MANAGING PROJECT CHANGE IN CONSTRUCTION: THE DEPENDENCY FRAMEWORK

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ABSTRACT: Unplanned changes during the construction phase of projects are inevitable, with potentially adverse implications for project cost, time and quality. Rework that is due to changes can cost between 10-15% of a contract's value. By managing these changes more effectively, these disruptive effects can be minimised or even avoided. This paper reports on ongoing research, which is developing and testing a toolkit to guide construction practitioners in managing change in construction projects. The Process Protocol Framework is used to contextualise the research and is extended to capture the complete change process, as presented in the "dependency framework".

Keywords – Project Change, Process Protocol, Dependency Framework

1 INTRODUCTION

According to the Egan Report (1998) one third of major construction clients are dissatisfied with how their construction projects are being delivered to them by the UK construction industry. They are unhappy with contractor performance in three key areas; cost, quality and time. Consultants also drew criticism in the areas of team co-ordination, design and innovation, timeliness, reliability and value for money. Couple these factors with the statistic that fifty percent of construction projects suffer from delay and over expenditure and that over thirty percent of completed projects have quality defects and the client's have a reasonable expectation that the industry will take measures to improve. Change is a major contributor to the problems raised above, in the construction industry.

2 BACKROUND RESEARCH STUDY

The background study identified the research problem; that disruptive direct and indirect consequences of project change require effective management methods. Lazarus & Clifton (2001 p10) view construction project change as "*an alteration or a modification to the pre-existing conditions, assumptions or requirements.*" These project changes are the *additions, deletions or revisions* within the scope of a project contract that alter the cost, duration (CII 1994) or quality. Change management in construction is central to the project management process.

The CII (1994) and Lazarus and Clifton (2001) both state that unplanned changes occurring during the design and construction phase, may cause time, cost and quality deviations that directly hinder project success. For example when change results in rework there is often a direct cost, which can amount to 10-15% of a contract's value (Brurati et al, 1992; Love & Li, 2000). An indirect manifestation of change may result in claims and disputes that interrupt schedules, cash flow and lower team moral (Cox et al, 1999).

Similarly, it was revealed by Hanna et al (1998) that as change orders increase productivity declines.

Effective change management allows change to take place in a controlled way so that viable alternatives are identified, developed and their impact assessed before implementation. Construction decision-making takes place in a team setting. Therefore effective project change management should not rely solely on the project manager; it should integrate input from all of the relevant team players.

Previous studies have attempted to approach construction project change management from different perspectives. The approaches and work of the CII (1994) and Lazarus & Clifton, (2001) are significant. They provide best practice guidelines for project change management that are based on five principles:

- The anticipation of change
- Recognising change
- The evaluation of change
- Resolving change
- Learning from change

These change management systems introduce proactive and reactive measures. When these measures are incorporated into a design and construction framework they should mitigate the disruptive effects of change. However, the success of these guidelines depends on how effectively the project team communicates and collaborates during change events and how well the systems are in place for effective management.

Other studies have considered change management from a process management perspective. The Generic Design and Construction Process Protocol (Kagioglou et al, 1998) considered the function of change management to be "*responsible for effectively communicating project changes to all relevant activity zones and the development and operation of the legacy archive"*. Change information is managed as part of the phase review process and is deposited into a central project information repository that is accessible by the project team. However at present the Process Protocol change process does not provide a mechanism for capturing and considering the tacit knowledge and experiences of team members gained during change events. Further, the level of granularity of the Process Protocol change process is not fine enough to consider change events in terms of cause, effect and characteristic at different stages in a project cycle.

Drawing from these previous approaches to project change management, it is evident that existing solutions only address the problem partially. To reach effective construction project change management, it is important to first gain a complete understanding of the change process throughout a project cycle and second to suggest solutions combining both hard and soft issues of team collaboration and knowledge management.

3 MANAGING CHANGE AND DEPENDENCY (MCD) RESEARCH PROJECT

The Managing Change and Dependency in Construction project was initiated to address the issues discussed in section 2. The project is funded by the EPSRC and is being undertaken collaboratively between The University of Salford, The University of The West of England and Loughborough University.

3.1 Aim and Objectives of the Project

The ***aim*** of this research project is to examine the way in which all of the project elements (for example human resources, design and delivery) are co-ordinated towards managing change and to propose a more flexible project co-ordination system that supports the total change management process. In the course of achieving this, the project will consider both hard and soft issues covering the change process. To achieve the research aim the project's ***objectives*** will be to:

- Identify the key task dependency variables for the change process
- Identify strategies adopted in practice
- Propose an integrated project coordination system to deal with changes

3.2 Literature Review

The research commenced with a comprehensive literature review of the issues and implications of unplanned change in construction. The team then captured and represented the attributes of the change process in a taxonomy. Internal workshops validated and grouped the elements of the change process as follows:

1. The nature of change in terms of scale, timing and need.
2. The root cause of change in terms of project specific, organisational and wider environmental causes.
3. The consequence of change in terms of direct and indirect effects.
4. The tools and techniques of change management in terms of proactive and reactive measures.

In order to sort and structure the research material relating to these four elements, it was necessary to develop the dependency framework. This framework provides an effective way of presenting a process view of the four elements of the change process.

3.3 Empirical Study

The research team chose to conduct exploratory interviews and workshops with industry practitioners to develop, refine and test the framework. For validation and to satisfy project objectives, in-depth studies of real life change events are being performed. Construction projects were identified according to criteria drawn up as part of the case study methodology. Selection criteria included projects that have escalated in cost, suffered from delays and/or high degrees of rework. A unit of analysis was defined as "construction projects".

Project team interviews and project document reviews were the selected data collection methods. The data collected is reviewed and the interim findings are shared with the project team. The interviews have been designed to examine:

- The decision-making process during change events.
- The recording of change event information.
- The cause and effect of change.
- The measurement of change effectiveness.
- Project control methods.
- Specific techniques used for decision-making.
- Attitudes towards an integrated system to deal with changes that occur.

It is anticipated by the research team that consideration of the above points should help to assess the impact, identify problems during change, identify key task dependencies, investigate different means for expected changes, simulate the problems arising from changes on projects and finally develop a mechanism to synchronise the decision making of a project team when dealing with change and rework.

4 THE MANAGING CHANGE TOOLKIT

An interim result of the research has been the conceptualisation of a change management toolkit that incorporates and contextualises the dependency framework, see Fig. 1.

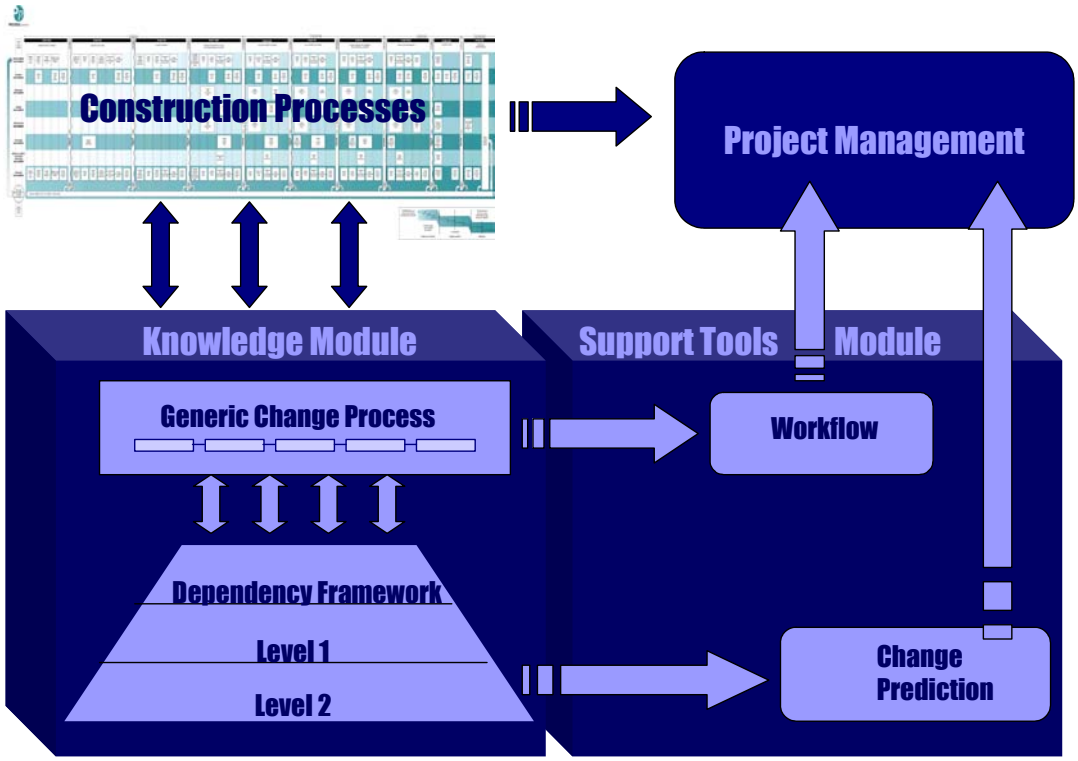

Figure 1. Change Management Toolkit

The Change Management Toolkit as illustrated in Figure 1 provides the concept for the integration of a suite of components that are being developed as part of the Managing Change and Dependency research project.

The toolkit's knowledge module contains a high level generic change process that interfaces with the dependency framework to identify, evaluate and approve changes. This knowledge is interrogated and manipulated by the project management support tools. These comprise a change prediction application that assesses the likelihood of changes occurring and a workflow application to assess the effect of change on the project programme. To enable users to visualise the toolkit's place within the design and construction process, an interface has been defined with the Process Protocol.

The Process Protocol presents a generic process for design and construction. The Protocol's processes were reviewed and a suitable interface was identified within the standard group processes. These are not phase dependent and are applied at the start, during and end of

a phase depending on when the project requires them. The interfacing processes occur during the phase and are referred to as "ongoing phase, standard group" and consider deviations from the project phase and programme, their causes, and impact. This Process Protocol Framework is used to contextualise the research and is extended to capture the complete change process, as presented in the "Dependency Framework".

5 THE DEPENDENCY FRAMEWORK

The Dependency Framework (subsequently referred to as The Framework) has been developed to consider the cause, consequence and project characteristics in greater detail. The Framework enables users to produce a rich description of the change event, see Figure 2. It is suggested that project management activities at all phases of the construction process will benefit. Especially since research has shown that projects with a high degree of change, experience lower productivity (Ibbs 1994). Therefore by using The Framework to consider and manage change an improvement in productivity should be achieved.

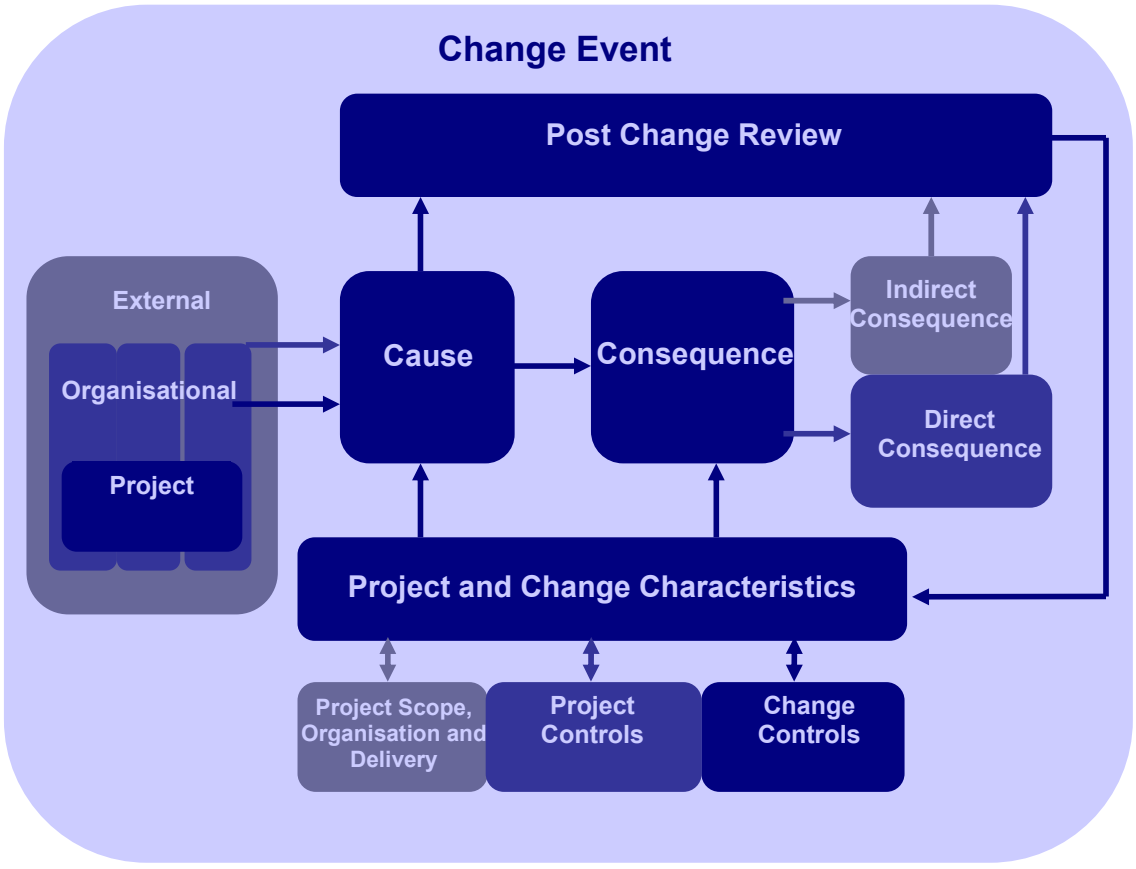

Figure 2. Change Event

5.1 Causal Factors Propagating Change

The modern construction project is subjected to influential forces from a multitude of sources. These forces can be classified as global/external pressures, organisational pressures and project/internal level pressures (Stocks 1999, Ibbs 2001), Figure 3. It is these forces that

can cause a change event to occur. By describing the applied force and its relationship with the project a root cause can be defined. It is very important to attempt to identify and understand this cause. A good understanding will help when planning future projects and should reduce the number of future changes that occur.

Figure 3. Causal classifications

5.2 Project Characteristics / Conditions

The project characteristics comprise the form of a project and include complexity, scope, delivery and the project controls (Ibbs 1994). In addition The Framework considers organisational and project team issues. Therefore, the characteristics considered by The Framework are project scope, team, delivery, execution and control see Figure 4.

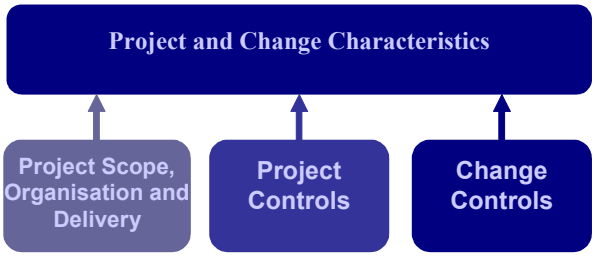

Figure 4. Project and change characteristics

Change events can cause substantial adjustment to a contract's duration and the total direct and indirect costs (Tiong 1990; Ibbs 1997; Ibbs et al. 1998). It is therefore important to consider the project's characteristics to determine if the project itself is acting as an incubator for change to occur. For example, if a change originates due to a design documentation error and the project in question has an extensive design team and a complex design then the change may be exacerbated if the project has non-effective communication protocols. In this case it may be possible to re-configure the project to reduce non-beneficial changes by focussing on the design team, complexity and communication.

5.3 Change Characteristics

There are tools / strategies available to construction projects to help manage change. When these are applied, the project will assume certain change characteristics. Construction projects vary in terms of client, contractor, location, team, budget and schedule. Therefore different

projects will have different drivers and therefore require different tools / strategies. For example a retail client may require the contractor to be able to incorporate design changes at very late notice. Therefore it is important to understand the context in which the project takes place when designing the change characteristics. The framework considers several approaches that can affect the change characteristics of a project.

Changes may be proactively anticipated and incorporated into the programme, or they may be reactively considered as and when they arise (Ibbs et al, 2001). Change may be implemented gradually or radically. Gradual implementation over a period of time may be chosen to minimise disruption, align with budgets or simply because the change cannot be implemented immediately. A radical implementation will change fundamental aspects of the project, often unexpectedly, for example, upon arrival of an unscheduled component changes may need to be made to save the schedule from disruption. The evaluation of change as either essential (involuntary change) or non essential (voluntary change) to a project's success. By prioritising changes it will be possible to allocate resources to the most essential changes (Ibbs 1994).

5.4 Change Consequences

The change event consequence is concerned with the change event after it has been caused. The New Shorter Oxford Dictionary, states that consequence "is the relation of an effect to its cause" therefore, if the consequence of a change event is understood it will allow the project to be planned and the change to be successfully integrated with the minimum of disruption. This will enable key decisions to be made, for example whether to abort the change because the consequences are too disruptive. Considering the consequence of a change in this way will be a departure from the common industry practice of quantifying the amalgamated changes at the end of a project (Akinsola, 1997). The Framework identifies direct and indirect consequences.

Direct consequences are directly attributable to a change event and will have an identifiable and clearly defined effect on the project. They will often have quantifiable metrics. Failure to meet quality standards and alterations to the project budget or schedule may be viewed as direct consequences. The Framework also considers work additions, deletions and revisions to the project (Ibbs, 2001).

Indirect consequences can be attributed to change events that occur during construction projects. They differ from direct consequences in that those can be measured by quantitative methods. Indirect consequences are often intangible and require qualitative measures to assess them. For example, lower morale amongst the project team could be a consequence of change and to measure this would require developing a measurement method especially for this. It is important to consider the indirect consequences. Often they are not immediately apparent and may appear insignificant, however Merna (Merna et al 1996) states that "variations having only a small direct cost effect can sometimes have a large indirect cost effect." This suggests that indirect consequences can eventually have a direct consequence. The Framework identifies several indirect consequences that may occur on construction projects; disputes, coordination failures and errors, uncertainty, lower productivity, indirect time consequences, intangible human issues, rework, wastage of resources, lower profit earnings and interrupted cash flow.

5.5 Change Review

A change review mechanism enables errors and mistakes to be identified and corrected. Depending on the project and the management system in place, reviews can occur during the pre project, ongoing project or post project stages. This will provide information that can adjust and improve the current project or be used when planning the next one. Change events may be reviewed individually or collectively to determine how they have been managed by the project. The review must use appropriate measures to determine this, as inappropriate measures will draw the wrong conclusions. The remedies will be wrong and current or future project performance will be lowered. A measure of change performance may be indicated by the amount of down time or inactive work periods that a change event has caused. Another indicator may be the level of work that is ineffective, for example work that has to be redone or repaired.

5.6 Framework Representation

The content of The Framework consists of the elements previously described; the causes, the consequences, the project/change characteristics and the change review. These elements are illustrated on templates that have been designed on Visio. The templates show four levels of decomposition see Figure 5.

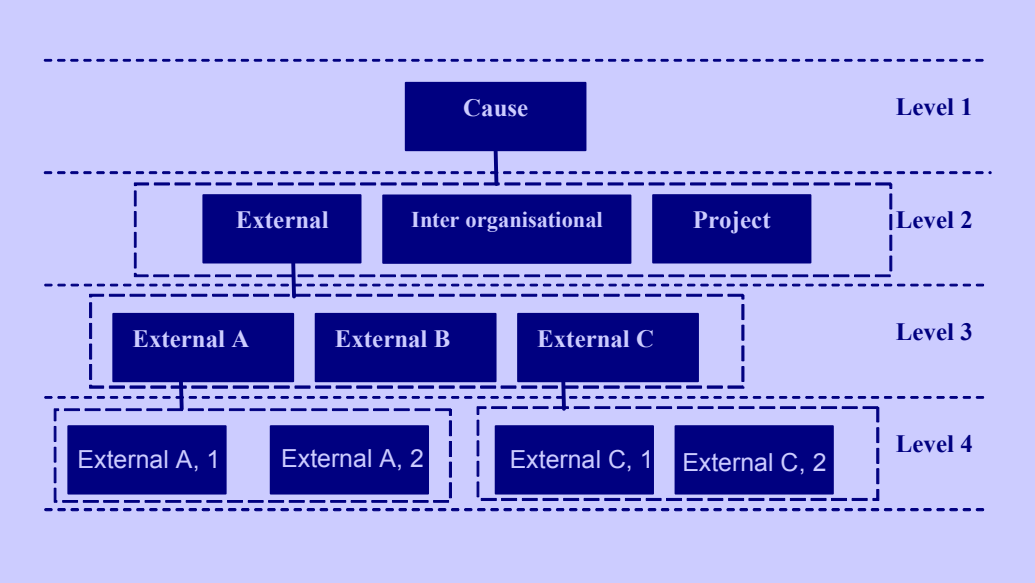

Figure 5. Example of framework component decomposition to four levels

A key requirement for representing The Framework is that no special or technical skills should be required for interpreting and using The Framework. The key was in the representation (Cheung, 1998) of the process and it was felt that none of the tools available met the project's requirements. Therefore it was necessary to develop an original process map template. A map was created that represented all of the information that the project required.

6 CONCLUSION

The Framework aims to provide construction professionals, academics and others associated with the management of project change with a tool that will enable them to consider and analyse the changes that occur on projects from cause to consequence. To determine whether a change is feasible and to provide a result that is favourable to all parties. What may be beneficial to one member may not be to another and it is important that this knowledge is available to support the team decision-making process.

The causes may be examined to help with forecasting and planning activities. The consequences may be examined to help identify changes that have occurred and to aid understanding. The Framework also prompts consideration as to how the project is equipped to manage change. Over the course of several projects a library of change events could be developed that can be integrated with an IT application to compare future scenarios against past cases.

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