Abstract

One of the greatest risks for clients lies in paying for work in progress. In an age of digital technology the development of a universal approach to the management of fair payments to subcontractors in Australia remains a challenge. Location Based Management (LBM) micro-milestones has been suggested as an innovative solution to reducing the risk in progress payments. The location-based solution proposed focuses on work completion micro-milestones to build process reference models for auto-generation of subcontractor certification and payment. Sub-contractors are vital for construction. Studies show that subcontracting for unique construction projects is both efficient and economical simply because general contractors are less skilled and more expensive than subcontractors. However, tardy payment remains a global problem. In Australia, payment systems rely on monthly lump-sum assessments of work, often after work has been completed. This retrospective method for validation of site-work is subject to error. Further, the lack of adequate site records often impedes compilation of a comprehensive payment record. This paper proposes a method that ensures payments are based on work completed and are connected to the productive delivery of the project.

Keywords: Certification and payment, location-based micro-milestones.

INTRODUCTION

The Quantity Surveying profession, through the process of certification of payment for work in progress, takes a central position with regard to the client’s exposure to financial risk. Accordingly, the current practice of engaging a Quantity Surveyor as a third party advisor to assess and certify the value of work in progress, is intended to minimise the risk of over payment while ensuring fair payment for work done. However the current methods for assessing progress claims are dated and heavily dependent on experience and even negotiation. The achievement of the conflicting aims of minimising client risk and fair payment to all parties is highly subjective and relatively unstructured. It should be no surprise that payments for sub-contractors remains a high risk factor for clients in the financial management of construction projects (Coggins, 2011).
The payment system is a significant problem of national interest. According to the ABS, AU$45.1 Billion was spent on Construction & Engineering Work during 2011 (ABS 8755.0). As at February 2012, the ABS estimates that over one million people are working in the construction sector (ABS 8155.0). If we use the ratio calculated for the industry in 2009 (ABS 1350.0), approximately 350,000 small businesses provide construction-related goods and services.

To minimise the impact of failure in the payment system, and in an attempt to ensure downstream participants are treated fairly, Australia has developed and implemented a number of legislative vehicles to provide security of payment. The five states and two territories all have differing legislation that regulates contractual agreements, each with differing purposes. The key principle underlying security of payment legislation is that any party supplying construction-related goods or services has the right to receive payment (whether or not an earlier party in the supply chain received their payment). It is expected that the legislation ensures that all parties benefit (Brand and Davenport, 2011).

However, the legislation to-date does not appear to have been effective in rectifying the risk for clients caused by the construction industry practice of payment for work in progress (Chen et al., 2009). In these days of modern information systems, it is surprising that mechanisms have not been developed to automate the certification process to reduce both the subjectivity and the workload (a very high transaction cost). Further, given legislation for security of payment and the desire by government to see fair payment down the supply chain, it is surprising that so little attention is paid to the downstream processing of payments. This paper proposes a new methodology for addressing these needs.

THE PROBLEM

Risk Assessment and Management

Risk management has become a basic function of all construction industry practitioners, but the definition of risk is complicated due to the different objectives of project stakeholders. For example, Chan et al. (2011) attempted to identify key risk assessment factors in their study in Hong Kong. They found that clients were more concerned than consultants or contractors with poor quality of work. At the same time contractors were more concerned with work delays and low productivity. The study was focused on contractual arrangements that encouraged cooperative rather than adversarial behaviour, so the study is not representative of the majority of the industry.

The Chan et al. (2011) results are indicative of why a common definition of risk within the industry, or within a specific project, is yet to be achieved. This lack of consensus does not, however, negate the fact that risk management is an expected process for all projects (regardless of size) to ensure a positive financial outcome (Ramachandra and Rotimi, 2011). The significant risk factor related to sub-contractor payment processes is that certification for payment is based on valuation of work progress.

The thorny issue of assessment of work progress has two distinctive issues that hinder certainty, and therefore create risk to the effective financial management of a project. Both
issues, quality of work and records management have been identified by researchers as significant contributors to a high level of conflict in Australia. It appears that security of payment legislation, other than in New South Wales, is focused on settling claims for payment for work done, rather than addressing the quality of the work (Coggins, 2011). In New South Wales, the adjudicator of a claim is entitled to assess both the quantity and the quality of the work. At the same time, lack of the ability to monitor quality of the work for which payment is made, remains a risk factor for most Australian clients.

Quality of Work

Sub-contractors are vital for construction. Ng and Tang, (2008) claim that 90% of construction is performed by subcontractors. Studies continue to show that subcontracting for unique construction projects is both efficient and economical because general contractors focus on managerial issues whereas subcontractors apply their technological knowledge. This division of labour means that uncertainty is moved down the supply chain (Karim et al., 2006). While it may be considered a good risk management strategy for clients, researchers have found that head contractors have difficulty monitoring the quality of work because of their distance from the site (Vandevoorde and Vanhoucke, 2006).

In part, the issue of quality cannot be verified through a manual process of estimated progress. Assessment of progress in Australia is often undertaken by the head contractors’ Contract Administrator and is assessed by the independent Quantity Surveyor, and each focus on contractual requirements rather than the quality of the work. Therefore, financial risk from poor or incomplete workmanship remains an issue that can cause both delays and additional costs due to rectifying defective work.

Work Records Validation

The traditional method of payment for subcontractors has been through retrospective validation in progress reports of work progress. Much of this assessment is based on the availability of documents, rather than the actual cost of goods and services. Thus, estimation rather than actual costs and completion dates are commonly used (Ramachandra and Rotimi, 2011; Uher, 1991).

The literature clearly identifies the difficulties of managing all required documentation for construction projects. For example, in their discussion of security of payments legislation Ward et al. (2007) indicate that standard construction contracts rarely contain details concerning required documents to ensure meeting contract commitments. The important issue of how records can be used to provide validation of work completed means that records not only must be maintained, but also up-dated and stored in a format that can be used for a variety of purposes. Ward et al. suggest the use of the Society of Construction Law (UK) Delay and Disruption Protocol to provide of details project records management. Thus, although focused on the UK, the Protocol provides a good guide for documentation needed for any project pay schedule. Use of a defined pay schedule, with complete documentation, can then be used by a contract administrator to monitor progress of work. It would seem that the solution had been found.
However, most of the people interviewed in their study (Ward et al., 2007) considered the use of the Protocol was not cost effective because too much time would be required to collect and store data. In addition, the question work progress records reliability was raised. At the same time, interviewees did not believe that consideration of using Information Systems/Information Technology (IS/IT) for the Protocol would prove useful to reduce risk to all stakeholders in a construction project (Mak, 2001). Ng and Tang (2008) also found that in Hong Kong the value of information technology was not considered by either contractors or subcontractors to be an important factor in subcontractor performance. Thus, a totally different approach must be considered to reduce the uncertainty related to certification of payment for work progress.

THE PROPOSED SOLUTION

In Australia, the certification payment systems rely on monthly lump-sum assessments of work, by definition often well after the actual work was completed. This retrospective method for validation of site-work is subject to error because of the lack of adequate site records. Secondary assessment of work in progress means that the extent and quality of work may not be well monitored, adding to financial risks (Kenley, 2003). What is required is a method that ensures payments are based on quality work actually completed, rather than percentage work progress. In addition costs can be contained if payments are linked to the productive delivery of the project.

One solution that meets these criteria is an innovative solution based on location-based micro-milestones, managed by a business process system. The term 'micro-milestone' has been coined to reflect the concept of payment on completion of locations, which is a key concept in location-based management (LBM) of construction (Kenley & Seppänen, 2010). Location-based micro-milestones provide the granularity of data to ensure payments reflect work done.

The Location-Based Management System (LBMS)

The location-based management (LBMS) is predicated on the proposition that construction can be viewed from a production perspective. Production is considered a continuous flow of resources through locations, ensuring optimal use of resources if planned and controlled with location-based scheduling techniques. Location-based management (LBM) postulates value is obtained through the identification of work-flows based on location as the unit of analysis and the task as the unit of control (Kenley and Seppänen 2010). The significance of location for planning, scheduling and controlling construction projects has been proven effective in a number of countries (Bjornfort and Jongeling 2007; Norberg and Olofsson 2008, Kala, et al., 2010).

Location-based production is explained using a sub-set of inter-related costs based on specific time in a specific location. Production is carried out in a defined location by a defined work-crew completing set tasks. Tasks are packages of work activities and the required quantities of materials to carry out those activities. Thus, location-based planning has more analytical complexity than traditional activity-based planning using critical path management (CPM).

Because CPM uses a single layer of logic between any two activities, repetitive activities are not intrinsically taken into consideration for calculation purposes. This is especially true of
the repetition of work in multiple locations. Location-based production theory organises both activity sequence and sequence work through layered logic based on location.

LBM expands the notion of production planning to include new layers of logic that add more detail to both the *internal* task production of the location-based task and the *external* links between tasks. LBM is based on five layers of logic that are applied equally.

- **Layer 1 logic**: external logical relationships based on a generic logic network defining relationships between activities in any location that is automatically replicated.
- **Layer 2 logic**: external higher-level logical relationships between activities driven by different levels of accuracy ensuring correspondence with location hierarchy.
- **Layer 3 logic**: internal dependency logic between locations within activities is critical to achievement of flow-line logic linking task factors for uninterrupted work.
- **Layer 4 logic**: phased hybrid logic between tasks in related locations is the manipulation of lag driven sequence to optimise adaptability for workflow.
- **Layer 5 logic**: standard CPM links between any tasks and different locations as a quality assurance process focused on circular logic effects.

Planning is supported through data analysis ensuring optimisation scheduling (Kenley and Seppänen 2010).

For management of the payment system, attention may be drawn to the two primary components of the LBMS. The location provides the container for cost related data and therefore the method allows data to be stored at a fine level of detail for certification of work in progress. Indeed, the detail is as fine as the location breakdown structure (LBS) employed for the work. As the unit of control, the task provides the timing for payment of work in progress, with completion of the task in each location triggering the valuation of the task for that location. These two components therefore provide the required data for certification of work in progress through the establishment micro-milestones on completion of tasks in locations.

**Location-based Micro-milestones**

Calls for milestone payments replace the current practice of payments based on an estimated measure of progress are part of a growing financial management trend. The implication is that a milestone provides a more definitive measure than the risky practice of attempting to measure progress. The problem with milestones is that they have to be generated and managed and are commonly related to significant stages in the work. As such, they are cumbersome and not sufficiently detailed to remove the need for certification of work in progress between milestones. A finer level of detail is required.

The LBM is a system using a method to provide a micro-milestone level of detail. The level of detail of the LBS provides the ability to achieve 100% completion of very small milestones. The term micro-milestone has been coined to describe milestones that form at the completion of a location-based “task” in each location of the LBS. The performance of the Task (method of control) as it moves through the Location (unit of analysis) affords LBM a rigorous methodology for managing and controlling projects, and the valuation of the work in progress.
Location-based Micro-milestone Payments

Micro-milestones are able to trigger milestone payments. Many contracts contain milestones as trigger for payment and this concept is not new. However, the use of LBM enables the tracking of milestones at the level of detail of completion of a task in a specific location – thus generating many (potentially thousands) of milestones. This would not be manageable within typical project administration systems, however modern location-based tools, combined with supporting business process models, now raises this as a very real potential.

Clearly the development of an entirely new approach to the management of the certification and payment system for sub-contractors in Australia could deliver fairer payments to individuals and provide greater security for the industry. It is expected that micro-milestones can provide an equitable way to trigger payment to all parties, according to their contracts, down the supply chain. However, new business process models are required to support the administrative burden such a system would present. It merely remains to develop the systems to support location-based micro-milestone payments.

BUSINESS PROCESS MANAGEMENT

For the last 20 years the construction industry has been focusing on radical and incremental change in an effort to alleviate the inherent disconnected, fragmented, customised and temporary nature of creating a sustainable built environment (Ajam et al., 2010). One method of achieving this goal has been the attempt to forge commonality using computing technology through identification of business processes.

Business Process Management (BPM), is the outcome of the growth in IS/IT (Mak 2001). Successful BPM implementation is able to provide significant efficiency through business process modelling and reference models. Efficiency is obtained because BPM is concerned with managing processes within and between organisations predicated upon understanding how an organisation works through describing what people do (processes). Identification of these work processes is now the core purpose of a multiplicity of tools and methodologies for software providing process-aware multi-level/multi-functionality systems (van der Aalste et al., 2003).

LBM processes reference models for auto-generation of payments

Reference models are generic conceptual process models capturing and reusing recommended practices for a certain domain (Fettke & Loos, 2003). The main objective of reference models is to streamline the design of enterprise-individual (particular) models by providing a generic solution (Fettke and Loos, 2003). Reference models accelerate the modelling process by providing a repository of potentially relevant business processes and structures for the domain of interest. The processes of certification and paying for construction work will form a single sub-system (or workflow) documentable as an AS-IS reference model (ter Hofstede et al., 2010).

As explained, LBM theory identifies a task within a defined location as a container for construction data at a scale that is easy to collect, monitor and analyse. It is therefore easy to envision that the completion of a series of tasks provides a well-defined business process. In
addition, because micro-milestones are based on workflows, identifying individual tasks (time and cost of resources) provides the data for certification purposes.

Moving from monthly payments to ‘location-based micro-milestones’ involves a significant increase in data and processing. Typically, there may be hundreds of micro-milestones per month on major projects. This is clearly beyond the capacity of traditional approaches to manage. The application of techniques from the field of business process automation can help manage such processes by keeping track of progress, starting work at the right time and routing it to the right participants.

**Auto-generation of processes from information models**

Completed locations can assist business information models (BIM) (Eastman et al., 2008) in the setting of parameters for a discrete building process. The BIM solution proposed is work completion micro-milestones based on building process reference models for auto-generation of certification and payment. However, while it is comparatively easy to conceive of an integrated information system (Perera, A. and Imriyas, K. (2004), it is more difficult to model accurately a system due to time/space limitations.

Techniques from the field of configurable reference modelling can be applied to enable the automated generation of payment processes. These process models would be sufficiently flexible to respond to the project specific data relating to location-breakdown structure, task makeup (subcontract resources and materials supply) and sequence of construction.

Automation requires new reference process models to be developed for location-based management. It can also be assumed that the rich data needed to support automation will be derived from Building Information Models (BIM) and that communication with quality and payment systems will use open-source protocols, such as the American General Contractor’s Extended Markup Language for project data agcXML (Mena et al., 2010).

It is proposed that future work will develop workflow models using a modelling language called YAWL (Yet Another Workflow Language). YAWL can provide a configurable process model that has the ability to incorporate variation which is part of a standard procedure. Thus the uniqueness of construction projects does not have to be considered problematic. Points of difference in a work-flow can be configured in relation to specific circumstances with commonality and variation considered as notion. These models could be AS-IS and TO-BE workflows based on LBM micro-milestones (ter Hofstede et al., 2010).

**CONCLUSION**

One of the greatest risks for clients lies in paying for work in progress. Location-based micro-milestones have been identified as a solution for reducing the risks involved with certification of work in progress. However, the solution offered is based on proposed research. The outcome of the research would be the development of configurable reference process models as the foundation for a workable prototype based on real rather than simulated data. Thus the solution to a risky sub-contractor system could be the auto-generation of certification and payment using location-based micro-milestone systems developed using YAWL.
REFERENCES


