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A Visual Exploration Approach to Project Portfolio Management

Extended Dissertation Abstract for AMCIS 2007 Doctoral Consortium

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Introduction

Defining projects is a very common method to manage operational goals and activities within an organizational unit. It is also effective to form organizational or cross-unit project teams to carry out strategic business activities. In fact, many organizations (and their major departments overseeing organization-wide resources such as information technology) are becoming project-oriented (Artto 2001, Gareis 2000). The major concern in these organizations or departments is the management of their projects in an effective and efficient manner. This requires clear understanding and communication of project status of each project, as well as balancing allocation of resources and their contribution to the overall organizational goals. A Project Management Office (PMO) is usually established to take such responsibility and an approach commonly understood as project portfolio management (PPM) is adopted. In PPM, all projects are managed as a group (a portfolio), which is treated as a basket of investments that can balance risks and returns. Besides following traditional single project management practices, such as defining, estimating, scheduling, tracking, and optimizing the tasks and resources required to plan and complete a project (IDC 2006), it also manages these projects at a higher portfolio level. Examples of common activities in PPM and decisions to be made are (Reddy 2004):

- Aligning business goals and IT projects (CIO level)
- Determining whether teams are working on the right projects (CIO level)
- Assessing and communicating portfolio status (program manager/director level)
- Prioritizing initiatives, resources, and assets (program manager/director level)
- Predicting project outcomes, assessing project status, and identifying inter-project dependencies (project manager level)
PPM is commonly perceived to be able to bring to the organization benefits such as cost saving, better communication, better resource allocation, and balanced risks and return (Brandon 2006, Cooper et al. 2000). However, despite such awareness and interest, few organizations appear to maximize its value that can be obtained from project portfolio management. In a pertinent survey (Leliveld and Jeffrey 2003), while 89% of the respondents were aware of the concept of portfolio management, only 14% of them used some kind of tools and 31% planned to use. Moreover, many manager and executives don’t have a strategically sense about and control of all their projects and are missing the big picture. Besides the reasons such as lack of training and culture, some top reasons are related to the inadequate support of software tools for portfolio management activities such as strategy alignment, project prioritizing and portfolio balancing (Cooper et al. 2000). A review of current PPM tools also indicates that although many systems offer transactional or operational functionalities to store and manage project data, there are few analytical and mapping capabilities (especially those can deal with complex high dimensional data) which are appropriate and easy-to-use for business users.

Traditional analytic approaches and tools are usually classified into three categories (Dickinson et al. 2001): 1) mathematical models which borrow from management science and financial management domain, usually with a focus on maximizing value; 2) classic indexes, using rankings, ratings and scores, which quantify complex project information into one or several simple numbers or categories; 3) mapping approaches, quadrants/matrix and grid models (Cooper et al. 2000, Ghasemzadeh and Archer 2000). But these approaches have limitations and challenges:

1. The Leliveld and Jeffrey (2003)’s survey indicated a financial skill gap in IT personnel (46% of the respondents). The skill is not about knowing and calculating financial indicators but the ability to apply them and interpret data. Many find mathematical models are not easy to understand and apply in daily practices. Tracking return and cost is a difficult task because they are volatile data.

2. Projects have complex and huge volumes of data with over hundreds of attributes. There is no consistent classification of projects and it is more a company-specific function (Leliveld and Jefffrey 2003). Indexes or scores can significantly reduce the amount of information and simplify the decision making process, but at the same time these numbers may only offer a limited view of the projects and the organization, and may potentially hide useful and relevant information.

3. Decisions are unstructured, usually involving multiple sources of information and human intuition. Diagramming tools usually help because their capability to give a direct impression of complex data and comprehend information in an intuitive way. But traditional quadrant or matrix diagrams usually model only 2 dimensions, such as risk vs. return, cost or time frame (while the use of color, size and shape increases the dimensions in a 2D map, the map is fundamentally constructed based on only 2 dimensions). Trying to fit high dimensional information into these predefined static models often lowers the richness of project information.
To address the above challenges, new approaches are needed to deal with rich project information and provide stronger support for decision makers. This leads to the general research question of this dissertation:

*How to provide better decision support in project portfolio management through analyzing project data?*

A desired approach has at least two requirements to be satisfied. First, it needs to handle multi-dimensionality of project data and provide a big picture for a better overall sense of projects. Second, the approach should be easy to understand and use by IT executives and managers. Based on these two requirements, I propose a clustering and visual exploration approach that is expected to address the problem and improve the outcome. Clustering is a general data mining method that groups objects based on their properties without predefined groups (Jain et al. 1999). It is used widely to analyze multi-dimensional information. Further, visual information exploration can better incorporate an expert's strength of intuition and comprehension in the decision making process. A combination of clustering and visualization is expected to be the basis of a potential analytic approach for project portfolio management.

Thus more specific research questions related to the proposition are:

1. *How can a clustering and visualization based analytic approach provide better project portfolio analysis?*
   1a. *How can clustering be used for IT managers to comprehend project portfolio?*
   1b. *What kind of information presentation and interaction model is effective for project portfolio management decision makers when exploring project information?*

There are many different tasks and decisions in portfolio management. The proposed approach is not expected to address all of them. What are the ones that are well supported? What are the characteristics of these tasks? More specifically, I expect to develop an approach that is effective to address tasks such as: comprehending the complete portfolio, finding and comparing similar projects, avoiding redundant or overlapped projects, determining project priorities, creating a balanced project portfolio (financially or technically), assigning and allocating the right resources, and aligning projects with business strategy. This leads to the second specific research question:

2. *What kind of portfolio management tasks and decisions are well supported by such an approach?*

**Research methodology and plan**

The primary objective of this dissertation is to develop and evaluate an analytic approach intended to provide better portfolio analysis and decision support for project portfolio management. It is believed that knowledge can be generated through designing such an approach and implementing it into an artifact. Thus, this dissertation project will exercise the philosophy and principles from design science research in the Information Systems discipline (Hevner et al. 2004, Vaishnavi and
Design science research involves the development of IT artifacts to solve research problems and the evaluation of developed artifacts. I will follow a prototyping method that results in a software application prototype which will be evaluated by domain experts and users. Through this development (prototyping) process, the approach can be further understood, refined, and tested. I have been in contact with an IT department of a university in the Southeastern U.S. and have confirmed their support in a number of ways, such as data sources and evaluation participation. The department recently adopted a system to centrally manage key project information. This has provided the start of project data of good quality, including such data as title, abstract, begin/end date, high-level deliverable and task definition, sponsor, project participants, as well as some metrics on project status and optionally some project budget figures. The prototype will be used to iteratively refine the proposed approach based on such actual (real) project data from the department. Following Vaishnavi and Kuechler (2004)’s model of design cycle, below is a detailed description of research design and actives in each stage.

**Awareness of the problem (understanding of the problem)**

This stage is to identify and define the problem that will be addressed by the proposed research. The problem needs to be properly defined so that it is notable and worth further investigation. It also should be properly scoped so that the solution can be properly developed and effectively evaluated. In this stage, I have identified the problem mainly from literature of the IT project management and real world experience. I conducted a review of current tools and methods used to manage and analyze projects as a portfolio. I also have been communicating with the IT department regarding its project management practices. Through these activities, I was able to appropriately identify and scope the problem to address a gap in research and practice, which is the lack of analytic support in current project portfolio management approaches and systems.

**Suggestion (proposing a solution)**

This is an exploratory phase to gain further insight into the problem domain and form a basic solution through initial analysis and design. I have been conducting a case study of project portfolio management with the university’s IT department. During this case study, I have been engaged with the department through various activities, such as participating in meetings, interviewing, and examining related documents, reports and tools. The purposes of this case study are three fold: 1) I need to have a solid understanding about the problem domain and be familiar with business needs. This helps me complete basic requirement analysis; it will also enhance the relevance and potential usefulness of the proposed approach. 2) I need to identify, collect and analyze specific project data. The expected prototype is intensively dependent on these data. 3) I need to find methods for future evaluation of the prototype system when it is completed. The evaluation will be better when the use of the prototype system is closely related to daily practices of project portfolio management.
Based on initial findings from the case study, as well as my relevant past research experience, I propose a visual knowledge exploration approach to project portfolio management. The approach is a process of visual knowledge exploration based on clustering of high dimensional project information and interactive information visualization (Figure 1). Initial design consists of the following elements:

1. **Analyzing project portfolio through data clustering techniques.** Projects are usually described by attributes such as size, owner, budget, status, purpose, etc. Each attribute is a dimension of project data. Traditional reports and mappings are based on only one or two of these dimensions. The proposed approach will utilize high dimensional analysis techniques such as clustering (Wang and Yang 2005) to explore associations and distributions of projects. A specific clustering technique, Self-Organizing Maps (SOM) (Kohonen 1995) will be the focus because SOM inherently provides a 2D map on which complex high dimensional data can be effectively mapped.

2. **Presenting usable and understandable information visualizations and interaction models for decision makers.** In a highly volatile and complex environment like business operations, it is important to include human thinking and perception in the information exploration process (Keim 2002). Effective information visualizations can improve human intuition and sense-making ability. Initial analysis indicates the following elements may be desired by business users, especially project management executives and managers:
   
a. A visual information exploration process (Keim 2002): big picture overview, sectional focus (zooming, filtering, distortion), unit details on demand, and dynamic visualization adjustment and rebuilding. In this process, the reference project sets can be used to help interpret the map.
   
b. Iconic data item representation to enhance presentation (Keim 2002): labeling, coloring, shaping, highlighting, etc.
   
c. Visual comparison among visualizations, including supplement diagrams such as a quadrant or a radar diagram.

![Figure 1: A Visual Exploration Process for Project Portfolio Management](image-url)
3. **Supporting multiple management perspectives in both clustering and visualization.** Allowing multiple perspectives directly supports “what-if” analysis in the decision making process. This is reflected in both clustering and visualization. Clustering is based on selection of attributes (dimensions) of project data and coding of attribute values. The approach allows flexible selection and adjustment of project attributes to reflect multiple perspectives by different levels of management under different situations. Currently I am considering several options: 1) weighting of attributes; 2) grouping of attributes for focused analysis; 3) varying attribute value coding levels. For visualization, a number of techniques can support multiple perspectives in the sectional focus step, such as zooming, filtering and distortion.

**Development (prototyping)**

This stage is to implement the suggested design into a working prototype. I will adopt the prototyping method to develop an IT artifact that supports the visual exploration process for project portfolio management. Each of the features designed in the suggestion stage will be prototyped and possible options will be examined and prototyped. The prototyping process is an iterative process that the design may be modified if there are new understanding and new needs. Currently the initial system architecture is being designed and is expected to be finalized in July 2007. A complete prototype is planned to be working by the end of 2007. Then several rounds of refining, testing and improvement will take place during spring 2008.

**Evaluation (testing the prototype)**

This stage is to determine how well the prototype work to address the research question. Its evaluation results will directly prove the significance of the proposed approach. I plan to utilize the collaboration with the university IT department. One of the purposes of the case study mentioned before is to seek evaluation possibilities for the prototype. I plan to extend the case study to include prototype evaluations. Due to the lack of well established metrics and portfolio performance data, a qualitative method (mainly surveys and interviews) will be employed to collect system evaluation data. A set of hypothesis related to the usefulness and the ease-of-use of the prototype are set up. Fourteen management people in the IT department were identified as potential users who are relevant and familiar with project portfolio management activities; these include one CIO, six directors, four assistant directors and three project managers.

**Conclusion (summarizing outcomes)**

If the evaluation cannot achieve the desired result, the stages of suggestion, development and evaluation may iterate several times and circumscription knowledge (Vaishnavi and Kuechler 2004) is accumulated during this process. If the expected outcome is achieved, then I can draw a conclusion and summarize findings and knowledge generated from this project.
Expected contribution

The research’s contributions lie in two aspects. First, this research is expected to provide a better approach to project portfolio management. The approach addresses a knowledge gap in project management and IS literature where there is a lack of easy-to-use analytical approaches to dealing with multi-dimensional project data. Once fully developed and tested, the approach will provide better decision support and knowledge management in organizational project management. Second, a generalization of this approach, visual exploration of complex information, will expand our understanding and application of knowledge discovery techniques for general tasks. This will greatly help common users to gain useful and relevant knowledge from vast and complex information spaces.

References


