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Are project management standards ignoring the characteristics and needs of different types of projects?

Usually a standard is understood as a norm or requirement. As such it can help us to evaluate the quality of operations, and to develop the current processes further. For projects and their management a standard can also work as a common framework for unified operations and practices over organizational limits and even over national boundaries.

On the other hand standards and standardization have their limits and shortcomings. Standards present almost without an exception a consensual understanding and wisdom. They can thus be too much based on past experiences and knowledge. Standardization as a process has often an idiosyncrasy by trying to harmonize and homogenize the object in question. There is a danger that this anchors thinking and solutions in a way which can hinder the development of the profession itself.

International and national project management standards are instances where we can see kind of characteristics of standards discussed above. Harmonization and homogenization have produced elegant definitions of a project and the processes how the projects can be managed. On the other hand the knowledge captured in these standards should explain also how management requirements change or can change between projects of different scale and complexity. It is acknowledged widely that different projects need different project management solutions but the project management standards are almost completely failing to include this rather fundamental principle.

Typologies of Projects are the theme of this Project Perspectives issue. By this we are approaching research results and knowledge to cover different types of projects, their categories and relating project management solutions. Our profession is all the time expanding to cover projects of different disciplines, projects of varying scale, projects of varying degree of complexity and furthermore projects of varying roles within the involved stakeholders. These are examples of dimensions which can be used for categorizing projects. To embrace this diverse world of projects successfully it seems that we need a new kind of standardization paradigm. This paradigm should move clearly towards inclusion of knowledge and solutions that can successfully explain the wide variety of different projects and link those to their particular management solutions. Otherwise the linkage from a generic standard to the actual practice can be almost completely missing. It is our main message that the developers of international and national project management standards should put attention on project typologies and how these could help to explain the world of different management solutions.

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Most organizations recognize that the projects they fund and execute fall within different categories, but the discipline of project management has not fully recognized that these different types of projects often exhibit different life cycle models and require different methods of governance, prioritizing, authorizing, planning, executing, and controlling. In spite of this de facto categorization of projects, projects often exhibit different life cycle models and require different methods of governance: prioritizing, selecting, and controlling projects. The discipline of project management has not fully recognized that these different types of projects the same, and how are they different? Which aspects of project management can be standardized, and which cannot? Each project must be identified within a defined project category. The most important and the most useful breakdown is by type of product or deliverable that the project is producing, such as building a building, developing a new product, developing a new computer software program, or performing a maintenance turnaround or outage on a chemical plant or electric generating station.

Defining The Purposes Of Categorizing Projects

Strategic Project Management

The most effective method of categorizing projects for strategic management purposes is not the same as the best categorization method for operational project management purposes. These strategic purposes include:
- Strategic selection: Determining which potential projects are to be funded and executed.
- Project portfolio management: Determining the relative importance of selected projects to assist in allocating scarce resources.
- Strategic planning: Determining the most effective way of grouping projects within specifically defined project portfolios.
- Manage project portfolios: Designing, implementing, and operating the project portfolio management process of the organization.
- Allocate resources to portfolios and projects within portfolios: Deciding the best deployment of money and other limited resources across all project portfolios and among the projects within each portfolio.
- Other: No doubt other strategic PM uses can be identified.

Operational Project Management

This area of use is used for studies. Case studies related to each of the agreed project categories will be more detailed. The most effective method of categorizing projects for operational purposes is the best categorization method for operational project management purposes. There are many purposes for categorizing projects, and the many variations in the key characteristics that can exist within those categories. This paper summarizes some of the research done to date on this subject, briefly discusses the need for and uses of an agreed project categorization system, and proposes a first approach to establishing a number of broad categories based on the projects or ends resulting being produced by the projects.

Attributes of projects
- Application area or product
- Stage of life-cycle
- Grouped or single
- Strategic importance
- Strategic driver
- Geography
- Scope
- Timing
- Uncertainty
- Risk
- Complexity
- Customer
- Ownership
- Contractual

Any of these, or any combination of them, could be used to categorize a group of projects, depending on the purpose at hand. Perhaps the reason that little progress has been made to date in developing an agreed categorization system is the existence of this wide variety of project attributes and their various combinations.

Project Perspectives 2013

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Honorary Fellow APM/ IPMA, Fellow PMI, PMP USA
effective in the focused educational and training courses and programs.
- Organize speaker tracks at congresses: One of the major
problems for participants in large congresses on PM is how to choose which speaker track to attend. With tracks focused on specific project categories, this problem will be reduced significantly.
- Develop specialized certification of project managers: The most popular current PM certification programs (PMI and IPMA) purport to certify individuals in some aspects of PM without regard for any specific project categories.
- Develop specialized certification of PM support positions: Certification of project estimators and schedulers, as examples, for large engineering design and construction projects will require proof of very different knowledge, skills and capabilities than the equivalent support positions in research and development, new product development, or software development projects.
- Develop PM career paths for individuals: Career planning and development of PM career paths differ widely for many of the basic project categories that can be identified.
- Other: Certainly there will be other purposes and uses related to people development of a systematic definition of project categories.

Prioritizing Purposes and Uses
Each organization will benefit from examining the various purposes and uses that are important to them, and determining which purposes and uses are most important for their strategic growth. Then they can determine which of the several methods of categorization make the most sense within their political, business and economic environment.

Rather than elaborating and making the list of purposes and uses longer and more complex, it is recommended that efforts be directed at consolidating and simplifying them as much as possible.

Characteristics Of A Practical Project Categorization System
Hierarchical and Multi-Dimensional
A practical system for project categorization must be both hierarchical and multi-dimensional. The resulting categories must be based on the same hierarchical approach used in systematically defining a project, as in developing a project/work breakdown structure (P/WBS):

Category levels
1. Major category
2. Sub-category 2
3. Sub-category 3
4. Sub-category 4

Recommended Categories and Sub-Categories
Eleven recommended basic project categories are listed in Table 1, plus a twelfth category for all others, oriented primarily to project products or the projects. Projects within each of these specific categories have very similar life cycle phases and utilize similar authoring, planning, budgeting, scheduling, monitoring and controlling procedures and tools throughout their life cycles no matter where in the world they are located. Subcategories are also identified within most of these basic categories. In most cases there will be differences—in some cases significant—between the project life cycle management process for the basic category and at least some of its subcategories. Additional major categories may also be required to assure that all conceivable projects of significance to the international PM community are included.

Not Mutually Exclusive or Rigorously Consistent It should be noted that these categories are not necessarily mutually exclusive: many projects will include aspects of two or more categories. For example, most communication systems projects probably involve at least the adaptation of information system software. Many facilities projects also include communication systems, and vice versa. In such cases the project probably should be classified in the more dominant category, or—if justified by its size, complexity or risk—defined as two or more projects (of different categories) within a program, with each project having a different life cycle definition.

Classifying Projects Within Categories and Sub-Categories
A wide range of projects within each project category or subcategory exists in large organizations. It is desirable for purposes of the proposed system to further classify projects within categories or subcategories using some of the attributes identified by Crawford et al (2004) cited earlier, or some of the following classifying characteristics:

Project Size
Project size can be measured in several dimensions: amount of money or other scarce resources (skilled people, facilities, other), scope and geography are the most tangible and obvious. Larger projects in any of these dimensions usually carry greater risks, of course.

Major and Minor Projects Within a Category
It is useful to identify at least two classes of projects within each category. The distinction between these major and minor classes will be noted in the following definitions:

Major Projects are those whose large size, great complexity and/or high risk require:
- Designation of an executive Project Sponsor.
- Assignment of a full-time Project (or Program) Manager,
- The full application of the project management process specified for the particular project category for major projects (all specified forms, approvals, plans, schedules, budgets, controls, reports, frequent project review meetings, with substantial levels of detail in each).

Minor Projects are those whose size, simplicity and low risk allow:
- One project manager to manage two or more minor projects simultaneously.
- Less than the full application of the complete project management process for the project category (selected basic forms, approvals, plans, schedules, budgets, controls, reports, less frequent project review meetings, with less detail required in each).
- No formal assignment of an executive Project Sponsor.

Project Categories each having similar life cycle phases and a unique project management process

1. Aerospace/Defense Projects
1.1 Defense systems
1.2 Space
1.3 Military operations

2. Business & Organization Change Projects
2.1 Acquisition/Pension
2.2 Management process improvement
2.3 New business venture
2.4 Reorganization/structural change
2.5 Legal proceeding

3. Communication Systems Projects
3.1 Network installations/systems
3.2 Switching communications systems

4. Event Projects
4.1 International events
4.2 National events

5. Facilities Projects
5.1 Facility decommissioning
5.2 Plant shutdown
5.3 Facility maintenance and modification
5.4 Facility design/procurement/construction
5.5 Civil
5.6 Environmental
5.7 Industrial
5.8 Construction
5.9 Residential
5.10 Ships

6. Information Systems (Software) Projects
6.1 Application software
6.2 System software
6.3 Data communications
6.4 Telecommunications
6.5 IT services
6.6 Business process re-engineering
6.7 Financial software
6.8 Internet

7. International Development Projects
7.1 Agriculture/rural development
7.2 Education
7.3 Health
7.4 Nutrition
7.5 Population
7.6 Small-scale enterprise
7.7 Infrastructure: energy (oil, gas, coal, power generation and distribution), industrial, telecommunications, transportation, urbanization, water supply and sewage, irrigation

8. Media & Entertainment Projects
8.1 Motion picture
8.2 TV segment
8.3 Live music event

9. Product and Service Development Projects
9.1 Information technology hardware
9.2 Industrial product/process
9.3 Consumer product/process
9.4 Pharmaceutical product/process
9.5 Services (financial, other)

10. Research and Development Projects
10.1 Environmental
10.2 Industrial
10.3 Economic development
10.4 Medical
10.5 Scientific

11. Healthcare Projects

12. Other Categories?

Table 1. Recommended project categories/sub-categories, with each category (or subcategory) having similar project life cycle phases and one unique process management approach

Archibald 2003, Fig. 2.3, p.35 -- with addition of Category 11.

Examples
- New weapon system: major system upgrade, satellite development/launch, space station operations
- Task force invasion
- Acquire and integrate competing company
- Major improvement in project management process
- Form and launch new company
- Consolidate divisions and downsizer company
- Major litigation case
- Microwave communications network
- 3rd generation wireless communication system
- 2004 Summer Olympics, 2010: World Cup March
- Closure of nuclear power station. Decontamination and closure stage.
- New project management information system. (Information system software is considered to be in the product development category.)
- People and process intensive projects: in developing countries funded by the World Bank, regional development banks, US AID, UNIDO, other UN, and government agencies; and
- Capital/civil works intensive projects: often somewhat different from 5. Facility Projects as they may include, as part of the project, creating an organizational entity to operate and maintain the facility, and lending agencies impose their project life cycle and reporting requirements.
- New motion picture (film or digital).
- New TV episode.
- New opera premiere.
- New desk-top computer.
- New earth-moving machine.
- New automobile, new food product.
- New cholesterol-lowering drug.
- New life insurance/annuity offering.
- Measure changes in the ozone layer.
- How to reduce pollutant emissions.
- Major surgical procedure.
Each project category and many sub-categories differ.

A globally agreed project categorization system is urgently needed.

Application of “One-Size-Fits-All” PM methods causes many project failures.

Project Complexity
The complexity of a project is indicated by the:
- Diversity inherent in the project objectives and scope;
- Number of different internal and external organizations involved, which is usually an indication of the number of required specialized skills;
- Sources of technology; and/or
- Sources of funding.

“Mega” Projects
“Mega” Projects or Programs are extremely large, complex projects (usually programs, in fact) that are so unique in their size, scope, risk and duration that they require specially designed organizational arrangements (usually joint ventures, often including both private companies and governmental agencies.) As these are broken down into their constituent elements it is usually practical to identify a number of major and minor projects within one or more categories that comprise the mega project/program.

“Commercial” or “Delivery” Versus “Transformational” Projects
It is important to differentiate between commercial (or standard, somewhat repetitive) projects and transformational projects (and programs) that create strategically important changes to the organization, which are often enterprises within the enterprise and include both projects and on-going operations.

Project Life Cycles: Searching For Common Processes
Within each project category and sub-category we might identify the commonly used models for project life cycle phases and decision points. These will form the basis for identifying adaptation management processes within each life cycle phase.

Defining Project Life Cycles
The purposes of defining and documenting the overall project life cycle for each project category are to:
- Enable all concerned with creating, planning and executing projects to understand the process to be followed during the life of the project;
- Capture the best experience within the organization so that the life cycle process can be improved continually and duplicated on future projects.
- Enable all the project roles and responsibilities and the project planning, estimating, scheduling, monitoring and control methods and tools to be appropriately related to the overall project life cycle management process.

Life Cycle Phases and Decision Points
There is usually an agreement that the four broad, generic project phases are (common alternative terms are shown in parentheses):
- Concept (initiation, identification, selection.)
- Definition (feasibility, development, demonstration, design prototype, qualification.)
- Execution (implementation, realization, production and deployment, design/construct, commission, installation and test.)
- Closeout (termination, including post—completion evaluation.)

However, these generic life cycle phases are so broad and the titles so generic that they are of little value in documenting the life cycle process so that it can be widely understood, reproduced, and continually improved. What is needed is the definition of perhaps five or ten basic phases for each project category, usually with several sub-phases defined within each basic phase, together with an appropriate number of decision points (approvals, go/kil, go/hold) in each.

Conclusions
1. Different project categories require different governance, management, planning, scheduling and control practices.
2. Each project category and many sub-categories differ in:
   - Maturity of related PM methods and practices
   - How PM methods of planning, authorizing, scheduling, contracting, and controlling the work are adopted and adapted
   - Most effective life cycle models
   - Degree of uncertainty: technology, funding, environmental, political, other.
   - How the project manager role is assigned and conducted
   - Experience and technical knowledge needed by the project manager
   - Plus others...

3. A globally agreed project categorization system is urgently needed and will have many practical uses:
   - Selecting the best PM methodologies and life cycle models
   - Defining project management systems and developing systematic methodologies for their creation
   - Tailoring education and training curricula, materials, and case studies
   - Developing specialized PM software applications
   - Certifying project managers and PM support specialists
   - Others.

4. Application of “One-Size-Fits-All” PM methods causes many project failures:
   - “Best practices” must be identified for each agreed project category
   - In the absence of agreed categories, the wrong PM methods are often applied
   - This is a root cause for many project failures.

References
Russell D. Archibald

Archibald, Russell, and Vladimir J. Varaparav

Archibald, Russell G.

Archibald, Russell G, and Vladimir J. Varaparav

Belanger, Thomas C.

Cooper, Robert G., and Elio J. Kleinpschmidt

Crawford, Lynn, J. Brian Hobbs, and J. Rodney Turner

Crawford, Lynn, J. Brian Hobbs, and J. Rodney Turner

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Archibald R. (1955) held engineering and executive positions in aerospace, petroleum, telecommunications, and automotive industries in the USA, France, Mexico and Venezuela. Russ had 9 years of active duty as a pilot officer with the U.S. Army Air Corps (1943-46) and the U.S. Air Force (1951–58.) Since 1982 he has consulted to companies, agencies and development banks in 16 countries on 4 continents, and has taught project management principles and practices to thousands of managers and specialists around the world.

He is the author of Managing High-Technology Programs and Projects, 3rd Edition 2003, also published in Russian, Italian, and Chinese, and has published other books (in English, Italian, Japanese, and Hungarian) and many papers on project management. Russ is listed in Who’s Who in the World (1985).

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The difference between Different Types of Projects

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As the Project Management profession moves into working on many different types of projects, we are going to have to move to a new level in the project management body of knowledge and develop extensions that define the differences in requirements and approach for different kinds of projects such as construction, new product development, and information systems. This paper attempts to define the unique characteristics of different types of projects as well as establish a typology or taxonomy of different kinds of projects. The classification is based on the product or deliverable of a project. A list of characteristics is developed that defines the differences between projects such as:
- Degree of uncertainty and risk (construction vs product development)
- Level of sophistication of workers (construction, VS information systems)
- Level of detail in plans (days or hours for maintenance vs months for research)
- Degree of new technology involved (research vs administrative projects)
- Degree of time pressure (maintenance or big event vs construction)

The paper then defines the essential characteristics of the basic differences between types of projects and outlines how the project management approach must vary for each different type of project. This will serve as a start toward developing one dimension of the needed extensions for the body of knowledge (BDK). A project management professional must know something about different types of projects and how the project management approach must differ for different types of projects. Filling out this taxonomy must be a high priority for the profession. Hopefully the profession can work together to share knowledge and come up with an agreed typology.

Introduction

How should we categorize different types of projects? The dictionary defines typology as the study of types as in systematic classification. It defines taxonomy as the science, laws, or principles of classification. It defines classification as the systematic grouping into categories by shared characteristics or traits. The project management profession needs a classification system for different types of projects so that we may communicate effectively across the entire world. There are many different potential purposes for a system of classification. One useful objective for a list of different types of projects is to segment the market for marketing purposes. Another is to define the different management approaches needed for different projects. The system of classification might change based on the purpose. Another purpose would be to select the right project manager based on the requirements of a specific project.

Other research

Shenhar and Wideman in several papers have proposed a system of classification based on three variables of (1) Degree of uncertainty at initiation, (2) Complexity based on degree of interconnectedness and (3) Pace based on the need for speed in the available time frame for the project. In a second paper they added the dimension of an intellectual product (white collar) versus a craft product (blue collar). These papers present several very useful analyses but they do not give us a complete list of different types of projects nor do they define all the differences between the different type projects. Archibald has carried this much further in several papers as listed in the References.

Alternative parameters for categorizing projects

There are four basic ways in which we can set up a classification system of projects as follows: (1) geographical location, (2) industrial sector (Standard Industrial Classification System), (3) stage of the project life cycle (See Figure 1) and (4) product of the project (construction of a building or development of a new product). The most important and the most useful breakdown is by type of product or deliverable that the project is producing such as building a building, developing a new product, developing new computer software program or performing a maintenance turnaround or outage on a chemical plant or electric generating station. Each of these types of projects has more in common with other similar projects producing the same type of product than with other types of projects. Conversely there is much less commonality between different types of projects in the same industrial sector or company. For example there is much more commonality between projects for developing a new software system in a construction company and a bank than there is between three projects in the same bank for constructing a new building, developing a new product and developing a new computer software system. Figure 1 presents a list of products of projects with a slightly different result based on Russ Archibald’s approach. Please note in Figure 1 that a phase of the project life cycle like Feasibility Study is a project in its sell and very different from a later phase like construction. Please also note on Figure 1 that projects have to also be related many times to the business function in the organization.

Major Types of Projects Based on Product of Project

Here is a list of nine different types of projects based on the product they produce. The profession should think of other products of projects not listed here and come up with an agreed list. I have combined some like Defense/Aerospace within New Product. They could be separated.

<table>
<thead>
<tr>
<th>Type of Project</th>
<th>Product of Project</th>
<th>(Examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Administrative</td>
<td>installing a new accounting system</td>
<td></td>
</tr>
<tr>
<td>2. Construction</td>
<td>a building or a road</td>
<td></td>
</tr>
<tr>
<td>3. Computer Software Development</td>
<td>a new computer program</td>
<td></td>
</tr>
<tr>
<td>4. Design of Plans</td>
<td>architectural or engineering plans</td>
<td></td>
</tr>
<tr>
<td>5. Equipment or System Installation</td>
<td>a telephone system or a IT system</td>
<td></td>
</tr>
<tr>
<td>6. Event or Relocation</td>
<td>Olympos or a move into a new building</td>
<td></td>
</tr>
<tr>
<td>7. Maintenance of Process Industries</td>
<td>petro-chemical plant or electric generating station</td>
<td></td>
</tr>
<tr>
<td>8. New Product Development</td>
<td>a new drug or aerospace/defense product</td>
<td></td>
</tr>
<tr>
<td>9. Research</td>
<td>a feasibility study or investigating a chemical</td>
<td></td>
</tr>
<tr>
<td>10. Other (International Development Projects)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table I. Different types of projects based on the product they produce.
5. Each of the nine basic types of projects.

Common characteristics of the major types of projects

1. Size
2. Duration (Length of time)
3. Industrial sector
4. Geographical location
5. Number of workers involved
6. Cost (large, medium or small)
7. Complexity
8. Urgency
9. Organizational design

Table 2. Parameters for project classification.

<table>
<thead>
<tr>
<th>Type of Worker</th>
<th>H</th>
<th>M</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Craft (blue collar)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge workers (white collar)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Important of Time

7. Types of projects as a kind

Let's now look at the different approaches that are necessary to manage each of the nine basic types of projects.

### Administrative

1. Administrative: Administrative projects involve intellectual workers. The scope may change as the project proceeds.

2. Construction: Construction projects generally run smoothly since the staff are all experienced and know their jobs. Control of labor costs and budget control is important for the contractor on lump sum type contracts.

3. Computer Software Development: Tight project control is necessary on software projects in which other factors may be quite loose. The Project Manager needs to be ready to adapt to changing requirements from the client.

4. Design of Plans: The design of any kind of plan is an intellectual endeavor. By the nature of the exploratory nature of design the scope may not be well defined at the beginning because the client may not have yet decided just what they want. Quality is of a higher priority than either time or cost.

5. Equipment or System Installation: This is a case of thinking through all contingencies ahead of time and being sure that all involved are headed in the right direction.

6. Event: Detaile planning and good team-building are important in these complex projects where timing is critical.

### Maintenance of Process Industries

1. Maintenance of Process Industries. With hundreds of workers involved in three shifts per day where a reduction of one day can be worth a million dollars, detailed planning and control is essential.

2. New Product Development: The business of managing a diverse group of various technical specialists in a matrix organization to meet quality and time objectives on a complex project is demanding. Good project management is necessary.

3. Research: Project Management is being used on long lead-time research projects but it is all the more essential to set goals and to measure progress against those goals.
A Contribution to Developing a Complex Project Management BOK

This paper proposes a project typology focused on system of systems (SoS) projects, which are recognised as complex in a hierarchy of simple, complicated, and complex. Three types of complex systems are proposed: traditional SoS projects, such as defence or air transport, in which a developing project incorporates an existing independent asset; SoS projects which address wicked problems and hence require use of soft system methods to determine stakeholders, boundaries and a solution process; and, integration of assets, such as states or enterprises into an encompassing system. Context, leadership style and personality types suitable for each are proposed. Some tools are referenced. Soft system integration of assets, such as states or enterprises into an encompassing system. Context, leadership style and personality types suitable for each are proposed. Some tools are referenced.

Introduction

While traditional projects have had available various bodies of knowledge to assist planning and execution, including the PMBOK® Guide (PMI 2008), IPMA’s Competence Baseline, ISO 21500, APM (2006), PRINCE2TM (2009) and the Japanese IPMA (IPMA 2004), complex projects do not yet have a BOK to guide their development. This has been under development since September 2009 by several dozen contributing authors and reviewers, carefully chosen from the Systems engineering field including many members of the International Council on Systems Engineering (INCOSE).

There are many relevant research papers to assist practitioners and researchers and these include Sorra, Sauser and Boardman, 2008, Sauser, Boardman & Gorod, 2009, Keating et al. (2003), Firesmith (2010), Bar-Yam (2003, 2005, 2008), and White (2009, 2008), and others referenced in this paper. Furthermore, all of these bodies of knowledge have a reductionist flavour and none explicitly recognise SoS projects. Furthermore, even more complex projects than the ‘traditional’ SoSs, such as addressing terrorism, international disputes, and climate change, which require a soft system methodology to identify stakeholders, boundaries and possible solutions, are not addressed in a BOK. This seems remarkable since there is an International Journal of System of Systems Engineering (IJSSE).

This paper recognised a hierarchy of Simple, Complicated and Complex among projects and explores three types of complex projects, these being:

- Traditional SoS projects in which there is inclusion of an existing system into a new project, the existing system being independent and autonomous (Type A complexity);
- SoS projects which require systems thinking to determine stakeholders, project boundaries, and soft systems methods of Checkland or Systems Dynamics to develop a potential solution (Type B);
- Integration of independent assets into a larger system (for example a corporation or a food supply) into a system in order to reduce waste (Type C).

Understanding System of Systems projects

It is now recognised that a new form of projects has emerged, these being system of systems (SoS), which are complex projects (Types A–C). There is no satisfactory definition of complexity. Ashby (1956) pointed out that complex systems were self-organising. They are unpredictable and uncontrollable and cannot be described in any complete manner. However, there are a number of texts focusing on systems of systems as applied to projects. Jamshidi (2009), Aguer et al (2010), and Braha et al (2006) are a few. There are many reviews of studies and papers with a number of annual conferences in countries based on system of systems.

Lame and Valerdi (2010) define a SoS as ‘a very large system using a framework for architecture to integrate constituent elements, which exhibits emergent behaviour, with constituents systems: they are independently developed and managed, with new or existing systems in various stages of development/evolution, they may include a significant number of COTS products, and their own purpose, and can dynamically come and go from the SoS’.

Norman and Kuras (2006:209) provide an example of a SoS in which this independence and autonomy is described. The Air and Space Operations Centre (AOC) of the US, which provides tools to plan, task, and monitor all the operations in Afghanistan and Iraq, is composed of 80 elements of infrastructure including communication balance, application, servers, and databases. The systems:

- Don’t share a common conceptual basis;
- Aren’t built for the same purpose, or used within specific AOC workflows;
- Share and acquisition environment which pushes them to be stand-alone;
- Have no common control or management;
- Don’t share a common funding which can be directed to problems as required;
- Have many customers in which the AOC is not only one:
  - Evolve at different rates subject to different pressures and needs.

SoSs have been further described as having:

1. Operational Independence of the Individual Systems;
2. Managerial Independence of the Individual Systems;
3. Geographic Distribution;
4. Emergent behaviour;

In the authors’ view the issue of inclusion of autonomous and independent systems is a technical aspect because this requires significantly different methods of management. Heylighen (2002) points out that complex projects are self-organising.

Categorisation of simple, complicated and complex projects

Categorisation processes

Addressing SoSs is assisted by developing granularity in describing complexity. Snowden and Boone (2007) take up the classification of systems into categories of simple, complicated, and chaotic. This is used by Glouberman and Zimmerman (2012) as well in the classification of health care systems. Tools texts focusing on systems of systems as applied to projects are provided by Cotsafis (2007). The text to identify whether it is a complicated or complex as: many reviews of studies and papers with a number of annual conferences in countries based on system of systems. The Systems projects

- Have many customers in which the AOC is not only one:
  - Evolve at different rates subject to different pressures and needs.

Figure 1. Degree of complexity for Simple, Complicated and Complex projects

Low

High

Simple Projects

Complex Projects

Degree of Complexity

Low

High

Management Effort

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This paper proposes a project typology focused on system of systems (SoS) projects, which are recognised as complex in a hierarchy of simple, complicated, and complex. Three types of complex systems are proposed: traditional SoS projects, such as defence or air transport, in which a developing project incorporates an existing independent asset; SoS projects which address wicked problems and hence require use of soft system methods to determine stakeholders, boundaries and a solution process; and, integration of assets, such as states or enterprises into an encompassing system. Context, leadership style and personality types suitable for each are proposed. Some tools are referenced. Soft system integration of assets, such as states or enterprises into an encompassing system. Context, leadership style and personality types suitable for each are proposed. Some tools are referenced.
Complicated and complex projects are separated by the following test:
1. Identify the degrees of freedom in the system (the number of variables or options, interdependencies to resolve any variable)
2. Decide if it is simple or complicated – how many degrees of freedom are there?
3. Check the number of control tools and do these match the degrees of freedom?

If the number of control tools is less than the number of degrees of freedom, the system is complex (Type A, B or C). In reasonably ‘traditional’ SoS projects the goal in integrating the systems is to integrate the legacy system into the SoS (Norman and Kurs, 2009). Such a process is labelled Complex system Type A. Examples are:
- Glauberman & Zimmerman (2002) for health-care
- De Laenert for transport (Jomshidi 2009:520-541)
- Thissen and Herder for infrastructure (Jomshidi 2009:257-274)
- Bhasin and Hayden for space exploration (Jomshidi 2009:379-397)
- Korba and Hiskens for electrical power systems (Jomshidi 2009:385-408)
- Bathman for Defence (Jomshidi 2009:218-223)
- Wilber for air (Jomshidi 2009:232-256)

Some more detailed examples of SoSs include:

New York Cabs

The SoS is the overall cab service (Sauzer, Boardman and Gorod 2009:233). Each operator conforms to each of the four factors noted in section 2. The overall cab service maintains its integrity, if one of the operators chooses to exercise their autonomy by choosing not to participate in the service at a particular time the overall service is maintained by other operators stepping in to take its place.

Electricity power systems

An integrated electric power supply system is a more complex example of a SoS. Each generator and distributor has the autonomy to be part of the system or not, and if one or more drop out of the system at a particular time the overall system is still performed by the others.

Defence

Most defence domain examples of SoSs have a centralised authority and a clear chain of command. The constituent systems in defence are required to exercise their independence – an air vehicle and a ground vehicle can operate without direct linkage to each other, or without integration of control and information systems. However, the world’s major problems or projects require a different approach to traditional projects. Projects such as terrorism, international disputes, the European debt crisis and control of illicit drugs, can be seen as wicked or messy problems and thus require a systems thinking approach (Jackson, 2003). This systems thinking approach initially distinguishes them from SoS Type A and we call this Type B.

Year: 2003) sees complex projects as:
- Those which have interdependent parts; the whole will equal the sum of the parts
- Central or hierarchical control assumption - Traditional projects assume central control which is exercised through a contract between the principal and the general contractor and subsequently further contracts between the general contractor and the subcontractors
- Strategic assumptions surface testing (SAST) is inhibited by just considering the parts separately.

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- Glauberman & Zimmerman (2002) for health-care
- De Laenert for transport (Jomshidi 2009:520-541)
- Thissen and Herder for infrastructure (Jomshidi 2009:257-274)
- Bhasin and Hayden for space exploration (Jomshidi 2009:379-397)
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Ulrich identified twelve boundary questions in the ‘ought’ mode:
1. Who ought the client (beneficiary) of the system be?
2. What ought the purpose of the system be?
3. What ought the system’s measure of success be?
4. Who ought the decision maker be? (ie have power to change the System’s measures of success)
5. What components (resources and constraints) of the system ought to be controlled by the decision taken?
6. What ought resources and conditions ought to be part of the systems environment (ie NOT to be controlled by the system’s decision taker)?
7. Who ought to be involved as designer of the system?
8. What kind of expertise ought to flow into the design of the system?
9. Who ought to be the guarantor of the system? (ie who among those affected should be given the chance of emancipation and will prove successful, as judged by the system’s measure of success)?
10. Who ought to belong to the witness report from the premises and promises of the affected be given the chance of emancipation and will prove successful, as judged by the system’s measure of success)?
11. To what degree and in what way ought the affected be given the chance of emancipation from the premises and promises of the involved?
12. On what worldview of either the involved or the affected ought system’s design be based? (Jackson, 2003:219).

Development of a solution
Checkland’s (1981) basic process to address wicked problems is to use the seven step approach, which is a soft system methodology (SSM), shown in Figure 2.

In the case of Van Haperen (2002) has developed a methodology that enables coherent development and definition of user requirements. Traditional system development and engineering methods no longer suffice and more qualitative methods and techniques need to be embraced. An evolutionary relationship exists between the methodologies and techniques used to define requirements, to design and develop the system and to assess its effectiveness. Wilson (1990) highlights that organisations, rather than dealing with ‘how’ to solve a problem, firstly should concern themselves with determining ‘what the problem is’. Worr (2001) highlights that ‘adequate performance in complex, high risk, tactical operations requires support by highly capable management’. Measuring performance, developing systems and conducting operational testing that cope with such complex conditions are a challenge.

Hence, Complex Type B projects, dealing with issues such as terrorism, managing climate change, addressing illegal drugs, disputes between countries which are traditional enemies, and others, require very different methods, primarily including the use of systems thinking methods, especially Checkland’s Soft Systems Methodology (SSM), to identify a potential solution (Jackson, 2003).

The first step is to understand the concept of different perspectives that are possible to draw out of the rich picture. The SSM process of using CATWOE standing for Customers, Actors, Transformation process, Weltanschauung or World View, the Owner to whom the “system” is answerable and the Environment that influences but does not control the system, all provide a tight process necessary for the breadth of vision required to see integration of systems possible.

Checkland’s approach of developing multiple CATWOEs (possibly 10-20), and comparing them for additional perceptions, contributes to development of a solution.

Bergvall-Kareborn (2002) suggests the perspectives of ethical, judicial, aesthetic, economic, social, linguistic, historic, logical, physical, faith, love, harmony, fraternity, social intercourse, symbolic representation, energy, vitality, and motion among others. Will (2012) points out that the roles in the CATWOE or BATWOE will differ depending on the perspective taken. Will also comments that the CATWOE approach can be amended to replaced C with two concepts; B for beneficiaries, and V for Victims producing BATWOE. Exploring each of perspectives suggested by Bergvall-Kareborn (2002) may not be appropriate, other perspectives may be more relevant to the systems being integrated. However, it is the recognition of the results from each and the comparison of these which provides the power of the method.

System Dynamics (SD) could be used as an alternative to SSM in developing a solution (Jackson, 2003:65).

Integration of systems such as enterprises, states and supply chains (Type C)
Korsten and Seider (2010) discuss the issue that many enterprises and entities could benefit by their integration to a higher level system. They reported that lack of efficiency in integration of enterprises into a system is costing the world $15 trillion pa in which they estimate that $4 trillion pa could be saved.

A clear–cut example of savings with regard to water management occurs as rivers pass through state and national boundaries. First users of the water often take more than their share of the water leaving inadequate supplies for downstream states (Elitte, 2006).

Another example is the integration of road jurisdictions between adjacent states and countries thus allowing integration of speed limits, emergency and maintenance services, and other aspects, over multiple jurisdictions hence producing increased average speed and thus reduced energy costs.

A further example is an integration of health care services. Reid et al (2005) propose that a four level approach be used to add the integration of systems in health care. The levels being the Patient, the Care Team, the Organisation and the Political and Economic Environment. They assert that real time monitoring of patients would save costs and lives.

Tools to deal with Type C complexity
Type C complexity is the integration of enterprises operating for similar purposes into an overall system at a higher level. Examples of these include:
- Rivers passing through different state jurisdictions;
- Different medical services available to a patient such as general practitioner, specialist medical services, hospitalised services, patient records, medical practitioner associations, medical guilds, and others;
- Integration of organisations in a supply chain;
- On the issue of river systems integration Ferreira and Beard (2005) outline practical insights for protecting groundwater in rural areas of Ontario. Governments, in recognising both the challenges and benefits of multi-organisational integration, can provide both legislation and taxation benefits to force and encourage enterprise integration Li (1964).

Other examples include transport systems integration between rail, bus, ferry motor vehicles on roads and use of bicycles. Examples of rail, bus and ferry coordination include integration of timetables to reduce waiting time at exchange points, use of an integrated ticket system, supply of bicycles by the city at railways stations. Air-traffic management and integration occurs at airports however the integration of control systems is a system of systems issue.

Comparison of projects
Based on this approach a comparison of projects is shown in Table I.

Can PMBOK be used on complex projects?
In the end the task of the project is to clarify the boundaries and objectives of the project and develop a solution which can be produced using traditional methods such as the Project Management Body of Knowledge, or another BOK, and systems engineering principles. However, it is only after a solution is developed using soft system principles that Type B and C projects can be delivered.
Some tools are suggested to assist project management.

Conclusions
It can be seen that it is possible to categorise projects into four types, these being simple, complicated, which can be developed in a reductionist manner, and a third type being complex projects, which can be broken up into three different types. Type A being a SoS such as defence, which include autonomous and independent systems, which are addressed by integration of independent system into the larger system of systems; and Type B which requires a soft system approach to define stakeholders, establish boundaries and develop a solution. Type B projects use Checkland’s soft system methods, or system dynamics, before a solution is developed in a similar manner to Type A projects. A third type of complexity, Type C is the integration of autonomous and independent assets, such as an enterprise or a state in a federation (for rivers or road systems) into a larger system, in order to reduce waste and increase benefits.

Some tools are suggested to assist project management. Finally once a solution has been developed the project can then resort to traditional project management techniques for development and implementation.

<table>
<thead>
<tr>
<th>Complexity Type</th>
<th>Context</th>
<th>Leadership Style</th>
<th>Tools</th>
<th>Choice of staff</th>
<th>Project Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple</td>
<td>A local and small project.</td>
<td>Top down</td>
<td>Scope development, WBS, Scheduling</td>
<td>Likes clear instructions</td>
<td>Repair of ship, Building a house, Managing a marketing campaign</td>
</tr>
<tr>
<td>Complicated and reductionist</td>
<td>Cause and effect relationships discoverable but not immediately apparent, Expert diagnosis required, More than one right answer possible, Known unknowns, Fact-based management</td>
<td>Top down</td>
<td>Tools for simple projects PLUS, PMBOK or IPMA ICB PLUS systems engineering tools for technology based projects</td>
<td>Likes clear instructions</td>
<td>Design and produce a jet engine</td>
</tr>
<tr>
<td>Complex Type A</td>
<td>Flux and unpredictability, No right answers, emergent instructive patterns, Unknown unknowns, Many competing ideas, A need for creative and innovative ideas, Pattern-based leadership</td>
<td>Top down</td>
<td>Balancing internal context with external environment, Architecture development, Requirements management, Incremental commitment, Addressing unk unk, Developing modularity, Systemigram, Managing governance, Identifying patterns</td>
<td>Abstract reasoning, Business acumen, Comfortable with ambiguity, Emotional Intelligence, Systems thinking, Understanding perspectives Helmsman (2010)</td>
<td>Integration of healthcare systems, Airport traffic management, Infrastructure integration, Space exploration, Electrical power systems integration, Defence system integration, Commercial airline development</td>
</tr>
<tr>
<td>Complex Type B</td>
<td>A wicked problem</td>
<td>Probe, sense and respond, Create environments and experiments that allow patterns to emerge, Increase levels of interaction and communication, Use methods that can help generate ideas, Open up discussion as through large group methods, Encourage dissent and diversity, and manage starting conditions and monitor for emergence (Snowden &amp; Boone 2007)</td>
<td>Type A tools but preceded by: - SAST - ESM - SSM - SD</td>
<td>Abstract reasoning, Business acumen, Comfortable with ambiguity, Emotional Intelligence, Systems thinking, Understanding perspectives Helmsman (2010)</td>
<td>Managing terrorism in Afghanistan, Managing multi-national integration for climate change, Managing international disputes, Solving the illicit drug problem</td>
</tr>
<tr>
<td>Complex Type C</td>
<td>An attempt to reduce waste</td>
<td>Not clear yet</td>
<td>Not clear yet</td>
<td>Business acumen, not territorial, opportunity focused</td>
<td>Integrating road and river systems between states Distributing food from rich countries to poor integrating transport systems</td>
</tr>
</tbody>
</table>

Table 1. Aspects of project types

References


PMBOK or IPMA ICB PLUS systems engineering tools for technology based projects


Managing terrorism in Afghanistan, Managing multi-national integration for climate change, Managing international disputes, Solving the illicit drug problem

Integrating road and river systems between states Distributing food from rich countries to poor Integrating transport systems


Davies, E., Place, P & Smith, D. (2006) Systems Engineering; New Patterns of Thought, CMU/SEI.


Dey, A. (2000) Understanding the Implications for Better Service Delivery, CMU/SEI.


Eyes Wide Shut: 
Expanding the view of portfolio management

This conceptual paper examines our existing world-view portfolio is defined the management of that portfolio from that of project and new product development portfolios to other portfolios that exist in an organisation, such as the asset portfolio, resource portfolio and ideas portfolio. Portfolios do not exist in isolation in an organisational context, but instead overlap and interact. This paper argues that there is a need to move another step higher, and examine the relationships between portfolios of projects and related activities across an organisation in order to optimise outcomes across the organisation. We propose the need for ‘enterprise portfolio management’ and suggest that this approach has the potential to improve organisational efficiency, and in the longer term could be a source of competitive advantage.

This conceptual paper suggests that we extend our world view from a rather myopic perspective whereby once a portfolio is defined the management of that portfolio occurs in an isolated manner. We argue that there is a need to move another step higher, and examine the relationships between portfolios of projects and related activities across an organisation in order to optimise outcomes. We use the term ‘enterprise portfolio management’ for this higher level capability and propose that organisations will benefit by understanding and managing the relationships between project portfolios and other organisational portfolios such as the asset portfolio, the resource portfolio and the ideas portfolio. This paper asserts that these portfolios do not exist in isolation in an organisational context, but instead overlap and interact. By examining each portfolio, and in particular the linkages and interfaces between each portfolio, we suggest organisational-wide communication and coordination improvements can be made. As such, ‘enterprise portfolio management’ has the potential to improve organisational efficiency, and in the longer term could be a source of competitive advantage.

Introduction

Project portfolio management (PPM) is an emerging aspect of business management that promotes and facilitates a holistic perspective to optimise benefits across the project portfolio. The goals of PPM are to align projects with strategy, maintain a balance of project types, and ensure that the project portfolio fits with resource capability so that the organization can sustain the maximum benefit from project investments (Cooper, Edgett, & Kleinschmidt, 2001; Rollins, 2003). Some of the PPM concepts have their theoretical underpinnings in business finance (Markowitz, 1952; McFarlan, 1998; Kendall & Rollins, 2003) and the evolution of PPM approaches have been heavily influenced by field of project development (Cooper, Edgett, & Kleinschmidt, 1999; Killen et al., 2008; Killen, Hunt, & Kleinschmidt, 2008).

The rise of PPM follows decades of improvements in project management skills and capabilities and may be considered the biggest leap in project management since the development of PERT or CPM (Levine, 2005). As the field of project management has matured, attention has shifted to multi-project management systems as a way to improve project success rates. It is no longer enough to ‘do things right’ with effective project management capabilities; it is also important to ‘do the right things’ using portfolio-level perspective (Cooper, Edgett, & Kleinschmidt, 2001).

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portfolios described above, an organisation could, for example, manage resources, assets or ideas from a portfolio perspective. Other types of organisational portfolios are also possible, however for this discussion, the resource, asset and idea portfolios will be discussed and will be illustrated followed by a discussion of the linkages between the portfolios.

We will start by examining the resource portfolio.

### The Resource Portfolio

An organisation’s resources include all assets, capabilities, organisational processes, routines of knowledge and control by an organisation to conceive and implement strategies (Barney, 1991). Extending this concept, Krebs (2019) suggests the notion of a resource portfolio, drawing the link between cross-organisational resource management and portfolio management approaches, with resource portfolio management being focussed on managing the common pool of ‘talent’ in the organisation ensuring there is an available pool of resources to work on both current and future projects across the organisation.

While the idea of resource management and forecasting is not a new concept in project management (for example, see Cleland & Ireland (2007) or Shenhar & Dvir (2004)) or project portfolio management (Krebs & Jerbrandt, 2002), the idea of a resource portfolio (as distinct from Barney’s (1991) resource-based view of the firm) remains somewhat poorly examined, with much of the discourse examining only human resources.

Traditionally, as part of a regular ongoing business process, both operational managers (for example, by as usual activity) and project managers (for project activity) forecast and define their financial and resource requirements for projects, programs and other work (PMI, 2008), taking into account these specificities, aspects of capabilities of such resources. Taking a resource portfolio view, short, mid-term and long-term resource forecasts can be used to determine the desired future level of resources, across the organisation. These forecasts take into account not only periods of normal operations but also for peak periods of demand, based on project and operational work that has been prioritised and strategically linked. When combined, an organisational demand profile can be developed.

These resource demands are fulfilled through the allocation of resources from the portfolio resource pool or by acquisition. Barney (1991) suggests that projects produce physical assets (as deliverables or capabilities delivered by the project) and business processes that right also generate a series of projects, by way of maintenance and enhancement activities required to ensure the asset continues to function and perform as designed. The assets may also serve to support or enhance the project portfolio outcomes. These asset maintenance and enhancement activities draw upon the organisational resource pool. Assets, such as a building plant or system, malfunction from time to time and require repair or emergency maintenance to be performed. While many of the expected activities and the required resources will be planned through an Asset Maintenance Plan, these unplanned activities have the potential to disrupt the resource portfolio and may draw resources away from other priority activities, jeopardising the viability of the organisation (Engwall & Jerbrandt, 2002).

### The Asset Portfolio

Traditionally, assets have been viewed as systems, buildings, equipment or other physical assets, practices and processes (American Institute of Cost Engineers, 2006). Extending the traditional view, an asset portfolio would also be comprised of knowledge-based components, such as the pool of an organisation’s intellectual property. The resource and asset portfolio is not an isolated entity, but interfaces with other portfolios in the organisation. Krebs (2019) suggests a link between a project demand profile and the portfolio:

- Portfolio Interactions
- Enterprise Portfolio Management

### Ideas Portfolio

The existence of an Idea Portfolio draws on the concept of the ‘fuzzy-front end’ (Larsson, 2007) that is examined extensively in new product development literature (Cooper, 2005). The idea portfolio is a systematic approach to transforming ideas into businesses opportunities by enriching the right ideas to maturation through the multi-stage ideas concepts. This approach helps organisations stimulate idea generation and choose those product ideas that have given limited investment availability and limited resources (Cooper et al., 1999). Much of the methodology suggests that ideas form the ‘fuzzy-front end’ of the new product development lifecycle, however, within the ‘fuzzy-front end’ occurs in a wide range of project environments. For example, new ideas are regularly generated for process, service delivery or operational improvements. Rather than using an ideas portfolio, ideas feed only into the new product development portfolio and then into the project portfolio (Figure 2), there may be organisational benefits of a more holistic definition of an ideas portfolio that includes product, service and process ideas. Alternatively, an organisation may manage several ideas portfolio (one for each area), with many of the expected activities and the required resources will be planned through an Asset Maintenance Plan, these unplanned activities have the potential to disrupt the resource portfolio and may draw resources away from other priority activities, jeopardising the viability of the organisation (Engwall & Jerbrandt, 2002).

### Portfolio Interactions

This portfolio interacts with the project portfolio management maturity benchmarking survey, the Centre for Business Practices (2011) discovered that more than one third of respondents also practiced product portfolio management, asset portfolio management and application portfolio management, with the priority increasing as the organisation’s portfolio management maturity increases.

Definitions and Findings of this nature business that there is an opportunity to manage the inter-relatedness between the varying types of portfolios that exist in the organisation. The prevalence of environments where project portfolios co-exist with other types of portfolios supports a move to manage portfolios in a more holistic sense and not limit our thinking to just the project portfolio or the new product development portfolio and processes.

Not only must we examine the life span from project inception to project closure, we must also examine project’s interaction with other types of portfolios due to the linkages and interdependencies across the entire organisation, which suggests the notion of an ‘enterprise portfolio management’ approach can improve the linkages and transfer of knowledge between portfolios.

Unless all portfolios are managed in an integrated manner, cross-portfolio impacts can occur, resulting in mis-alignment between overarching organisational priorities and individual portfolio priorities (Figure 4). An integrated approach is required to ensure a consistent and common set of priorities across all organisational resources, assets and projects. Such an approach is suggested to recognise the cross-organisational impacts of unplanned projects and activities and to facilitate the ability to adapt to evolving or changing priorities that may shift in relation to environmental, political or other influences.

### Enterprise Portfolio Management

The proposed holistic portfolio approach (Figure 5), links multiple organisational portfolios and focuses on ensuring that each portfolio maintains alignment with overarching organisational priorities. The approach operates at a pan-organisational level and within the context of the external environment, reflecting the dynamic nature of decision-making in response to environmental shifts.

The proposed approach illustrates how organisational priorities flow through to a range of organisational portfolios, such as the idea portfolio, NPD portfolio, project portfolio, resource portfolio and asset portfolio. These organisational priorities and the portfolios are not singular, linear or static, but are linked and dynamic in nature.

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*Figure 2. Two-way interaction between project and asset portfolios*

*Figure 3. Portfolio Interfaces (after Larsson 2007)*

*Figure 4. Conflicting Portfolio Priorities*

*Figure 5. Enterprise Portfolio Management*
Interactions between portfolios are central to organisational processes. For example, in the idea portfolio raw ideas are conceived and pass through an idea filter to the idea portfolio. Visible ideas are prioritised and tagged for development at which point they flow through a Stage-Gate idea-to-Launch Framework for New Products and Projects (Pennypacker et al., 2006). Conceptual ideas in the idea portfolio can be extended into the product development pipeline, where the project portfolio operates. This limits the degree of top-down control that can be achieved. The inter-relatedness between the idea portfolio and the product development pipeline is critical and inter-connected with the project portfolio.

In the project portfolio, projects that develop, create and manage the organisational assets that deliver the organisation’s objectives (Cooper, 2005) or the IT project portfolio (after Larsson (2007) and Cooper, 1999). The projects that develop, create and manage an optimum set of organisational assets consume resources (from the resource portfolio) and interact with the idea portfolio. The management of these linkages and interactions is a high-level challenge. The traditional wisdom has suggested that projects be prioritised, however, project priorities may not align with resource priorities. If the resource portfolio lens is used to examine the situation, a different set of priorities and organisational strategies may become apparent. If the relative priorities amongst the various portfolios are not consistent with each other, or with the overarching organisational priorities, then the organisation’s strategic objectives may not be achieved.

The concept of portfolios of portfolios is a necessary asset to the larger organisation in which it operates. This limits the degree of top-down management vision and support. Unless a corporate level approach is taken to ensure all portfolio priorities are consistent, the organisation may not achieve its desired or stated objectives. By taking a pan-organisational enterprise ‘portfolio management’ approach, portfolio management concepts can be extended into the mainstream management domain to facilitate the optimal alignment and adaption in the implementation of business unit-level strategy.

Conclusion

The introduction of the portfolio concept in the finance, new product development and information technology (IT) portfolios has been further extended in this paper to the asset, resource and ideas portfolios. From the early development of portfolio concepts in the new product development discipline, portfolio management has evolved to include a range of tools and techniques particularly in relation to project selection, prioritisation and balancing. Existing portfolio project tools and techniques help organisations to identify, select and manage an optimum set of projects in order to achieve the organisation’s strategic objectives, yet, such concepts are not regularly applied to the management of an asset portfolio or resource portfolio. If we assert that portfolios of investments, projects, resources or assets should not be managed in an isolated manner, it is only when organisational priorities are linked across all portfolios that contention may occur. In order to achieve the organisation’s strategic objectives, yet, such concepts are not regularly applied to the management of an asset portfolio or resource portfolio.

We assert that portfolios of investments, projects, resources or assets should not be managed in an isolated manner, it is only when organisational priorities are linked across all portfolios that contention may occur. In order to achieve the organisation’s strategic objectives, yet, such concepts are not regularly applied to the management of an asset portfolio or resource portfolio.

References


Weiss, P., & Broadbent, M. (1998). Long-term learning the New Infrastructure: how market leaders capitalised on innovation, technology innovation, and organisational capability to outperform competitors. Harvard Business School Press. Michael Young Michael Young is an award-winning project and program manager with significant experience managing high risk and complex projects in Australia and throughout the Asia-Pacific across many industry sectors including IT, transport and logistics, education and training, government and not-for-profit. Michael is a Certified Practicing Project Director. Fellow of the Australian Institute of Project Management (AIPM), is an AIPM endorsed assessor, certified Gateway Review team member and is currently leading the development of the Australian National Competency Standards for project portfolio management. He is a former national board member of AIPM and is currently completing his PhD. Michael currently chairs the AIPM Standards Committee, the AIPM Knowledge and Research Council and is also a member of the AIPM Professional Development Council and the National Project Reference Group for the redevelopment of vocational project management qualifications in Australia.

Michael’s research interests include project management competencies, organisational project delivery capabilities, strategy implementation and project portfolio management.

Dr Catherine P Killen Catherine Killen is a leader in Project Portfolio Management (PPM) research. Catherine’s significant contributions to the field include the identification of PPM as a dynamic capability and the extension of PPM practice through exploration of new approaches - such as the use of network mapping to improve understanding of project interdependences. Catherine joined LTE after 10+ year career in industry. She maintains strong links with industry and has convened a special interest group of 80 PP professionals and researchers since 2005.

Catherine completed a PhD in Management on “Project portfolio management for project innovation in service and manufacturing industries” at the Macquarie Graduate School of Management, Sydney, in 2008. Her earlier degrees are in Engineering Management and Mechanical Engineering.

Dr Raymon Young Dr Raymon Young is a fellow of Chartered Secretaries Australia, an Assistant Professor at the University of Canberra and an adjunct at the University of Sydney. Prior to academia he was a CIO within Fujitsu Australia and a management consultant with Deloitte. His research in project governance focuses upon the boundary-level implications of PPM. His research has been published by Standards Australia and he is a major contributor to Australian and International Standards on the governance of IT and projects enabled by IT (AS6016, IS38500).
Methods and Tools of Success Driven Project Management

Advanced project management methodology called Success Driven Project Management integrates scope, time, cost and risk management suggesting reliable tools for project planning and performance management. After brief step by step instructions on SDPM application we will discuss risk simulation approaches that may be used for setting reliable project targets, their strong and weak sides. SDPM suggests to use optimistic estimates for creating working plans and manage project time and cost buffers. In SDPM project buffer is the difference between target and scheduled values. During project execution buffer penetrations are estimated by analyzing success probability trends. Since success probability depends not only on project performance but also on changes in the project environment success probability trends are perfect integrated performance indicators. Negative trends require considering corrective actions. SDPM has some common features with Critical Chain project management but there are also many differences that will be discussed.

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Introduction

Success Driven Project Management (SDPM) is project management and performance analysis methodology developed in Russia in 90-s and since then successfully used in many projects, programs, and organizations in Russia, East Europe and Brazil. SDPM is supported by Russian PM software Spider Project but its basic approaches can be used with other PM software tools.

SDPM methodology has some common features with Critical Chain approaches to project management but there are also many differences discussed in this paper.

SDPM Methodology Steps

Step 1 – Define integrated project success criterion

With multiple success criteria decision making is complicated – increasing one of them may decrease another. There is need for some weighting factor that may be used for decision making. It is necessary to be able to measure overall benefits of projects and portfolios, to be able to compare options and to select the best management decisions. We suggest to set one integrated criterion of the project/portfolio success or failure. One of the potential approaches is to use money for measurement of everything. For example, defining the cost of one day for project acceleration and delay we will be able to estimate if it is profitable to pay more for faster performance and if project performance was successful if its finish was late but certain amount of money was saved.

Step 2 – Create optimistic project schedule model

Optimistic model is based on optimistic estimates of all project parameters and includes only most probable (with 90% probability or larger) risk events. This model will be used for setting performance targets for project workforce. It is clear that optimistic targets will not be achieved but in any case performance targets shall not include contingency reserves or they will be lost (Parkinson Law).

Step 3 – Simulate risks and set reliable targets for project management team

Project management team shall have time and cost buffers for managing certain risks and uncertainties. Project or phase buffer is a difference between target value and the value for the same parameter in the optimistic schedule. Targets shall be set using risk simulation. These targets shall have reasonable probabilities to be met (usually in 70-80% probability range).

Project and phase targets and buffers may be created not only for integrated project success criterion but also for other parameters like project cost and duration, they can be set for the project as a whole and for certain project phases. Probabilities to meet project/phase targets are called success probabilities.

Step 4 – Set project sponsor targets

Management reserves for unknown unknowns are usually considered basing on past performance data. When these data are missing or not reliable project sponsor targets are set using the same risk analysis model but with higher probability to be achieved (usually in 30-35% probability range). So project has a set of targets – tight targets for project team, reasonable targets for project management team that include sufficient contingency reserves, and more comfortable targets for project sponsor that include additional management reserves.

Step 5 – Estimate buffer penetrations

It is natural that project will be late to optimistic schedule and project/phase buffers will be penetrated in the process of project execution. It is necessary to be able to estimate if these buffers are still sufficient and if project performance was better or worse than expected. The natural way for estimating buffer penetrations is calculation of current probabilities to meet the targets. If these new probabilities are higher than initial project performance was better than expected though success probabilities depend not only on internal factors, project performance was perfect but new risks were identified, success probability may become lower because initial contingency reserves did not cover these new risks.

Step 6 – Analyze success probability trends

Current success probabilities show project status but project status information is not sufficient for decision making. Decision making shall be based on the analysis of project trends. If the probability to meet project target is rising then project buffer was consumed slower than expected, in other case project buffer was consumed too fast and project success is endangered. Management decisions shall be based on the trend analysis. Even if current status is good (success probability is high) but the trend is negative corrective actions shall be considered.

Success probability trends are the best integrated project performance indicators – they take into account project risks, they depend not only on performance results but also on the project environment changes.

Step 7 – Simulate model under stochastic assumptions

Simulation models are used for project risk management. The key problem is the stochastic nature of project parameters. So we use Monte Carlo simulation. Proper Monte Carlo simulation requires a lot of time. Usually necessary time is not available and people are satisfied if the results are “good enough”. We prefer 3 scenarios approach for the reasons explained further.

Let’s look at the difference between accuracy and precision. Accuracy means that the measured values are close to the true value. Precision means the values of repeated measurements are clustered and have little scatter. Monte Carlo means Accuracy but lack of Precision. Precision may be achieved by very large number of iterations but for large projects with limited resources the time needed is too large.

Three scenarios means Precision but lack of Accuracy. A bias in estimating success probability is systematic.

The choice depends on management approach. Our approach may be called “Management by Trends”. Applying Trend Analysis we rely on data precision.

We think that trends supply management with most valuable information on project performance. Trend analysis helps to discover performance problems ASAP and to apply corrective actions if necessary.

It is the main reason why 3 scenarios approach may be selected. It is fast, simple and has sufficient precision though probability estimates are not accurate.

The quality of initial data for project risk simulation is never good enough but Monte Carlo risk simulation creates an impression of accuracy that is actually dangerous for project managers. In any case we need Optimistic schedule and budget for project performance management. We need to understand what happens with success probability during project performance and we need data precision.

Three scenarios approach to Risk Simulation includes following steps:

A project planner obtains three estimates (optimistic, most probable and pessimistic) for all initial project data (activity durations and volumes of work, resource productivity,

Figure 1. Accuracy and Precision

Setting project targets with risk simulation

Traditional approach to risk simulation utilizes Monte Carlo simulation. Proper Monte Carlo simulation requires a lot of time. Usually necessary time is not available and people are satisfied if the results are “good enough”.

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Success probabilities depend on project performance, scope changes, risk changes.

Success Driven Project Management and Critical Chain Project Management

Both SDPM and CCPM suggest to set tight schedule for project work force and create and manage project time buffer. Both methods suggest to prioritize projects managing project portfolios. But there are also many differences described below.

Working Schedule

CCPM suggests to use 50% probability estimates for Critical Chain schedule development. But using 50% probable estimates means that activity duration estimates still include some reserves and these reserves will be lost due to Parkinson Law.

SDPM suggests to use optimistic estimates in the schedule that is used for project workforce management.

Project Buffers

CCPM suggests to estimate excessive contingency reserves that people added to most probable activity duration estimates, take them away, summarize and put in a dummy activity that is called Project Buffer and follows the last activity of the Critical Chain.

SDPM uses risk simulation for setting reliable targets and project time buffer is the difference between project optimistic and target finish dates. Project time buffer does not belong to any chain.

Besides, SDPM suggests to set targets for project costs, materials, and integrated success criterion. Cost Buffers, Material Buffers and Project Success Criterion Buffer are managed together with Time Buffers.

Critical Chain Protection

CCPM suggests to create feeding buffers on activity paths that precede Critical Chain activities to protect Critical Chain. CCPM proposes that Critical Chain shall never change.

SDPM does not protect any chain – project schedule is regularly recalculated and risks analyzed. Change of Resource Critical Path during project execution is usual. Besides Resource Critical Paths in optimistic, most probable and pessimistic schedules may be different.

Portfolio Planning

CCPM suggests to “pipeline” projects in the portfolio (to perform them one after another) to avoid multitasking.

SDPM suggests almost the same – always apply priorities to the portfolio projects when calculating portfolio schedule. But if resources are available they may be used in the projects with lower priorities. Besides there are special cases when multitasking is useful.

Buffer Penetration Estimation

CCPM does not suggest reliable quantitative methods for analyzing buffer penetrations. Suggested methods are qualitative. Dividing buffer into three zones (green, yellow, red) is one of them. Entering yellow zone means an alert, red zone penetration requires considering corrective actions.

SDPM estimates buffer penetrations by success probability trends. If the trend is negative then project buffer is consumed faster than expected. If in the middle of the project execution project buffer is half consumed it may mean excellent performance if most risks are behind and poor performance if most risks are ahead.

Conclusions

Success Driven Project Management is powerful methodology that provides project managers with reliable tools for integrated scope, time, cost and risk management. It includes risk planning and simulation for setting reliable project targets and selecting optimistic estimates for creating working schedules and budgets. The differences between target and scheduled finish dates, between target and optimistic project cost are called time and cost buffers.

CCPM suggests buffer penetration by calculating probabilities to meet set targets (success probabilities) and analyzing their trends. Negative trends show that buffer penetrations are larger than expected and corrective actions shall be considered.

Success probabilities depend on project performance, scope changes, risk changes. Success probability trends are perfect project performance indicators that supply management with reliable integrative estimates of project performance.

Reference List


Liberzon, Vladimir “Success Driven Project Management”, XVI IPMA World Congress on Project Management, Moscow, Russia, 4-6 June 2001

Liberzon, Vladimir “SDPM Truly Integrated Project Scope, Schedule, Cost, Resource and Risk Management”, 8th Australian Performance Management Symposium, Canberra, Australia, 18 - 20 February 2004

Liberzon, Vladimir “Tools and techniques for corporate project management”, PM Global Congress 2008–Latin America. Proceedings, PMT01LA08.PDF, São Paulo, Brazil

Purnus, Augustin, Liberzon, Vladimir, and Dobre, Mihaela “Implementing Project Portfolio Management in a Telecom Company”, PMI College of Scheduling 6th Annual Conference, Boston, MA USA, May 17-20 2009

Liberzon, Vladimir “Application of SDPM approach to managing EPC projects”, EPC Risk Management Conference, Singapore, June 3-4, 2010

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Critical Chain Project Management

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Project Management Methodologies: An Invitation for Research

Having existed for millennia, project management has attracted increasing research interest in the last three decades. In this time the details leading to project success have been researched extensively. Surprisingly little attention has been paid to the popular practice of establishing and employing structured collections of project management processes and best practices, usually in an attempt to enhance project effectiveness and increase the chances of project success, typically known as project management methodologies. This paper provides a review of extant research, identifies central emphases, and proposes a definition of the concept. Research aiming to improve the understanding of project management methodologies is crucial for practitioners as well as researchers operating in the field of project management: In addition to increasing the chances of project success and enhancing project effectiveness, an improved understanding of project management methodologies is likely to provide clues towards a formal theory of project management.

Introduction
Project management has become increasingly recognized since the 1950s through global endeavours connected to the Apollo space program, the Concorde aircraft, the English Channel tunnel and the Sydney Opera House (Morris & Haugh, 1987; Morris 1994; Packendorff, 1995; Bredillet, 2007). Many practical works, such as the PMBOK Guide (PMLB 2008) and the PRINCE2 (OLC, 2005), and research papers have been published to identify the factors leading to project success, and the issues to avoid in order to elude project failure. Concurrently many organizations have been collecting project management processes and best practices and compiling them into structured collections known as project management methodologies. It appears these collections have, up to now, received very limited research: Papers mentioning project management methodologies usually leave the concept undefined, and logics, structures, dimensions, contents, as well as results without attention. This may be due to the concept being considered too trivial, or the unintentional boundary which appears to exist between the practical and the theoretical fields of project management. This is starting considering the practical reasons, and the rich empirical data project management methodologies offer for project management research. This paper aims to increase interest in project management methodologies by reviewing extant research, identifying central emphases, and proposing a definition of the concept. This paper describes an analysis of published research covering or relating to project management methodologies through questions: How much published project management methodology research exists? What emphases, if any, do these researches have? Is it possible to propose a definition of the concept based on these materials? This paper is a part of a greater research endeavor into project management methodologies, theory of project management, and the connection between the two. This paper comprises three main sections: The first one provides a review of extant research covering or relating to project management methodologies, the second one identifies the central emphases, and the third one proposes a definition of the concept.

Method
The research method applied can be best described as a form of discourse analysis, focusing on extant papers covering or relating to project management methodologies, published in the English language in top-rated peer-reviewed research journals such as International Journal of Project Management, Project Management Journal, and International Journal of Managing Projects in Business. Discourse analysis, a method for examining language, is employed as it is well suited for scrutinizing texts on management study, and widely applied when studying management issues including professional and organizational identities, strategic sensemaking and institutional logics (The editors, 2010).

Results
Review of extant research relating to project management methodologies
Packendorff (1995) notes project management methodologies, such as PRINCE, have been set up by the public sector, such as government agencies, to control project budget, schedule and quality disasters. Laufer et al. (1996) identify principles project managers use in turbulent projects: Adjusting the project management methodology according to extant circumstances is a key component towards project success. Conroy and Solomon (1997) find contemporary project management tools unable to provide sufficient decision-making and conflict-handling support, and devise a project management methodology for assisting project managers with multiple disciplinary challenges. Clarke (1999) finds structured project management methodologies a potential way to achieve significantly improved benefits from projects. White and Fortune (2002) analyse project practitioners’ experiences, and report PRINCE2 the most popular methodology.

Crawford et al. (2003) describe government encouragement for employing formal project management methodologies, developed in a “hard” project environment, and in an effort to increase project effectiveness, and develop a “soft” system project management approach for integrating soft systems methods into project management methodologies. Investigating determinants for project manager communication, Müller (2013) refers to project management methodologies as credible collections of project management best practices. Pennypacker and Gratton (2013) refer to project management methodologies as credible collections of project management best practices. Pennypacker and Gratton (2013) refer to project management methodologies as credible collections of project management best practices. Pennypacker and Gratton (2013) refer to project management methodologies as credible collections of project management best practices. Pennypacker and Gratton (2013) refer to project management methodologies as credible collections of project management best practices. Pennypacker and Gratton (2013) refer to project management methodologies as credible collections of project management best practices.
methodologies and standards, proceed in an organized manner. Hobbs and Aubry (2007) report statements such as “A PMD is an entity that develops and implements a standardized project management methodology” (p 97). Aubry et al. report similar claims. While 67% of the 500 PMO’s in the survey consider project management methodology as an important component, as contractors, Hurt and Thomas ascertain there is a point of inflection, beyond which the methodology development is not likely to benefit project success. This point, they argue, is slightly lower than the PMO’s 2006 report (p 77). Aubry et al. (p 81) contend that project success is influenced by the way projects are defined, documented, and disciplined management approach according to the preferred project methodology, including the number of PMO tasks, the first one being “...practice management, including the subtasks of project management methodology and project knowledge management...” (p 413).

Emphases in extant research relating to project management methodologies

Several emphases emerge from extant research on project management methodologies and standards, as well as contractors, Hurt and Thomas ascertain there is a point of inflection, beyond which the methodology development is not likely to benefit project success. This point, they argue, is slightly lower than the PMO’s 2006 report (p 77). Aubry et al. (p 81) contend that project success is influenced by the way projects are defined, documented, and disciplined management approach according to the preferred project methodology, including the number of PMO tasks, the first one being “...practice management, including the subtasks of project management methodology and project knowledge management...” (p 413).
for increasing methodological effectiveness. Point of inflection and light methodology relate to optimizing methodology structures and contents on tactical level. The difference between methods and methodologies is defined by coherence of functions: Organizations may employ tools, techniques and methods to enhance project work, however, these must be systematic and coherent, be employed in a coordinated way, and reinforce one another in order for the resulting system to be considered a methodology.

Organizational fit and contingencies relates to the concept of contingency theory, according to which organizational structures and ways of working must fit organizational backgrounds and circumstances in order for the organization to operate effectively and succeed. This is exactly what project management methodologies are all about: Even a collection of recognized project management processes and best practices must be applied, as opposed to blindly followed, according to relevant backgrounds and circumstances. It is no surprise contingency management is recognized as a platform for a theory of project management (Bredillet, 2007; Arto and Kuopio, 2008; Söderlund, 2010). It is very likely project management methodologies can offer clues for establishing such system to be considered a methodology.

The results of this study indicate insufficient research has been published regarding project management methodologies: Further research is necessary to enhance understanding and the employing of this important concept. For practitioners this means means increasing project efficiency and chances of project success. For researchers and academics, this offers clues for establishing a generally acceptable formal theory of project management.

The main issues which should be considered in future research include:
- Project management methodology logics, structures, dimensions and contents
- The connection between backgrounds and circumstances, methodologies and projects
- The connection between project management methodologies and theory
- The expected and actual benefits of project management methodologies

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References

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Project Perspectives 2013
Next generation of Meeting Tools for Virtual Project Teams

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Introduction
Virtual 3D-worlds attract increasingly attention in non-gaming applications. SecondLife, Google Lively, HiPiHi, Alpine Executive Centre are but a few of the many 3D-products and environments. At the same time, it looks like while many people try out some of these applications, few people return regularly. Why? Because most virtual settings - be it 2D or 3D - still lack a feeling of 'presence', 'place', 'importance' and 'lack' viable meeting tools - which has a negative impact on cohesion, performance and satisfaction. Question is how dispersed project members yet can be effectively supported while working in virtual worlds?

A selection of reviewed literature
Potential of virtual worlds
A yearly online research conducted by the Universities of Eindhoven/NL and Hong Kong provides insight into virtual teams working on developments (IT, software-related fields). This online research produces reports that integrate user interface, 'structure of the meeting process' and 'collaboration'. Overall results indicate that providing space/3D is good for 'brainstorming', 'idea organizing' and 'voting'.

Method
This paper reviews a selection of current literature on doing real work in 2D- and 3D-virtual worlds. Aim is to build an understanding of successful applications of 3D-virtuality, critical success factors and how these environments might evolve - to bring the future of dispersed project teams.

Research was conducted 'to 1st see whether a 3D interface increases the sociability of meeting tools and 2nd to know whether users think that 3D-meeting tools help to 'brainstorm', 'organize ideas' and 'make decisions'. All three meetings were tested with participants geographically distributed during virtual meetings. Results show positive effects of space/3D on ‘user interface’, ‘structure of the meeting process’ and ‘collaboration’. Overall results indicate that providing space/3D is good for 'brainstorming', 'idea organizing' and 'voting'.

Meeting tools in virtual worlds
Based on research results several improvements to the virtual world were added. Three dimensional (3D) meeting tools were added and for dispersed business units and project teams, reveal how 3D-virtual worlds can be exploited for truly collaborative work: Virtual project teams, reveal how 3D-virtual worlds can be exploited for truly collaborative work: Virtual project teams.
should be able to: Conduct meetings with several tools: ‘brainstorming’, ‘idea organizing’, ‘decision making’ etc. Reinforce the project manager’s objectives concerning the outcome of the meeting. Inform participants precisely about what exactly is going on in the joint working process. Handle expectations and dynamics of large as well as small virtual groups; Identify key issues that are the networks of project meetings with the same remote project members; Use techniques for exploring issues more in-depth such as pointing out contradictions in arguments or supporting critical reflection on practice, etc.

Experience of project meetings in virtual worlds: Comparative research on collaborating in 3D-virtual worlds is prevalent. Can a project meeting in a virtual world be better than a project meeting in the real world? Yes, five reasons: Convenience, Right People, Costs, Virtual meeting participants can simply take a break from their current tasks and connect with their colleagues they would like to meet and what they are doing. This convenience not only saves a lot of money. It makes them accountable to come to the meeting. In a virtual meeting it is easier to gather all the essentials (i.e. I’m not alone because I can see other people around me). D. & Van Onna M., 2004) the facilitator needs to actively engage remote participants. The same facilitation is provided. The same facilitation is provided.

Discussion: In our context, there is an urgent need to technologically support virtual teams working on projects like risk assessment, product design and improvement, benchmarking, best practices, or strategy planning. Technically, it is difficult to recreate the essence of a real-world virtual meeting if the virtual meetings typically require degree of participation. This facilitates trying to achieve the likelihood that a feasible structure is built, within the virtual meeting of the project. (Adams, 2010).

Virtual Presence: Virtual-world meeting participants may be absent physically, but are more likely to be present mentally in a virtual world as it can be a highly interactive experience. It’s the facilitator’s job to help the group dynamics to become and remain positive throughout the meeting. Therefore some facilitation skills are required to make appropriate use of 3D meeting tools. According to research (Veil C., Saunders S., Hunt A., Kayyaghi D. & Van Onna M., 2004) the facilitator

Yet what are the drawbacks in virtual project meetings? And what are the remedies for remote project teams? According to the objectives from our literature research mentioned above this challenge is present best met by meeting services offered by Alpine Executive Centre. It facilitates highly demanding work sessions of dispersed teams of your colleagues displayed spatially right in front of you, being dynamically updated as discussions continue. 'Google involved at the same time' (Adams, 2010).

Convenience – Asynchronous Meetings: It’s not always convenient for everyone to log in at the same time for a virtual project meeting. In addition to personal work schedules, time-zone differences may have to be taken into account. Synchronic same-time meetings are the norm when meeting virtually in any medium. However, with the right meeting tools, some meetings can be structured to run asynchronously, where participants login at different times, make their contributions, and later return to complete the meeting. Planning and running asynchronous meetings takes careful preparation and guidance together with well-designed text-capturing tools and a linked database with report producing capabilities.
project members. Working in this virtual group can be tricky to manage when compared to a real-world project meeting. Drilling down to a drill-down scenario like this in a virtual project meeting requires careful planning and execution so activities occur in manageable chunks. This is where well-designed meeting tools and expert facilitation play a big part in the success of virtual meetings.

Lost Importance – Point of Reference: One unfortunate drawback of virtual business or project meetings is that these meetings frequently lose their degree of importance and their impact becomes insignificant. Virtual project meetings frequently take on a persona of a temporary or ad hoc event and eventually get lost in a hazy repository of routine business activities. So it is important to promote the virtual project meeting as an ‘event remembered’, along with the ‘venue of choice’, a unique place in one’s mind.

Conclusion

Since 2010 meeting tools are offered to take advantage of the three dimensional potential of virtual worlds – including instant voice messaging via do-it-yourself-made ‘avatars’. This is accomplished by supporting the visualization of parallel contributions and by enabling the visualization of the meeting process. By making the 3D-interface of meeting tools understandable and easy to use, it is now possible to increase sociability and the feeling of co-presence, while actively engaging the participants in the meeting process. The space (3D) provided in virtual worlds improve the feeling of meeting at a ‘place’, where ‘everybody can see each other’. The interactive 3D-tools keep activities interesting and fun while helping to drive a manageable process with documented protocols that are instantly available to the dispersed project members. Working in this virtual group each action of a remote project member has a visible contributing effect on the results.

So meetings in virtual worlds have the potential to be almost as effective as real world meetings. Drawbacks to virtual meetings can be overcome with the right process, expert facilitation, and special 3D-meeting tools. Networking and socializing in handsomely designed 3D-virtual environments (‘scenic places’ like the Alps) can work just as it can in the real world. To overcome the constraints of the artificial looks of ‘avatars’, a beam-ing-technology is coming up for 2014. It may allow tip-to-toe jumpsuits with electrodes or personal scanner devices which transfers a representation of body and facial movements into the 3D-world. Thus you can beam your natural ‘alter ego’ into the 3D-world.

More Time – Travel Offsets: Accomplishing tasks in a virtual-world project meeting takes longer than a real-world meeting. This is because participants have to simultaneously manage many tasks that are not required in the real world. To keep up with proceedings in a virtual meeting, participants have to: Make their own contributions, read the contributions of others, listen to public and private conversations (voice), read public and private text messages, and manage their own voice and camera view. However, it’s worth noting that time differentials are appreciably offset when you consider the amount of travel time that is eliminated from everyone’s schedule”.

Limited Topics – One Subject: It is more difficult to accomplish everything you might like in one virtual project meeting as compared to a real-world project meeting. In the real-world it’s somewhat easier to manage several issues at once or change the topic. In a virtual meeting it’s better to stick with just one subject for a meeting so remote participants know exactly what is expected of them without issuing additional instructions during the meeting.

Managing Process – Design Scenarios: Process flow in a virtual-world project meeting can be tricky to manage when compared to a real-world project meeting. Drilling down to a decision may involve for example: surfacing issues, identifying causes, proposing solutions, prioritizing solutions, and assigning actions. To deal with drill-down scenarios like this in a virtual project meeting requires careful planning and execution so activities occur in manageable chunks. This is where well-designed meeting tools and expert facilitation play a big part in the success of virtual meetings.

References


Meetings in virtual world have the potential to be almost as effective as real world meetings.

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Future Practitioners of Project Management – Are We Disciples of Stanley Kubrick or Ridley Scott?

To peer into the future, we need to explore the tracks we have left behind as well as the prism through which we envisage what is yet to come. In this paper, the author examines the nature and historical role of project management, the forces that have defined the role of the project manager in society, and the challenges that lie beyond our immediate horizons. Stanley Kubrick provided images of inspirational visions of our future heroes who may be asked to manage the very existence of the human race. Who are the key attributes? Who are the key players moulding future generations of project managers? What are the appropriate visions of our future heroes who may be asked to manage the very existence of the human race?

Such undertakings have illustrated the evolution of what we now regard as project management. Key stakeholders have articulated or organisational (or national) goals and objectives, allocated responsibility for achieving those objectives to those with leadership and vision, allocated resources to facilitate the required change, developed new technologies to support the mission, identified and managed risk as best they could, and put in place an integrated strategy to see the project through to its conclusion. We are riding on the shoulders of thousands of leaders across the eons who have tested their instincts with little or no framework of knowledge, and either lived to tell the tale for the benefit of others, or disappeared without trace.

The more recent history of project management

Numerous authors (Fondahl, 1987; Snyder & Kline, 1998; Stretton, 1994; Urli & Urli, 2000) have traced the more recent history of project management from its formalisation around the time leading up to World War 2, the development of sophisticated tools for better evaluation of what we now regard as project management, the forces that have defined the role of the project manager in society, and the challenges that lie beyond our immediate horizons. Stanley Kubrick provided images of inspirational visions of our future heroes who may be asked to manage the very existence of the human race. Who are the key players moulding future generations of project managers? What are the appropriate visions of our future heroes who may be asked to manage the very existence of the human race?

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Introduction

In this conceptual paper, the author explores one of the key themes of the International Project Management Association (IPMA) Congress – the Future. The project management profession has a longstanding legacy that allows us to reflect on the past: what evolutionary patterns have developed, and where they are likely to take us in the future in the context of education and training for future practitioners.

An historical view of project management in human history

Homo Sapiens evolved over approximately two million years in Africa and then undertook an amazing journey over the last one hundred thousand years or so across Asia, Europe, the Americas and Australia (Lahr & Foley, 1998). Motivated by the search for food, and perhaps curiosity, Homo Sapiens ventured out of the security of Africa into an unknown landscape. Evolutionary forces allowed those who managed risk well to survive and procreate and to continue the journey, while those who managed risk badly, perished. Survival strategies were passed on from generation to generation in the form of communal learning as tales, stories and folklore, until more permanent communication strategies such as drawings, hieroglyphics, writing and printing allowed learning and wisdom to be distributed across all social layers.

The availability of resources flowing from the adaptation of technology allowed those with vision and leadership abilities to conceive and orchestrate larger and more complex undertakings. The Chinese and the Egyptians built complex civilisations thousands of years ago, and the Romans spread an empire across Europe and northern Africa. Columbus recognised the patterns of the winds on either side of the equator and risked everything on a project to cross the Atlantic and to forge a new route to the East Indies. His assumptions were correct, although he discovered the West Indies to his surprise – it pays to be flexible in defining key project objectives (“Christopher Columbus,” 2001). The outcome of that one project changed the pattern of trade routes across the world forever (Law, 1986).

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Do we travel forward to a world envisaged by Stephen Spielberg in ‘A.I.’ where failed projects in artificial intelligence have changed the landscape of society and blurred the meaning of life and death.

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projects have allowed those who can afford it to leave planet Earth to live in style and safety, with those who can't inheriting the legacy of a failed social project of multiculturalism where non-human replicants are hunted down by blade runners? Or do we travel forward to a world envisaged by Stephen Spielberg in *A.I.* where failed projects in artificial intelligence have altered the landscape of society and blunted the meaning of life and death.

What message is there for future project managers in such art forms? Authors of such storylines incorporate sound research into their premise, although artistic licence tends to exaggerate time lines and story outcomes tend to spin out of control for the sake of drama ([http://www.msnbc.msn.com/id/5058474/ns/ ms-nws-environment/]) but key messages remain. The conflict between the rapid and inequitable consumption of finite resources and societal expectations of increasing standards of living will be a key challenge for projects in the near and distant future. Ethical and moral views on sustainability will place demands on the economic dimensions of future projects, requiring difficult choices and decisions to be made in terms of project evaluation. What is desirable? And what is acceptable, as standards of living are inevitably falling where technology does not find ways to compensate for the diminishing availability of physical resources?

Where will future project managers come from?

Project managers will inevitably be caught in this ethical and social crossfire. Who will be the project managers of the future? Will project managers increasingly emerge from industry on a 'learn as you go' basis, or will the responsibility for the development of future project managers be placed with the tertiary education institutions? Will society demand a new breed of project managers with competence at levels expected of historians? Historically recognised professions such as medicine and law? Will society continue to tolerate the extent of project failure that is seen to be commonplace ([Pinto & Mantel, 1936])? As educators, do we have a strategy for development of our would-be profession? I contend that at present, we don't. We have alternative views on ways in which skill sets can be developed to the level that should be expected of an aspiring profession. Recognition of professional mastery has historically moved from local actors to state and national authorities, and more recently to international authorities, and the role of professional bodies should be as advocates of those members of their profession who have earned their place at the table, not competing at commercial levels for training and certification dollars.

**Project management as a future profession**

The rights of project managers to regard themselves as part of a profession have been explored by numerous authors ([Barber, 2001, p. 952; Curling, 1998; Mitchell, 1991; Ringer, 2000]). Project management has often been called the 'accidental profession' ([Stratton, 1994]) and this has tended to the/news between PM as a profession and the relationship of professional associations. First-generation professions of medicine, law and accounting have matured through a recognition of and sharing of ideas. Through such teaching and learning practices, consensus has been achieved in language, terminology, practices, values, and cultures which have become enshrined in discrete disciplines and programs of study. Second-generation professions of architecture, engineering, nursing, accounting, etc have tried to model themselves on first-generation professions. Industry-based practices have evolved into theoretical frameworks through research and have now become part of the domain of universities and recognised undergraduate disciplines of study. There are valid reasons for university involvement in the development of professions, including objectivity, development of evidence-based practices through research, availability of infrastructure and a focus on 'higher learning' skills.

Third-generation professions such as project management are attempting to jump over that stage and bolt on professional 'wings' that allow them to fly with the minimum of training and formal education. Jon Whitty has used a 'peacock' metaphor for project managers on previous occasions ([Whitty, 2011]) and this may be an apt example of its application – project managers who provide a colourful and noisy show but with little real ability to fly. An analysis of higher education for medicine reveals a comprehensive pattern of learning, moving from early stages of basic science to knowledge of the essentials through to developing skills. The right to practice in more specialised areas of medicine requires greater levels of training and education ([Booth, 1995]). In project management, we have a fragmentation of training and education. Non-registered training organisations have carved out a sizeable niche providing competing professional education (CPE) courses. Registered training organisations (RTOs) and the Technical and Further Education (TAFE) sectors offer programs structured by the Project Management Qualifications Framework (AQF) ([http://www.aqf.edu.au/ Portals/0/Documents/Handbook/AQF_Handbook_07.pdf] accessed 24 April 2010) and the Australian National Competency Standards for Project Management (NCSPM) ([http://www.aipm.com.au/html/regpm.cfm](http://www.aipm.com.au/html/regpm.cfm) and [http://www.rmit.edu.au/programs/bp208](http://www.rmit.edu.au/programs/bp208)), producing practitioners who may not have spent any significant amount of time in the workplace.

This is offset to some extent by the increasing adoption of 'work integrated learning' ([WIL]) ([Orrell, 2004]) in university programs, and this should be expanded significantly to capture workplace experience.

Similiar industries are concluding that an undergraduate degree is a clear indicator of an aspiring profession. The Financial Planning Association has recently committed to a minimum entry requirement for professional recognition as a Personal Financial Planner of an appropriate Bachelor's degree ([http://www.fpa. asn.org/default.asp?action=article&ID=21638]). Educators in the area of project management must put aside their competitive tendencies and share practices and resources to ensure that future graduates meet the expectations of all stakeholders. Where is the 'International Project Management Education Council' or its equivalent? It does not exist yet but it should. At this stage, the profession of project management has multiple competency frameworks developed by multiple organisations. The AIPM developed the Australian National Competency Standards for Project Management (NCSPM) ([http://www.aipm.com.au/html/pcspm.cfm](http://www.aipm.com.au/html/pcspm.cfm)) in the 1990s and these have been revised over the years. The PMI has published the Project Management as a Future Profession (PMI), 1999).
Manager Competency Development (PMCD) Framework, and the Global Alliance for Project Performance Standards (GAPPS) (http://www.globalpmstandards.org/) provides a forum for the creation of performance-based frameworks and standards for project management.

Project managers of the future will find it increasingly more difficult to access education and training due to workplace constraints. Physical attendance at universities and other places of higher learning will become more difficult, creating more demand on the utilisation of technology for access to learning activities. The need will be for more flexible learning opportunities but what is ‘flexible’ in pedagogical terms (Laurillard & Plargenson, 1997; Moran & Myringen, 1999)? The profession of the future will demand quality project management education that is flexible in terms of place and time, and wrapped around a pedagogical framework that is consistent from one institution to another (Todhunter, 2009). Unfortunately, there is considerable waste and duplication in the development of learning resources, most of which already utilise a common industry framework such as the Guide to the Project Management Body of Knowledge (PMBOK) (Project Management Institute, 2008). Synergies are largely untapped in terms of the multiple cohorts of project management students across the world, who could undertake learning activities in team-based environments that would reflect an authentic project management practice.

Project outcomes can be difficult to coordinate (Centre for the Study of Higher Education, 2002; James, McInnis, & Devlin, 2002). Social and professional expectations to manage the complexity and scope of future projects and the outcomes, with projects progressively coming from different backgrounds, have different attributes, demand more extensive education and training, and require different professional skill sets to manage the complexity and scope of future projects. Social and professional expectations will place greater demands on higher education to provide appropriate teaching and learning environments to cater for the needs of our future project managers.

**Conclusion**

This paper commenced with a reflective view of the evolution of project management – the drivers, the practitioners, the stakeholders and the outcomes, with projects progressively contributing to a cumulative body of knowledge. This platform provided the basis for development of project management practices and processes that have become formalised in contemporary methodologies. A view over the horizon has highlighted the changing nature of projects resulting from social and economic pressures and rapid technological advancement. These changes will impact on the profile of future project managers who will come from different backgrounds, have different attributes, demand more extensive education and training, and require different professional skill sets to manage the complexity and scope of future projects.

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A Universal Management Mode for Permanent Organizations Based on Management by Projects

Based on the assumption of regarding “goals, tasks and resources” as three core elements of organizational management and the perspective of “Management by Projects (MBP)”, a universal management mode for permanent organizations based on MBP (MBP-mode) is presented through case study and empirical study. This paper establishes a conceptual model for the MBP-mode with project orientation and the highlight of sufficient utilization of management resources and external resources. In accordance with that, a structure of the management system based on MBP for permanent organizations and its basic construction elements is developed by using four-quadrant chart. A compound organizational structure based upon the improved models is further developed in this paper. In order to support the implementation of the management system based on MBP, this paper proposes five key mechanisms which focus on dealing with relations among goals, tasks and resources.

Introduction

A project is a temporary organization (Turner, 2006). In project practice, we are aware of the fact that project management usually can not achieve favourable results merely by the temporary organization itself. It calls for a broader management and supporting platform provided by the strategic level or the level of permanent organizations. What’s more, tasks (Maylor, 2006) in permanent organizations become projectized to deal with the rapid changing macro and micro environment characterized by diversity and uncertainty. However there is a lack of a project-oriented management system which can dynamically integrate organizational resources to better achieve project goals in permanent organizations so that they can thrive in the uncertain external environment. The MBP-mode presented in this paper is hereby to cope with the questions abovementioned.

Relevant researches have been developing from ideas to specific aspect of organizational project management. Andersson (2003) points out that projects without strategic instruction from permanent organizations usually end up with failure or poor performance. Thiry (2007) proves that there is a collaborative relationship between project management practise and organisational practise in project-based organizations (PBOs). Turner (1990) provides a viewpoint that governance structures and operational control in PBOs should vary according to the difference of projects and then offers different governance models for PBOs (Turner, 2001). Aubry (2007) and Hobbs (2008) present PMOs as part of a network of complex relations that links strategy, project and structures and thus is a point of entry to foundation of organizational project management. Some researchers talked about the effectiveness of programme management and portfolio management in organizational project management (Payne, 1998; Lycett, 2004). Some other researches focus on the role of project management capability in organizational project management (Crawford, 2005; Jugdev, 2007). Above all, it’s not hard to observe that researches abovementioned are basically conducted from certain facet of organizational project management or specific field of organizations such as PMOs, PBOs etc, while they don’t give out a whole picture to deal with organizational project management. Therefore, this paper intends to develop a systematic management framework (the MBP-mode) for all kinds of permanent organizations.

Research methodology

The MBP-mode is presented as a universal management application system framework in this paper. Experimental Research is applied into the research of such a model which stands upon the methodology “coming from the practice and tested by the practice”. The research process lasts for nine years by following certain methodological route (figure 1).

This study intends to build up a universal management mode for permanent organizations from the perspective of MBP (MBP-mode). And thus we firstly categorize permanent organizations from the light of tasks into three types; operation-based (not accounted in this study, since projects have been well acknowledged as an essential part in organizations), hybrid tasks-based and project-based. In order to analyze the commonality among all types of organizations. And then this study conducted several case studies on different type of organizations to answer the two questions: what permanent organizations need to do to support the application of project management methods, and how to establish a comprehensive and efficient management system for project-based organizations. This research then conducted literature survey incorporating operation management, organizational project management, PBOs, PMOs, change management, programme management and portfolio management etc to discover the common features of permanent organizations and the theoretical and practical system frame of the MBP-mode. This research further conducted expert interviews with more than 800 business management and project management professionals to receive more professional suggestions to improve the MBP-mode. Empirical study of several R&D institutes and public sectors were then conducted to testify the validity and applicability of the MBP-mode.

Conceptual model

Assumptions are the logic starting point, independent perspective or the fundamental theoretical premises on which some certain theory or method framework is built. Based on the definition of “management” and common characteristics of organizational management, the MBP-mode is developed on basis of the assumptions (A) as follow:

A1: Goals, tasks and resources act as the three core elements of organizational management (see figure 2.).

A2: The major tasks of organizational management are to obtain and maintain favourable relationships between strategies and tasks, between strategies and resources, as well as between tasks and resources.

A3: There are two types of tasks in a permanent organization: projects and operations. The former is the key of organizational development, characterized by a growing proportion of projects in it.

A4: There are two kinds of resources utilized in permanent organizations; internal resources and external resources, and external resources utilization now act as a growing important mean for expanding rapidly, coping with changes and reducing risk. Organizational resources can be separated into two parts: technology resources and management resources, and management resources have become a significant component of the organizational core competitiveness.

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This is an updated and edited version of a paper that was first published in the proceedings of IPMA 2011 World Congress.
A management mode can be viewed as a system which consists of management thoughts, management organizations, management methods and management tools. In accordance with the assumptions abovementioned, this paper constructs a conceptual model (see figure. 3) of the MBP-mode by understanding the basic characteristics of organizational management elements and the growing concern of strategy elements of the MBP-mode. The conceptual model contains 5 key points (K) as follow:

K1: the management system based on MBP comprises management thoughts, management organizations, management methods, management mechanisms and management processes. The management system incorporates four basic construction elements of which briefly explained on the following:

1. Single project management sub-system
   - Projects with similar characteristics of management can be put into one category, for each of which the corresponding management system is developed.
   - Single project management sub-system is project-oriented, which incorporates the control and support from the permanent organizations and all business carried out by temporary organizations.
   - Single project management sub-system can be used within organizations in which two or more projects simultaneously exist. Such management system concerns about the relationship among projects and how to build up the body of project management capability improvement from the perspective of supporting all projects inside the organization.
   - Correlation analysis among projects, multi-projects management mode and methods constitutes the core content of the sub-system.

2. Multi-projects management sub-system
   - The multi-projects management system can be used within organizations in which two or more projects simultaneously exist. Such management system concerns the relationship among projects and how to build up the body of project management capability improvement from the perspective of supporting all projects inside the organization.
   - Correlation analysis among projects, multi-projects management mode and methods constitutes the core content of the sub-system.

3. Partnership management sub-system
   - Partnership management sub-system is defined as the one which deals with the issues from stakeholders outside. It concerns how to establish the external resources network in light of strategies, how to maintain a favourable relationship among partners, and how to select appropriate partners and effectively manage the cooperation.

4. Organization platform for MBP
   - The organization platform for MBP introduces temporary organizations with project orientation to enhance organization flexibility and help realize the strategic goals of permanent organizations.
   - Temporary organizations are the highlights of the Organization platform for MBP of which the relationship between temporary organizations and the permanent organization stands on a key position.

Organization model

Organizations lay a solid foundation to complete tasks by centring on resource allocation. Based upon the thought of MBP, this paper recommends a universal organizational structure for permanent organizations-a compound organizational structure based on the improved matrix (see figure 5). The organization platform for MBP is presented, which clearly cites the basic temporary organizational elements of the MBP-mode on the organizational level.

Management mechanisms

Management mechanisms are referred to the static structure and dynamic operation mechanism of the management system, which stand as the core of enhancing management performance. They are in nature the internal relations, functions and operation principles within the management system. Management mechanisms generally contain operation mechanism, dynamic mechanism and constraint mechanism. The implementation of MBP-mode requires key mechanisms (PM) in order to reinforce the thought of MBP, which are depicted in the figure below (figure 7):

M1: Project Initiation and Evaluation Mechanism
   - Project Initiation and Evaluation Mechanism is used to ensure projects goals in consistent with organizational strategic goals, primarily pointed at establishing the scientific and normative projects planning, project project evaluation process as well as projects decision process and methods.

M2: Resource Allocation and Integration Mechanism
   - Resource Allocation and Integration Mechanism basically focuses on allocating core resources in accordance with the

Figure 3. A conceptual model for the MBP-mode

Figure 4. The structure of management system based on MBP for permanent organizations

Figure 5. A compound organizational structure based on the improved matrix
requirements of strategy development by constructing reliable external resources networks for organizations and integrating internal and external resources to attain the projects goals. Primarily pointed at developing the strategic planning system for organizational resources, the internal resources allocation mechanism and the external resources integration mechanism.

M3: Communication and Knowledge Accumulation Mechanism aims at creating an open, convenient as well as effective environment for information flow and consolidating knowledge accumulation in order to successfully address the relationship between the temporary nature of projects and the requirement over knowledge asset from permanent organizations, primarily pointed at developing the communication mechanism among stakeholders, management information system and knowledge accumulation mechanism.

M4: Performance Appraisal and Motivate Mechanism aims at guiding organizational and individual behaviours and correctly inducing their working motivation through appraisal to sustain or correct their behaviour so that the requirements or strategic goals of both organizations and individuals can be realized. It mainly centres on establishing the corresponding appraisal system and motivation measures to support the implementation of the “MBP” thought.

M5: Project Management Capability Continuously Improvement Mechanism focuses on constantly strengthening Project Management Capability, the core competitiveness of permanent organizations that see the MBP as their leading idea, which mainly aims at developing the Project Management Capability evaluation system and activation mechanism for capability improvement. The MBP-mode presented in this paper also serves as a reliable reference paradigm for the five mechanisms abovementioned.

Conclusions
On the basis of the assumption of three core elements in organizational management and the perspective of Management by Projects, the MBP-mode is developed through case study and empirical study. It has been attested by practices to be a valuable guideline to build up the management system based on MBP for permanent organizations (particularly project-based organizations and project-oriented organizations) in rapid changing environment. This paper provides project management with a new study perspective which starts on an organizational level. And by introducing the MBP-mode, it brings about a new clue for the study of organizational management.

Figures:
Figure 6. A temporary project organization structure
Figure 7. Five key mechanisms and their relationships

References

Sustainable Beauty - achieving sustainability goals by fulfilling materialistic aspirations

Project production involves creation of original goods ranging from engineer-to-order ships and buildings to bespoke clothes and furniture. These goods fulfill the most sophisticated materialistic aspirations for unique goods that make personal statements about their owners. Established perspectives on project production can be found in, for example, International Project Management Journal (e.g. Yang, 2012) and the International Journal of Managing Projects in Business (e.g. Fox, et al., 2009). This paper introduces new perspectives on the environmental and economic potential of project production. These perspectives are possible because of innovative production technologies and new lifecycle strategies.

**Challenges and opportunities in project production**

**Production challenges**

Currently, project production of goods is carried out through the application of craft skills and engineering practices. In particular, smaller goods, such as clothing and jewellery, are created for individual customers by bespoke businesses, which use craft practices. Larger goods, such as homes and yachts, are created for individual customers by engineer-to-order (EtO) enterprises involving, for example, building architects or naval architects. In either case, the starting point is the incomplete and imprecise picture envisaged by the individual customer in the mind’s eye.

A project produced good is first seen in the mind’s eye of the individual who imagines its form and function. The good is not seen then as a complete and precise picture. Rather, it is seen as incomplete and imprecise mental images. Thus, when individuals speak of the goods that they envision—whether goods that they are individually creating or goods that they imagine for others—there is a degree of imprecision. Many individuals, for example, speak of their dream house or their dream car. Typically, the individual customer’s requirements are elicited through multiple iterations of dialogues, measurements, sketches, models, etc., which lead to the definition of design information. These multiple iterations lead to a description of an original good that is unique meaningful for the individual customer. This is because the design information brings completeness and precision to what the individual customer has previously envisaged as an incomplete and imprecise conceptualization in the mind’s eye. As the design information is manufactured a physical good, through multiple iterations of shaping, fitting, and fixing, the individual customer experiences the tangible form of what is ‘first seen in the mind’s eye. Thus, bespoke businesses and EtO enterprises do not offer goods. Rather, they offer production services that enable individual customers to realize their personal dreams as original goods, which for them are especially beautiful.

By contrast, companies operating mass production or its derivative, mass customization, pre-design the sub-assemblies of the goods that they offer, and they pre-define all the possible configurations of those sub-assemblies. This pre-design and pre-definition of goods is aligned with what the marketing departments of mass companies define to be the common denominators among masses of consumers. According, technological innovations are needed that reduce the time and cost of creating goods, but that do not depend upon pre-design of sub-assemblies and the pre-definition of their potential configurations.

**Sustainability opportunities**

As summarized in Table 1, the differences between project-produced goods and mass produced goods are not limited to their design and manufacture. They also include status and longevity. In particular, mass production drives throwaway consumerism by “installing in the buyer the desire to own something a little newer, a little better, a little sooner than is necessary” (Stevens, 1954).

Throwaway consumerism is driven by mass companies through planned obsolescence: in particular, obsolescence of desirability and obsolescence of function. Omission of obsolescence is imposed by mass marketing. This tells consumers over and over again that the goods they recently bought are no longer in fashion. Thus, if they want to have self-esteem and social standing, they must replace those goods with new goods. Hence, this throwaway good have only extrinsic value for their owners. Obsolescence of function is imposed by introducing alternative types of goods, rather than offering parts, servicing, etc. to improve the functionality of existing goods. Living under the threat of obsolescence, billions of consumers are locked into an unsustainable cycle of buy—throwaway—buy again—throwaway again—and again and again and again. This throwaway cycle is unsustainable because of the massive quantities of raw materials that are consumed in producing new goods. It is unsustainable because of the millions of tonnes of greenhouse gas emissions are pumped into the Earth’s atmosphere through endless cycles of extracting, transporting, and processing. It is unsustainable because of the vast quantities of throw-away goods that are pushed into landfills, piled onto scrapheaps, and dumped off-shore.

Unlike mass companies, bespoke businesses and engineer-to-order enterprises make goods that they intend to be thrown away as soon as possible. Rather, they create treasured possessions that their owners can value for decades. They can even become family heirlooms, and be valued by their owners’ subsequent generations. The goods are treasured because they are uniquely meaningful for their owners. This is because beauty is in the eye of the beholder; and their owners’ discern the beauty in their own minds’ eye. Then, they had input into every stage of their design and production. Hence, these goods have strong intrinsic value for their owners.

Importantly, project produced goods are a materialistic aspiration for many. This is be-
cause many consumers aspire to the lifestyles of the rich and famous as presented in celebrity magazines, etc (Robins, 2010). Yet, the rich and famous are not presented with mass consumer goods. Rather, their wealth enables them to have their own uniquely beautiful treasured possessions. These goods range from original jewelry, clothing and furniture to original boats and buildings, which are created through project production.

Project-produced goods that are treasured for decades can make an important contribution to sustainability, because they can make an important contribution to reducing the materials consumption, greenhouse gases, and waste arising from throwaway consumerism. Until recently, the time consuming and labour intensive processes involved in the design and manufacture of project-produced goods has put them beyond the financial reach of many people. As described in the following paragraphs, this situation is now changing through the introduction of innovative technologies for project production.

Innovative project production technologies

Technological innovations are needed that reduce the time and cost of creating goods, but that do not depend upon pre-design of sub-assemblies and the pre-definition of their potential configurations. Three such innovations are digital data capture technologies, generative computation and digitally-driven manufacturing equipment.

Digital data capture technologies

Digital data capture technologies include digital pens. These enable rough sketches drawn on paper to be rapidly converted into digital computer models. Other digital data capture technologies include digital photograph cameras and digital video cameras. The data captured with these can be converted into digital computer models through photogrammetry. Another versatile digital data capture technology is low cost scanners. These can be hand-held or table-mounted, and like digital cameras, enable ordinary people to easily make digital descriptions of physical objects as computer models. Together, these technologies enable ordinary people to formulate digital approximations of what they behold in the mind’s eye. As described by Song et al. (2009), the lifecycle of mass produced functional goods can make an important contribution to reducing the materials consumption, greenhouse gases, and waste arising from throwaway consumerism. As described in the following paragraphs, sustainability can be further increased by the project production of goods involving the augmenting of standard assemblies and the upcycling of existing goods.

Generating computation then automates the evolution of an infinite variety of designs from the initial form. The individual customer chooses the particular design that provides the most complete and precise representation of what is envisaged in the mind’s eye.

The Birds Nest Stadium, created in Beijing for the 2008 Summer Olympics, is an example of the application of generative computation to an initial approximate representation of design intent. As well as generating unique aesthetic, generative computation yielded a design for the Bird’s Nest Stadium that met exacting criteria for production. The setting of goals for the generative computations, such as minimum material usage, can filter the number of designs to be viewed by the individual customer to a practical number (Krish, 2011).

Generative design computation

Generative design computations can be linked to digitally-driven manufacturing equipment such as multi-axis routers or additive manufacturing object printers. These types of equipment are well-suited to the production of unique geometries. In particular, generative computations can be linked to digitally-driven manufacturing equipment to enable the production of snap-fit components directly from digitally-driven manufacturing equipment.

Digitally-driven manufacturing equipment

Generative design computations can be related to optimal combinations of manufacturing machinery and materials (Fox, 2011). It is not infrequent that the new design options are both conceptually and numerically superior. Additionally, it is often the case that the generation of new design options is possible because the generative computations can be formulated - both conceptually and numerically - to be more creative than human designers/engineers. Next, generative computations can be at least as creative as human designers/engineers. However, unlike human designers and engineers, generative computations can work relentlessly across days and nights without a break. Thus, generative computations can generate many new design options that might not have been created by human designers/engineers. Consequently, generative computations can make uniquely beautiful casings, which calls to mind the aesthetic of famous building architects, such as Frank Lloyd Wright, and famous product brands, such as Harley Davidson (Fox, 2011).

Table 2. Innovative technologies for project production

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mass produced good</th>
<th>Project produced good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desirability</td>
<td>Obsolescence of desirability is imposed mass marketing</td>
<td>Goods have intrinsic value because they originated in owner’s mind’s eye</td>
</tr>
<tr>
<td>Function</td>
<td>Obsolescence function is imposed by continual introduction of whole new goods</td>
<td>Goods can have removable components to enable improved functionality</td>
</tr>
</tbody>
</table>

Table 3. Addressing the planned obsolescence of throwaway consumerism

Innovation Reduces obsolescence

Reduce reliance on human skills

Reduced iterations of dialogues and measurements

Reduced iterations of sketch / model – feedback – sketch / model – feedback

Reduced iterations of explanation needed to set-up equipment

Reduced iterations of calculations needed to establish a tight fit

Reduction of design iterations

Goods can have removable components to enable improved functionality

New lifecycle strategies for project production

Project production goods that are treasured for decades can make an important contribution to sustainability, because they can make an important contribution to reducing the materials consumption, greenhouse gases, and waste arising from throwaway consumerism. As described in the following paragraphs, sustainability can be further increased by the project production of goods involving the augmenting of standard assemblies and the upcycling of existing goods.

Increasing standard assemblies

The lifecycle of mass produced goods can be extended by augmenting them with uniquely beautiful casings, housings, etc. The company Bespoke Innovations, for example, makes uniquely beautiful casings, which calls forings, for standard prosthetics (http://www.bespokeinnovations.com). These casings are...
unique to the owner and have a beauty that they treasure, such as a particular geometry which mimics their favourite motorcycle.

Many other project produced goods could be created by augmenting standard assemblies such as structural frameworks. Project produced cars, for example, can deploy Body on a Frame structures. These use an internal space frame to carry loads. External non-load-bearing panels are attached to the internal frame to keep out wind, rain, etc., and to provide car body shape. Uniquely beautiful panels could be made from, for example, carbon fibre composites, rather than the steel sheets used in mass produced cars. This is because very strong solid equipment is needed to enable the shaping of strong solid materials, such as high strength steel bars and sheets, into strong solid steel car body panels. This equipment includes sets of huge mechanical presses, as well as very large convex and concave moulds. By contrast, manufacturing materials that are not so strong individually, such as liquid resins, or more flexible, such as carbon fibres, do not require such strong or solid equipment for their shaping into strong solid composite car body panels. This opens up possibilities for reducing manufacturing costs from manufacturing while creating car bodies that are more individual to the owner.

In addition to creating more individual body panels, new technologies can be deployed to augment or enhance them. For example, cars with unique features such as original dashboards, handles, mirrors, pedals, etc. The type of additive manufacturing called mammmoth stereolithography can produce components of very large and very small size, from meters to two meters in width. Such augmenting of components could be widely used in project production. In fact, mass produced standard goods were made as partially completed shells. These could comprise the necessary physical frameworks for cars as they become older, until new ones are needed to ensure their reliable operation. This strategy is already being applied with commercial success by the innovative car company, Local Motors (Pierce, 2010).

Upcycling existing goods
The augmenting of project produced components to existing goods can bring about widespread expansion of upcycling. That is the process of converting waste materials into new materials, or converting goods, that are considered to be obsolete into valued goods (Paul and Hartkemeyer, 1999). Thus far, upcycling has largely involved the conversion of waste materials. The company, TerraCycle, for example, has established partnerships with major brands in order to upcycle waste packaging materials into shopping bags (http://www.terracecycle.com). Now, the augmenting of uniquely beautiful components to existing goods can enable the upcycling of many existing goods which would otherwise be thrown away due to perceived obsolescence. Consider, for example, goods such as business laptops, which are considered obsole- lute even if they are only a couple of years old. Their functionality still be more than adequate for home use, but they can be considered to have an obsolete style by the children who could use them at home. Now, the exact geometry and dimensions of the laptop can be captured and designs for additional components can be gen- erated and efficiently manufactured; such components can be quickly snap-fitted onto the laptop to give it a unique style of its own. Most importantly, the unique style is first envisaged in the mind’s eye of the child who will use the laptop. Thus, the new style of laptop is uniquely beautiful to its user.

Upcycling does not have to be limited to stand-alone goods such as laptops. Consider, the door handles and sink taps that are often replaced when people’s grip and vision deteriorate. Then, these such built-in fittings have had to be replaced in order to make them easier to grip and operate. This has involved trying to find components made for elderly people, which are removed and thrown away. Next, new larger fittings are installed. All of this work is time consuming and labour intensive. Now, however, new snap-fit components can be added to existing handles, taps, etc. These new components can make them more aesthetically pleasing, as well as easier to grip and operate by elderly people. Such components are needed to serve the ever expanding multi-billion dollar commercial market for Assistive Technology in Industry and Security, 2012). A summary of contributions to beauty and sus- tainability from is provided in Table 4.

New perspectives on project production
A sustainable alternative to mass production
The State of the World Report 2010 contains a grim warning, “Preventing the collapse of human civilization requires nothing less than a wholesale transformation of dominant cultural patterns. This transformation would result from the restriction of the total size of global warming to less than the lifestyles of the rich and fa- mous (Robins, 2010). Indeed, current trends of increasing levels of sustainability are so unappealing to some that they would prefer to consume what remains of the Earth’s resources. Then, attention to journey to other planets where fresh new resources would be available (Monbiot, 2010). This state presents the opportunity to have their own project produced goods may be a more attractive op- tion. Beauty is in the eye of the beholder, and project produced goods are first seen in the mind’s eye of the individual customer. Then, design information brings completeness and precision to the individual’s preference. Each individual customer has previously envisaged as an incomplete and imprecise conceptualization in the mind’s eye. As the design infor- mation is manufactured as a physical good, the individual customer experiences the tangible form of what is first seen in the mind’s eye. Thus, individual customers can realize their personal dreams as project produced goods, which for them are especially beauti- ful. This creation of goods with intrinsic beauty will probably change the throwaway consumerism, which is driven by instilling in the buyer the desire to own something a little newer, a little better, a little sooner than is necessarily. Importantly, innovative production technologies can bring about new opportunities for the growth of both mass production and post-industrial economies.

A means of achieving sustainable economic growth
Countries that have previously off- shored mass production of physical goods are trying to find ways of rebalancing their economies by revi- talizing their manufacturing sectors. However, this cannot simply bring back mass production, because it is now too deeply entrenched in other parts of the world. (The Economist, 2011). These post-industrial econom- ies seek to increase economic growth through creative industries, including project production of original goods (Florida, 2002). However, the shifting of production to the United Nations, “Decoupling natural resource use and environmental impacts from economic growth”, calls for resource consumption to be decoupled from economic growth (UNEP, 2011). Using the new lifecycle strategies of aug- menting and upcycling, project pro- duction businesses can meet both of these apparently contradictory goals at the same time. This is because they can expand manufacturing activity with less consumption of raw materials and less emission of greenhouse gases.

Overall, innovative production technologies and new lifecycle strat- egies enable project production now to be seen as a means of achieving sustainability while supplying ma- terialistic aspirations. This introduces opportunities for the growth of project production businesses, thus contributing to the growth of post-industrial economies.

References
Uncertainty Management in Projects - A New Perspective

This paper focuses on a Norwegian research project, called “Practical uncertainty management in a project owner’s perspective” — in short, the PUS-project. The PUS-project had 6 major industrial partners — from public and private sectors. Both qualitative and quantitative methods were associated with this collaborative project work. This paper describes some of the major results produced by the PUS-project. In this regard, this paper touches upon approaches, methods and practices related to managing uncertainty in projects. The PUS-project emphasised on the role of project owner and giving adequate consideration on opportunities, when it comes to managing uncertainty. This emphasis, which is not common in the project world, is discussed in this paper with relevant theories and practical examples. This paper also presents examples from the industry to highlight some of the benefits that the involved organisations obtained in collaboration with the PUS-project — a research project’s contribution to create value in the industry.

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Introduction

This paper focuses on a research project called “Practical uncertainty management in a project owner’s perspective” — in short, the PUS-project. The purpose of this paper is to describe some major contributions of this research project to create value in the industry and academia.

In order to materialize this purpose, this paper has the following structure: The paper starts with a short description of the PUS-project. A brief description of methodology follows it. Then, some contributions of the PUS-project are described. Firstly, the topic of dealing with opportunities in uncertainty management in projects is discussed. This is one of the significant focus-areas of the PUS-project. And then, examples from the industries are presented to point out some concrete benefits that the involved organisations achieved in collaboration with the PUS-project. Contribution to academia is then briefly described. Finally, concluding remarks wind up the whole discussion.

The PUS-project

The PUS-project (2006–2010) had an ambition of focusing on leadership and culture connected to practical management of uncertainty in major public and private projects. lot of work was done on the issue of uncertainty analysis both in Norway and abroad, and much of this kind of work was carried out in the early phase (“front-end loading”) of projects. But, there was less research on the issue of how to manage opportunities and threats in a project’s life cycle in a practical manner. Furthermore, there was not much research on what the project owner role should be with respect to management of uncertainty. PUS had an ambition to shed light on the owner’s role in uncertainty management throughout the project life cycle. The project had a keen interest in influencing large organisations’ thinking patterns and actions associated with identification and management of uncertainty elements in projects. The PUS-project collaborated with the Research Council of Norway and the Norwegian Centre of Project Management (NSP). The main industrial partners (both from public and private sectors) of the project were:

1. Statoil (an international energy company with operations in 34 countries, headquartered in Norway).
2. Norwegian Directorate of Public Construction and Property Management
3. Telenor (one of the world’s largest mobile operators with 33208 employees worldwide, headquartered in Norway)
4. Norwegian Armed Forces
5. Norwegian Public Roads Administration
6. Norwegian National Rail Administration

Apart from these main industrial partners, other Norwegian organisations were also involved in the PUS-project. The project’s cost frame was approximately 4 million euro. This frame included spin-off projects and own efforts.

Methodology

Methodology that we mention here is a mode of cooperation that the PUS-project had with its industrial partners. During the cooperation, the PUS-project used both qualitative and quantitative research methods: (1) Questionnaire studies (2) Interviews (3) Document analysis (4) Action Research.

During the project, two focus-seminars per year were conducted with the intention of anchoring plans, developing new models, procedures, routines, and transferring experiences between project managers and project owners in the involved organisations.

Focus on opportunities

When it comes to managing uncertainty in projects, there has been more focus on dealing with threats than with opportunities (Ward & Chapman, 2003). We believe that it is relevant and important to look at opportunities — the positive outcome of uncertainty — deliberately, because it can generate benefits to projects / organisations.

A project can be seen as a system. The system is basically unstable and flexible at the start of the project, and it tries to achieve stability and order by the help of establishing objectives, sub-objectives and plans. This will reduce uncertainty of the system. And, the system becomes gradually more stable and controllable. Though the system becomes more controllable when it goes from the early phase to the execution phase, it becomes more rigid, and the flexibility with respect to changes and adopting new opportunities in later phases of the project therefore tends to diminish.

However, new opportunities can emerge at any time in a dynamic work environment. There can be new internal conditions (such as, higher level of competence, effective resource / work environments, new external conditions (such as cooperation with new projects in the nearby area, which can lead the project to save money by, for instance, common procurement, new products in the market, which can lead the project to simplify its technical solutions) that the project did not consider when objectives and plans were established.

If these conditions are exploited effectively, then the project can deliver the product / service with the predetermined quality at a lower cost, or quicker than previously expected.

Active involvement, knowledge and authority are required from the management in order to materialize the benefits of opportunities.

Here are two examples that can illustrate that opportunities can appear / created during the course of projects:

- Project E18 Østfold — a road construction project — was assessed by quality assurance procedure (QA2) and given a cost estimation of approximately 16.3 million euro. When the initial contracts came in, a new analysis showed that the project, with a low probability, would manage to keep itself within the predefined frame of cost. The analysis showed that the cost forecast was approximately 176 million euro. The project carried out a process with the focus on finding potential opportunities that could reduce cost. In the course of four hour time, opportunities were found and they were used to reduce the cost more than approximately 20 million euro.

- Project R6 – Construction of 3 government buildings was at the phase of developing keys and lock-systems that could deliver safe and secure solutions. This process originally included among other things, design / project engineering, purchase and installation. But, the project participants found out that there was another project that was going on primarily in connection with key and lock-systems in government buildings. Then, the project participants found out that there was another project that was going on primarily in connection with key and lock-systems in government buildings. Then, the project participants found out that there was another project that was going on primarily in connection with key and lock-systems in government buildings. Then, the project participants found out that there was another project that was going on primarily in connection with key and lock-systems in government buildings.
Having a broader view on the consequences of a project:

Consequences of a project can be seen in several dimensions: first, second and third order consequences. The first order consequences are the concrete result that the project is intended to produce (for example, constructing a hospital building with respect to time, cost and quality). The second order consequences are the effect of the project’s concrete result (for example, applying new knowledge that has been gained by the people and organization(s) that were involved in the project, curing and taking care of sick people). The third order consequences are a larger, social impact (for example, better health care system, wellbeing, new business establishments near the hospital – kiosk, etc.).

Table 1. Examples of consequences

<table>
<thead>
<tr>
<th>Project</th>
<th>First order consequences</th>
<th>Second order consequences</th>
<th>Third order consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Opera house, Oslo</td>
<td>A modern building where opera shows can be arranged.</td>
<td>Having the possibility to apply the experience that the involved organisations gain in future projects.</td>
<td>- Tourism in Oslo / Norway - Town-development (Bjørvika)</td>
</tr>
<tr>
<td>Constructing the highway EB, Distadl</td>
<td>New, modern road</td>
<td>Less accidents - Faster traffic-movement - Shorter queues.</td>
<td>- New firms / businesses; f. ex. gas station, grocery store, restaurant</td>
</tr>
</tbody>
</table>

The second order consequences are the effects that emerge after the project is completed. These effects include benefits to the organisations that have been involved in the project, i.e., access to new markets and technology, development of new knowledge and competence within the respective organisations.

The third order consequences are broader effects of the project on the society. Opportunities in this regard encompass establishment of new organisations and services as the result of the completion of the project. An example in this regard is a construction project called Snowwhite project in the Finnmark region, Norway. When the construction project was completed and operations were begun, then the surrounding environment / society started to obtain benefits from it; for instance, there were new work opportunity for the local people, day care facilities for children, and schools.

Cooperation between project managers and project owners:

It is beneficial to have a broader perspective in managing projects. The broader perspective can be developed by establishing a good cooperation between project managers and project owners – with a strong involvement from project owners.

A project owner has rights to and is responsible for the project. Olsson, Johansen, Langlo, & Torp (2007) say: “The beauty behind the concept of a project owner lies in the fact that a project owner has incentives for weighing costs against benefits for a project. Project owners are therefore expected to strive for project governance aimed at maximising the value from the project.”

Table 1 shows examples of first, second and third order consequences.

Now, we shall use the description of the 3 orders of consequences (the 3 different objectives that are associated with projects) to illustrate the role of project owner in handling opportunities in projects.

Creative thinking:

We see that there is a clear connection between creativity / innovation and the topic of opportunities in projects. It can be said that creative and innovative thinking can promote identifying and creating opportunities in projects. In this
Identifying and creating opportunities, materializing them and harvesting the benefits of them can also encourage innovative and creative thinking in organisations.

In the beginning of 2011, the SUS-project won Statsbygg’s innovation prize. A description that accompanied the prize says that the project has provided documentation of both threats and opportunities over time in projects, including effects and efforts related to them, and that the overview of uncertainty, provided by the documentation, gives both project managers and project owners more confidence in executing their roles in managing uncertainty in projects.

Another industrial example is Telenor (from the private sector). Telenor developed a tool called “Health check” in collaboration with the PUS-project. The tool has 20 questions that can be used to check how project participants experience their work situations. The questions can be used in different phases of a project – as a kind of an early warning system. The tool is now available at the website of the Norwegian Centre of Project Management (http://www.nsp.ntnu.no/) to its members. Telenor indicated its willingness to continue the work, which had been started with the PUS-project, through its “risk forum” (PUS-project, 2011).

**Contribution to academia**

The PUS-project contributed to academia too. In this regard, 17 master degree theses and 11 student project theses were produced at the Norwegian University of Science and Technology (NTNU), Trondheim, Norway. Two doctoral theses were also connected to the PUS-project. Eleven journal articles and 22 conference articles were published during the 4 year period.

The academic contribution was in collaboration with the PUS-project and the involved organisations, such as Statsbygg, illustrates how a research forum can contribute to the wider management field.

Furthermore, the cooperation between the PUS-project and the involved organisations, such as Statsbygg, illustrates how a research forum can contribute to the wider management field.

**Acknowledgement**

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**References**


PUS-project (2011) Report on the final PUS-forum that symbolises the formal completion of the PUS-project. The report (Norwegian version) is available at the website of the PUS-project: http://www.nsp.ntnu.no/PUS/.

The rolling wave scheduling problem solved by the real options approach

This paper presents a methodology for the rolling wave scheduling. The methodology aims to manage the cost and risk of delay of the project by identifying the best schedule using the available information. The literature shows the absence of specific quantitative algorithms for the rolling wave schedule since most of the approaches are merely qualitative. Therefore it is necessary to define and test a new methodology to evaluate the overall alternatives. This new approach first lists all the possible schedules than evaluate each schedule with a real option based optimization model. The methodology described has been implemented in Matlab, in order to perform the related sensitivity analysis. The results show how this approach is able to reduce both the expected cost and the variance respect to a not real option approach.

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This paper presents a methodology for the rolling wave scheduling. The methodology aims to manage the cost and risk of delay of the project by identifying the best schedule using the available information. The literature shows the absence of specific quantitative algorithms for the rolling wave schedule since most of the approaches are merely qualitative. Therefore it is necessary to define and test a new methodology to evaluate the overall alternatives. This new approach first lists all the possible schedules than evaluate each schedule with a real option based optimization model. The methodology described has been implemented in Matlab, in order to perform the related sensitivity analysis. The results show how this approach is able to reduce both the expected cost and the variance respect to a not real option approach.

Introduction
This paper presents a model for project re-planning using real options as a tool to value the information available to the Project Manager (PM). Traditional scheduling methods do not consider the possibility to include on the algorithm the information about uncertain events. This paper aims to fill this gap providing, describing and implementing a model able to consider the risks and the costs to hedge them. The application area of the model is the Rolling Wave Scheduling (RWS) i.e. the periodical short-term project rescheduling. The model aims to determine the best schedule based on the available information at the time of evaluation. The model’s goal is to hedge the risk of delay through possible rescheduling of Work Package (WP) and “exercises of options” available for the PM. The model makes the execution risk on the project when it is quantifiable and when actions to reduce the risk considered are available.

Literature review
Even if most of the projects deal with RWS only few authors provides quantitative algorithms. The main contributions are a set of guidelines to implement a well-structured process control project progress. Therefore the methodology presented in this paper relays mainly on the following contributions:

- Final deadline and delay cost [money/time];
- Precedence constraints among WPs;
- Total resources availability;
- Optimal schedule;
- Total cost of the solution.

The inputs required are:
- WPs characteristic: duration, early start, float, resources usage;
- Total resources availability;
- Precedence constraints among WPs;
- Final deadline and delay cost [money/time];
- Risk-free rate (r);
- Risk described by probability and magnitude (number of days);
- WPs jeopardized by the risk;
- Counter-measure to avoid the risk and its cost.

While the output provided are:
- List of options to exercise and options to drop;
- Optimal schedule;
- Total cost of the solution.

Problem Solving
General overview
Figure 1 summarizes the method presented in this section.

Identification of WP
This phase lists the WPs included in the time window considered.

Identification of Feasible Schedules
The method (Matlab based) creates all the possible schedules. From a computation point of view this is the most time-consuming. Since the method creates and evaluates all the possible schedules it could be defined as an “optimal enumerative algorithm”.

Figure 1. Method
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Application of Kernel Algorithm
For each feasible schedule identified in the previous steps the Kernel Algorithm (presented in the next section) evaluate the total cost. This cost, called “Rolling Wave Scheduling Cost (RWSC)” represents the main attribute of each schedule. The schedule with the minimum RWSC is the best schedule.

Project Replanning
The method provides the news schedule with the list of options to exercise

The Kernel Algorithm
The options embedded in a project are considered as “European call options” since can be executed in each moment but has the maximum value at maturity. To use the real option algorithms it is necessary to “translate” the PM parameters in real option parameters:
- The Option underlying (St), is the evolution of the delivery date under different scenarios
- The strike price (X) is the delivery date at the time now.
- The evaluation of each option is divided in four main steps

STEP1: analysis of each WP and the related risks/options
This steps analysis each WP to assess if it is jeopardized and if there are options available to hedge the risk.

STEP 2: compute the value of each option
The method used to evaluate the option is the binomial tree. The method implies the evolution of each option respect to its cost

STEP 3: parameters updating
The Kernel algorithm uses three parameters

1. A single branch if there are not risks or the risks are neutralized. Without the risk the duration is deterministic.
2. A ramification of two branches if the risk can occur or not
3. Global state: This indicator merges the two state

STEP 4: Compare the value of the option respect to its cost
This first step is to convert the value embedded in the option in monetary terms with the formula

α = option payoff * delay - Global state

This value is compared with the cost of exercising the option

β = α - exercise cost

If β>0 it is worth to exercise the option
β<0 it is not worth to exercise the option

Now the method can provide the new schedule with the following informations:
- The new schedule of each WP
- Which option to exercise

The time bucket is one day (or the units of measure used in the project). The underlying tree is defined starting from the S (expected delivery date) at the time now. There are two possible evolutions:
1. A single branch if there are not risks or the risks are neutralized. Without the risk the duration is deterministic.
2. A ramification of two branches if the risk can occur or not

As a consequence the underlying tree shows the delivery date (underlying (St)) according to the different paths. It is worth to exercise the option if it provides a positive effect. If building a temporary roof avoids the risk from the bad weather the positive effect is the number of days saved. This value can be easily computed by subtracting in the final value for each scenario (considering the risk) by the value of a scenario “without risk”. The remaining nodes are calculated with a back-forward approach using as strike price (X) the delivery date at the time now.

The Kernel Algorithm
- The total cost of this solution is 32,000 (include the overload cost for resources).
- The schedule is risk free and lasts 15 days (figure 3). The risk A has been neutralized by exercising the option and activity G has been postponed.
- A set of parameters has been investigated in order to assess the time required to the algorithm to solve the problem and usually:
  - the optimal schedules are 1/3 of the feasible schedules;
  - the time required to generate the feasible schedules is about 80/120 of the total time.

### Table 1. Time required to solve the problem

<table>
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<tr>
<th>#WP</th>
<th>Float availability</th>
<th>Number of configurations</th>
<th>Number of feasible schedules</th>
<th>Number of optimal schedules</th>
<th>Resolution time [minutes]</th>
<th>Evaluation of optimal schedules time [minutes]</th>
<th>Total time [minutes]</th>
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<td>8</td>
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<td>54</td>
<td>32</td>
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<td>0.02</td>
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<td>144</td>
<td>0.21</td>
<td>0.02</td>
<td>0.23</td>
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<td>1004.30</td>
</tr>
</tbody>
</table>

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The application: results and risk management
This paragraph shows how the algorithm presented in section 4 deals with risk management. The algorithm, developed to minimize the “expected total cost” can even reduce the variability of the delivery date and therefore is a useful Risk management tool. For example, let’s consider the project in figure 2 jeopardized by two risks:

1. Risk A:
   - Impacts on activity A
   - Can occur the day 1 (70% probability)
   - Strike price of option A to cover the Risk 20.000Euro

2. Risk G:
   - Impacts on activity G
   - Can occur the day 2 (80% probability)
   - An earliest delivery date the day 15 (32% probability)
   - Strike price of option B to cover the Risk 5.000 Euro

Without any countermeasure this project has:
- Among these 32 schedules 12 of them have the same minimum cost. The model minimizes the total rolling wave cost, i.e.
- The optimal solution.
- The total of this solution is 32,000 (include the overload cost for resources).
- The schedule is risk free and lasts 15 days (figure 3). The risk A has been neutralized by exercising the option and activity G has been postponed.
- A set of parameters has been investigated in order to assess the time required to the algorithm to solve the problem and usually:
  - the optimal schedules are 1/3 of the feasible schedules;
  - the time required to generate the feasible schedules is about 80/120 of the total time.

From table 1 it is clear how the computational cost of the algorithm is mainly due to the generation of feasible schedules. This is the main disadvantage of using an enumerative algorithm.
Conclusions
This paper presented a model for the project’s rolling wave planning using real options as a tool to exploit the information and the degrees of freedom owned by a PM.

Each day a PM faces many risks and there are options to overcome them. Some options could be free of charge, as rescheduling some not critical activities, other are costly (as building a temporary roof). Therefore a tool is required to identify the optimal schedule with the relative options to exercise. The method presented in this paper aims to support the PM in managing the risk in the RWS. The literature review showed as the real options have the characteristics to become a valuable tool in project re-planning, however it is necessary to shape them according to the specific PM field.

The main assumptions of the model are:
- The underlying was identified in the delivery date of the project, and consequently it was assumed that the PM owns one or more options on its evolution.
- The financial reference option has been identified as a European call option without dividends, in particular a deferred (real) option.

The scheduling algorithm is associated to an optimization model with an appropriate objective function that has to be minimized: the decision variables are measured in monetary terms: cost of option, resources and risk assumed. The model presented allows an efficient and effective risk reduction.

Reference

1 - A European option may be exercised only at the expiry date of the option, i.e. at a single pre-defined point in time. An American option may be exercised at any time before the expiry date. Even if the options are American the algorithm treats the option as European. Let’s consider the stroke risk. Until the last moment it is not necessary to give the pay raise since the treat of stroke can be a bluff or can be avoided with other cheaper solution.
The mission of the 27th International Project Management Association (IPMA) World Congress is to balance the project management experience and move forward. Therefore this congress will inspire the people who will add balance to the Project Management Society and thus push the world forward.