Applications of value management in the construction industry in China

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Keywords

Construction industry, Value analysis, Management effectiveness, China

Abstract

Value management (VM) was introduced in China during 1978, when the reform and open door policy started. After a surge of VM applications that emerged in the late 1980s, the development of VM has declined sharply in the recent years in China. Although some successful applications of VM in China's construction industry have been observed, many actions should be taken to exert its full potential to improve value for money for clients. Aims to draw a holistic picture of the current VM practices and provide recommendations for its future development in China's construction industry. Provides a comparison between China's VM approach and the international mainstream to highlight the major differences.

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Introduction

Value management (VM) evolved from value analysis, which was first developed by Lawrence Miles during the Second World War. Although some researchers tend to distinguish value management from other relative terms such as value engineering (VE) and value analysis (VA), VM in construction is increasingly being seen as the term to describe the total process of enhancing a project value from concept to operation (Male *et al.*, 1998a). VE and VA can be viewed as special cases of the generic discipline of VM. For the sake of simplicity, VM will be used in this paper as a blanket term that covers all value methodologies whether they are named VA or VE.

As a systematic, multi-disciplinary and structured methodology, VM aims to improve the value and optimise the life cycle cost of a facility through identifying opportunities to remove unnecessary costs while ensuring that quality, reliability, performance, and other critical factors will meet or exceed the customer's expectations (Dell'Isola, 1997). Its tremendous potential in functional enhancement, cost reduction, communication improvement and creativity promotion has been widely appreciated by construction professionals and clients. Successful applications of VM in the construction industry have been observed in a number of countries (Norton and McElligott, 1995).

After China started its reform and open door policy, it is an urgent task for national industries to improve their competitive ability for achieving a share in the global market. As one of the 18 modern and advanced management methodologies (i.e. total quality management, project management, risk management, etc.), VM was introduced to Chinese state-owned manufacturing companies in 1978 for making savings (Qian and Gu, 1987). The concept was first learnt by Chinese researchers in manufacturing through Japanese literature. The lecture entitled "Introduction of Value Engineering", which was presented by Professor

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Shengbai Shen in the Shanghai Philosophy and Society Association in June 1978, was the earliest event of VM recorded in Chinese literature (Han, 1998). The first application of VM emerged in the manufacturing industry where tremendous cost savings was achieved by using it (Han, 1998). Encouraged by the success in the manufacturing industry and supported by Chinese government, VM was soon adopted by other industries, including electronics, textiles, coal, defence and construction (Shen, 1998). VM grew smoothly and rapidly in the first 15 years after its entry into China and boomed in the late 1980s. According to a report published in *Value Engineering* (Hu, 1999), which is the only formal journal of VM in China, in the first ten years of VM applications, starting from 1978, over RMB 250 million was achieved through VM studies in 373 enterprises in Shanghai. During the same period, many VM societies were found around the country to drive the wheel of VM forward both in theory and in practice.

Government support made an important contribution to VM spread in China. In 1987, the first national VM standard *Value Engineering-General Terms and Work Program (GB8223-87)* was published by the National Standards Bureau. Within this standard, the terminologies concerning VM were defined, the purposes and characteristics of VM were introduced, and the procedures of the VM workshop were illustrated. This event stands as a milestone in the progress of VM development in China. In 1992, the China Association for Business Administration in collaboration with the China Association of Science and Technology and the China Central TV organised a 625 min training programme, which was attended by several millions of people in China. At present, according to a government survey, VM has grown to become the second most famous management methodology in the manufacturing industry, second only to total quality management (Hu, 1999).

VM applications have declined since China started the transition from the planned economy to the market economy. This transition presents many challenges to local companies. Many state-owned manufacturing companies, the main users of VM in China, were struggling to survive in the new business environment. The traditional mechanism ensuring VM implementation in these companies, which was set-up according to the principles of the planned economy, has broken down, but no replacement in the new economic system has been established. Without the support of companies, VM applications have declined sharply in China. Many local VM societies ceased to exist and a number of VM-related publications came to a close.

It was noticed that VM applications in China were mainly confined to the manufacturing industry, and seldom occurred in other industrial sectors. According to the estimation of local VM experts, around 80 per cent of VM studies in China happened in manufacturing industry from 1990 to 1995 (Xiao, 1998). Although the construction industry is an important field of overseas VM practices, it has not yet become a fertile land for the implementation of VM in China. Only around 4 per cent VM studies were deployed in this field in the same period (Xiao, 1998). In order to promote the application of VM in China's construction industry, a research project was established last year to explore the current state and to set-up future direction for VM development in the industry. Although the research concentrates on China, the findings should be relevant to many developing countries, as they face similar problems in terms of promoting application of VM in the construction industry.

Research methods

Two main methods were used to achieve the research objectives. The first one is the document analysis of VM cases in the literature. The method allowed the researcher to draw specific information and recognise changes in practice over time. In order to gain an appreciation of VM applications in China's construction industry, 25 VM cases in Chinese literature was carefully studied to address this objective. These cases were collected from books, journals and conference proceedings published from 1997 to 2001. A summary of the cases referred in this study is given in Table I. Although the description of some cases in the

Table I Summary of the VM cases referred in the study

No.	Description of project	Estimated cost	Savings (per cent)	Participants
1	14-mile underground railway	3,200M	3.5	Staff of contractors and an invited VM expert
2	Foundation of a new commercial tower	2.1M	13	Original design team and a VM expert
3	54-mile highway	1,080M	6.3	Staff of contractors and an invited VM manager
4	Refurbishment of a public building	3.4M	7.2	In-door construction staff of client
5	Extension of a hospital	18M	–	Original design team and client representatives
6	New pre-fabricated building to provide a new plant	9.7M	11	In-door construction staff of client and an invited VM expert
7	New elements production facility	3M	5.4	Original design team
8	Three railway stations	48M	36	Staff of contractors and an internal VM manager
9	New residential housing for sale	540M	4.1	External designer
10	Extension of a control tower of a airport	56M	5	Original design team
11	Waste reduction plant	21M	–	Original design team and an invited VM expert
12	New park development	13M	–	Original design team
13	Passenger facilities of a airport	3.8M	14	Original design team and client representatives
14	New bridge	87M	3.9	Original design team and an internal VM manager
15	New building of a university	36M	8.4	Original design team and client representatives
16	Refurbishment of a housing project	–	–	In-door construction staff of client
17	Extension of a railway station	2.3M	12	Staff of contractors and an internal VM manager
18	New high school	230M	9	Original design team and client representatives
19	Extension of a business centre	6.7M	12	Original design team and client representatives
20	New government office building	62M	10	Original design team and an invited VM manager
21	Tunnel across a river	370M	8.3	Staff of contractors and two invited VM experts
22	137-mile highway	3,140M	3.7	Staff of contractors and an internal VM manager
23	New bridge	230M	4.5	Original design team and an internal VM manager
24	New chemical factory	37M	15	Original design team and client representatives
25	Refurbishment of a drain	5.4M	7.3	Staff of contractors

Note: Here the estimated cost refers to the construction cost before VM study; the unit of the cost is Million Yuan RMB

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publications was not so comprehensive, the information aggregated by the cases was deemed adequate to reflect the overall picture of VM practice in China's construction industry.

The second research method adopted is the semi-structured interview. A total of 11 VM experts in China were interviewed through several research tours and national VM conferences. These experts are the leading VM researchers in China, including some VM gurus, such as Professor Shen Ming, President of the VM Research Institute of China Association for Tertiary Education; Professor Tan Haobang, President of the VM Research Institute for Universities in Guangdong Province; and Mr Zhao Shirong, President of the Shanghai Value Engineering Society. The interviews aimed to gather further comments, elaboration and explanation about the preliminary findings from the document analysis and explore opportunities and obstacles to develop VM in China's construction industry. Each interview was guided by a set of prepared questions, but at the end of the interviews, an open discussion with the interviewee was carried out to get wide information.

Value management in construction

The findings from the case studies and follow-up interviews reveal the main aspects of VM applications in China's construction industry, including the approach to VM, composition of VM team, performance levels of VM studies, techniques used in VM studies, outputs produced by VM. Additionally, a comparison with international VM practices is provided at the end of this section.

Approach

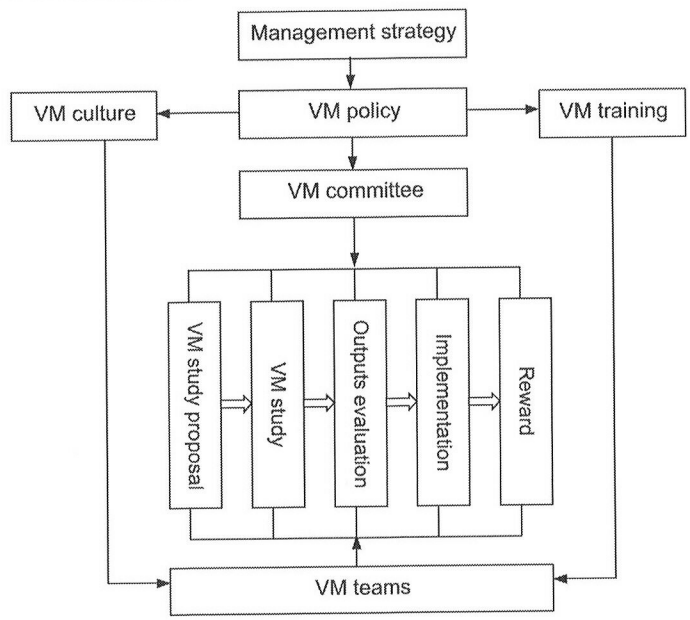
The main approach used in these cases was quite different from the formal approaches: the Charette, the 40 h value engineering study, the value engineering audit and the contractor change proposal, which were identified by Kelly and Male (1993). From 25 VM cases, it was found that no VM study was sponsored or required by clients, although client representatives participated in several studies.

The use of VM mainly depends on the initiative of project executors, such as designers, contractors or other professionals. The follow-up interviews revealed that the internal VM programme within design institutes and contractors is the important force to drive the application of VM in China's construction industry. After learned VM in the middle of 1980s, some designers and contractors appreciated VM benefits and subsequently set-up a mechanism to promote its application within their companies for achieving competitive edge in the construction market. The companies that rooted VM programme in their business operation have become the main force of current VM practitioners in China's construction industry. Figure 1 shows a typical framework for implementing VM in these companies. Normally, a VM study goes through the following three stages.

Stage 1 – VM study plan

Any project team can submit the VM study plan to a VM committee (often consisting of senior managers, chief engineers, cost engineers and VM coordinators), when they undertake a construction/design task. In a VM plan, the team explains the objectives, reasons, costs, schedule, estimated outputs, and the preparation for the proposed VM study. The VM committee will evaluate the plan against

Figure 1 The typical job plan of VM in China's construction industry



a number of criteria. If the committee approves the VM study plan, it will be submitted, in the name of the design institute or contractor, to the client to seek approval and support. After the client endorses the plan, the project team will conduct the VM study, under the management and support of the VM committee.

Stage 2 – VM study

The VM team carries out the VM study in accordance with the VM philosophy, techniques and job plan. The job plan often follows the paradigm (Figure 2) introduced by the national standard (GB8223-87). It is entitled "four phases, twelve steps", which means that the job plan consists of four phases and each phase includes three steps. This four-phase job plan is different from Miles' (1989) original seven-phase job plan, but the essential of them are quite similar. However, instead of a concentrated, continuous workshop such as a 40 h workshop, the VM team members, sometimes including client representatives, invited external experts and others as required, meet irregularly to explore, create and develop alternative solutions without suspending their normal duties. The VM study embedded with the project progress and the job plan was split by design/construction activities. Therefore, the duration of VM study highly varies according to the nature of the project under the study. It is not uncommon for a VM study to last for several weeks even longer.

Stage 3 – VM proposal evaluation and implementation

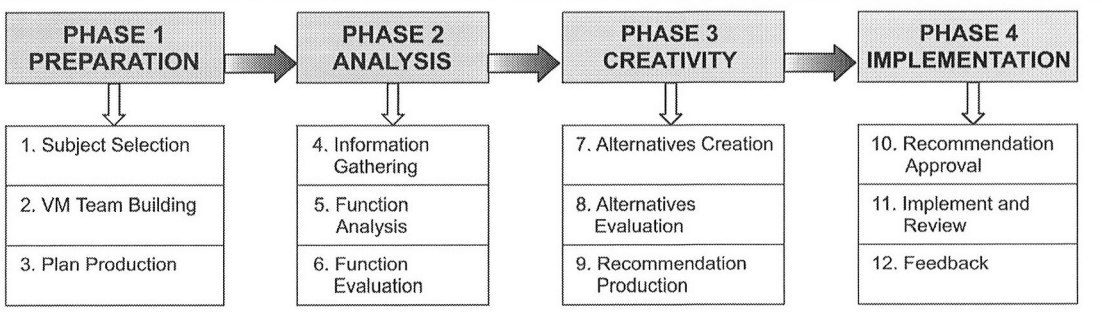
The developed alternative solutions with the VM report will be submitted to the VM committee. Their effects on value enhancement will be thoroughly evaluated before they are submitted to the client for seeking implementation approval. After this step, the approved VM proposals will be implemented by the project team.

Composition of VM team

As shown in Table I, besides case 9 which was carried out by an independent external VM team, the others were undertaken by the original project executors or the original executors with client representatives and invited external experts. The role of value management team facilitator/coordinator was often taken up by the senior technical manager or director of the professional team since there is no VM facilitator certification mechanism in China. Although the use of an external team to conduct VM studies has been recommended by many researchers and practitioners (Dell'Isola, 1982; Zimmerman and Hart, 1982), most local VM experts, who were interviewed by authors, thought that the hybrid team consisting of original project executors, VM experts and invited technical experts was more suitable for current VM practices in China's construction industry. The reasons are as follows.

(1) The benefits of VM have not been widely recognised by clients. Therefore, the opposite attitude from the original team cannot be overcome easily without strong support from clients if an independent external VM was employed.
(2) Relationship is a crucial and complex issue in China's society. Although competitive tender has been adapted on many construction projects, it is common in China that the design and construction task executors have a special link with clients (usually public clients). In this event, it

Figure 2 Job plan outlined by the national standard



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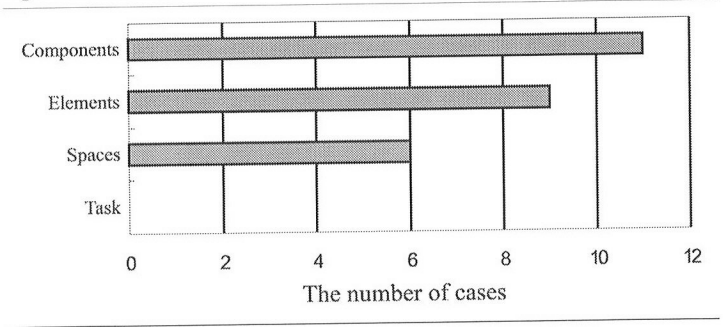
cannot be expected that the client will employ an external team conducting VM studies with the risk of damaging a long-term friendly relationship with the original team.

(3) The findings from case studies found that the use of the original team also could carry out successful VM studies under a careful management.

Performance levels

Kelly and Male (1993) identified four performance levels in their proposed VM approach for a building project, i.e. task, spaces, elements and components. According to Kelly and Male (1993), the performance level of 19 out of 25 cases was identified and shown in Figure 3. The other six VM cases were conducted to optimise construction methods and material procurement, thus they were excluded from this analysis. Because more than one performance level is involved in several cases, the total number in Figure 3 is over 19. It can be observed that VM studies in most cases focused on the elements and components levels rather than the task or spaces levels. As explained by interviewees, this phenomenon mainly caused by that approach of VM in the construction industry was learned from the manufacturing sector, where VM studies were mostly limited to the elements and components levels. However, the task and spaces performance levels often mean that VM committed in the early stage of a project, which is when the value improvement is higher and the cost for the implementation of alternative solution is lower (Norton and McElligott, 1995). The performance levels of these cases focusing too much on elements and components imply that most VM studies in China's construction industry were too late to exert its potential.

Figure 3 Performance levels of the VM cases in study



Techniques

The main techniques used in VM cases are set out in Table II. Particular attention is worth giving to the techniques used to highlight poor value areas of the project. Besides the function-cost/worth ratio, which is the typical technique used in the USA (Dell'Isola, 1982), there are three other techniques named as ABC, value indicator and the hybrid of the former two used in China. ABC determines poor value areas based on Pareto's law of maldistribution, which indicates that the relatively small number of elements or functions that comprise 80 per cent of the project cost may be the best targets for value improvement.

The value indicator (VI) technique was advocated by many influential VM authors and researchers in China (Chen, 1985; Song, 1994; Tan and Yang, 1996). Its underlying hypothesis is that the cost of an element/component should match the importance of its realised function(s). The relationship between function and cost is described by value index-VI. If it is less than 1, poor value and high cost are indicated.

The value of VI is calculated from equation (1) where the function index (FI) is divided by the cost index (CI) of the element/component. The function index is a value ranging from 0 to 1, delegating the importance of the degree of the function(s) realized by the element/component. It is often measured by VM team members using some mathematical methods such as force decision (FD) method, decision alternative ratio evaluation (DARE), etc. (Tan and Yang, 1996). The cost index is equal to the cost of the element/component divided by the whole cost of the project (or a part of the project) which contains the element/component. Although the value indicator technique has widely been used in China's VM practice in all kinds of industry sectors, the weakness of this technique is obvious. This technique leads practitioners to paying more attention to the problem on the components and elements levels, and hampers the use of VM to resolve high-level problems.

$$VI = \frac{FI}{CI}. \quad (1)$$

Table II The main techniques used in VM applications of China's construction industry

Phases	Techniques
Function analysis	FAST, verb-noun function definition (SAVE International, 2000)
Function evaluation	ABC, function-cost/worth ratio, VI (forcing decision making, DARE, worth to cost) (Tan and Yang, 1996)
Creative phase	Brainstorming (Norton and McElligott, 1995), Open discussion
Evaluation phase	Criteria scoring matrix (Connaughton and Green, 1996)

Outputs

According to case studies, the outputs were produced by VM including cost reduction, function enhancement, quality improvement, time shortening and constructability improvement. Within 25 VM application cases, the cost savings data of 21 cases could be obtained directly or indirectly. The figure fluctuated from 3.5 to 36 per cent of the initial construction cost, and the average cost savings of them was around 9 per cent. It should be pointed out that this figure is higher than the actual level in practice, since the cases reported in literature represent only the most successful VM studies. Compared with the savings ratio of 15 per cent, which can be expected in American VM practice (Kelly and Male, 1993), the savings level indicates that a significant improvement can be made in China's VM practice. Because life cycle cost is a fairly new term to China's construction industry and due to the lack of historic data, the life cycle cost savings could not be reached in these cases. However, savings of the operation costs of electrical and mechanical equipment were reported.

Comparison with overseas VM practice

Table III shows a comparison between VM practice in China's construction industry and the mainstream practice in the world, where the international mainstream is summarised from the work of Male *et al.* (1998b), Norton and McElligott (1995), Pasquire and Maruo (2001), and SAVE International (2000). The comparison also reveals the gap between China's VM practice and the international mainstream.

Opportunities and obstacles to VM development

The findings and relative discussion in the previous section have indicated that VM development in China's construction industry is still in its early stage. In order to set-up strategies for promoting the development of VM in the industry, the major opportunities and obstacles in the road of VM growth, which were mainly summarised from the discussions with interviewees, are presented in following paragraphs.

Opportunities

More dynamic and competitive business environment

China has entered the World Trade Organization (WTO) in 2002. The forthcoming intensive competition caused by the growing globalization of the world's economy, together with ever-accelerating changes in technology has increased the speed of establishing a dynamic and competitive market-oriented economic system in China. A number of changes have already occurred, for example, the financing system of construction projects has been changed from governmental allocation to loans from commercial banks; the project procurement system has been changed from traditional governmental assignment to competitive tendering; and the state owned companies have been changed from rigorous government control to greater autonomy (Chan *et al.*, 1999). As a result of these changes, clients have to fund their projects at their own risk. Consequently, they have increasingly demanded on the provision of construction products satisfying their own requirements with relatively low life cycle costs, i.e. value for money. On the other side, in order to obtain competitive edge for surviving and developing in the construction market, the designers, contracts and consultants of the industry are put under fierce pressure to seek help from modern management techniques.

Table III Comparison between China's VM practice and international VM practice

Items	Chinese practice	Overseas practice
Subjects of VM studies	Existing projects, focused on tactical problems	Proposed and/or existing products/projects, related to both tactical and strategic problems
Facilitator of VM studies	The original team leader	Independent Internal or external VM expert
Timing of VM studies	Mainly at design or construction stages	From the concept to completion of a project/ product
VM team composition	Original team member, several external experts familiar with the subject under study	Relevant stakeholders, often a large number of persons are involved
VM workshop style	Informal workshop adopted	Concentrated, continuous workshops preferred
Function analysis	The purpose is to identify poor value using mathematical methods	The purpose is to clarify clients' requirements, to understand their value system and to identify poor value
Duration	Depending on the subject under study, possibly several months	Normally last for only a few days

Government strategies

"Developing China through Education and Science" is one of the most important development strategies that have been highlighted repeatedly by the Chinese government in recent years. In compliance with this strategy, the Ministry of Construction has devised an agenda entitled "China Construction Industry Nine-five Plan and Long-Term Objectives in 2010" to direct the future development of China's construction since 1996. Two items "adopting professional construction management practices" and "establishing effective management skills" encourage construction professionals to improve their service with modern management skills. Under the promotion of the government, an unprecedented will to learn and apply advance management techniques has emerged among construction professionals. This is a great opportunity for VM to get support from government and be appreciated by construction professionals.

Potential benefits for VM intervention

One of the significant barriers to VM applications in construction is that VM is perceived by some as time-consuming and interruptive to the work flow of the design team (Kelly and Male, 1993). However, the project design process in China most likely has adequate room for VM intervention. China does not have the equivalent of the RIBA plan of work or the AIA guideline for architectural and engineering service (Flanagan and Li, 1997). Broadly, the design progress of construction projects can be clearly divided into feasibility, concept design, preliminary design and detailed design (working drawing). After each of the first three stages, a mandatory formal presentation must be given by designers to major stakeholders (e.g. representatives of local authorities and anyone affected by the project), who give comments on the project. The length of the presentation is normally at least one day and sometimes longer. The designers are expected to take the comments and criticisms into consideration in the subsequent design stages. However, because the large number of stakeholders (50 or 60 people is not uncommon) and the lack of good understanding of the project (some of them are new to the project), most of the criticisms/comments in the presentations are superficial or due to misunderstandings, hence often disregarded by the designers. Each interval following the feasibility, concept design and preliminary design stages provides an opportunity for VM implementation without sacrificing the succession of the design process. If the traditional ineffective presentation were replaced by a systematic VM study, fruitful results could be expected which should pose little interruption to the normal design process.

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Obstacles

Overemphasis on quality

In China, good quality is the most important objective of a construction project. For many years, the Chinese government has been advocating the importance of quality. Almost every construction professional in China is familiar with a slogan "For realizing a hundred-year plan, quality is the highest priority". Emphasising the importance of quality cannot be criticized. However, overemphasis on quality has resulted in the conservative attitude of construction professionals against change, creation and innovation. Any creative ideal spark could be stifled by its possible impact on quality, even though it may lead to significant cost savings or time shortening of a project. As a methodology encouraging creative thinking, VM will be confronted with an intensive challenge caused by the conservative attitude. If this attitude cannot be changed, even if a VM study is carried out, the beneficial proposals generated by the study cannot be implemented effectively.

No practical guidance for implementing VM in construction

A lack of practical guidance for implementing VM in China's construction industry is another key factor blocking the wide application of VM in the industry. VM was first used and boomed in the manufacturing industry in China, the job plan, approaches, performance levels and techniques of VM in most published books were introduced according to the nature of the manufacturing industry. There are no practical VM guidance notes or manuals for implementing VM in the context of construction in China. The introduction of VM is only contained as a chapter or section in books such as *Construction Economics* (Huang, 1992) and *Construction Technical Economics* (Liu, 1998). Even in these books, VM is not introduced in accordance with the characteristics of the construction industry, but following the traditional way used in the manufacturing industry. Based on their experience, most interviewees thought this way was not suitable for most cases in the construction industry. In order to promote the application of VM, it is necessary to establish a practical framework for implementing VM in China's construction industry.

The transitional problems in the construction market

The Chinese construction industry is in a transitional period. The co-existence of the centrally planned economy and the market economy has led to the construction market in disorder. Administrative intervention from government, together with serious local protectionism, an incomplete legal system, and corruption practices cloud the transparency of the construction market. Current project procurement in China is in fact a partially competitive system that includes both competitive tender and administrative assignment (Shen and Song, 1998). The distribution of design and construction task of many projects does not totally depend on a fair tendering approach, but influenced by local government (Liu, 1995). Moreover, from the conception to the occupancy of a project, a number of tedious approvals have to be obtained from the relevant government authorities. Therefore, many construction practitioners in China have to pay more attention to maintaining good relationship with the relevant authorities for winning tasks and smoothing approval process than to improving their competitiveness with advanced management techniques. This is not a favourite culture for promoting the development of VM.

Recommendations

Although VM has been developing for more than 20 years in China, it has not been widely accepted and applied by the construction professionals. This situation is even worsened by the recent decline of overall VM development in China, which is induced by the radical economic transition from the socialist system to the market system. From case studies and interviews, it was revealed that most VM studies in China were conducted with a discrete approach, rather than a concentrated workshop was widely used by overseas VM practitioners; the original design/construction team often participated in VM studies; the performance levels of VM studies focused on elements and components; and too many mathematical techniques were used in VM studies. Based on a comparison analysis with the international mainstream, it can be

concluded that VM in China's construction industry is still in its early stage and many actions should be taken to promote its development.

Referring to overseas experience, some strategic issues are recommended as follows.

(1) *A successful application framework in the context of construction should be developed.* VM in the construction should has its own road rather than just imitate the approaches in the manufacturing industry. In order to promote VM applications in the construction industry, establishing a framework in China's construction industry is one of the most important actions to be taken.

(2) *Communication with the outside world should be enhanced.* This study reveals that local experience of VM applications in construction is very limited. Communication with the outside world could allow China a shortcut to learn and adapt the overseas experience. A successful example is Hong Kong's VM development. Through a number of activities such as employing foreign VM experts as facilitators, holding annual international VM conferences and organising short-term training courses lectured by foreign VM experts, VM development in Hong Kong has made significant progress in recent years.

(3) *Continuing government support should be sought.* Referring to the experience of other countries, government support is a necessary driving force in the initial stages of VM development. There was a good start in getting government support for promoting the use of VM nationally in China, but it did not continue. Since most construction projects are funded by government or state-owned companies in China, to persuade the government to increase the demand for VM in public projects is more important.

Conclusions

This paper has provided a comprehensive review of the current applications of VM in the construction industry in China. A detailed comparison and contrast with the common practices in the developed countries has also been given. Based on these discussions, recommendations were given in terms of how VM can be fully utilised to improve value for money for client organisations. It is envisaged that there will be increasing demand for the proper use of VM in construction projects, and the full potential of VM can only be fully exploited if a practical guide can be developed which incorporates the latest development of the VM methodology in the developed countries, and executive support from both the central and local governments.

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