A CHANGE MANAGEMENT MATURITY MODEL FOR CONSTRUCTION PROJECTS

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Change is considered to be one of the main risk factors for construction projects. Common consequences of changes include, inter alia, time and cost overruns, quality defects, conflict and safety issues. Existing research has largely focused on the identification of causes of change, analysis of potential change effects, and change management systems which help to minimise the occurrence or the effects of changes. Although these systems have indeed provided effective process support, they do not intend to measure the effectiveness of the change management process and thus, they do not provide clear evidence of the improvement of the change management capability of a project team. In construction, process capability measurement and improvement has evolved over the last decade principally based on capability maturity models (CMM). This paper presents a CMM which aims to provide a measurement framework for assessing the improvement of a project team's capability in dealing with contract changes. Following a review of the change management literature, a questionnaire survey and a number of interviews, a Change Management Maturity Model (CM3) is developed adopting the Capability Maturity Model Integration approach. The model defines five levels of maturity – ad hoc, informal, systematic, integrated and continuous improvement. Measurement is carried out on six key process areas – management process, risk management, communication, management information, collaboration, and leadership/objectives. The model is then evaluated through three case studies which assess its applicability in practice.

Keywords: capability maturity model, change management, process measurement framework, project management.

INTRODUCTION

Changes occurring during the lifetime of a construction project are considered to be one of the major sources of risk in construction. They are usually associated with cost overruns, time delays, disputes and rework (Li 1996, Mezher 1998, Love and Irani 2001). As a consequence, the Democritean aphorism 'it is better to plan in advance than to think afterwards' is widely accepted. However, changes in construction projects do occur and hence, a robust change management process is a prerequisite for an efficient project management system. Over the recent years, numerous sophisticated contract change management tools such as Prolog and Expedition have been developed. These systems have certainly proven valuable in managing project change by providing process support; nevertheless, they are not intended to improve the change management process capability of the project team. Based on process improvement methodologies, originally developed in the software industry, process capability measurement and improvement in construction has been principally based

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on capability maturity models (CMM). As a result, a number of generic project management capability models have been developed over the last decade. These models have largely focused on the establishment and improvement of the project management process quality level of organisations. The research presented in this paper adopts the concept of CMM in order to develop a framework for the assessment and improvement of change management process capability. Furthermore, considering the project-oriented nature of construction organisations, the research focuses on the capability of the project team rather than the maturity of individual construction organisations.

CHANGE MANAGEMENT IN CONSTRUCTION

Construction projects are one-off in nature, have short-term, multi-disciplinary and multi-organisational team structure and are affected by varied site conditions and unpredictable climate. These factors often trigger project changes which incorporate high levels of risks. The literature provides numerous studies which have specifically established the negative impact of changes on project performance and the need for managing project changes effectively (see, for example, Ibbs 1997, Hanna *et al.* 2002, Moselhi 2005). These works involve mainly the identification of the origins of change and subsequently the assessment of its impact on project performance.

Further research on change management can be linked with project planning techniques and change management processes. Respectively, the main focus of these efforts is to minimise the occurrence and reduce the disruptive effects of changes. Process-focused approaches have recently received widespread attention from the construction management research community. This was largely instigated by the Egan Report (1998) which highlighted the need for improving construction processes. Along these lines, prior research includes extensive mapping and modelling of the change management process. Ibbis *et al.* (2001) developed a systematic approach to manage project change founded on five principles: 1. promote a balanced change culture; 2. recognise change; 3. evaluate change; 4. implement change; and 5. improve from lessons learned. Utilising a similar concept, Sun *et al.* (2004) developed a project change management toolkit which supports a project team in anticipating potential changes and evaluating their impacts. Their model, as well as the one suggested by Charoenngam *et al.* (2003), underline the requirement for effective communication and information sharing and highlight the usefulness of IT for supporting change management.

Using software patterns, Karim and Adeli (1999) built a prototype application (CONSCOM) to aid the owner in schedule monitoring and cost-time analysis for change order approval. Park and Pena-Mora (2003) following a system dynamics approach developed a rework cycle embedded in the project development process which resulted in a dynamic control methodology (DPM) and tool for the management of unexpected events. Subsequently, the DPM was utilised by Lee *et al.* (2005) for the development of a change prediction framework and enhanced by Motawa *et al.* (2007) who integrated a fuzzy logic-based change prediction model with the system dynamics model of the DPM to manage change scenarios based on information at the early stages of projects.

A review of literature reveals that several generic frameworks, specific models and IT support systems have been developed in order to support change management in construction. Certainly, these developments can facilitate change management processes and indeed have the potential for further development. However, they do

not provide for an assessment of the change management capability and consequently, cannot be considered as a basis for systematic process improvement. This is also supported by Sarshar *et al.* (2000) who highlight that the construction industry still looks for a methodological framework that enables process capability assessment and prioritises process improvement.

SYSTEMATIC PROCESS IMPROVEMENT

The need for a methodical approach to process improvement has been addressed successfully within the software industry through the development of Capability Maturity Models (CMM). Although the concept of CMM originated from the area of software development it represents a generic framework for continuous process improvement and hence, has been applied in diverse areas such as project management, systems engineering, risk management, service development and e-learning.

The concept of CMM was originally proposed by the Software Engineering Institute at the Carnegie Mellon University and provides "a path of improvements recommended for software organisations that want to increase their software process capability" (Paulk *et al.* 1991). Other popular frameworks for assessing an organisation's quality of software development processes include the Software Process Improvement and Capability Determination standard (SPICE/ISO 15504) and the Bootstrap assessment approach, a European-cultured version combination of CMM and ISO (Alshawi 2007). Although a review of these frameworks is outside the scope of this paper, it should be noted that they all aim to continuously improve organisational processes encompassing three inextricable steps: understand; control; and improve (Dutta *et al.* 1999).

Following the example of the software industry, a number of process improvement frameworks have been developed for the construction industry within the last decade. Mainly focused on Project Management, these models have included areas such as Programme and Facilities Management. Table 1 lists the maturity models particularly developed for the construction industry identified in the existing literature.

Table 1: Maturity models developed for the construction industry

Name	Abbreviation	Process	Developed by
Programme Management Maturity Model	PMMM	Programme management	PMI 2001
Structured Process Improvement Framework for Construction Environments – Facilities Management	SPICE FM	Facilities Management	Construct IT 2001
Organisational Project Management Maturity Model	OPM3	Project Management	Rayner and Reiss 2002
Project Management Process Maturity Model	PM2	Project Management	Kwak and Ibbs 2002
Portfolio, Programme and Project Management Maturity Model	P3M3	Portfolio, Programme and Project Management	OGC 2003
PRINCE 2 Maturity Model	P2MM	Project Management	OGC 2004
Standardised Process Improvement for Construction Enterprises	SPICE	Project Management	SCRI 2005

Recently, a Change Management Maturity Model has been developed by Prosci, an independent research organisation (Prosci 2007). Prosci's maturity model, built on the

CMM general principles, describes the varying levels of change management capability across individual organisations. It consists of five levels or stages of maturity, each level involving more attention and management of the people side of change. Prosci's model has been applied successfully in the retail and manufacturing sector; however, it lacks sufficient information to be applied effectively in construction. Also, similarly to the construction-oriented models, it has focused on the understanding and improvement of a single organisation's change processes. Thus, it is not directly applicable to project organisational structures such as construction project teams which include individuals from different organisations, possibly with processes of different maturity. Nonetheless, it is acknowledged that the change management capability of the individual organisations will undoubtedly have an impact on the capability of the project team. Therefore, the rest of the paper will present the process of developing a CMM which addresses change management capability improvement on a project level. The process is divided into two successive steps; the development stage which follows the CMMI approach and the evaluation stage which adopts a Capability Maturity Grid.

CM3 DEVELOPMENT PRINCIPLES

The development of the Change Management Maturity Model (CM3) is based on the latest version of the CMM, known as Capability Maturity Model Integration (CMMI) (Paulk *et al.* 1993). CMMI defines 22 generic process areas, such as requirement development, project monitoring and control, risk management, measurement and analysis, etc. It also defines five process maturity levels: Level 1 – Initial; Level 2 – Repeatable; Level 3 – Defined; Level 4 – Managed; Level 5 – Optimising. CMMI has two different representations: Staged and Continuous. The Staged representation defines the required Process Areas, out of the total 22, at each of those five levels of maturity. It assesses an organisation against the existence or absence of these Process Areas and produces an overall Maturity Level rating. An organisation with no process improvement programme is usually at the lowest level of maturity – Level 1. As it adopts the appropriate goals and practices of processes defined at higher levels, the organisation can progress through the maturity hierarchy until achieving a Maturity Level 5. Here, the organisation is expected to have continuous improvement processes, such as Organisational Innovation and Deployment, and Causal Analysis and Resolution.

Continuous representation of CMMI has the same 22 Process Areas. However, rather than allocating Process Areas to different Maturity Levels, it assesses all Process Areas against Maturity Levels from 0 to 5. The Maturity Level 0 has been added to indicate that a particular Process Area is nonexistent. This approach allows greater granularity in the capability measurement. It recognises that some higher level Key Process Areas might be partially achieved in an overall lower level of maturity organisation. It also allows organisations to identify their strengths as well as weaknesses. For these reasons it was decided that this approach would be more pertinent to project teams consisted of members of organisations with potentially different process areas and overall maturity levels.

The measurement scale of the CM3 is based on the Quality Management Maturity Grid (QMMG) as conceptualised by Crosby (1969). Crosby suggested that the typical behaviour of an organisation evolves through five 'stages of maturity', namely uncertainty, awakening, enlightenment, wisdom and certainty. These stages were applied to six 'measurement categories' in rating an organisation's quality operation.

The QMMG inspired Humphrey's (1989) landmark work in developing a framework for managing the software process which essentially laid the foundations for CMM. The principal idea of the maturity grid, and one of its major advantages, is that it describes in a few phrases, the typical behaviour exhibited by a firm at a number of levels of maturity (Fraser *et al.* 2002). Therefore, an assessment of process capability via a maturity model can indeed be facilitated by the construction of a grid or matrix (Austin *et al.* 2001, Caffyn 1999). This is particularly applicable in the CM3 case since the model adopts a strong evolutionary approach resembling the original QMMG. Also, the adoption of a Crosby grid approach will offer an alternative to the complexity of CMM derived maturity assessment methods.

CM3 FRAMEWORK

The development of the CM3 involved the identification of the relevant Key Process Areas and the definition of the different levels of maturity. To achieve this, a questionnaire survey was conducted with client, contractor and consultant organisations that make use of change management systems or apply some sort of change management processes. The aim of the survey was to find out the views of the respondents on the personal and organisational attributes that constitute good change management practice and ask them to identify the benefits of change management systems. The questions, multichotomous and open ended, were categorised in 8 categories, namely: 1. process improvement; 2. business improvement; 3.risk management; 4. communication; 5. management information; 6. efficiency; 7. collaboration/ partnering; and 8. traceability. The survey secured 85 valid responses which represent a return rate of approximately 33%. The analysis of the survey results was followed by a number of interviews with participants to facilitate the establishment of the Key Process Areas (KPAs) and Maturity Levels (MLs). Finally, the CM3 included six KPAs, namely, management process, risk management, communication, management information, collaboration, leadership/objectives. Additionally, five MLs were defined including ad-hoc change management, informal change management, systematic change management, integrated change management and continuous improvement in change management. The following paragraphs describe the CM3 model in more detail.

Key process areas

KPA1: Management Process - Change Management processes help project teams to establish a standardised procedure of working and handling project changes in the event of their occurrences. The Change Management processes include all the events right from the beginning of the occurrence till the completion of the change. The purpose of assessing the maturity of project team's change management process is to evaluate the consistence and effectiveness of their change management procedures.

KPA2: Risk Management - Risk Management helps to identify, analyse and avoid the negative effects related with risks during a project. It involves the use of standardised documents for managing and reducing risks. The purpose of establishing Risk Management maturity is to ascertain the existence of any risk management procedures in a project team and how effectively and efficiently these procedures are implemented.

KPA3: Communication - The purpose of Communication is to establish information flow across the project team and to ensure that all the partners have the necessary tools and skills to share information and coordinate their activities efficiently. Its

assessment should include both the capacity of the communication systems used and the extent that capability is utilised by the project team.

KPA4: Management Information - Management Information should ensure that the project team is able to share information in the most efficient manner. The level of maturity in this aspect is determined by whether project information is managed effectively so that the right information is provided to the right people at the right time and in the right format.

KPA5: Collaboration - Collaboration helps to improve trust and cooperation between the project partners in dealing with contract changes. Good collaboration promotes good teamwork. It will help to identify project risks early and avoid some unnecessary changes. When a change becomes inevitable, good collaboration will help the project team to find an optimum solution.

KPA6: Leadership/Objectives - The purpose of Leadership/Objectives is to assess the involvement of the Senior Management in preparing the project team to deal with project changes. It also ascertains the objectives of the whole project team as well as of individual project partners. Senior Managers should ensure that the project team has the required skills to perform the project tasks effectively and provide necessary training.

Maturity levels

ML1: Ad-hoc Change Management - A project team is characterised as ad-hoc or even having no change management processes in place. Few processes are defined or followed on a regular basis, and success depends on individual effort and their heroics. At this level a project team is in a 'dormant' state as far as change management is concerned.

ML2: Informal Change Management - Informal change management processes are established. The necessary instruction is in place to repeat earlier successes on similar programme with similar performance levels. However, it is not enforced consistently. At this level, the project team is 'reactive' to changes.

ML3: Systematic Change Management - A project team has set up systematic protocols and procedures to repeat the processes. Process is controlled and documented according to pre-agreed set procedures. The project team is 'adaptive' to managing changes.

ML4: Integrated Change Management - The change management processes are integrated throughout the team. Process is integrated with other functions of project management. There is a dedicated measurement system. The project team is 'supportive' to managing changes.

ML5: Continuous Improvement in Change Management: The change management process is continuously improved so as to prevent any repetition of any failures. The main focus is on learning and improving continuously. The project team is 'pro active' towards change management processes.

Maturity grid

Based on the above information the Change Management Maturity Grid (CM3 Grid) is constructed. This is presented in a matrix form with the columns denoting the 5 maturity levels and the rows representing the 6 key business process areas. Each cell of the matrix is a detailed description of the process capability being institutionalised

by the project team at each step of the maturity framework. In terms of process improvement, each cell refers to the activities expected to contribute to the achievement of the goals of a specific process area. Figure 1 illustrates a fraction of the CM3 Grid, with KPA – Management Process MLs 1, 3 and 5. Due to its large size, the CM3 Grid can only be presented epigrammatically in this paper.

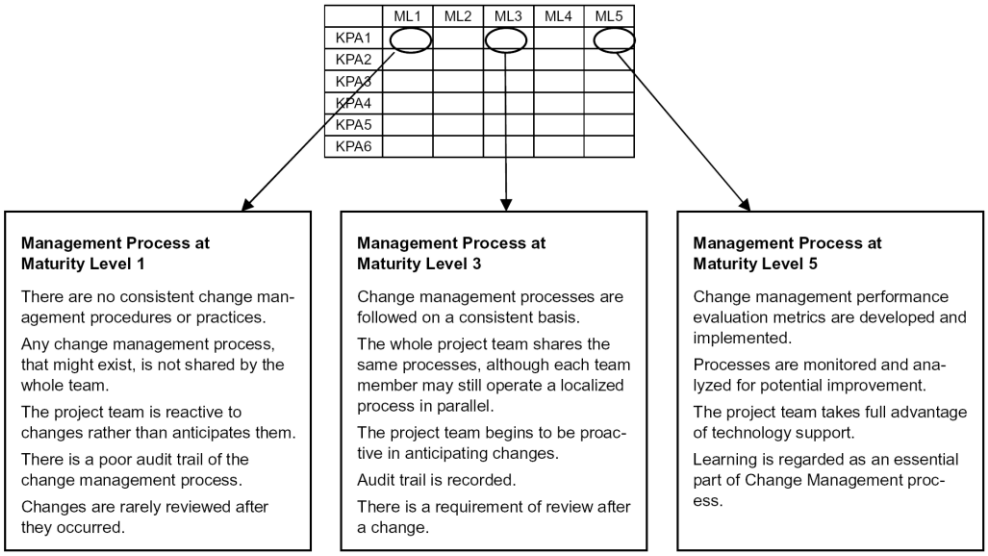

Figure 1: CM3 grid (fraction)

Assessment methods

In terms of capability assessment, following the widely adopted principle of CMMI, three different assessment methods are considered (Paulk *et al.* 1993). The simplest assessment (Class C) can be done by a single individual, most likely the project manager. The assessment is done easily by comparing the assessor's judgment of the project team's capability and performance against the maturity levels description in the CM3 grid. Class B assessment method requires a small assessment team which normally includes the project manager and representatives from the key project partners. The assessment team still uses the CM3 grid directly to assess the project team's levels of maturity in the key process areas. Class A method provides the most comprehensive and reliable assessment. It consists of five steps: Planning and Preparation; Data Collection; Data Consolidation and Validation; Rating; and finally Review and Feedback. In addition to the participation of the key project partners, an independent facilitator is required in the core assessment team. The facilitator needs to be someone external to the project team and familiar with the CM3 framework and the requirements of its assessment procedures.

At the end of an assessment, regardless which method is used, a maturity level rating is assigned to each key process area based on collected evidence and expert judgment of the assessment team. Rating is not done automatically through a computerised algorithm. Different Maturity Levels may be awarded to different Key Process Areas. For example the project team may score a maturity level 4 for Management Process and maturity level 3 for Communication.

CASE STUDIES

The applicability of CM3 was empirically tested through the following case studies:

- Case study 1 is a £34million refurbishment project for an office block in central London, carried out by a team that has not collaborated previously. The

project is fairly standard and low-risk. Project partners have relatively little experience in working with change management support systems.

- Case study 2 is a sub-station power plant with a budget of £6million. The project team has collaborated on other projects before, while its members have mixed levels of experience with change management support systems.
- Case study 3 is a £3million civil engineering project of refurbishment for a river weir. The project team members are all experienced with change management support systems. Due to the nature of the project and its site condition, this project has a high level of risk.

In all projects above project teams utilised a change management support system. The assessment of the change management capability of the project teams took place at the late stage of each case study project. This was carried out by partially following the Class A assessment method of the CM3 framework with the researcher acting essentially as the external facilitator. The assessment results and their comparison to a typical industry benchmark are presented in Figure 2 in the form of a spider diagram. The diagram has the 6 KPAs as its axis and 5 MLs on each axis. A maturity profile is formed by linking all the key process area ratings, which indicates the overall maturity of the project team in change management.

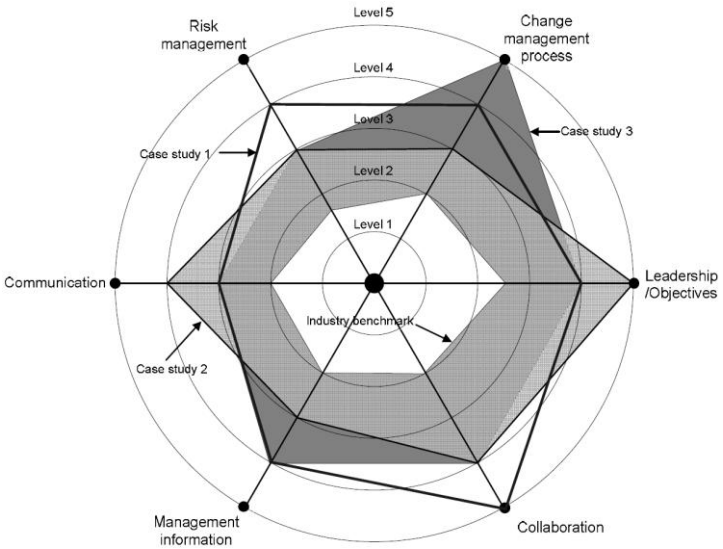

Figure 2: CM3 case studies assessment results

From the figure, it is apparent that the utilisation of change management support systems by the project teams has resulted in all projects having achieved relatively high capability MLs. The MLs which are between 3 and 5 in all key business process areas are well above the industry benchmark which includes processes of MLs 1 and 2. However, it has to be highlighted that this benchmark is based on the limited literature available on the subject of change management process maturity of project teams. Also, the assessment exercise may have changed the behaviour of project teams, similarly to the Hawthorne effect, causing issues in terms of data quality. Thus, the establishment of an industry standard level of change management maturity as well the formulation of more efficient assessment methods can be suggested as directions for further research.

CONCLUSIONS

The Egan report identified process standardisation and improvement as a critical area for improvement in construction. As a consequence, an increasing number of IT

systems are being developed to provide process support without however allowing for a methodology for systematic process assessment and improvement. While addressing this gap of the literature, the paper reported the findings of a research project undertaken to develop a CMM for the assessment and improvement of the capability of project teams to deal with contract changes. The Change Management Maturity Model - CM3 was developed by adopting the CMMI concept and consists of 6 Key Process Areas evaluated against 5 Maturity Levels. The model was tested following a Maturity Grid approach through three case studies which also indicated areas for further research. Previous studies in both construction and other sectors have already established that higher capability maturity levels lead to better and more consistent performance. Considering that the management of changes in construction is almost synonymous to the management of risk, improvement of the change management capability of project teams will have a direct impact on issues associated with cost overruns, time delays, disputes and rework.

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