Towards Project Portfolio Management for Sustainable Outcomes in the Construction Industry

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Abstract

It is imperative that organisations improve their sustainability and there is a global push to reduce the environmental impact from project activities. This is especially true in construction, yet there is no existing framework to guide decision making and project portfolio management (PPM) for sustainable construction. This paper discusses the application of project portfolio management to the area of sustainable development in the construction industry. Using the understanding gained from existing PPM practices in a range of industries and the current approaches to risk and sustainability management in the construction industry, we propose a new maturity model for PPM. The maturity model aims to guide the introduction of sustainability factors into multi-project resource scheduling and risk analysis in the construction industry, and can be used to make the contribution to sustainability from an overall portfolio more sustainable than the sum of the contribution from individual projects.

1. Introduction

Sustainability considerations must be included in project decision-making frameworks to address the global requirement to improve the environmental impact of project activities and their outcomes. Environmental considerations are receiving increased attention in the construction industry due to the large impact on sustainability in that industry, both during the construction and ongoing use. Therefore, the field of construction is studied here to optimize methods of project selection and PPM using sustainable criteria. In particular, this study aims to enable the management of portfolios of projects whereby the sustainability of the portfolio is greater than can be achieved through evaluating each project in isolation.

We look at how best practice industry benchmarks have informed the development of maturity models for Project Portfolio Management (PPM) in IT and New Product Development (NPD). We then consider the problems solved by existing PPM practices. Risk analysis is of particular interest and we evaluate the current industry practices used to select construction projects so that risks are shared through portfolio selection. Using the understanding gained from such practices, we propose a maturity model to guide the introduction of sustainability factors into multi-project resource scheduling and risk analysis in the construction industry.

2. PPM in construction

2.1 Projects and project portfolio management

The Construction industry is organised around projects where each project has its own deliverable such as a building, road or bridge. Each project typically develops its own project organisation, consisting of a management team from the contracting company together with sub contractors who perform specialised work. At a larger scale, companies in the construction industry usually have several projects in progress, and are continually organising future projects for continuity of business. Having multiple simultaneous projects complicates the management process, and requires a higher level of coordination. Two types of coordination exists: (i) Mega-projects may have several of these organisations working on different sub-deliverables where the overall deliverable is too big for a single project organisation; and (ii) Project portfolios which recognise that projects do not exist in isolation but are interdependent of each other in a number of ways. Project portfolio management practices provide a portfolio level perspective where these interdependencies can be managed and balanced across the portfolio. The Project Management Institute's Standard for Portfolio Management (PMI 2006) defines Project Portfolio Management as: 'the centralized management of one or more portfolios, which includes identifying, evaluating, prioritizing, authorizing, managing and controlling projects, programs, and other related work, to achieve specific strategic business objectives'.

Several related terms are frequently used such as Multiple-Project Management (e.g. Patanakul and Milosevic, 2009), Project Portfolio Management (e.g. Thiry, 2006), or Program Management (e.g. PMI 2006) to describe this coordination. These terms are all consistent with Cooke-Davies' (2002) definition that project portfolio management is predominantly about 'choosing the right projects'. However the experience in the construction industry is that these terms are not well understood and there is no universal understanding of the terms in the industry (Milosevic et al. 2007). Programme management is confused with schedule management and Gantt charts are often seen as interchangeable with project management (Ferns, 1991).

2.2 Benefits of portfolio level management

Investigation of construction activities shows that many projects are increasingly undertaken in a multi-project milieu (Blismass et al. 2004a). Turner and Speiser (1992) contended that the vast majority of projects nowadays take place within portfolios of related, small-to-medium sized projects. In a portfolio, projects are interdependent in objectives, and make use of common resource pools (departments or expertise). Payne (1995) estimates that up to 90% by value of all projects are carried out in a multi-project context of some sort.

Kangari and Riggs (1988) observe that when a construction company invests in many projects, a diversified portfolio of projects poses less risk than the average of individual projects considered alone. Pellegrinelli (1997) highlights that programmes create value by improving on the management of projects in isolation, especially where the working environment is not only made up of a myriad of small projects, but also where projects integration, in terms of both development and deliverables, is crucial to competitive success.

Furthermore, analysis by Kometa et al. (1995) and Chinyio et al. (1998a, 1998b) demonstrate that the majority of construction clients surveyed were actively initiating numerous projects annually, supporting the suggestion that the construction industry operates with a significant contingent of multi-project clients. In a study of construction client typologies, Blismass et al. (2004b) found that despite the widespread multi-project nature of many construction clients, single project management strategies were usually adopted for managing programmes and portfolios and that this resulted in only limited success.

2.3 Applying PPM in Construction

Project success should be understood as a multifaceted strategic concept that goes far beyond meeting the time and budget constraints (Shenhar et al., 2001; Andrus 2005). Thus, in addition to criteria indicating effectiveness in the management of single projects, the success of projects should be evaluated through their contribution to the organisation's strategy. According to Cooper et al (2001) and Iamratanakul et al.(2009) the three goals of project portfolio management are maximising the value of a portfolio (MVP) using optimisation techniques, achieving a balanced portfolio through visual tools, and aligning a portfolio with business strategy.

The literature on PPM methods and outcomes, identifies three approaches to project selection: management and organisational inputs; processes; and outputs of multiple-project management.

Selection by management and organisational inputs looks at how projects are selected based on their relevance to the organisation's business objectives, the appropriateness of the project size, the schedule and technical feasibility, the financial viability, etc (Patanakul and Milosevic, 2009). Payne (1995) and Adler et al. (1996) emphasised that it is very ineffective when an organisation implements too many projects to be handled by its available resources.

In process-based project selection, the concept of portfolio management is applied at an operational-level so that functional managers, multiple-project managers, and team members can couple the planning and control cycles for single projects and the portfolio of projects (Patanakul and Milosevic, 2009). This identifies the balanced trade-off among the interests of multiple-project managers and functional managers in a team effort (Platje and Seidel 1993; Platje et al., 1994). Doerner et al. (2004) describes a two-phase procedure that first identifies the solution space of all efficient (i.e. Pareto-optimal) portfolios and then allows an interactive exploration of that space. Platje and Seidel (1993) have demonstrated portfolio thinking require the delegation of all responsibilities to the lowest possible organisational levels to manage by projects with improvement in communication to enable intervention by the multi-project leader only when problems occur. The idea is

to manage all projects as a collection, by adjusting and linking their schedules to match available resources, and removing unnecessary variation in workloads of multi-project managers and increasing efficiency (Alder, 1996).

Project selection by outputs of the process relates to utilisation of resources (Ireland, 1997) and the managerial expectations (Kuprenas et al., 2000). Anttila et al. (1998) argue that only the final end result matters. In this view time, cost, resources and organisational policy are constrained objectives of the project so it is more important to focus on defining and managing the final project product (Artto et al. 2001)

Best practice studies indicate that portfolio management decisions made by experienced and diverse teams are associated with better project outcomes than decisions made by an individual (Cooper et al 2001, Killen et al 2008). Such group decisions are aided by visual techniques such as portfolio maps or bubble diagrams, histograms, bar charts, and pie charts. These techniques help portray the various factors that lead to portfolio balance.

2.4 Adopting PPM

The complexity of PPM forms a major barrier to adoption. In particular providing evidence for improvement by PPM is difficult. The work by Shehu and Akintoye (2010) looked at the factors effecting uptake of Programme Management and the results of their empirical study displayed neither positive nor negative correlation between having established rules and procedures for management in multi-project environment and success. This suggests that formal procedures are appropriate for some organisations, while others may yield better results with an informal approach. Thus, the need for formal procedures is specific to an organisation. A study by Loch (2000), also concluded that no 'best' approach is evident and that the approach used must be tailored to the environment.

3. Sustainability Ontology

The current sustainable agenda takes its roots from the initiative put forward by the World Commission on Environment and Development (WCED 1987), and reflects predominantly the environmental dimension of sustainability (Lélé 1991). Sustainable development depends heavily on supply chain management (Facanha, 2005), as this encompasses the entire life cycle of products, from the procurement of materials, their transformation into finished products, or in this case constructions and the product use and maintenance, as well as disposal, recycling, and remanufacturing. Indicators of sustainability performance for the different stages of the life-cycle of construction projects are illustrated in (Al-Kilidar et al. 2009).

A sustainable supply chain is defined as the one that is profitable and resource effective and that 'meets the needs of the present without compromising the ability of future generations to meet their needs' (WCED, 1987). This definition provides a model similar to the management of multiple projects in a limited resource environment. Edum-Fotwe and Price (2009) divide the ontologies for sustainable development into three areas: economic, environmental and social (Figure 1) which are interdependent.

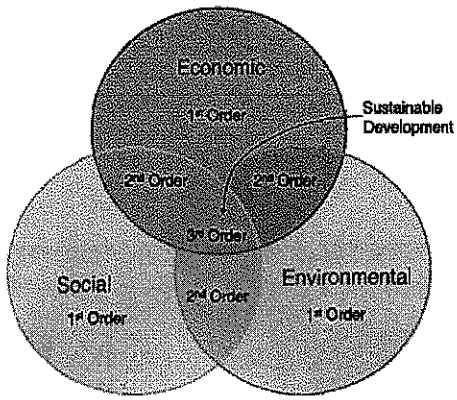

Figure 1: Underlying ontologies of sustainable development from Edum-Fotwe and Price (2009)

3.1 Social Ontology

Edum-Fotwe and Price (2009) describe the social ontology by looking at three spatial scales and their related life cycles.

Scale	Life cycle
Material	Investigation, extraction. processing , storage and distribution
Building	Feasibility, design, construction, maintenance and demolition
Urban	Planning, infrastructure, community building

Each sub-category of life cycle and spatial scale has its own collection of sustainability issues. These issues relate both to the built products, the workforce involved, and the end users.

3.2 Environmental Ontology

The WCED (1987) defines the concept of sustainability to reflect natural resource utilisation in the quest to attain development objectives by national, regional, and individual stakeholders.

As an example of existing practise, Zou et al. (2006) conducted a comprehensive review of the current literature on risk management and summarised environmental sustainability risks to include: direct environment risks such as dust, harmful gases, noises, solid and liquid wastes; and indirect environmental risks which are influenced by a project but are not necessarily a direct result of the project, such as the exposure of contaminated materials during the excavation of soil for footing.

3.3 Economic Ontology

Existing environmental and social risk calculations usually refer back to the economic factors of cost, time, and quality (Cardona 2003). These factors include clean-up and replacement of resources (such as personnel or equipment), and future environment and safety impacts, which may be outside the responsibility of the organisation. In attempting to put all such costs in to the scope of the construction project, qualitative costs such as public dissatisfaction or the often hard to calculate carbon emission values need to be considered.

3.4 Sustainability Assessment

Sustainability has been considered in metrics for project assessment in some studies discussed above. However there are many metrics that have not been considered due to their complexity and qualitative nature. Here we look at how sustainability has been incorporated into existing metrics. Two approaches to management that are most relevant to sustainability are green buildings and value engineering. Also we can consider the existing process of developing an Environmental Impact statement as a process that informs the organisation as well as publicly validates the process. Life cycle assessment (LCA) is used to assess the impacts of supply chains. LCA can also add the environmental and social perspective. LCA maps every process associated with a product within the system boundaries, to its associated energy, material inputs, environmental outputs, and wastes. (EIO-LCA, 2003).

Green Building has emerged as a new building philosophy, which is the reflection of the concept of sustainable development, encouraging the use of more environmentally friendly materials, the implementation of techniques to save resources and reduce waste consumption, and the improvement of indoor environmental quality, etc (Wang & Hwang 2005; Thormark, 2006).

Value Engineering (VE) is a management tool used to achieve essential functions of a product, service or project with the lowest cost. VE derives its power from being a team-based, process driven methodology using function analysis to examine and deliver a product, service or project at optimum whole life performance and cost without detriment to quality (Shi and Xie, 2009). It has been widely practiced in the construction industry with an aim to produce innovative ideas and solutions for enhanced project value and become an integral part in the development of many civil infrastructure projects. In the design and construction phases, the construction alternatives and its performances are analysed in order to obtain a lowest budget. Similar procedures could be applied to the environmental and social/cultural aspects to improve the sustainability of projects.

4. Maturity Models for project and portfolio management

Maturity Models have been developed in several industries for providing benchmarks for process improvement. The Standardized Process Improvement for Construction Enterprises (SPICE) as developed by Sarshar et al (2000 & 2004) is described in Table 1.

Level 5 Continuously improving	Key processes from original • Process change management • Technology change management • Defect prevention
Level 4 Quantitatively controlled	Key processes from original • Quality management • Quantitative process management
Level 3 Well defined	SPICE recommended key processes • Organisation process definition • Organisation process focus • Integrated design and construction management • Construction life cycle engineering • Training programme • Peer reviews
Level 2 Planned and tracked	SPICE key processes • Brief and scope of work management • Project planning • Project tracking and monitoring • Sub-contract management • Project change management • Health and safety management • Risk management • Project team co-ordination
Level 1 Initial	

Table 1: SPICE Maturity levels and key processes
From Construct-IT (2000)

The model is based on the US Capability Maturity Model with modification to applying the SPICE framework across the supply chain

and increased flexibility for maturity to change during a project's life cycle.

Research into the existing practises in terms of maturity of process in the construction industry is relevant to this study, and we summarise some major studies here:

Ibbs and Kwak (2000) note that there are no universally accepted standards in methodologies or well-defined processes for measuring project management processes either in one organisation or across an industry. They also note that research previous to their study has been qualitative and used narrative measures, or focus on practise and look at the productivity driven impact of this alone. From questionnaire responses they calculated the average of the data within the five planning phases of: Initiating, Planning, Executing, Controlling and Closing, to highlight strengths and weaknesses, and provide a benchmark for the maturity level occurring in industry, as a peer assessment technique. The maturity levels are based on increasing management control and process repeatability. They suggested that a possible capability scale is that key activities will be performed with increasing complexity or increasing rigour.

Case studies by Sarshar et al (2004) evaluated the presence of process enablers at each stage and assessed capability. These enablers are: commitment by the organization; ability through resource management; verification through independent external means; evaluation internally through review; and activities described to implement the process.

Cooke-Davies and Arzymanow (2003) performed a benchmarking study that explored variations in project management practice in 21 organisations across six industries. The empirical research was based on in-depth interviews with knowledgeable project management practitioners. The results are qualitative rather than statistically reliable indicators of project management maturity and the data showed the detailed variation across 10 domains studied. These individual domain results are important, as they can direct where effort is needed to improve practice.

Wang and Ramiller (2009) look at factors affecting the uptake of innovation, such as Enterprise Resources Planning, and how organisational learning effects this uptake. They look at how such a process within organisations reaches maturity. The technique starts with a balance between understanding what and why the process used, later followed by knowing how to implement it.

Ansari et al. (2010) conclude that management practices cannot be adopted by user organisations as "off-the-shelf" solutions.

A study by Cooper et al. (2004) showed that a statistically significant relationship between more formal PPM processes and the performance measures in New Product Development (NPD). Among the specific findings is the revelation that although financial measures are the most common method used, they are not the best method to use as primary selection criteria. Also, for management tools, bubble diagrams or portfolio maps and strategic methods have the strongest links to successful PPM outcomes.

Reviews of maturity models (CBP, 2005; Pennypacker 2005; Miller 2004, Loch, 2000), are mostly in the IT industry and significant challenges are highlighted in selecting a high value portfolio of projects with the right balance and an appropriate number of projects. The appropriateness of rigid maturity hierarchies is challenged due to the established need for portfolio management processes to be customised and tailored to the individual environment and the fact that interactions between elements are not adequately considered when developing maturity models.

5. Proposed Maturity Model for Sustainable Portfolios

In this work we propose the outline of a maturity model specifically designed for the construction environment. Building upon Ansari et al.'s (2010) conclusion that management practices cannot be adopted without customisation for the context, we suggest that practices are likely to evolve during the diffusion and implementation process, requiring custom adaptation, domestication, and reconfiguration to make them meaningful and suitable within specific organisational contexts.

Stage 1 Projects Managed Individually. Project Management is enacted, with each project managed separately. Organisation may include sustainable factors in their risk or cost analysis. This is the stage where the business identifies the factors they need to analyse in order to plan, coordinate and execute their projects. This may include gathering metrics.

Stage 2 Resource Balancing. The Organisation is matching their projects to their capabilities. Resources in the form of personnel, materials, infrastructure and money; are sought to fit organisational niches. The organisation is starting to measure its needs and capabilities.
An example of this is where an organisation re-organises the schedules of its projects so that big pieces of plant are not over-booked.

Stage 3 Synergies. The Organisation is developing synergies between potential projects; and between potential and existing projects. For example management is planning for the reuse of resources, facilities and processes. Can introduce here the re-use of sustainable expertise. The organisation is starting to use metrics to plan and develop portfolio.
An example of this is where an organisation plans its portfolio so that the rate of excavation from its projects that produce a surplus of soil balances the rate of soil required for the projects requiring imported soil. Thus maintaining soil sustainability for its operations.

Stage 4 Risk Spreading. The Organisation's portfolio is diversified so that the risk associated with sustainability outcomes is reduced in comparison with individual projects. This is because the sustainability consequences of various risk factors on different projects are uncorrelated, or even anti-correlated.
For example: An organisation needs to select a new project to add to their portfolio. At the time the government is choosing between two different carbon pricing schemes. The organisation looks at their current portfolio and notice that their portfolio will perform very well if method A for carbon pricing is adopted by the government, but not so well if method B is adopted. They therefore select their next project so that it will perform well under method B. This means that regardless of which method is adopted by the government, the organisation will have some projects that will thrive and cover for any losses made by projects that do not do so well.

6. Conclusion and future research

This paper presents a maturity model for implementation of sustainable project portfolio management in construction. It reveals that the current emphasis in the PPM literature on PPM is at the level of resource balancing. The maturity model proposed in this paper provides guidance on how project portfolio management can move beyond resource balancing to provide a higher level of portfolio oversight for the construction industry including the incorporation of sustainability considerations. Future research is required to verify how the proposed model fits with industry practice and how it will need to be tailored to be able to be implemented. We suggest that future studies that generate rich data and help to develop a deep understanding such as industry case studies or action research that implements the framework in pilot portfolios are appropriate.

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