & Artto, 2003; Rungi, 2007).

The research presented in this paper aims to help improve PPM capability by testing the use of a new type of visual representation called visual project mapping (VPM).

This paper first overviews project portfolio decision-making practices and then focuses on the problems associated with the management of project interdependencies. Network mapping approaches as applied to a range of applications are presented followed by a proposal that such approaches may be useful for the management of project portfolios. The methods used for this research are followed by the findings, discussion and concluding sections.

Project portfolio decision making

PPM processes help organisations manage their project portfolios through a range of tools and methods designed to generate and evaluate project information and to steer decision making to maintain a balanced project portfolio that is aligned with strategic goals (Cooper et al., 2001; Levine, 2005). The literature suggests that the successful management of project portfolios extends beyond the processes used and that the organisational structure, people, and culture are also important aspects of the overall PPM capability (Killen & Hunt, 2010). Research repeatedly shows that a PPM capability must be developed over time (Cooper et al., 2001; Eisenhardt & Martin, 2000; Martinuso & Lehtonen, 2007) and that, although a range of methods and tools are commonly used for PPM, they must be tailored to the individual environment for best results (Loch, 2000). The proliferation of 'best practice' studies and maturity models highlights the relationship believed to exist between PPM maturity and improved outcomes (Kahn, Barczak, & Moss, 2006; O'Connor, 2004; Pennypacker, 2005; PMI, 2003). Similarly, the strong focus on processes and methods for PPM reflects a belief that these processes and methods can improve PPM outcomes (Archer & Ghasemzadeh, 1999; Phaal, Farrukh, & Probert, 2006; PMI, 2006); indeed, empirical research provides evidence of some practices that are associated with improved outcomes (Cooper et al., 2001; De Reyck et al., 2005; Jeffery & Leliveld, 2004; Killen, Hunt, & Kleinschmidt, 2008).

Research indicates that 'best practice' organisations make PPM decisions in meetings, and use graphical and visual information displays such as portfolio maps and roadmaps to facilitate the group decision making (Christensen, 1997; De Maio, Verganti, & Corso, 1994; Killen et al., 2008; Mikkola, 2001; Rungi, 2007). These graphical forms of communication can illustrate complex multi-dimensional aspects of organisations in a simple and powerful manner (Meyer, 1991). Visual information enhances analysis because is it cognitively processed while preserving spatial orientations and interrelationships between multiple

components, whereas alphabetic, numeric, and verbal forms of information do not have that ability. Visual displays are shown to aid in the attention, agreement, and retention of strategic information (Kernbach & Eppler, 2010). Portfolio maps display projects and the strategic options they represent on two axes, augmented with additional data to provide a visual representation that incorporates information such as strategic alignment, risk, return, and competitive advantage (Cooper et al., 2001; Mikkola, 2001; Phaal et al., 2006). Roadmapping tools use visual representations of the timing of sequenced and linked development stages for planning and communication and for assisting with the integration of business and technology strategy (Albright & Nelson, 2004; Groenveld, 1997; Phaal, Farrukh, & Probert, 2001). Due to the multiple types of data represented, these types of visual displays are often called two-and-a-half dimensional (2½-D) displays (Warglien, 2010).

Management of Project Interdependencies

Project portfolio decision meetings require that the members of the portfolio review board consider a wide range of factors. Interdependencies are acknowledged as important factors (Söderlund, 2004; Stummer & Heidenberger, 2003), however current PPM tools and techniques do not address such interdependencies well – in particular multi-level dependencies. Projects are said to be interdependent when the success of a project depends upon other project(s). For example, projects may experience resource interdependencies (the need to share resources or wait for scarce resources until they are released by another project), market or benefit interdependencies (complementary or competitive effects), outcome dependencies (the need to use the end result of another project, such as technical or other outcomes), learning dependencies (the need to incorporate the capabilities and knowledge gained through another project), and financial dependencies (Blau, Pekny, Varma, & Bunch, 2004; Eilat, Golany, & Shtub, 2006; Verma & Sinha, 2002).

To support project portfolio decision making, organisations need to be able to capture, codify, and share data from previous or concurrent projects (Kim & David, 2007) and to view that data from a portfolio perspective (Cooper et al., 2001; Durant-Law, forthcoming; Levine, 2005; Mikkola, 2001). Resource dependencies are often addressed by scheduling optimisation systems (Archer and Ghasemzadeh, 1999); however these types of systems require large amounts of numerical input and are not considered useful in many PPM environments. Dependency matrices are a more common method that are used to provide a view of interdependence between projects (Dickinson, Thornton and Graves, 2001; Slade 2009). A dependency matrix uses a two-dimensional grid to show inward and outward project dependencies in the rows and columns, however it is difficult to view accumulated or multi-level interdependencies using a dependency matrix.

Network Mapping and Analysis

Network mapping has applications in a range of fields including organisational, mathematical, biological, and economic modelling (Hanneman & Riddle, 2005). Network mapping displays relationships between nodes in a network at multiple levels and reveals accumulated effects (Scott, 2008). The mapping uses software-based tools that help to record, analyse, and visually display the relationships between items or *nodes* in a network. The graphical displays provide an intuitive and easy-to-interpret format that can help reveal patterns more clearly than verbal explanations or matrix displays of data (Hanneman & Riddle, 2005).

Social network analysis (SNA) and the related organisational network analysis methods are common applications of network mapping where relationships between people or organisations are analysed and presented in a visual form (Anklam, Cross, & Gulas, 2005). The network mapping exercise involves collecting data from people representing each node of the network on their interaction and relationships with other nodes. SNA is shown to be an aid to understanding and improving relationships between networks of people or organisations, promoting collaboration, supporting critical nodes in the network, and managing and maintaining networks during organisational restructuring (Cross, Borgatti, & Parker, 2002; Scott, 2008; Wasserman & Faust, 1994).

Visual project mapping for understanding project interdependencies

This research proposes that a network mapping approach may support strategic project portfolio decision making by providing a visual representation of the interdependencies between projects. Research findings illustrate the benefits of visual displays for strategic decision-making, and one early tests of the use of VPM indicates that network mapping and analysis can be useful for project, program, and portfolio management (Durant-Law, forthcoming).

Visual project mapping (VPM) is the name of a technique developed for this research to create network maps of project portfolios and the interdependencies between projects. VPM considers each project as a node in the network and captures and displays information on the relationships or interdependencies between nodes

using arrows, as shown in Figure 1. There are many options for VPM displays; for example, in Figure 1 the circles representing each project (node) are sized according to the level of importance based on accumulated dependencies. Alternatively, the size and colour of the circle can be related to the project characteristics such as the size of the investment or the area of responsibility. In addition, the strength or type of interdependency can be indicated through the use of arrows of a different line weight or of different colour. The use of NetDraw (Borgatti, 2002) allows VPM displays to be dynamically filtered, rearranged, and displayed in a number of ways to highlight different types of data and relationships. By allowing a subset of data to be displayed, filters provide the ability to highlight critical connections or selected information.

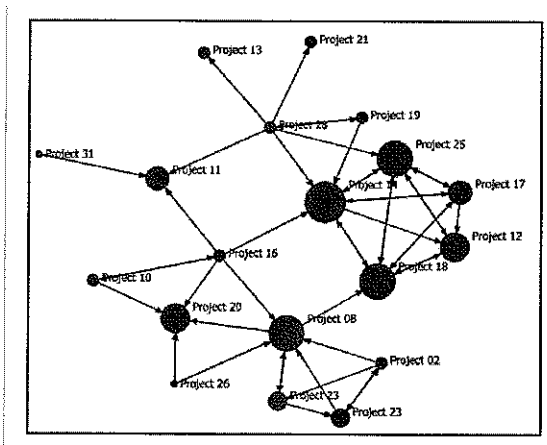

Figure 1: Example Visual Project Map (VPM)

Method

This paper reports on an exploratory study that tested the use of visual project mapping (VPM) displays for understanding project interdependencies in strategic project portfolio decision making. Two organisations were selected that represent diverse project environments; one in the public sector (defence) and one in the private sector (telecommunications).

The initial phase of the research comprised semi-structured interviews, phone conversations, and analysis of project and portfolio documents and information to qualitatively evaluate the organisational environment and the nature of the interdependencies, and to determine the bounds of the portfolio for the study. Both authors and a research assistant conducted the interviews to reduce bias and to enhance the ability to collect, interpret, and analyse the qualitative data. The initial interviews lasted for 1.5 hours with two representatives from Org1 (telecommunications) and 1.75 hours with two representatives from Org2 (defence).

In the second phase the project managers responsible for each project in the portfolio being analysed were asked to input data on the dependencies between their project and other projects in the network using the ONA Surveys survey tool[1]. The tool was customised for this research to allow each project manager to select projects from a list or to nominate other projects on which they are dependent to deliver their project, or that they believe depend upon their project. The respondents then categorised each dependency with respect to the strength (minor, important, and critical) and type (outcome, learning, resource or other type) of dependency. This data was used to map project interdependencies by VPM using network mapping and analysis tools (Borgatti, 2002). Data was collected and mapped for 24 projects in Organisation 1 and 34 projects in Organisation 2.

The third and final phase of the study involved collecting rich qualitative data during a semi-structured two-hour feedback session with three senior portfolio managers and executives at each organisation, with a second feedback session (45 minutes) conducted at Org2 to allow an additional high-ranking executive to review the results. Prepared VPM displays were presented followed by a 'live' session where the displays were interactively filtered and adjusted. This allowed us to generate what-if scenarios and specifically filtered displays based on the executives' interests. These sessions were conducted using a semi-structured question format. The feedback was collected through careful recording of the high-level portfolio stakeholders' structured and spontaneous reaction and their responses, questions, and discussions as they were viewing the maps.

Findings

The feedback sessions explored three main questions. A brief summary of the feedback is reported below in sections for each of these questions.

Are the VPM displays easy to interpret? The VPM displays use circles for each project and arrows to indicate which project depends upon another project, as shown in Figure 1. The direction of the arrow can be set in either direction, and this can be customised as desired. For this research the VPM displays were created with arrows pointing from a dependent project to the project it is dependent upon. Some managers initially thought

[1]ONA Surveys is a tool for capturing network data for display in network maps—www.ONAsurveys.com.

that the arrow may indicate a dependency flow, which would represent the opposite direction. Therefore it was highlighted that it is important to introduce the mapping conventions for the information to be interpreted correctly. Once introduced, most managers they felt that the VPM displays were clear and logical. The portfolio manager [p1] at the first organisation [Org1] could see "flow patterns from the data that were easy to interpret" [Org1p1]. A high-ranking decision maker at Org2 exclaimed that the maps provided the ability to "see the connections and where the work needs to be done ... it is like moving from a 2D to a 3D picture!" [Org2p1] and commented further, "it does add value to me and I can see (the relationships) which I had not seen before. You can see the connections, that is excellent" [Org2p1].

VPM displays can be presented in a number of formats and participants acknowledged that the best type of display would depend on each individual situation. Managers at Org1 suggested that if organisations were using VPM regularly it would be best to adopt a few standard formats so that the maps could be quickly and easily interpreted.

Were any new insights gained from the maps? Both organisations gained new insights by viewing their project interdependencies in the VPM format. The maps provided some very powerful insights for Org2 in particular, prompting action on one project issue. Some of the insights resulted from the maps presenting information in a new way, making connections easier to grasp ("there is a forest of information within project portfolios and the network maps allow you to see the 'bang for buck'"[Org1p1]), and other insights stemmed from the data being collected from the project managers and providing information not previously available ("We have new information available here, that hasn't existed before to help us make decisions and justify actions" [Org2p2]). Other managers commented, "I'll tell you, ... this brings dependencies out to the light, and gives me a better appreciation (of the dependencies)" [Org1p3] and "the maps allow bottlenecks to be predicted within projects and external to project ... and allow for the prioritisation of projects to show the risks in following through with a decision"[Org1p3].

Participants also identified more general insights, with the maps providing a useful antidote to the tunnel vision that can be caused by the increasing specialisation in the workforce. In the increasingly technical and complex project environment, specialisation is necessary, but it can limit strategic vision. Participants felt the maps helped to "contextualise the information" and provide a vision across the specialisations [Org2p1].

Do you think the use of VPM could provide benefits to organisations? The main benefits in both organisations were related to communication and decision making, although the managers had different views of the relative benefits. For example, one manager at Org1 saw the value of the maps mostly at the decision-making level because "they add rigor and transparency" [Org1p1], but another manger felt that the maps would be more useful for communicating the decisions than making the decisions [Org1p2]. At both organisations, participants felt the maps were very useful for communicating the portfolio interdependencies, both upward to support strategic decision-making and downward to help individual project managers understand priorities from a portfolio perspective. The maps were "definitely a very good communications tool, REALLY good" [Org1p3] and very powerful for getting senior manager support with the "direct evidence" the maps provided [Org2p2]. The value of such maps was particularly strongly emphasised at Org2, where a senior decision maker commented that with the visual representation of the data one could "go straight in" and make decisions or take action: "you are on a winner here" [Org2p1].

Managers reported that the use of VPM on an ongoing basis in an organisation presented some potential challenges. The method of data collection used for the research has generated a snapshot of the project portfolio at a given point in time; however, both organisations agreed that developing a method to regularly refresh the data to reflect the dynamic portfolio would be even more useful. Planning the appropriate frequency for refreshing the data was one challenge [Org2p2], and both organisations pondered whether it might be practical to identify and capture the incremental changes as they occur, rather than performing a complete survey of the relationships periodically. A manager at Org1 said that there were methods in place that could probably be adapted to automatically refresh the VPM data [Org1p2]. In addition to incremental updates of the maps, managers felt that displaying a future scenario using the maps might be useful, while one manager questioned, "How would the maps be affected if a project was completed? How could this be shown in order to then see future interdependencies?" [Org1p1].

In summary, the qualitative findings from the feedback sessions indicated that the VPM displays helped illuminate the relationships between projects and provided new insights to the high-level portfolio stakeholders at the two organisations. Both organisations thought that benefits from using the maps would come primarily from their use as decision-making and communication tools. Although both organisations were quite positive

about the maps overall, managers at Org2 were particularly enthusiastic and specific about the benefits, especially as a tool for informing strategic management decisions.

Discussion and Conclusion

It is generally accepted that organisations need to understand the interdependencies between projects in order to strategically manage their project portfolios. This research has generated insights on how organisations may be able to improve their understanding of project interdependencies by testing the creation of visual network maps of project portfolios through VPM. Findings indicate that VPM can offer insights that improve understanding, and that it has the potential to provide benefits as a decision-making and communications tool. The findings align with and extend existing research. For example, the comments by Org1 regarding the need to adopt a few standard VPM formats follow common PPM approaches where templates and standard formats for graphs and portfolio maps are developed and adopted to assist with analysis and comparison (Cooper et al., 2001; Loch, 2000). In another example, the comment by Org2p1 that viewing a VPM display was like going from "2D to 3D" aligns with literature that suggests that a well designed visual information representation in 2D can, in effect, be more than a 2D representation (2½-D is suggested in the literature) due to its power to provide rich and complex information (Warglien, 2010).

Limitations and Future Research

The findings suggest that VPM may become one of the tools identified as useful for PPM; however, further research is required to better understand whether and how VPM can enhance an organisation's PPM capability, and how VPM representations can be best constructed, interpreted, and used in practice. This research used responses from project managers to develop the VPM displays. This may not be the best source of knowledge about project interdependencies and the use of other sources of information about interdependencies should be explored. In addition, future research should evaluate the effectiveness of methods of updating VPM displays to represent dynamic project portfolio environments.

This is the first stage of an exploratory study involving two organisations. Further research with other organisations and industries is required to verify or extend these findings and refine insights into the factors that affect an organisation's understanding of project interdependencies.

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