INCREASING CLIENT CAPABILITIES THROUGH REQUIREMENT ENGINEERING

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ABSTRACT

Studies have demonstrated the relationship between project failure and poor requirement management. Whereas information technology (IT) organizations have adopted requirement engineering or configuration management tools and methodologies to ensure alignment between IT strategy and project outcomes, there is almost no research for the construction industry to develop clients' capabilities to manage their requirements.

This paper proposes a conceptual framework for client-driven integrated requirement management. It argues that the client needs to describe and measure project outputs not only in terms of expected end results, but also as requirements to be met. This framework aims to help the client track project performance and alignment with strategic expected outcomes, using requirement metrics. It also seeks to provide industry with the infrastructure to move to performance-based e-procurement. The objective is to get away from traditional and inefficient cost and schedule metrics to move to systematic planning, management and tracking of client requirements for measuring the efficiency of the project team and construction suppliers in generating best value for money.

The research benefits for the construction industry can be significant. This paper proposes a new paradigm for accelerating the adoption of IT in construction, by systematizing emerging client-driven performance or value-based management though systematic requirement management. IT acts as an enabler and driver of change in this paradigm.

KEY WORDS

Strategic management, maturity management, requirement management, project management, change management.

INTRODUCTION

Extensive researches and numerous reports have emphasized the problems related to the construction industry (1994; Egan 1998; Barrett and Lee 2005). The industry's system procurement is driven by low initial cost, as opposed to quality and life-cycle value (NSCIC 2002). The "voice of the customer" is often lost within more technical or regulatory requirements. One possible cause for these problems is the industry's inability to use Information Technology (IT) as for a means of improving its processes. The construction industry invests the least amount in IT (Andresen et al, 2000); it also has the lowest maturity

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in the integration of IT (Clark et al 1999). To fully benefit from technologies, it is necessary to redefine processes both at the organization and business network levels (Venkatraman 1994), but the industry does not invest in IT, because it sees no benefit in doing so. This paper asserts that the client, who is at the top of the construction value chain, is the only one who can reap the true benefits of applying IT, by ensuring that requirements are met. Redefining processes has to emerge from the client domain. It also suggests building on initiatives in the client domain, such as the British government Latham seminal report (1994), which triggered a series of actions, not only for rethinking the industry, but also for redefining how projects are identified and managed, and for increasing the government's capabilities in project management. At the heart of this business reengineering is the concept of "value for money"(VFM). This paper argues that VFM demands increasing client capability to manage the value chain. Moreover, it considers that project requirements have to be client-driven in order to maximize client benefits, i.e. to get the best value.

REDEFINING THE CONSTRUCTION VALUE CHAIN TO ACHIEVE VFM

The value-chain model (Porter 1985) has been extensively utilized in other industries, to identify how process reengineering and IT integration could be used to gain competitive advantage. Porter's key concept is that to gain this advantage the organization not only has to reduce its support activity costs, i.e. streamline its operations using information systems, but also to maximize the production of value in its primary activities - the driving force being the customer/product relationship. Besides, the value chain of the firm doesn't exist in isolation; it is part of an industry value system or a set of value chains that ultimately link the source raw material to the end product. Little has been said about the application of the value-chain model for the integration of IT in construction. One explanation may be that it was usually regarded from the supplier's perspective. Our idea is to explore this model from the client's perspective.

The construction paradigm regarding the value chain is framed within professional associations' compounded frameworks, which define a precise phasing built around traditional cost-based procurement. The value chain is driven by the supplier. The problem is that the supplier is not an entity, but a temporary grouping of companies that deliver a unique product. It is therefore very difficult, if not impossible, to improve value and procurement chains that will last only one project. This is why the British government, following the National Audit Office (2001) statement that cost-based procurement was not providing VFM, adopted a value-based procurement approach. This decision entailed rethinking the client's role in relationship to the supplier: first, to express expectations regarding value; second, to clarify participation in the creation of value. The definition of value, once associated with cost, has slowly evolved, and is now considered a mixture of tangible and intangible benefits, something much more difficult to measure. This is a major issue, which has not yet been solved when using a value-based procurement approach. A possible solution is to translate value in terms of requirements. Some authors (O'Reilly 1987; Koskela 2000) associate VFM with meeting client requirements. A requirement is a robust definition of what is expected: it is tangible and measurable. A client's lack of capability to define and manage projects has a direct impact on the value generated (Comptroller and General 2005). Furthermore, value-

based procurement requires that the client define what value is, in tangible and measurable terms.

Other disciplines have acknowledged the importance of managing client requirements. For example, IT recognizes that specifications and managing customer requirements are the two largest problems when delivering projects (ESPITI 1995); two-thirds of projects run into trouble for reasons directly related to requirements (Standish 1994). Much can be learned about requirement management from weapon systems and IT. Requirement management is prominent in System engineering. The US Department of Defense (DoD), a strong proponent of system engineering, has strongly advocated the use of requirement management for the development and maintenance of complex weapons systems. DoD has also accelerated research in software engineering, to systematize the management of requirements for the development of software-intensive weapons systems. This work has encouraged the advance of new iterative development lifecycles, to capture stakeholders' emerging needs now combined with configuration and requirement management tools to maximize creation of value for the stakeholders.

Requirement management is not new to construction. Methods to improve the briefing process have been proposed, such as applying value management techniques in the early stages of a project (Green 1996), or at the strategic level (Kelly, Morledge et al. 2002). Some interesting research has been done to automate the capture of requirements: techniques and tools derived from product development, such as "Quality Function, Deployment" have been put forward to introduce the voice of the client in the design process (Kamara, Anumba et al. 2002). However, this research usually stems from the supplier's perspective, in which the management of client requirements is driven from the supplier's side (architects and engineers). They don't question the existing paradigm which defines the "who", and "how" requirements are handled at project level. They also failed to address the need to be adaptive to emerging strategic requirements. Construction has, therefore, much to learn from other disciplines about better handling project requirements.

RESEARCH METHODOLOGY

The aim of this research is to develop a client framework or construct for managing requirements. This construct is addressed to clients managing large or complex real estate portfolios in which they are conducting their business operations. The objective is to maximize the business outcomes of projects and programs, using systematic requirement management. The expected benefits from applying this construct to the management of a construction project portfolio are a streamlined planning and delivery processes, and results aligned with corporate and business needs.

A constructive qualitative approach is used for this research. Constructive research strives to empirically demonstrate the practicality of a constructed entity. It is a goal-directed problem-solving activity that can be defined as follows (Kasanen, Lukka et al. 1993):

- The constructive research produces an innovative theoretically grounded solution for a relevant problem

- The usefulness and usability of a construct is shown
- The scope of the applicability of the solution is considered

The aim of constructive research is to build, from research and observation, a construct applicable to a business context, to measure its value within this context, and to assess its replicability to other business environments. Some considerations were necessary in the research design:

- The research topic is grounded in industries with different cultures and processes.
- The research topic is an emerging one. Most client organizations may not yet have the maturity/capabilities to test such a construct.
- Constructive research usually requires a relatively long time span, namely, several years.

An agile approach was devised to address this complexity. The feasibility of adapting configuration and requirement management practices from system and software engineering was determined in a first set of iterations: a case study and action research was realized to develop a project requirement management concept of operations, and to develop a client capability roadmap. An on-going second set of iterations was defined to expand the first framework from project to strategy. A choice was also made to use commercial off-the-shelf software (COTS) to test the framework, generic robust solutions maintained by trustworthy third parties being already available on the market.

BUILDING CLIENT-DRIVEN REQUIREMENT CAPABILITIES

Little has been done in the field of improving clients' capabilities to manage their requirements. Whelton (2004) has explored the aspect of capturing client requirements. He advocates cultivating a more adaptive approach to briefing, by developing project managers' soft skills to elicit stakeholders' requirements. For two reasons, his perception is that systematic requirement management is not suited to defining building project requirements: the -complex nature of problems related to designing a building, and; the effort and expertise required by the project manager to systematically manage requirements. This view has its place within the traditional cost-based paradigm. It provides a more involved role to the project manager in defining project requirements, which is in line with the modern definition of project management (PMI 2004). It is argued that to achieve VFM, the requirements have to be client-driven, i.e. the client has to build capabilities both to elicit requirements and to systematically manage them. This paper grows from previous research on adapting, from other industries or disciplines tools and practices, a requirement management framework applicable to construction projects: Forgues, Gendrau et al (2005) suggest a model derived from software engineering, which combines a gating process with the German government "V" software engineering model; Begin and Forgues (2003) propose a 9-step project requirement management framework derived from weapon-systems development. This concept of operation, which integrates both configuration and requirement management into an existing construction project management system, was developed using a gap analysis

between 2 case studies: the real estate organization, from which the business problem and a benchmarked organization stemmed, uses advanced program and requirement managements tools and processes to develop a complex weapons system. The underlying assumption was, in order to successfully implement the 9-step project requirement management framework; the real estate organization had to build specific capabilities.

TOWARD A CLIENT-DRIVEN REQUIREMENT MANAGEMENT FRAMEWORK

The concept of operation developed by Begin and Forgues provides the client with a systematic process for managing the requirements at the project level. It is an evolutionary, incremental and team approach to requirements gathering and development. It also includes a disciplined approach to change control. The objective is to take broad and abstract business needs obtained from the stakeholders, and to translate or break them into a series of more precise, focused, unambiguous and manageable requirements that can be easily understood by those designing the facility. This, in turn, allows the project manager to control the design, development, implementation and commissioning of the end result, so that the project delivers a product that meets the clients' expectations. The requirements tracking and control process involves setting up a documented process in which tracking of requirements can occur. This framework helps to streamline the delivery process, and to eliminate waste generated by non value-added iterations.

The concept of operation provides a solution to the business problem at the project level. However, one aspect of the business problem that is hardly explored in the academic literature is how broad and abstract business needs are generated and translated into projects within the organization. A further unexplored aspect is the importance of aligning project outcomes with the strategic objectives. This strategic dimension cannot be handled at the project level. For example, in the construction case study used for the research, a program with a span of 25 years, involving two large organizations, with capabilities for delivering stand alone projects was presented. However, this construction and renovation program - involving multiple stakeholders with conflicting interests and changing needs, and a complex intricacy of technical, technological, and operational requirements to be met - was more about strategic alignment of strategic needs and project outputs. Traditional facility management and construction project delivery practices failed to handle this complexity.

Such business issues had received little research in real estate and construction. Authors explored the applications of value management at the strategic level of the organization (Kelly, Morledge et al. 2002), or adapted strategic management tools to the real estate context (Spencer and Winch 2002). While theory is yet to be established in real estate, other disciplines can provide some insights for relating project outcomes to strategy: in IT, value creation is related to the capability of dynamically aligning projects with business strategy (Henderson and Venkatraman 1999). The need for this dynamic link is also expressed in project management research and standards (PMI 2003; Thiry and Matthey 2005). There is, therefore, emerging theory about strategic alignment, but no proposed construct for defining how it can be achieved. Considering that value is generated through the realization of requirements set at the organizations strategic, business and project levels, alignment could be accomplished by dynamically synchronizing these layers or requirements. It has been

asserted that VFM is achieved through meeting client requirements at all organizational levels. Therefore, the process of defining, managing and tracking requirements on the client side has to encompass not only the project but also the organizational dimension of requirements.

Client requirements evolve from the corporate strategy applied to projects. The problem stems from the fragmentation of strategic requirements within the departments and layers of the organization. It is very difficult to trace the strategic foundation of specific project requirements; thus, it is almost impossible to verify whether or not the project results meet the strategic expectations. By building traceability between the different levels of the organization, decision paths can be traveled in both directions, from broad to detailed requirement, and vice versa. Traceability is probably the most important feature provided by requirement management systems. Traceability is understanding how high-level requirements – objective, goals, aims, aspirations, expectations, needs - are transformed into low level requirements, and the relationship between layers of information. The proposed framework expands and enhances the project requirement management framework, by structuring the process of dynamically aligning requirements from strategy to projects within these 3 dimensions:

- strategic requirements: the benefit realization aspect of the project: achieving the organization's strategic objectives
- business requirements: the value generation aspect of the project: meeting the user/occupant's needs and expectations with the best value for money
- project requirements: the technical aspects of project delivery: meeting the project objectives in terms of quality, cost and schedule

The realization of best value for money within these dimensions is exemplified in the much-heralded museum of Bilbao, in Spain. The project dimension of requirements was defined against strategic requirements - (national) increasing national wealth and gaining international prestige (local) economic and urban revitalization for the city of Bilbao - and business requirements: the Guggenheim family specific financial, functional and architectural requirements. Dealing with all of these dimensions is usually a long, painful and expensive ad hoc process. A 3-dimensional requirement management framework will drastically help to reduce the number of iterations; thus, streamlining this process. Another advantage of organizing the management of requirements within these 3 dimensions is that it fits both the traditional hierarchy of an organization's decision process (executive, mid-management, operation) and the emerging systemic approach of organizational project management (portfolio, program and project). It is suggested that to benefit fully from this framework the organization has to first build program management capabilities. Authors (Thorp 2003; Thiry and Matthey 2005) agree that the program is the driving belt between strategy and project outcomes. A Program is defined as a group of related projects managed in a coordinated way to meet a specific business need. It aims to maximize the business outcomes of the projects, by carefully choosing them and managing their dependencies. The challenges in program management are: finding the right balance between project constraints and strategic expectations, and; building the right synergy between related projects to maximize the

outcomes. Figure 1 illustrates the pivotal role of program management in translating strategic requirements into projects.

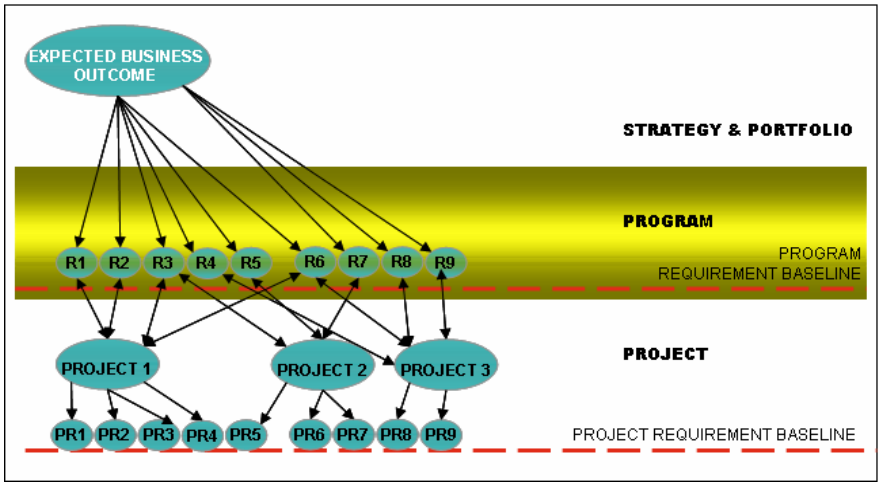

Figure 1: The requirement management framework

Strategic requirements set the targets to be met. At the strategy or portfolio level, the expected business outcomes are identified. Then, at program level, a specific business outcome is translated into sets of requirement scoped into a program requirement baseline. Finally, these requirements are distributed among projects and scoped within each project baseline. This two-tier baselining enables one to dynamically link the 3 requirement management dimensions previously outlined. In this model, the strategic requirements for the specific business outcome are identified by the program sponsor (the executive accountable for the outcome) at the portfolio level, and documented at the program level into a set of requirements. Three aspects have to be managed at the program level to translate the business outcome into projects: the elicitation of requirements from the program stakeholders, and their translation into a set of characteristics or business requirements; the definition of the program configuration (program baseline), and; identification of the best set of projects to meet this configuration. The same process is used for each project, to document client requirements with the project stakholders. The requirement management system provides a connection among all levels of requirements. Confirmity of design solutions to client requirements is measured against the project client requirement baseline (validation). Changes to project or program requirements have to go through a systematic process, in which the impact of the change on project or program configuration is assessed through a project-gating process. The management of the life cycle of the project or program requirements generates new information or knowledge that could:

- influence requirements in the program, or on the scope of the projects
- induce questioning about the value of strategic requirements or constraints

In the case study, client stakeholders directly involved with a specific project made changes to their needs in the project requirements without regard to the impact on the overall

program. Because there was no baseline against which the program or project team could assess the impact of the changes on the business outcome, changes were made that had serious consequences, not only to the program's overall business value, but also to the resources required to maintain the program's integrity: the program was plagued with cost and schedule overruns, and projects were delayed or cancelled. In this proposed framework, the program requirement baseline acts as the barometer for balancing the evolving vision with the reality of the field, and as the driving belt for dynamically linking project and strategy. Tracking requirements at the program level has two main advantages: changes to projects are dealt with considering not only the project itself, but also its business value and its impact on related projects, and; the process encourages the capture of emerging strategy.

Figures 2 and 3 detail how the framework modifies the traditional approach to dealing with requirements. In the traditional construction process (figure 2), client requirements are crystallized within a very narrow timeframe and communication band dominated by two key stakeholders: the project manager, who is the client representative, and the architect, who represents the design team.

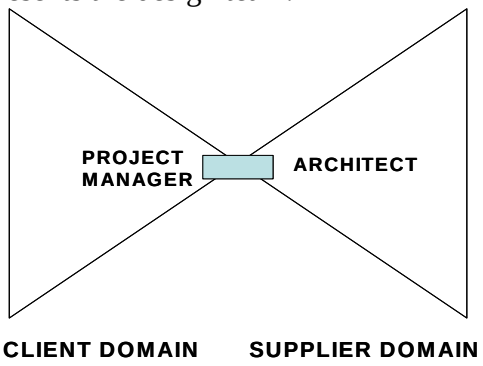

Figure 2: Traditional paradigm

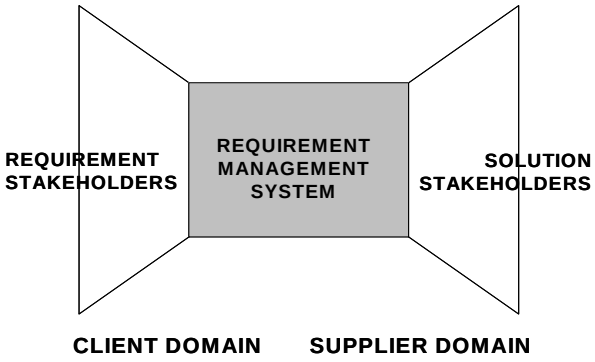

Figure 3: proposed concept

The concept proposed in the framework is expressed in figure 3: in this model, the communication broadband is enlarged to encompass a much larger group of stakeholders, both in the client and the supplier domains. Key client stakeholders are assigned a specific set of requirements. The stakeholders are responsible for validating supplier related components of the solution, and agreeing to changes in these components. The requirement management system serves as:

- a collaboration tool to capture, organize and share requirements
- a project data/information repository
- a validation and change management system

The requirement management system is managed at the program level. Configuration managers are responsible for supporting the systematic management of project requirements related to the expected business outcomes.

CONCLUSIONS

The research suggests that, to maximize IT benefits to the industry, the existing project delivery paradigm has to be challenged. The proposal is to use emerging trends advocating a focus on value, as opposed to costing, as a lever to introduce a client-driven requirement management process. The requirement management system acts as the enabler and driver of this change. The new processes are built around the emerging capabilities offered by the system for facilitating dynamic alignment of strategies with project outcomes.

The proposed framework should offer important incentives to the client, to justify the required redesign of the existing processes, by providing a much better return on investment from building projects, and a more efficient use of resources The framework also opens the door to automation of the existing inefficient procurement process. Building the client's ability to define requirements and to measure the value of design solutions against them is the first step in moving from prescriptive specification-based to performance-based procurement; e-business solutions are available for automation of this latter type of procurement. These could be easily adapted to the construction context.

The application of this framework is, however, limited to a specific group of owner-occupier clients. Implementing it will require extensive revisiting of organizations' existing processes to handle construction projects. The expected return on investment from applying such a framework may be sufficient to justify the change.

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