

# **PRODUCTIVITY EXCELLENCE THROUGH AN INTEGRATED CONSTRUCTION MANAGEMENT SYSTEM FOR THE BUILDING AND CONSTRUCTION INDUSTRIES**

Peter Yan, Chief Executive Officer

Global e-Business Services Limited  
30/F., MLC Millennium Plaza, 663 King' s Road, North Point, HONG KONG

## **ABSTRACT**

This paper describes the actual case of how an Integrated Construction Management application designed specifically for the construction industry can enhance productivity, efficiency and competitive advantage.

The application is an advanced web-based system covering construction tendering, procurement, workflow management, document management and project management functions. It is a full Internet based system with advanced PKI-based (public key infrastructure based) security features to ensure data confidentiality, data integrity and authenticity.

Among the users of various components and/or modules of the Integrated Construction Management system are the Hong Kong Government and various commercial enterprises.

In the paper, we will illustrate through describing one of our success cases, how various functions of the application have brought about the said improvements and elaborate on the quantitative achievement of such improvements. We will also illustrate the benefits of the application not only to the construction companies themselves but also how the implementation of such applications has improved the business partners of the construction companies, such as their subcontractors or suppliers.

In addition, we will also share with the audience the experiences we have in implementing such applications for various organisations. These include our assessment of the critical success factors, the challenges normally faced, the considerations of different stakeholders in the implementation process and the justifications for implementing such applications.

## **KEYWORDS**

Integrated Construction Management System, Electronic Tendering, Bill of Quantity, Document Management, e-Procurement, Workflow, Project Management, Productivity

## **INTRODUCTION**

In April 2000, the Chief Executive of the Hong Kong Special Administrative Region formed the Construction Industry Review Committee (CIRC) to review the current state of the industry and recommend improvement measures. The Committee has proposed items of improvement measures aiming for better performance of the industry. There were recommendations on certain areas which comprised of improvement on the existing tendering process and procurement logistics. This paper illustrates how information technology can be applied in real life situation through an Integrated Construction Management System (ICMS) to implement the recommendations of the CIRC review report and to improve companies in the construction industry in their productivity, efficiency and competitive advantage.

The paper starts by providing the background and characteristics of the construction industry, reinforcing the challenges faced by its practitioners and how ICMS applications could overcome such challenges. The paper concludes by illustrating a real case in Hong Kong – the Shui On Construction and Materials Limited, on how ICMS can achieve significant result in productivity and efficiency gain.

## **CHARACTERISTICS OF THE LOCAL CONSTRUCTION COMPANIES**

The local construction industry is characterized by a high level of subcontracting. There are a small number of large local contractors while most local construction companies are usually small in size. More than 90% of the local construction companies had less than HK\$10 million gross value of construction work performed in 1999. Many of them act as subcontractors to the large companies, that is, the main contractors. (Source: [July 2001] Profiles of Hong Kong Major Service Industries – Building and Construction, Hong Kong Trade Development Council). The industry is labour-intensive, traditional and old-fashioned. The result of such a manual characteristics is lengthy process and procedures in project administration, leading to loose control, increase cost and low productivity. Occurrence of several non-compliant construction incidents occurred in 2001 have increased much awareness and concern to improve existing practices in project management.

Since most of the companies are low in profitability, industry participants usually adopt a short-term vision. Many of them are resisting to invest in advanced construction technologies and more efficient work processes, it will ultimately decrease the industry's competitiveness in the long-term.

## **WHY IS A COMPREHENSIVE CONSTRUCTION MANAGEMENT SYSTEM REQUIRED FOR THE INDUSTRY?**

According to the CIRC report, it is not uncommon that construction projects experience delays and exceed budget. In such cases, penalty would be incurred and results in financial loss and poor professional image. The reason behind as suggested by the report is due to a lack of accountability through the prevalence of many non-value adding multi-layered subcontractors with lax supervision (Source: [Jan 2001] Construct for Excellence, Report of the Construction Industry Review Committee).

When too many parties are involved in a construction project with the existence of a large amount of subcontractors in different stages, it is always be difficult to control the project progress since delivery of the construction products would be pieces by pieces. It is therefore recommended in the CIRC report that a structured site supervision system should be set up to safeguard the built quality. It allows the factors of consideration to be planned and designed at the very beginning

stage to facilitate downstream activities such that all processes and practices should be rationalized as far as possible to shorten the learning curve and to provide greater predictability over outcomes. To achieve this, IT solution will be required to improve the information flow among all project participants and to enhance project logistics management. For example, an on-line project management system would allow each construction sites situated in different locations to report project progress to head office. In this way, the most up-to-date project status can be readily compiled at the head office and travelling between the head office and the project sites will be greatly reduced.

Another highlight in the report is relating to the existing procurement and logistics practices. It points out that the method of procurement will directly affect the construction work quality and outcome. Focus has been imposed on two particular areas: pre-qualification of subcontractors and assessment of bids and contract award with a scoring system. However, the existing tendering system is much paper-based and traditional. There is low transparency and lack of openness to both tenderers (here refer to subcontractors) and the general public. The CIRC report suggested the use of prequalified tendering to identify the past performance and quality attributes of tenderers and use of a marking scheme to select the quality subcontractors.

To ensure that developers and contractors comply with the mechanism and to create an open and fair environment for industry players, the use of IT through a web-based electronic tendering solution is recommended. The CIRC report encourages the adoption of electronic tendering in the construction industry by endorsing the Works Bureau's initiatives in electronic tendering.

The CIRC report also advocates on the extensive use of information technology in other specific areas like document management system and workflow improvement processes. It concludes that an integrated system combining the above applications serving as a one-stop solution specifically designed for the industry is much desired in achieving significant productivity gain.

## **WHAT IS INTEGRATED CONSTRUCTION MANAGEMENT SYSTEM (ICMS)?**

ICMS is a web-based application and is construction industry oriented. Users of the system require no proprietary software/hardware installation and the set up cost is minimal. It deploys strong encryption technology through PKI-based security framework to ensure extremely high level of data confidentiality, data integrity and authenticity.

The ICMS components include construction electronic tendering, procurement, workflow management, project management and document management functions. The characteristics of each component and their benefits to industry users are discussed below.

### ***Electronic Tendering System***

In the CIRC report, it stresses the importance of pre-qualification and bid assessment. To achieve this, an open and transparent tendering and procurement process is inevitable. The Electronic Tendering function, equipped with subcontractor pre-qualification exercise and on-line purchasing features, is able to improve industry users in daily tendering process. The suppliers and contractors registration management supports pre-qualification procedure by enabling the developers or main contractors to approve those qualified subcontractors with proven track records. Contracts could then be awarded to those industry participants with consistently good performance.



Features of Electronic Tendering System at a glance:

*Suppliers and contractors Registration Management*

- Online vetting for new and approved registration
- Pre-qualification of registered subcontractors
- Updates supplier's information for developer / main contractor's future assessments

*Project based Tender Management*

- Creation of project reference for new project
- Tender documents defined in individual project reference for easy identification

*Refine project by Trade Management*

- Categorizes project items in different trade, expandable sub-level and secondary sub-level
- Divides suppliers and contractors role according to their engaged business

*Easy Site Purchase Management*

- Direct site purchase requests from site office
- Simple and user-friendly instant online request for quotation

*Other Features*

- Supports open and registered tender posting
- Supports electronic security keys certified by Hong Kong Post
- Supports tender clarification, postponement, suspension and addendum posting
- Online Q&A enquiry box
- Real time service by synchronizing with the Hong Kong Observatory
- Consolidated tender submission by highly secured tender box program

Based on the experience in developing the ETS system ([www.ets.com.hk](http://www.ets.com.hk)) for the Government Supplies Department (GSD), the Electronic Tendering System offers the most secured platform to industry users in disseminating tender notice and documents arising from works projects. Contractors could, through a simple web-browser, instantly download and submit their tender offer to a highly secured tender box.

***Bill of Quantity (BQ) System***

Integrated with the Construction Tendering System, the BQ (Bill of Quantity) Management System facilitates tender evaluation. The BQ summary report enables users to access all tender offers at a glance with automatic comparison process to facilitate bid evaluation.

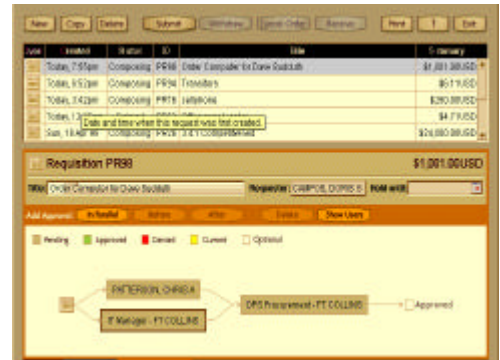
*Features of Tender BQ Management System*

- Facilitates tender preparation and evaluation
- Displays in excel format
- Intelligent “waterloo” comparison of returned BQ Excel file to track unauthorized changes
- Discrepancy Report Generation to highlights only insertions / deletions / modifications
- Allows the import of returned BQ files from diskettes or CD-ROM with BQ summary report



***Procurement and Workflow Management (e-Procurement)***

Traditional procurement involves manual paper-flow processes which are time consuming, difficult to control, non-productive and inefficient. e-Procurement can streamline those tedious processes, resulting in procurement cost reduction. It could significantly reduce purchasing cycle time and increase operation efficiency accordingly.



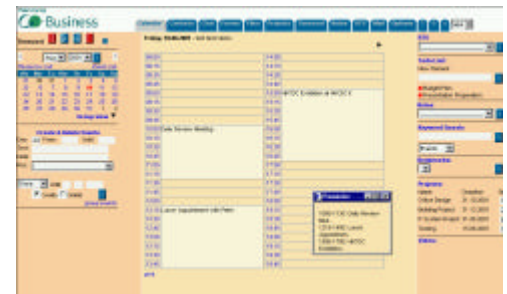
Workflow management also applies in various project stages, ranging from project initiating, suppliers record vetting, tender posting, document and suppliers' bid sharing. Information could be exchanged between headquarters and site offices without boundary. Site offices could perform approval requests directly and send them to Headquarters for approval.

#### *Features of e-Procurement*

- Electronic catalogues for product / site materials selection
- Pre-customized electronic forms for on-site procurement request
- Establishes dynamic sequence workflows for request, review and approval according to company structure
- Real-time status tracking and control of entire process
- Advanced reporting tools for data analysis and supplier evaluation in business negotiations and strategic planning

#### *e-Project Management System (e-PMS)*

e-PMS is a real-time management tool for multi-construction projects. It is proficient in categorizing projects with status highlighted as well as to allocate relevant parties and timeline. The features of e-PMS are described:



#### *Group Calendar*

- Organization of related activities and perform group schedules
- Update meeting status among group members
- Resources and time allocation for projects
- Alert box to remind upcoming event

#### *Project Administration*

- Role-based control for member's identity
- Allows administrator to manage resources, groups and users
- Assigns and shares events of current projects to group members

#### *Group Communication*

- Supports e-mail or fax sending with file attachments to select group members
- Contact Manager Tool to import directories from other formats
- Chat Forum for users to conduct on-line discussion
- Dialogues and data are displayed and stored as documentation for future retrieval

#### *Request Tracker System*

- Products and services support management
- Categorizes incoming request and automatically assign respective user
- Acknowledge request and online status checking for customers
- Views pending requests and assigns work time for billing calculation

- Forms a knowledge base for public searching or restricted for authorized access

#### *Time Card System*

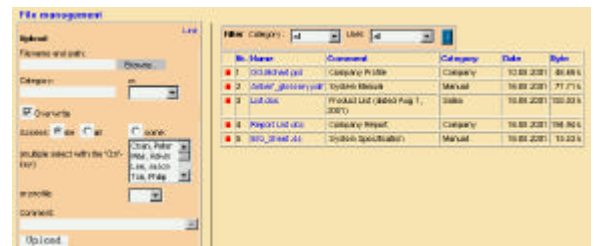
- Administrates working hours and assigns working days to several projects
- Actual measurement of working hour by out and back on duty
- Calculation of working hours for progress tracking and cost estimation

#### *Other Benefits*

- Multi-languages support – English, Chinese and up to 15 languages
- WAP and PDA access
- Online Help Support, FAQ and tips

### ***e-Document Management System (e-DMS)***

Traditional filing system results in numerous loose-leaf papers difficult for searching and sharing. The construction industry produces tones of documents, maps and diagrams everyday which makes filing more complex and time-consuming. DMS can improve the existing situation through the following features.



#### *Features of DMS:*

- Central repository for users to share files and documents
- Uploads files / intranet links and directories
- Assigns access right for relevant parties
- Adds remarks and comments on each document
- File sorting and searching by categories

The e-Project Management System (e-PMS) together with e-Document Management System (e-DMS) served as a real-time management tools for multi-location construction projects. This function facilitates the coordination of construction activities and enables the multi-location construction sites to report the project progress to its head office. All paper documents including sizable maps and diagrams can be uploaded from all locations to the system which serve as a central repository for authorized users to share. The e-PMS is also equipped with time card system for recording of “in” and “out” time for duty or work which assist in working hours calculation for progress tracking and cost estimation.

Through these features, industry users can be benefited by monitoring the cost and time spent by group members against budget and schedule in a real-time basis. Project manager can modify the project plan and reassign resources immediately with quick response to unexpected circumstances. It also facilitates the circulation and access of confidential documents and drawings.

ICMS provides audit trail for all actions taken and which parties have been involved. It increases control and accountability of personnel involved and reduces improper access and approval within the process. ICMS aims at reducing the project cycle time, increasing contractors relationship management, achieving operation efficiency and ultimately, increasing project compliance and control.

## **CASE STUDY: SHUI ON CONSTRUCTION AND MATERIALS LIMITED**

### ***Company Background***



SOCAM.com Ltd. is a wholly owned subsidiary of the Hong Kong construction giant –Shui On Construction Materials Ltd. (HKSE: 983) of the Shui On Group. It is a leading Hong Kong company engaged in construction, construction materials and property development in Hong Kong and the mainland China.

### ***Applied Applications:***

SOCAM.com is developed by SOCAM.com Limited for providing total solutions in tendering and procurement logistics. Selected modules in the ICMS are applied. One of the key functions is the electronic tendering (e-Tendering) system, a web-based tool to conduct the entire tendering process based on a secured system. For those low value purchasing items where tender document is not necessary, ec-Purchasing function is available for instant quotation. The whole implementation and operation, including supplier enablement, training and hotline, of this platform is outsourced to an application service provider.

### ***Useful Statistics:***

The system has been in operation since September 2000. As of March 2001, the total number of registered suppliers in the system has already exceeded 500 which accounts for more than 60% of the active supplier base of Shui On Construction and Materials Limited. More than 18,000 visitors have been attracted to the site with more than 3,800 tender documents downloaded. It generated more than HK\$380 million tender value through its electronic tendering and procurement portal. In November 2001, SOCAM.com has been enhanced to include the Shui On Plant and Equipment Services Ltd. (SOPESL) and the MIS department as system users.

### ***Benefits to SOCAM:***

- Achieved 1 per cent cost savings in production within 3 months after implementation
- Productivity gain with 10-30 per cent improvement
- Streamlining existing tendering process, increase communication between SOCAM and existing/potential partners e.g. clients, subcontractors and suppliers
- Prompt delivery: implementation timeframe within 3 months through a ready-to-market application
- Enabled internal staff from different sites and offices to access updated project information remotely which expedite for tracking and information/data retrieval
- Outsourcing non-core operations to outside party, such as application hosting; telemarketing; help desk; supplier vetting/recruitment and user/supplier training, allows the company to focus on its core business

### ***Key Issues Encountered and How They Are Resolved:***

*Issue: The implementation of SOCAM.com requires re-engineering of existing procurement and tendering process.*

#### **Actions taken to resolve the issue:**

- A dedicated business unit was set up to oversee the electronic tendering system and capitalize on the business opportunity of this system.
- Strong management support and commitment were demonstrated and communicated to the working level at various levels of management.
- The benefits of process re-engineering were communicated to all internally
- Mass internal training on IT usage to all employees were conducted prior to the rollout of the electronic tendering system
- Advises were solicited from the expert opinion of the application service provider that has numerous experiences in building electronic tendering systems.

*Issue: SOCAM has faced resistance to change from its subcontractors and suppliers.*

Actions taken to resolve the issue:

- Special offers were given to award first movers.
- The message that electronic tendering will replace traditional process in the long term was repeatedly communicated to the contractors and suppliers.
- A step-by-step implementation plan was devised, starting with the more ready and capable contractors/suppliers, then extending gradually to those less ready companies
- A comprehensive suite of supplier enablement services, including training and help desk, was solicited from the application service provider.
- A Pilot Run was conducted to ensure the full consideration of the supplier/subcontractors' requirements before implementation

*Issue: Concerns from internal users and external suppliers regarding security.*

Actions taken to resolve the issue:

- Strong encryption technology based on PKI-based security framework was deployed to ensure high level of data security, integrity and identity authentication.
- A reputable application service provider with track records of implementation experiences of similar platforms was selected for the development of the system.
- An independent third party (i.e. the Hong Kong Productivity Council) was employed to conduct comprehensive audit review on the provider's technical infrastructure.

## **CONCLUSION**

Despite of the recent economic downturn in Hong Kong, there is still a lot of infrastructure and construction works ahead. The government has proposed to award construction and consultancy contracts worth about HK\$280.8 billion by the end of 2002, subject to funding approval of the Legislative Council Finance Committee. Sizable projects are underway which include the redevelopment work for old Kai Tak Airport and adjacent areas, works arising from railway development, public and private sector housing construction, etc. As recommended in the CIRC report, the construction industry must improve its long-term competitiveness through the use of innovative technologies and more efficient work processes. The government has already taken the lead in encouraging the use of I.T. in various industries.

The China's accession to World Trade Organization (WTO) enabled local construction industry to capture the opportunities in the mainland real estate development and construction market. However, the local industry players must maintain its competitive edge against local and overseas competition. The ICMS provides a mean for local industry practitioners to achieve significant productivity gain through the application of information technology.

## **REFERENCES**

Henry Tang and Construction Industry Review Committee (2001), Construct for Excellence – Report of the Construction Industry Review Committee  
Profiles of Hong Kong Major Service Industries – Building and Construction, [http://www.tdctrade.com/main/si/spcons.htm] (1.10.2002).  
SOCAM – Annual Report (2001)