



Changes and change management in construction and IT projects

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ABSTRACT

Modelling for change management in construction might benefit from experiences from other industries. This study compares reasons for change as well as change practices in interorganizational relationships in construction and information technology. Sixteen contractual relationships have been studied through a questionnaire and interview survey conducted among both clients and providers. Project-type relations are contrasted with more continuous service support contracts. More than their providers, clients tend to ascribe high change frequencies to an increase in technical understanding during projects. Early provider participation is associated with lower change frequencies, while the strength of incentives is less influential. The ease of transforming changes into new projects varies between technologies. Irreversibility is important, as well as relations between pre-investigations and the successive revealing of initial conditions, together with the life-cycle of formal and informal communication. Findings can be used for transfer of agile practices.

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1. Introduction

How changes in construction projects originate, are negotiated and resolved has attracted many investigators. A growing number of empirical studies of why and how contracts are renegotiated throw light on the reasons for change and on the patterns of change management in individual projects. Researchers increasingly see a potential for model-based systems to make the handling of project changes more efficient [1–4]. A successful design of change models needs a basis for understanding why changes arise and current ways of managing change.

Better insight into the relations between underlying technologies and changes should support the interpretation and transfer of change management procedures between different types of projects and between different industries. The project typology developed by Shenhar and Dvir [5] and Shenhar [6] partly relies on degrees of technological uncertainty associated with a low-technology to high technology scale, where construction belongs to the low end of the scale and the software industry at the other end, but this simplification might not be efficient in a project change perspective.

In their proposal for modelling building projects, Isaac and Navon [4] argue for learning from how requirement traceability is practiced in software development projects. However, there is more to be learnt from a comparison of IT and construction. Construction projects usually result in goods that are immobile and durable, and this is reflected in their typical production processes. There is an issue of hidden faults that might be discovered only after several years of building use.

Construction technology changes slowly over the years. There are significant environmental consequences of most construction projects. The organization of production is typically based on numerous and specialized subcontractors, who might work together for the first time. Carried out outdoors, construction projects are subject to many types of external disruptions. IT projects, on the other hand, have results that often are highly and globally mobile even if tailored to a specific and localized use. There are similarities with construction: many software projects leave durable results, and some hidden defects may take time before they emerge as evident to users. However, information technologies develop rapidly; access to novel technological solutions can be a reason for the existence of a software project, and sometimes, technology shifts so quickly that it presses for change in ongoing projects.

An increased depth of the industry comparison of what different technologies imply can be achieved by having a control population of corresponding business services within the two industries. Since parties to project contracts may expect to meet in future projects, the difference between project contracts and support service contracts, as well as the corresponding models for change management, should not be exaggerated.

Therefore, in the present investigation, the aim has been to compare change management (reasons for change and change practices) in contractual relationships in construction and information technology, relying on pairwise interviews with both clients and providers. To support the analysis, there has been an equal number of parallel interviews in contractual relationships for the corresponding business services: management of built facilities, in order to match the construction projects, and IT support services to match the software projects investigated.

The structure of this paper is as follows. In Section 2, the literature is reviewed, locating the interesting gaps in knowledge and

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identifying the questions that led to our survey design. The survey method, which generated a set of sixteen contractual relationships, is described and explained in Section 3. Here, our first empirical step is to study relative frequencies of various reasons for changes in contracts. In the following step, the procedures used by clients and contractors are scrutinized. Results are presented in Section 4. Next, these findings are discussed against the background of earlier research, highlighting the dynamic issues raised by the survey results. Conclusions, both as to promising ideas for research and implications of a more practical nature, are drawn in Section 6.

2. Literature review

The review of the literature begins with studies of project change in particular industry or sector contexts, and then studies of reasons for project change and how these reasons can be classified are brought in. Some investigators have looked at the dynamics of contractual relationships over the life cycle, and there is a stream of literature that explores the importance of the degree of complexity in contracts. The existence and consequences of incentive elements in project contracts have been analysed by many researchers. Fewer publications report studies of capabilities and their influence both on initial specification of project requirements and on subsequent contract renegotiations.

2.1. Industry contexts

Surveying the literature on change and flexibility, there is a number of studies of construction projects with a focus on flexibility and change [7–11]. In a more normative vein, Ibbs et al. [12] have pioneered a systematic approach for managing project change, stressing the communication and documentation of critical project success factors. There are slightly fewer useful studies of change that include or exclusively deal with IT projects [13–15], although the emerging literature on 'agile' software development is relevant here [16,17]; e.g., the agility taxonomy proposed by Conboy [18]. However, there are many empirical studies that concern IT service contracts [19–28]. Contractual change in facilities management has drawn attention from fewer researchers [29–31].

Industry comparisons with a focus on project changes are unusual. Dvir and Lechler [13] included construction and software projects together with machine tool manufacturing and a few other project types in their study of how changes affect project success, but did not compare results and discuss how underlying technologies lead to different results. A recent survey, albeit not primarily with a focus on changes, fails to show significant overall differences in how people perceive project management performance when viewing construction against a broader background [32]. Olsson [33] included five types of projects, dominated by construction, whereas Barthélemy and Quélin [34] investigated outsourcing in five industries; in their statistical analysis, a simple 1/0 manufacturing/services dummy control variable failed to reach significance.

Nevertheless, there are a few project analyses which have taken industry-specific production systems as their starting point, and Chang and Ive [35] have done so for their study of bargaining power in construction projects, introducing the concept of 'process specificity'. If there are technology-based differences between styles in specifying requirements, in choosing contractual incentives and in renegotiating, it should be possible to argue that these differences reflect specific needs for change and change management models.

2.2. Reasons for changes

A number of authors have suggested change typologies, as opposed to project typologies. In their knowledge-based decision support system for management of construction variation orders, Arain and Pheng [1] identify types of control that they link to variation causes, with an

emphasis on design-related issues. Motawa et al. [3] argue for the necessity of including change causes in change identification as an element in an integrated system for construction change management.

Taking a broader view of projects, Dvir and Lechler [13] distinguish between plan changes and goal changes, where plan-changes are by definition lacking impact on project goals and are typically induced by the project environment. Hsieh et al. [36] studied public works projects and they split the causes of change orders into technical and administrative. A recent overview of earlier investigations of change in construction projects suggests that there are three main types of change causes: external, organizational and project internal causes [11]. Six types of unexpected events in defence-related projects were identified by Geraldi et al. [37]. In a classification to be used for a wide range of both project contracts and service contracts, it seems fruitful to distinguish between client origins, supplier origins and external origins of reasons for changes. Within these three major groups, further categories can be identified.

The first category of changes originating with the client is due to high initial search or information costs for the client; as a consequence, and unintentionally, the original contract documentation from the client may contain errors, omissions and contradictions in specifications [29,36]. The second category is when the client finds that the primary business to be supported by the project or service contract has changed its needs in a way unforeseen in the original contract [13–15,38–41]. This category is often referred to as scope issues. In an IT case study with incentives in the contract, the parties faced a problem of determining whether scope changes implied 'new' features [42]; in this case, the authors distinguished between three categories of scope increases: fixes, clarification and enhancements. Their first category, 'fixes', are close to 'dealing with errors in original documentation'. 'Clarification' is close to improved core understanding, and 'enhancements' appear to combine features from core change and improved core understanding.

A supplier related category of reasons for change is when the provider begins to argue that the client's primary business would be supported better by another set of specifications or contractual regulations during the execution of a project or a service contract [15]. Another supplier change category is due to changes in delivery technology that were wholly or partly unforeseen when the contract was signed, rendering the original choices of technology obsolete [21,22,43]. A third supply side category is instantiated when a supplier to the primary supplier contacts the client directly and proposes a change of technology.

In addition, there is a category of changes that have a joint client and supplier origin: as when a provider discovers during the contractual period that the state-of-nature or the technical state of the initial system is not as expected [14,36], and when both parties find that the mutual communication routines set up for the duration of the contract are inefficient [19,20,22].

The third main group of change categories refers to those arising from causes that are external to the parties to the contract [36,38]. External causes are thus a narrower concept than 'environmental uncertainty', as used by Barthélemy and Quélin [34] in their study of outsourcing in several industries, and who consider uncertainty from the viewpoint of the provider and thus also include all client-initiated changes in the environment of the contract. External causes can be of natural origin or societal. So there may be unexpected natural events, although many such risks are routinely allocated to the client in a *force majeure* clause of the contract and thus in most cases will not lead to any contractual changes. Finally, there are the external disruptions of societal or human origin, such as unexpected legal changes, political turmoil and labour unrest.

Only a few studies have thrown light on how various reasons for change are related to each other. This is an important complication for model based change management. The Reuer and Ariño investigation [38] based on a contractual renegotiation model for strategic alliances in a range of Spanish industries relied on two categories of *ex-post*

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