Available online at www.sciencedirect.com

SciVerse ScienceDirect

International Journal of Project Management 31 (2013) 804–816

International Journal of Project Management

www.elsevier.com/locate/ijproman

Evaluation of project interdependency visualizations through decision scenario experimentation☆

Catherine P. Killen *

University of Technology, Sydney, School of Systems, Management and Leadership, Faculty of Engineering and Information Technology, PO Box 123, Broadway, NSW 2007, Australia

Abstract

The interdependence between projects in complex portfolios sharpens the challenge of project portfolio decision making. Methods that assist with the evaluation of data can address decision challenges such as information overload and time pressure. A decision simulation in a controlled experiment explored the use of visual representations of project interdependency data to support project portfolio decision making. Dependency matrices and network mapping were compared with non-graphical lists of dependency data. The findings show that the type of tool used may influence the quality of the resulting decision. Using visual tools, particularly network mapping displays, is correlated with the best results.

The research provides a practical example of experimentation in project and portfolio management research and illustrates how such studies can complement organization-based research. Findings of interest to management include the importance of ensuring adequate time for decision processes and the potential benefits from using visual representations of project interdependence.

Keywords: Visualization; Data representation; Experimentation; Project portfolio management; Decision making

1. Introduction

Project portfolio management (PPM) is of growing importance in an increasingly complex project landscape (Cicmil et al., 2006; Jonas, 2010; Levine, 2005). By managing projects from a portfolio level and evaluating all projects and their interrelationships, PPM aims to improve the performance of the project portfolio as a whole. Project portfolio decisions require managers to analyze a variety of information in limited time. These portfolio-level decisions affect the success of the portfolio by ensuring resource adequacy, dynamic agility, and strategic alignment using a portfolio-level rather than a project-level perspective (Floricel and Ibanescu, 2008; Petit, 2011). PPM processes are designed to assist such decision making by providing a holistic view of the project portfolio, ensuring that data are available and offering tools and methods to collate and analyze project data (Cooper et al., 2001; De Reyck et al., 2005; Kester et al., 2011).

Portfolios of complex and interdependent projects are particularly challenging for decision makers and there is an identified need for better tools to understand and manage project interdependencies. New processes, tools, and techniques are regularly proposed and evaluated in PPM literature and research (Archer and Ghasemzadeh, 1999; Dawidson, 2006; Dickinson et al., 2001; Kester et al., 2009). Case studies and action research are commonly used to test the application of new tools or methods for project management or PPM. However, measuring the effect of a new tool or method is difficult because each organizational environment is different and there are many uncontrollable factors that influence project performance. Organizational research settings do not provide a reliable and static environment where it is possible to generalize findings by testing the effects of changes in a systematic method in an experimental fashion.

☆ Note: This paper was presented at the EURAM 2012. The valuable feedback from the conference and journal reviewers has been incorporated in this paper.

* Tel.: +61 2 9514 1830; fax: +61 2 9514 4492.
E-mail address: c.killen@uts.edu.au.

0263-7863/$36.00
http://dx.doi.org/10.1016/j.ijproman.2012.09.005

This paper outlines the use of controlled experimentation in a classroom setting to test the ability of visual data representations of project interdependencies to support PPM decision making. The ultimate aim of the research is to develop understanding of the relevant factors and tools to improve decision quality. The research reported in this paper also provides an example of the use of experimental decision simulations for PPM research and explores what can be learned from such experimental studies.

2. Literature review

2.1. PPM decision making and project interdependencies

PPM processes are a set of organizational activities that provide a holistic framework for the management of the project portfolio. By managing project investments from a portfolio level and allowing opportunities for new projects to be considered along with decisions about whether to continue investing in existing projects, PPM provides a high-level strategic perspective that enables organizations to identify and respond to trends and opportunities. PPM decisions require consideration of multiple factors and the ability to envision alternative future consequences of project decisions across a portfolio.

Best practice studies indicate that high-performing organizations use carefully compiled executive-level teams, often called portfolio review boards (PRB), to make portfolio decisions (Cooper et al., 2001; Dickinson et al., 2001; Killen et al., 2008). The PRB usually consists of experienced managers who represent the breadth of functions or divisions affected by portfolio decisions. PPM activities include the collection, collation, and presentation of up-to-date information on the existing and proposed projects to inform PRB decision making. Managing a portfolio of projects represents a complex multi-dimensional decision challenge. Information on aspects such as strategic alignment, financial projections, project status, market trends, the availability of skills and resources, and sources and levels of risk must be considered and balanced across the portfolio (De Reyck et al., 2005; Levine, 2005). Visual representations of data, such as 2 × 2 risk-reward portfolio maps, are regularly used to support PRB discussions and balancing decisions (Mikkola, 2001). The use of such visual data representations is correlated with better portfolio performance (Cooper et al., 2001; Killen et al., 2008).

The challenge of managing a portfolio of projects is amplified by the presence of interdependencies (Collyer and Warren, 2009; Perminova et al., 2008). It is widely accepted that organizations must be able to understand the dependencies between projects in their portfolio in order to make appropriate project decisions for the best portfolio outcomes (Verma and Sinha, 2002; Blau et al., 2004; Rungi, 2007). Many PPM tools and methods, while providing a portfolio-level perspective for balancing project decisions, still treat each project as an isolated entity. Projects are said to be interdependent when the success of a project depends upon another project. A portfolio-level perspective is required to reveal such inter-project effects; however, these effects can be complex and difficult to predict (Aritua et al., 2009).

As PPM matures and project complexity and interdependency increase, it is no longer sufficient to apply traditional PPM tools that consider projects as independent of each other. PPM processes and tools exist to help managers identify the dependencies so they can make project decisions with the understanding of the possible flow-on effects to other projects in the portfolio (Shenhar et al., 2001). Interdependencies are often identified in project databases and dependency matrices. Dependency matrices allow interdependencies to be visualized on a two-dimensional grid that displays dependencies between each pair of projects in a portfolio (Danilovic and Browning, 2007; Dickinson et al., 2001). Such tools are limited to dependency pairs and do not readily illustrate multi-step dependencies. For example, when a first project is dependent on a second project that in turn is dependent upon a third project, a dependency matrix does not identify a relationship between the first and third projects. The management of interdependences is acknowledged as an area of weakness for PPM (Elonen and Artto, 2003). To meet the challenges of PPM, especially as complexity and uncertainty increase, researchers are active in developing and evaluating new decision-making tools (Aritua et al., 2009).

2.2. Bounded rationality and PPM decision making

Management decisions such as PPM decisions must often be made by considering multiple criteria and large amounts of data. However, humans are subject to 'bounded rationality', which limits their ability to interpret data and make rational decisions (Simon, 1955). According to the bounded rationality concept, three elements affect decision-making capability: the lack of complete and accurate information, the human cognitive limitations in interpreting the information, and the finite amount of time available to make decisions. All three of these elements contribute to the challenge of PPM decision making, especially in complex and dynamic environments.

The need for compete and up-to-date information to inform decision making is one of the primary drivers of PPM implementation. Data completeness and accuracy present a constant challenge, especially in dynamic environments or where projects are diverse in type, region, or sponsorship. PPM aims to provide a holistic and consistent framework for PPM decisions that enables data to be collected and presented uniformly. However, it is difficult to obtain complete and accurate data and to present all of the possible information. Therefore PPM approaches aim to filter and present the data in a manner that highlights the most important information.

Most PPM decisions involve human judgment, often in a PRB where each individual's experience, diversity, and judgment contributes to a powerful team perspective for decision making. However, human decision makers work within cognitive limits. Experiments have revealed the limitations in human capability to recognize interdependencies and resultant flow-on effects from their decisions and actions in complex systems (Doerner, 1989). Complex and critical decisions are particularly affected by human cognitive constraints (Foreman and Selly, 2002). While human capabilities are limited, research suggests that visual data