Theme:

Title: **Developing National Standards for the Classification of Construction Information in Singapore**

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Abstract: *Despite lagging far behind countries which have started developing construction information classification systems over the last 30 to 50 years, Singapore is fast catching up in this area of development via the formation of the Construction Industry IT Standards Technical Committee (CITC) in 1998. The Government's intention is to create Singapore into a business and IT hub, and the National IT Standards Committee (NITSC) was formed in 1990 to spearhead the development of national IT standards in all sectors of the economy.*

To date, the CITC has initiated and established standards in the areas of CAD, cost and resources information, and specification. The paper discusses the developmental process for one published standard, the Singapore Standard Code of Practice for Classification of Construction Cost Information (SS CP 80: 1999), and one standard which is in preparation, the Proposed Singapore Standard Code of Practice for Classification of Construction Resources Information. The intention is to share the Singapore experience with countries which are embarking on a similar programme.

The next challenge for CITC is to manage change and promote widespread adoption of these standards by the industry. Results from the questionnaire survey and interviews indicate a positive attitude towards standards development but less positive towards full adoption. Lack of incentives, little immediate benefits, cost to be incurred from re-classifying historical data and cross-disciplinary differences are some of the findings.

The key pointers for intended standard developers are: make a conscious effort of involving industry players in the development of the standards in order to help bring down barriers to change; adopt a two-pronged approach so as to achieve a win-win-win result; identify leaders in the industry who can drive the developed standard/technology in order to convince other players to follow suit; and develop assistance schemes to help small firms embrace standardisation and IT.

Keywords: *Construction information, standardisation, classification, computer-integrated-construction*

INTRODUCTION

The construction industry is unique in that it involves parties from a myriad of professions. Different types of construction information are exchanged between the various parties for the purpose of communicating design, construction and contractual matters. Individual firms have developed their own means of classifying and disseminating construction information to facilitate this process. However, as there is no standardised system of classifying and sharing of such information, much of the data is lost along the way.

The development of classification systems in Britain, America and Canada began some 30 years ago. The Swedish system, SfB, has been in existence for more than 50 years. However, in Singapore, efforts in this direction have only surfaced in the late 1990s via the formation of the Construction Industry IT Standards Technical Committee (CITC) as a national effort to prepare the industry for the IT age of the 21^{st} century.

The paper discusses the development of the Singapore Standard Code of Practice for Classification of Construction Cost Information (CP 80:1999) which is to ensure that construction cost information is structured and stored in a way that is consistent and reliable within and between the different disciplines so as to reduce any duplication of work. Similarly, the proposed Code of Practice for the Classification of Construction Resources Information will present a uniform system for classifying information relating to construction products, materials, services and machinery. The main intention is to develop and provide a standardised format to facilitate procurement activities in the construction industry. As construction projects use a broad range of products and services, there is even greater need for a classification standard to ensure a consistent and structured way of information exchange and storage. Findings from a recent industry survey on the adoption of CP 80:1999 are also presented to show the response of key players to change via information standardisation.

COMPUTER-INTEGRATED-CONSTRUCTION (CIC)

IT plays a vital role to integrate construction both vertically and horizontally and is widely recognised as a key-enabler of the integration of data, process, participants, etc. on a building project life cycle. Over the last decade, IT has tried to permeate every aspect of construction but, because of a lack of integration, IT applications are mainly isolated. It is used to tackle individual tasks, like drafting, quantity take-off, engineering analysis, etc. Bjork (1995) described the proliferation of IT in the construction process as the "islands of automation".

This isolated situation of IT application can be attributed to the nature of the industry, which is, fragmentation, owing to each party to a project is driven by individual business goal. The fragmentation in construction can be distinguished by two dimensions (Howard et al., 1989; Brochner, 1990):

a) degree of vertical fragmentation (between project phases, eg. planning, design and construction); and
b) degree of horizontal fragmentation (between different specialists at a given project phase, eg. architects, structural engineers and HVAC engineers at design stage).

The term computer-integrated-construction (CIC) is derived from computer-integrated-manufacturing (CIM) concept. Integration can be identified in the construction industry via (Gielingh and Tolman, 1991):

a) integration within the whole construction cycle (from design and planning to maintenance and demolition);
b) integration of construction technologies (design technology, material technology, and manufacturing and construction technology);
c) integration of information technology components (application programmes, computer-aided-x systems and computer controlled production equipment); and
d) integration of data, or information.

CIC can be regarded as a strategy as well as a concept for associating existing resources, technologies, processes and organisations by information integration and automation to optimise overall construction activities and functions (Yamazaki, 1992). The key factor in CIC is the integration of the different computing applications used in the life cycle of a building (eg. CAD, engineering analysis, production planning and facilities management).

Zhong (1998) noted the three approaches to facilitating CIC are:

a) Computer-aided-design (CAD)

    CAD systems have become the main carrier of the design information in the construction industry.

b) Information classification in construction

    The development of a standardised system of classifying and sharing of construction information, such as, design, cost, contractual, products and materials.

c) Conceptual building model

    The enabling of the migration of CAD systems from pure geometric-based systems to a high semantic model-based one to allow intelligent data exchange and collaboration between different applications.

INFORMATION STANDARDISATION: SPECIFICATION AND CLASSIFICATION

One of the approaches to enable CIC is to develop a standardised system of classifying information. Typically, the standardisation of information in the construction industry covers the following aspects:

a) CAD
b) Specification
c) Cost information
d) Product information.

There is a need for a common language if IT is to be used as a means to better and more efficiently manage and exchange information. As such, unorganised information is difficult if not impossible to access and is therefore as good as lost. On the other hand, a properly organised information store, based on a common language, guarantees timely access for users and speedier transmission and exchange. Organised and freely accessible information would optimise the deployment of scarce manpower for increased productivity and help to make our highly diversified and fragmented construction industry more efficient (Lee et al., 1989). In a broader context, it also allows for interoperability between or among firms.

In Singapore, the Singapore Productivity and Standards Board (PSB) is the national standards authority. PSB co-ordinates the national standardisation programme and Singapore's participation in international standardisation efforts. One of the 9 Committees appointed by the Singapore Standards Council in August 1990 is the National Information Technology Standards Committee (NITSC) which is responsible for IT standardisation. This is a collaborative effort supported by PSB and the Infocomm Development Authority (IDA), with IDA serving as the secretariat to the NITSC.

NITSC's mission:

"To spearhead the formation of Singapore's national IT standards to support the establishment of Singapore as an IT and business hub."

The formation of the Construction Industry IT Standards Technical Committee (CITC) in 1998 is an industry effort to prepare the Singapore construction industry for the IT age of the 21st century.

CITC's mission:

"To establish an industry-wide framework for the development and adoption of IT standards in the construction area."

CITC tracks, adopts and promotes construction industry specific IT Standards. It ensures that our national standards are aligned with international standards as well as other industry de facto standards. To deploy strategic IT systems, CITC works closely with the International Alliance for Interoperability (Singapore Chapter), IAI (S), which focuses on 4 main thrusts, namely, design, procure, build and maintain that cover the entire life cycle of a building project. Some developed Singapore Standards include:

- SS CP80:1999 – Classification of Construction Cost Information
- SS CP83:2000 – Implementation of Computer-aided design (CAD) Standards
    - Part 1: Organisation and naming of CAD layers
    - Part 2: CAD symbols
    - Part 3: Organising and naming of CSAD files
    - Part 4: CAD drafting conventions
    - Part 5: Colour and Linetype
- SS CPXXXX – Classification of Construction Resources Information *(in preparation)*

SINGAPORE STANDARD CODE OF PRACTICE FOR CLASSIFICATION OF CONSTRUCTION COST INFORMATION (SS CP80:1999)

This national standard was one of the first initiated by CITC in January 1999. It was in view of the different types of cost information being exchanged by various parties for the purpose of communicating design, construction and contractual matters. Over time, individual firms have developed their own means of classifying and disseminating cost information to facilitate this process. Hence, it was timely for CITC to consider developing a code of practice for the standardisation of construction cost information classification. The broader intention is to develop a classification standard for the construction industry to ensure that cost information is structured and stored in a way that is consistent and reliable within and between the different disciplines so as to reduce any duplication of work. The main users of the standard would be property developers, quantity surveyors (QS), mechanical and electrical (M&E) engineers, as well as contractors. The project was jointly funded by the PSB, Building and Construction Authority (BCA), National Computer Board and IAI(S).

The development of the first draft involved two main stages. They were: (1) a review of international standards; and (2) adaptation to local industry practices. In the first stage, one US, one Australian and three UK standards were evaluated. Endorsement was given for the team to adopt the Royal Institution of Chartered Surveyors' Building Cost Information Service (BCIS) method for the elemental format and the UK Standard Method of Measurement (SMM), 7th edition, method for the trade/work-section format.

In the selection process for the elemental format, five classification approaches were considered and they are:

a) BCIS standard list of elements for cost analysis (UK)
b) CI/SfB Table 1 elements (UK)
c) Unified Classification for the Construction Industry (Uniclass*)* Table G elements for buildings (UK)
d) Mastercost construction element categories (US)
e) National Public Works Conference (NPWC) list of elements (Australia)

Owing to the predominance of the UK practice in the local QS profession, a more detailed comparison was made for the three UK methods. The analysis found their classification of building elements to be similar except for the different levels of grouping. The BCIS approach was chosen on the basis that it is the most widely adopted, although not in full, in the local industry for classifying elements. Modifications were made to incorporate parts of the other four methods, as well as some local conventions during the process of verifying the first draft against industry practices.

For the work-section format, two classification approaches were considered and they are:

a) SMM (UK & Singapore)
b) Uniclass Table J work sections for buildings (UK)

The SMM method was chosen on the basis that the UK version would serve as the proposed standard's framework while the local SMM would provide the contents. Again, the pervasive use of the SMM for classifying work sections in the local industry was the key reason for its choice.

In the second stage, a project-based approach was used to adapt the first draft to local practice. The basis was to adopt the BCA Awards and Certificates of Merit for Construction Excellence to select a few 'model' projects for the study. The rationale being that such successful projects would imply effective information exchange amongst the different parties involved. In addition, they should be high-rise developments with basement and have a high M&E content. This requirement implies the selection of development types, such as high-rise residential, office, retail and hotel, that cover all the elements or components of a building. Interviews were also conducted with the clients, QS and M&E consultants, and contractors of these projects in order to tailor the drafts more closely to industry practices. The final stage involved validation of the developed system by the whole industry.

The national code of practice, SS CP80:1999, was officially launched at the International construction trade fair, BauCON Asia '99, on 6 October 1999.

PROPOSED SINGAPORE STANDARD CODE OF PRACTICE FOR CLASSIFICATION OF CONSTRUCTION RESOURCES INFORMATION

Following the launch of SS CP80:1999, another initiative commenced in April 2000. In this instance, it was to develop a standardised system for the classification of construction resources information. As construction projects use a broad range of products and services, there is an even greater need for a classification standard. A listing of numbers and titles would organise information about construction resources or, more specifically, construction products and activities describing the physical aspects of construction. It would present a uniform system for classifying information relating to construction products, materials, services and machinery. The main users will be those directly involved in construction resource specification, pricing and procurement, such as architects, mechanical and electrical (M&E) and civil and structural (C&S) engineers, quantity surveyors (QS), contractors and material suppliers. Other users will include property developers, as well as facility managers.

The development of the standard involved three main stages. They are:

a) a review of international standards;
b) a selection of international standards for detailed evaluation; and
c) a localisation of terminology.

The following international standards had been reviewed in the first stage:

a) Unified Classification for the Construction Industry (Uniclass) Tables L, M and P
b) CI/SfB (or SS376:1995)
c) United Nations – Central Product Classification
d) United Nations – UN/SPSC
e) CSI/CSC MasterFormat (1995 edition)

Based on the strengths and weaknesses of the above standards, the following few had been shortlisted for in-depth evaluation:

a) Uniclass
b) UN/SPSC
c) CSI/CSC MasterFormat (1995 edition)

The process involved multi-level mapping or interfacing of two or more standards with SS CP80:1999. The intention is to check for alignment with existing standards and CP80 is one for the classification of construction cost information. The MasterFormat surfaced as the most suitable standard, in view of its generic terminology which would be familiar to most construction practitioners, and even suppliers. The evaluation also included a detailed comparison by structure, content, development time and maintenance requirement. The final stage involved aligning the MasterFormat with local industry practice, via a localisation of terminology. Inputs from the industry had been gathered to develop the list of local terminology for titles having a local equivalent.

The Draft Singapore Standard has been released for public comment on 21 January 2002 by the PSB. It comprised two parts: (1) National endorsement of CSI MasterFormat, 1995 edition; and (2) National amendment to highlight deviations from the national endorsement to suit local use.

INDUSTRY SURVEY (QUESTIONNAIRE AND INTERVIEW) ON THE ADOPTION OF SS CP80:1999

An industry-wide survey was conducted, adopting a questionnaire and interview approach, to gauge the response from direct users of this classification standard after 12 months from its launch. The targeted respondents were QS, M&E engineers and property developers.

The scope of the survey covered the following aspects:

a) The level of awareness of the types of construction cost information available in the industry;
b) The ways in which firms and individuals handle cost information;
c) The effects of CP80 on firms and individuals;
d) The perceptions of CP80 as a national code;
e) The strengths and weaknesses of CP80; and
f) Recommendations to improve on CP80.

The key findings from the survey are summarised as follows:

1) Sample population (Table 1)

Categories	**No. of firms surveyed**	**No. of responses**
Quantity surveying	34	17
M&E engineering	34	16
Property development	45	13
Total:	**113**	**46**

2) Awareness of release of CP80? (Table 2)

Categories	**Yes (%)**
Quantity surveying	60
M&E engineering	13
Property development	27
Total:	**100%**

(Note: 41% of the total no. of firms surveyed knew about the release.)

3) Is CP80 comprehensive?

Yes: 93 %
No: 7 %

4) Welcome the release of CP80? (Table 3)

Categories	**Yes (%)**
Quantity surveying	41
M&E engineering	21
Property development	38
Total:	**100%**

(Note: 86% of the total no. of firms surveyed welcomed the release.)

5) Willingness to adopt CP80? (Table 4)

Categories	**Yes (%)**
Quantity surveying	50
M&E engineering	9
Property development	41
Total:	**100%**

(Note: 60% of the total no. of firm surveyed have expressed willingness to adopt.)

6) Some advantages of CP80:

- CP80 helps to standardise cost data across the industry.
- The code serves as a guide for firms.
- It provides a platform to communicate and obtain nationwide cost information.
- It simplifies cost estimate preparation.

7) Strengths of CP80:

Rank
1. Enhances industry productivity.
2. Tailored to suit local practice.
3. Easy to use.
4. Provides a consistent approach.
5. Provides a common language.
6. May help to reduce possible disputes.
7. Aids in computerisation of cost information.

8) Some disadvantages of CP80:

- All firms will have the same costing approach which reduces competition.
- Past data requires time and cost to re-classify.

9) Weaknesses of CP80:

Rank
1. Mindset is difficult to change.
2. Difficult for wide adoption if lack of strong coordination by government.
3. May not encompass all cost factors.
4. May not be easily updated owing to fast-changing market.
5. Firms may lack incentive to change.

10) Suggestions to promote CP80?

- Publish articles in construction journals and association yearbooks.
- Organise talks and seminars.
- Government's role to initiate change.
- Increase promotion of electronic transfer of construction information.
- Architects and Engineers to take the lead to adopt CP80 in their specifications.
- Clients to make consultants adopt.

In addition, a total of 9 interviews were conducted to elicit qualitative feedback from industry professionals. The interviewees comprised senior management staff in large property development firms, as well as design and cost consulting firms.

Some of the remarks by the interviewees are given below under the respective headings.

1) Is such a national initiative welcomed by the industry?

<u>An Associate Director commented:</u>

"The players in the industry have all along been working in isolation. Each has his own way of doing business. As a result, the industry has been lagging behind other sectors in terms of productivity and performance. A standard to govern how each player behave and work will without a doubt allow the industry to progress and improve."

<u>Incidentally, another Director also mentioned:</u>

"This initiative is a good start to enhancing the industry's performance. But, in order for it to fulfill its role, the respective players in the industry must change." … "Having a standard without keen users is as good as having none. Players must show their support by keeping an open mind to changes in their area of work. To rigidly follow old methods of working will not help."

2) Do you feel that CP80 is comprehensive?

<u>A QS in Research & Development (R&D) affirmed that:</u>

"The CP80 has given an exhaustive list of elements and trade sections that was needed. On the whole, this Code of Practice can be considered comprehensive and up-to-date."

<u>However, a Director in an M&E consulting firm had a differing view:</u>

"This National Standard may in the eyes of the QS be a comprehensive standard as it comprises almost all the components that fall under the building category. But if the Code also aims to standardise the M&E engineering classification of cost data, it is far from being a comprehensive one."

3) Will CP80 be largely adopted by the industry?

<u>A Senior QS remarked:</u>

"CP80 proposes a comprehensive classification method that is very similar to many company's practices, both elemental and work sections. Thus, there is no real need to alter our method to follow CP80."

<u>A Director in an M&E consulting firm also commented:</u>

"The M&E engineers constitute only a small proportion of the entire industry players. To them, such a standard will not benefit them much." … "To be frank, the aim of firms is to earn profit. If the present practice is good enough, why should they alter it?"

4) Will you encourage your firm to adopt CP80?

A QS firm Director replied:

"CP80 can only be used as a guide. Our firm will not adopt it wholesale but will take reference from it when we classify the cost data."

However, a Project Manager in a Client's organisation made an encouraging remark:

"We have recently formed a committee to look into this issue and CP80 came at the right time. We hope to adopt CP80 so that we can enforce it on the consultants to provide cost advice on a standardised format."

5) Do you think the size of the firm affects its decision to adopt CP80?

A supportive comment came from a QS in R&D:

"To implement CP80 with computerisation is not difficult. From what I see, simple software is sufficient. Any firm, big or small, should be able to accommodate this change."

And, from a Project Manager in a Client's organisation:

"The size of the firm and the availability of resources should not be a hindrance to the company's ability to adopt CP80. I believe one do not require to be a specialist to make such changes. The firm should be equipped with the fundamentals to survive in this industry. Otherwise, the firm will become obsolete in the industry in no time."

6) Short-term and long-term impacts on the industry

A senior QS offered her views:

"In the short term, CP80 may enhance the Quantity Surveyors in retrieving cost data more efficiently. Cost information will be more reliable since the elements are grouped in a standard format with precise definitions."

A Project Manager elaborated:

"I think the transition will take quite some time. But if all firms eventually adopt this Code of Practice, not only will firms benefit, the industry as a whole will gain even more." … "the construction industry in Singapore will make a great leap in terms of information exchange and quality services. It will be a more productive industry relying on better technology in their work execution. This is very true as we are moving into the IT age. Everything must be fast and accurate. CP80 is capable of realising this."

DISCUSSION AND IMPLICATIONS

Several broad implications could be drawn from the intention of this paper, as well as from the industry survey results.

Firstly, in order to facilitate CIC, information classification has been acknowledged as one of the three approaches. Information integration and automation is only possible with the existence of a common language. Hence, it is inevitable that a standardised system of classifying and sharing of construction information be developed to bring about integration of different computing applications used in the life cycle of a building.

Secondly, despite lagging far behind other countries in the development of classification systems for the construction industry, Singapore is fast catching up. The CITC was specially formed to establish an industry-wide framework for the development and adoption of IT standards in the construction area. Since 1998, several standards have been initiated and established in the areas of CAD, cost and resources information, and specification. The speedily results are achievable via strong governmental backing as Singapore, as a whole, works towards becoming an IT and business hub.

Thirdly, the experience gained from drafting the two classification standards mentioned in this paper has stressed the importance of adopting a two-stage approach: (1) review of international standards; and (2) adaptation to local industry practice. It brings about a win-win-win scenario as there is no need for 're-inventing the wheel' if an international standard is adopted and, furthermore, it allows communication beyond home boundary. With the adaptation, it attempts to lower any resistance to change via standardisation of industry practices.

Fourthly, despite acknowledgement from the survey respondents that the drafted standards are good and applicable, there is still relatively strong resistance to adopt them in full. The key reasons given by the respondents were a general lack of incentive and benefit to change, and the cost to be incurred from change especially in re-classify historical data. Cross-disciplinary differences (in this instance, the M&E engineering profession is not agreeable with the way quantity surveyors classify costs) could also be implied.

Finally, the survey respondents have generally acknowledged the need to standardise their practice for longer-term benefits, both to the firm as well as the industry. They are fully aware of the need to provide faster and higher quality service to clients through the use of IT so as to stay competitive.

CONCLUSION

The paper has highlighted the need for information standardisation in order to facilitate CIC. However, the greatest difficulty, as gathered from the survey findings and interview responses, is in convincing the industry to change by adopting a standard way of practice. If industry players cannot see immediate tangible benefits, they will not want to make adjustments to their current way of doing things. Change incurs cost which acts against profit; it being a key concern for all firms. In Singapore, there is also the mentality that if standardisation is a government-driven initiative, then the cost of change should be borne by the government. This is despite available government incentive and assistance schemes based on a co-funding principle. To this end, the standard response is that the government should bear the full cost.

Finally, it is intended for the paper to share the Singapore experience and benefit countries embarking on the programme of standardisation and, subsequently, CIC. The key pointers are given as follows:

- to make a conscious effort of involving industry players in the development of the standards in order to help bring down barriers to change;
- to adopt a two-pronged approach so as to achieve a win-win-win result;
- to identify leaders in the industry who can drive the developed standard/technology in order to convince other players to follow suit; and
- to develop assistance schemes to help small firms embrace standardisation and IT.

If industry players can view change as a necessity rather than burden, the path towards integrating construction via data integration and, IT connectivity and interoperability would be much clearer for the future.

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