

# Integration of Financial and Contract Management on the Shanghai Expo Construction Program

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**Abstract:** The management of facility construction for hallmark events is critically important for their financial viability. However, little knowledge has been produced regarding the management of this type of construction. Based on the construction program for the Shanghai Expo 2010 and other cases reported in the literature, this paper provides an analysis of the common characteristics of construction for hallmark events, the challenges of financial management due to these characteristics, techniques to address these challenges, and lessons learned from the Expo construction. It is believed that one critical factor that contributes to the success of the Expo construction program is the integration of the financial management and contract management processes, assisted by a specifically designed computer program. The techniques used to integrate the two processes involve (1) mapping the program's work breakdown structure, cost breakdown structure, and contract breakdown structure; (2) integrating the information flow between the two processes; and (3) automation in information generation, dissemination, and storage. Areas that may be further improved in managing construction programs of a similar nature are also discussed. DOI: 10.1061/(ASCE)CO.1943-7862.0000618. © 2013 American Society of Civil Engineers.

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## Introduction

Mega events such as the Olympics and World Expo are often used by city managers as an instrument to boost the economy and urban redevelopment (Essex and Chalkley 1998). Their impacts on the economy have been widely discussed in the literature (e.g., Shoval 2002; Ong 2004). By attracting visitors, increasing employment and revenues, and boosting cities' images, these events can be potentially beneficial for the hosting cities. They are also used as opportunities to pool and leverage resources to implement infrastructure projects that would not happen otherwise. For example, in the 1996 Atlanta Olympic Games, US\$644 million was spent on the construction of the sports facilities and Olympic Village for the athletes, US\$50 million was invested in infrastructure improvement, and US\$609 million was spent by federal agencies on transportation, public housing, and other projects (Andranovitch et al. 2001). In the Seville World Expo held in Spain in 1992, the event was clearly intended as a catalyst to revitalize the city and the historically depressed region (Monclus and Guardia 2006). As a result of the Expo, mega projects were constructed, including

bridges, roads, and high-speed train connections (Monclus and Guardia 2006). Compared to the short-term effects, the impacts of urban redevelopment on the hosting cities are long lasting and more profound.

However, the potential benefits of running hallmark events are associated with high risks. For example, the city of Montreal incurred a heavy financial loss due to the 1976 Olympics Games. After the Games, the total debt was US\$2.7 billion (Levesque 2001; Preuss 2004), which was finally paid off by the city in the 2005–2006 fiscal year (Preuss 2004). The Expo 2000 in Hanover, Germany, recorded a deficit of DM 2.4 billion, although it was paid by state and federal governments (Shoval 2002). Even if these events cannot be judged solely by the amount of money spent or earned, financial viability is an important dimension in evaluating their impacts. Therefore, city managers need to carefully weigh the benefits and costs of running such events and take measures to reduce financial risks.

From a city's perspective, the financial risk of hosting a hallmark event depends on the revenue generated from the event, the funding sources, and the effectiveness of cost management. If a higher-level government or external body absorbs or shares a significant portion of the costs, then the financial risk of the organizer will be reduced. Another way to reduce financial risk is to manage expenditures cautiously, especially the major expenditures associated with capital development. For example, the Los Angeles Olympic Games of 1984 caused only a modest investment in facilities and primarily relied on the private sector for funding (Miller 1992; Essex and Chalkley 1998). The limited expenditure combined with the success in broadcasting and sponsorship resulted in a surplus of \$215 million (Los Angeles Olympic Organizing Committee 1985; Essex and Chalkley 1998). In the 1976 Montreal Olympics, however, the large-scale infrastructure development was financed by the city. Major technical and management problems arose in construction that significantly drove up the construction costs: not only did the site condition and the use of

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nontraditional materials and methods cause major cost overruns, but 24-h work days were also imposed at a later stage to accelerate the schedule (Essex and Chalkley 1998).

The efficiency of the facility construction program for a hallmark event is a critical factor in its success. However, little information has been generated regarding the management of this type of construction. Particularly neglected appears to be research into the following questions:

- What are the unique characteristics of the facility construction program serving a hallmark event?
- What challenges or difficulties can arise in construction management due to those characteristics?
- What methods and techniques can be used to assist managers in overcoming such challenges and difficulties?
- What lessons are learned from organizing this type of construction program?

Answers to these questions will be invaluable for the sound management of similar construction programs. Based on the authors' involvement in the program management of the facility construction for the Shanghai Expo 2010, this paper attempts to shed light on the questions raised previously. Special attention is paid to the techniques and tools used to facilitate and integrate the financial management and contract management processes. Although the case upon which this paper is based took place in China, lessons drawn may apply to similar programs in other countries.

## Characteristics of Construction Program for Hallmark Event

### *Background of Construction Program for Shanghai Expo 2010*

The urban population of China increased from 17.9% in 1978 (Hu 2003) to 49.7% by the end of 2010 (Ma 2011). Every 1% increase implies that approximately 10 million people leave their rural dwellings and move to cities. This creates high demands on infrastructures in cities as well as the land on which to build them. Mega events are often sought after by cities in China as a catalyst for infrastructure development, city expansion, and urban renewal. These events provide city managers with opportunities to raise funds for construction, to mobilize social resources, and, most importantly, to carry out relocation and land acquisition with less resistance.

The 2010 Expo site is located in a fully developed district in central Shanghai City, covering an area of 5.28 km<sup>2</sup>. The residents and businesses were relocated from the site, and the existing buildings were demolished and replaced with more than 400 new buildings with a total floor area of 2.4 million m<sup>2</sup>. In addition, a large number of infrastructure facilities were built to support the Expo, including highways, cross-river tunnels, and metro lines and stations. The construction of the Expo facilities, which lasted about 1,000 days, employed an average of 20,000 workers, with the peak number approaching 60,000. The characteristics of the facility construction for the Expo program are discussed in what follows.

### *Project Complexity*

Construction for a hallmark event can be a complex endeavor, reflected in both the scale and technical difficulties of the construction. Fig. 1 shows the high-level work breakdown structure (WBS) of the Expo construction program. As can be seen, it consists of a large number of diverse yet interrelated projects. In addition, iconic buildings and structures are likely to be erected in a mega event to add luster to the event and the hosting city, such as the Seattle Space

Needle for the 1962 World's Fair and the Bird's Nest for the 2008 Beijing Olympics. These buildings, however, create technical difficulties in construction. In the Shanghai Expo case, many buildings chose nonstandard and complicated structural forms whose constructability and impacts on costs and schedules were not fully considered. For example, in the Sunshine Valley project [Bureau of Shanghai World Expo Coordination (BSWEC) and Shanghai Urban Construction and Communications Commission (2010)], each of the six cone-shaped structures is 41.5 m tall and has an ostentatious shape. The largest one has an upper opening of 90 m in diameter, but the bottom opening is only 20 m in diameter. They were designed for architectural impression as well as the functional use of collecting sunshine and rainwater for the basement. Nearly all of the 10,348 steel connection nodes used on these structures were uniquely shaped. After the design was finalized, an extensive search had to be conducted to find a steel fabricator who had the capacity to fabricate those nodes in a timely manner, and expert panels were formed and additional consulting contracts were signed to address technical issues arising from the design and construction.

### *Tight Schedule*

Unlike other types of mega projects such as a tunnel or pipeline, construction for a hallmark event has a deadline that cannot be delayed. Consequently, time is often the top priority for this type of construction. In addition and as previously mentioned, the example of construction for the 1976 Montreal Olympics and concerns regarding construction delays in the 2004 Summer Olympics made headlines in newspapers worldwide. Similarly, because the Expo 2010 had to open on May 1, 2010, the schedule was the top priority in construction. Two shifts were normally used in construction, and during the peak time, three shifts were used. The contracts also included time incentives, which were paid based on the actual progress made quarterly and yearly. In project development, design and construction overlapped whenever possible. This, however, created a large number of design changes and revisions and caused difficulties in contract and cost management. In addition, spending was often maximized to accelerate the schedule, but the budget approval lagged behind: some projects even started before the official budget had been approved. These uncertainties made it difficult to keep costs under control. On the other hand, the uncertainties made it important to update the financial information frequently and closely monitor expenditures.

### *Numerous and Diverse Participating Organizations and Stakeholders*

Construction for mega events normally involves a large number of different organizations. To coordinate the construction process for the Shanghai Expo, a program executive headquarters (PEH) was established. A PEH is a temporary organization often used on large-scale, complicated government projects/programs in China. It is composed of government officials, government technical personnel, and professionals who are retired or borrowed from private firms. The PEH must work closely with various government agencies to advance the projects they control, manage, or coordinate. The other key participants include the owners of the self-financed pavilions, designers, contractors, material suppliers, and others.

Besides the program participants, other stakeholders included businesses and residents in and around the Expo site. Before the start of construction, land had to be acquired from the previous property owners or users. It was a difficult task considering this

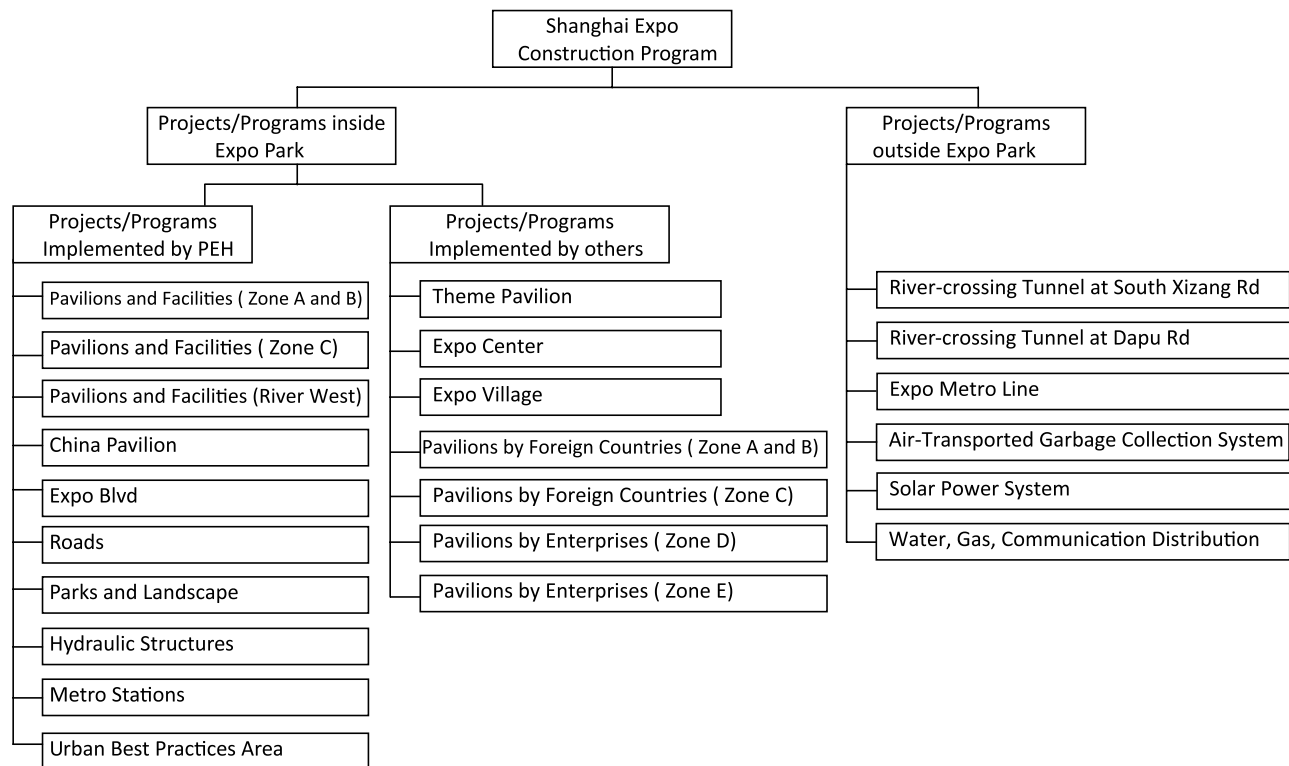


Fig. 1. High-level WBS of Shanghai Expo construction facilities

highly urbanized area and the large number of people and businesses affected (officially 10,765 households and 142 enterprises) (Fang and Cui 2007). Because the acquisition and relocation were deemed to be critically important, they started as soon as the city won the bid for the Expo. Information openness and fair compensation assisted the relocation process: within 1 year, more than 99% of residents voluntarily signed relocation agreements (Fang and Cui 2007). The large-scale and nighttime construction made it necessary to take extra measures to reduce disruptions to the surrounding residents and businesses. For example, most buildings used steel structures instead of site cast concrete, impact hammers were avoided in driving piles, and noisy operations were scheduled during the daytime from Monday to Friday. These measures increased the costs of certain construction operations. Another challenge was working with the building owners who commissioned design and construction by themselves. Since such designs were often conducted in foreign countries, different design standards were used; however, the design documents had to be checked based on the Chinese standards. Special requirements on land development raised by some foreign owners also needed to be addressed, e.g., the replacement of polluted soils in brownfields with unpolluted soils. To facilitate the construction process, construction market information and a list of qualified contractors were sent to the foreign owners.

### Complicated Funding Structure

The funding sources of these projects were also complicated: some were from the central and local governments, some were jointly funded, and others were funded by enterprises, foreign governments, and international organizations. For government-funded projects, the funding was generally secured. However, for funding from other sources, the availability of funds depended on the fundraising process. As a result, several projects were delayed due to

fundraising issues. In such cases, the overall program schedule had to be frequently updated and adjusted so that the delays of some projects did not affect others. However, projects like road paving and construction of entrance and common areas had to be postponed to accommodate those delays.

### Large Amount of Shared and Operational Costs

Although used interchangeably sometimes (e.g., Barrie and Paulson 1992), project management and program management are usually treated as two different concepts [e.g., Project Management Institute (PMI) 2008]. According to PMI (2008), a program refers to “a group of related projects managed in a coordinated way to obtain benefits and control not available from managing them individually.” The Expo construction was a program, instead of a single mega-size project. The construction costs of the program were not a simple sum of all the individual project costs. Instead, it was composed of project construction costs, the shared direct costs of the projects, program overheads, and various fees. The shared and indirect costs could be substantial for such a construction program. For instance, it was estimated that the interest for construction loans alone would reach US\$239 million. The costs for site preparation, facility operation and maintenance, security, temporary facilities, and others shared by projects would reach US\$90 million. The wages and fringe benefits of the program staff, along with other operational costs, constituted another significant source of spending. These shared and indirect costs and fees normally did not appear in the form of contracts and could easily get out of control.

### High Risks in Program Implementation

Construction contingencies may include time delays, significant cost overruns, and major accidents and quality defects. Additional financial resources are required to deal with the contingencies.



Even if the contingencies do not occur, management of contingencies ties up and consumes financial resources. For example, US\$134 million was set aside for contingency management (BSWEC 2006) in the Shanghai Expo program. Insurance companies were involved in undertaking some risks, and preventive monitoring and control were used during the construction.

### Involvement of Public Money

Construction for mega events is often publicly financed or subsidized. The use of public money generally requires that financial management follow regulatory procedures and policies, which typically slows down the processing time for finance-related submissions. In addition, a high degree of accountability and transparency is expected in the financial management of such projects (programs); hence, clear and complete documentation is needed. A common problem for many large construction projects in China has been the lack of project documentation, which makes it difficult to settle final payments as well as perform project auditing. For the Shanghai Expo, the government made a commitment to conduct financial auditing and disclose the auditing results to the public shortly after the event. Therefore, there was a high expectation on the procedural justice and transparency in construction.

### III-Defined Financial Goals

Another characteristic of construction for mega events is that financial goals are usually not well defined. When applying for hosting a mega event from an international organization, the organizer often needs to declare financial goals and make a commitment to such goals, part of which is the expenditure on capital development projects. For example, in the 2005 *Shanghai Expo Registration* report, an estimated US\$4.28 billion was already proposed as the program's financial goal (including construction and operation) (BSWEC 2006), within which the goal for construction costs was US\$2.69 billion. However, the design of the facilities started at a much later stage, e.g., the solicitation for the design of a landmark building, China Pavilion, only took place in 2007. Hence, it is

difficult to use a predetermined financial goal to control construction costs.

## Challenges of Financial Management Due to the Characteristics of the Program

For the Shanghai Expo construction program, although the priority was to deliver the facilities on time, meeting financial goals was also a major concern. Particularly important in financial management are keeping construction costs under control, prompt allocation of financial resources to support construction, and maintaining a high degree of accountability and transparency. However, these goals are sometimes conflicting, and the characteristics discussed previously pose unique challenges to financial management. The causal relationships between the characteristics and the challenges are shown in Fig. 2.

### Cost Overruns

Cost overruns were a major concern for the Expo construction program, and perhaps for any construction project. Unfortunately, cost overruns are a common phenomenon for many large construction projects (programs). Based on a large number of case studies, Flyvbjerg et al. (2003) summarized various studies and concluded that cost overruns above 40% are quite common for built mega projects. In China, rigorous comparisons between estimated and as-built costs of large construction projects (programs) are scarce. A comparison between final expenditures and original estimates of 23 hydropower projects in China indicated that the average overrun was 85.6% (Lu 2004). It is argued that the main causes of cost overruns are inaccurate predictions of project duration, low contingencies, project changes, changes in exchange rates and escalation of quantity and prices, risks, and others (Flyvbjerg et al. 2003). Poor management in project implementation is another important contributing factor.

The construction programs for hallmark events, being mega projects themselves, possess the characteristics of large projects that may cause cost overruns. Moreover, they suffer additional

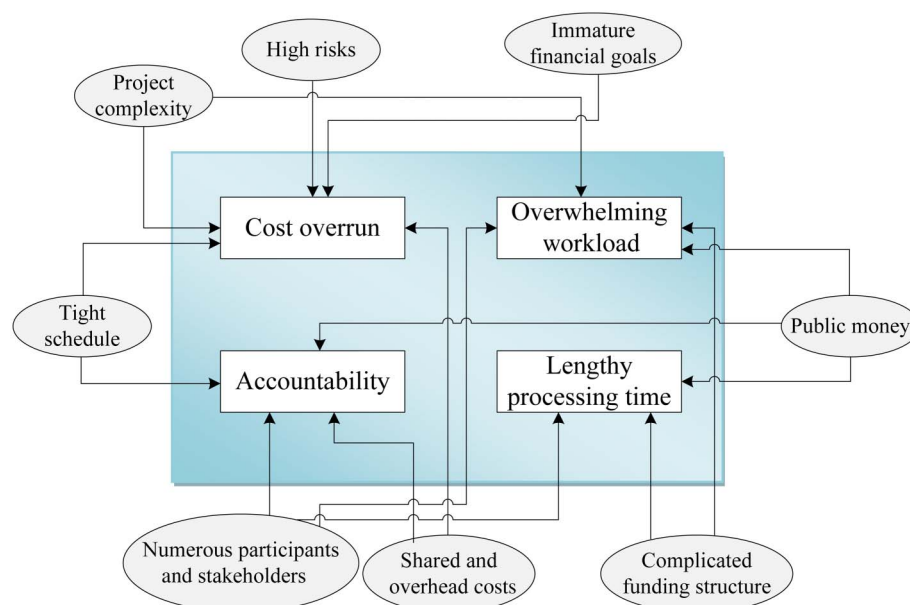


Fig. 2. Challenges of financial management due to characteristics of Expo construction program

issues, as shown in Fig. 2, e.g., immature financial goals, tight schedules, complexity associated with diverse facilities and landmark buildings, and high risks. Besides the immature financial goal as previously discussed, the tight schedule negatively affect costs in three aspects: fast-track construction that creates a large number of changes, expedited processing and approval of project changes without sufficient time for negotiation, and extensive use of overtime. Unlike on ordinary large-scale projects, technical complexities also raise construction costs. Another factor that increases costs is risk, appearing in both the losses due to the occurrence of the risk events and measures taken to mitigate the risks.

### **Accountability and Transparency in Financial Management**

Another concern for the construction program is accountability and transparency. Fraud and corruption in construction is a global issue that takes a heavy toll on construction investment. According to a study by Transparency International (2009), the construction industry is one of the most corrupt industries. This can be partially attributed to the nature of construction (Transparency International 2006), particularly the lack of routine in procurement, involvement of many participants including government authorities, and frequent project changes. In China, corruption in construction is widespread and severe. It is reported that from January 2006 to June 2009, prosecuted bribery crimes in construction accounted for 46% of the total prosecuted bribery crimes in China, and the major bribery crimes in construction accounted for 70.9% of all the major cases (Wu and Xu 2010).

On the Expo construction program, factors shown in Fig. 2 potentially aggravated concerns regarding accountability. The tight project schedule caused numerous project changes. To accelerate the schedule, the changes were approved on site by the program managers and endorsed by the owner's representatives, without being submitted for more detailed review, as would be requested for an ordinary project. The involvement of a large number of participants and stakeholders made it difficult to monitor the contracting and transaction processes. Moreover, a significant portion of the spending was not from the formal contracts but in shared and overhead fees. Tracking and monitoring this type of spending was difficult. As the construction program was primarily funded by public money, there were high expectations with regard to accountability and transparency.

### **Lengthy Processing Time and Excessive Workload in Financial Management**

Because public money is involved, construction programs for public events are subject to regulatory requirements for public projects. The particular procedures related to financial management include design and construction procurement, equipment and materials acquisition, project payments, change orders and claims, and final payments. The bureaucratic procedures in dealing with these matters are typically time consuming, compared with the procedures for private projects. Hence, the procedural requirements will likely hinder action or decision making and cause project delays. Considering the large number of participants and complicated funding structure, it would have been impossible to accomplish the time objective for the Expo construction if all the activities had complied with the standard governmental procedures.

On the other hand, the administrative agencies would have been neither adequately staffed nor well equipped to handle the sudden increase in workload caused by the construction program if the normal regulatory procedures had to be followed. Every month

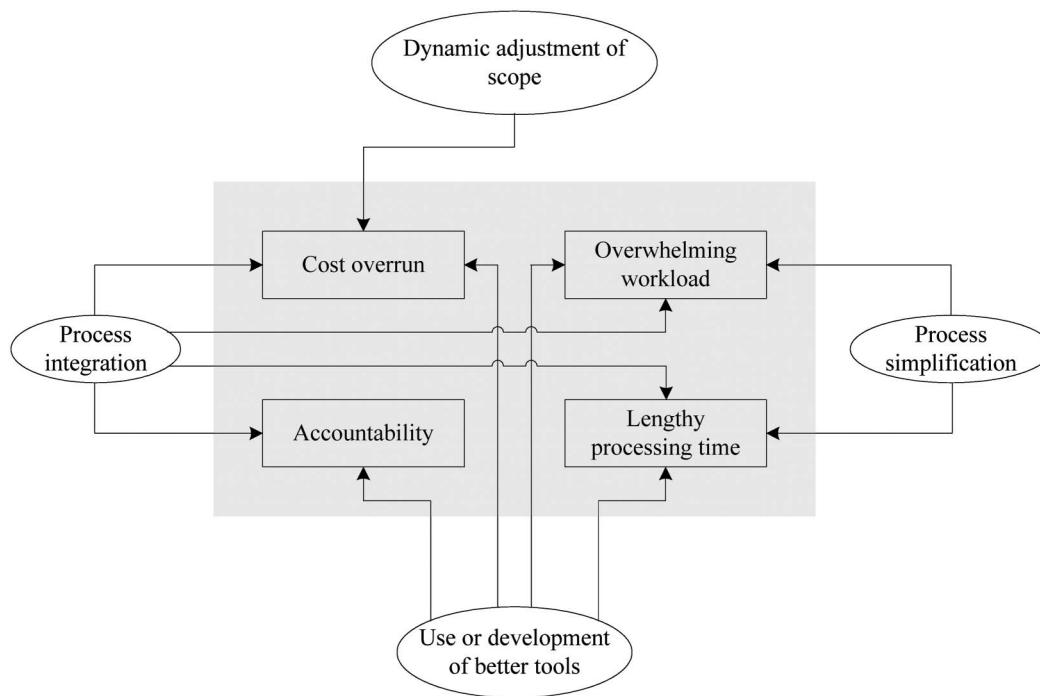
saw hundreds of contractors who needed to be paid and countless change orders that needed to be processed. Many government stakeholders were also involved in the process. The administrative workload would be overwhelming for agencies dealing with increases in program complexity, participants, and the number of transactions.

### **Integrated Management of Financial and Contract Management Processes**

In spite of the challenges that make program construction costs difficult to control, financial health was an important goal for the Expo construction. From the government owner's perspective, even if the final cost might not be controlled within the original goal, expenditures still needed to be closely monitored and brought down to within the original budget as much as possible. In addition, the financial management process must respond promptly to the resource requirements in construction. It also had to face the accountability and transparency concerns and the understaffing issues in processing the overwhelming financial workload. To address these challenges, it was believed by the management that the construction administrative processes had to be reengineered for simplification, the key to process reengineering was to integrate the financial and contract management processes, and automation was needed to support the generation, circulation, and storage of information related to financial and contract management. In addition, during program implementation, some projects were modified in scope or even canceled in responding to delays.

The use of these approaches to dealing with the challenges depicted in Fig. 2 is shown in Fig. 3. In the Expo construction case, a total of 43 standard management procedures were defined, many of which were greatly simplified, compared with the typical procedures for a publicly funded project. For example, permitting and approval are normally handled sequentially among the relevant government agencies, but in the Expo construction, they were processed in parallel. The simplification helped reduce the lengthy processing time and workload in financial management. One of the approaches to avoiding cost and time overruns was the adjustment of the overall program scope. Toward the end of the construction, a few projects, which were deemed not to be key components of the program, were eliminated to save time. One example was a project to build a Chinese garden, which was eventually canceled to save time and money. However, the adjustment of the scope of the Expo construction program was done more passively than proactively. It would have been more effective if alternatives and different degrees of importance of the program components had been well thought out in the program planning stage. The process integration in Fig. 3 refers to the integration of the contract management and financial management processes, and use or development of better tools refers to the computer program developed specifically for process integration in the Expo program. These two approaches are discussed in more detail in what follows.

It was realized by management that the key to cost control was effective contract management, which offers the rigor and formality of making all financial disbursements accountable. However, this is only possible with the integration of the financial management and contract management processes. Mitropoulos and Tatum (2000) proposed that "increased integration of the facility development process is a major opportunity for improvement of organizational operations." PMI (2008) believes that "program management integration is most valuable where program components interact." Therefore, efforts were made to analyze the financial and contract



**Fig. 3.** Techniques to address challenges in financial management

management processes, their interactions, and the integration of the two processes.

### Financial Management Process

The financial management of a program is different from the cost management of a project in several respects. First, financial management takes place earlier than project cost management. In the Shanghai Expo case, financial demands/benefits were already part of the strategic planning when the government decided to initiate the program. Second, project construction costs are only a portion of the total construction costs, which are only a portion of the total program costs. Third, program financial management and project cost management have different emphases: financial management focuses on the overall financial liability and financing options, budgeting, and the use of financial resources to meet program goals (PMI 2008), whereas cost management follows the process of estimating, budgeting, and controlling (PMI 2004). Nevertheless, project cost management is a key component of a program's financial management. The financial management processes that are closely related to construction include strategic financial analysis, development of financial management plans, financial administration, and monitoring, updating the funding plan, and forecasting program costs.

In strategic financial analysis, the costs and benefits of running a program are weighed. The major costs of the Expo included construction and operation costs. In addition, there were also social costs that were difficult to measure in financial terms, such as those associated with, for example, real estate acquisition and relocation, disturbance to transportation and local businesses, and construction pollution. However, social costs may be gradually offset by social benefits such as increased tourism, better infrastructures, and improved living environments. The benefits of the Expo program were believed to outweigh its costs.

The financial management plan included several components such as plans for program financing, construction cost management, nonconstruction cost management, and financial oversight.

The majority of the Expo facilities were financed by government through revenues, bonds, and loans. In addition, 42 buildings were financed and built by independent owners from foreign governments, enterprises, and international organizations. For construction projects, financial management started with preliminary cost estimation, followed by budgeting and aggregating construction costs based on the program's master schedule. The result of the analysis was a capital investment plan, showing the funds required to support project implementation. When a contract was reached, the contracted amounts and schedules of values were used to generate the funding plan, which was different from the capital investment plan because it needed to consider more specific financial arrangements, including cash advances, retainages, owner-furnished materials, utility fees, and others. For nonconstruction costs, an innovative dummy contract approach was used, which classified such costs and placed them under the contract management system. The procedures and organizations for financial oversight were also established in the financial management plan.

During construction, the project management teams were assisted by two independent professional organizations: construction oversight and financial oversight. The construction oversight is a nongovernmental, third-party organization mandatory for construction projects in China; it certifies the completed work, makes quality inspections, and endorses requests for progress payments. Construction oversight is also referred as construction supervision in other literature (e.g., Dai et al. 2006). The financial oversight reviews the requests for progress payments and makes recommendations for owners. When the fund was transferred to the Expo program, it comprised a total amount shared by many ongoing projects. It needed to be separated to pay different parties for various reasons.

The funding plans needed to be updated frequently to reflect changes in the program. Thirty detailed monthly funding plans were generated for the Expo program by April 2010. Based on the actual program spending and updated funding plans, program

costs were also forecasted. Timely updates and forecasting were important, but it would have been impossible without the assistance of a computer program.

### Contract Management Process

Contract management was a key component in the management of the Expo construction. Galloway (2004) believes, and Puddicombe (2009) concurs, that project management issues are largely due to a failure to understand the basic tool, the contract that governs all projects. The contract should be used as a managerial tool to “accomplish the project tasks, not as an abstract legal document that comes into play during conflicts (Puddicombe 2005, 2009).” In the planning stage, it was decided that all the program construction costs, overhead, and fees had to be managed through the contract management system. The contract management of the program includes the following subprocesses: contract planning, contractor selection, contract circulation, contract implementation, and contract update.

In the Expo construction program, the first step in contract planning was to analyze the scope of projects and group them into contract packages. The grouping did not necessarily follow the WBS of the Expo program. For example, one large building project may be divided into several separate contracts, while one contract may cover several smaller buildings or facilities. The type of contract also needed to be identified for each contract package. The program overhead and fees were classified based on the nature of the spending such as, for example, office operation, staff salaries, and meetings, and were treated as a special type of contract, the dummy contract, and managed like actual contracts. Following this step is contractor selection, typically based on competitive bidding. When an agreement with a contractor was reached and a draft contract developed, the draft contract needed to be approved by different government authorities. Once the approved contracts were implemented, they needed to be frequently consulted to

develop funding plans and making payments. Due to the unavoidable changes in most construction projects (e.g., Hanna and Swanson 2007), the contracts needed to be amended and updated frequently.

### Integration of the Two Processes

From the preceding descriptions, it can be seen that there are extensive information exchanges between the financial management and the contract management processes. The integration of these two processes on the Expo construction program was achieved by establishing the integration framework, defining the information flow between the two processes, and using a specially developed computer program to assist the management of these two processes and their interactions.

- Establishing connections: The first step toward integration was in the establishment of connections between the program WBS, the cost breakdown structure, and the contract breakdown structure. The breakdown structures are important for managing process interfaces (Chua and Godinot 2006). The program WBS was based on the planning and design documents and was continuously adjusted as the program progressed. At the feasibility and planning stage, the WBS was based on the investment entities and the funded projects. At the design stage, it was based on the function of the facilities, divided into pavilions, auxiliary facilities, transportation infrastructures, and municipality facilities. At the construction stage, the WBS was regrouped based on the function, project manager, and location of the facilities. The major divisions of the cost breakdown structure followed the WBS. However, the cost breakdown structure also included items not in the WBS (e.g., contingency and interests), and its detailed divisions followed the format of the local cost reference book. The contract breakdown structure was based on the nature of the contract (i.e., design or construction), locations, and scope of the contract. The contract packages were classified

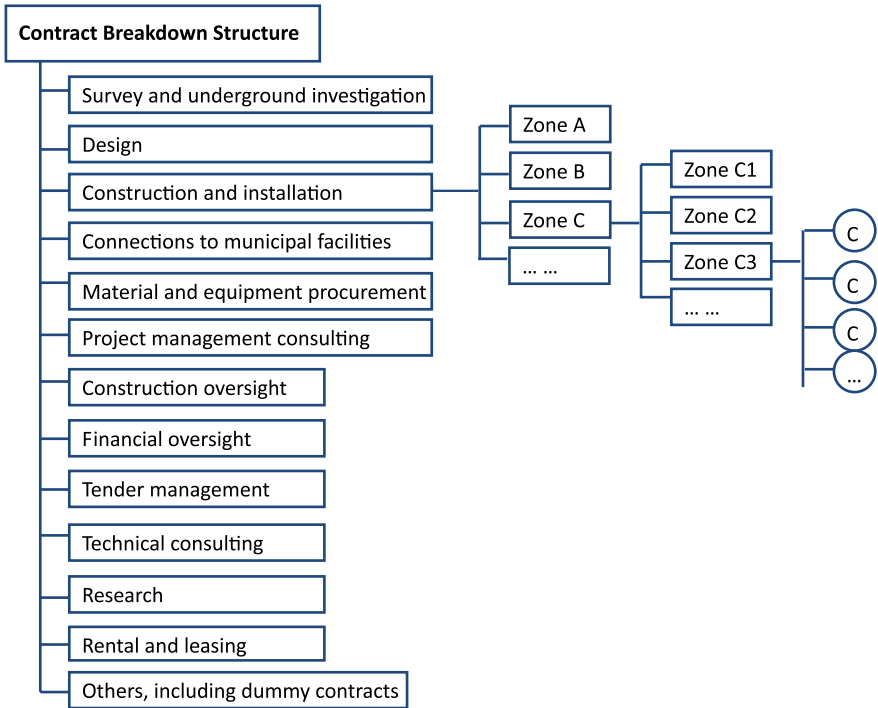


Fig. 4. Contract breakdown structure in Expo construction program



into 13 types of contracts and were linked to the program WBS and the cost breakdown structure, except for the dummy contracts (Fig. 4). Breaking down the program, costs, and contracts into finer components was necessary to establish connections among them, and the connections helped identify information flow between the financial and contract management processes.

- Identification of information flow: The major subprocesses where financial management and contract management were closely related are shown in Fig. 5, which also shows examples of information exchanges. Under the subprocesses were detailed procedures specifically developed for the construction program. As can be seen from Fig. 5, at the early stage of program development, contract management mainly received information from financial management, while at the later stages, financial management needed information from contract execution. Information from the financial management process was useful in optimizing the contract packages. For example, small projects

that were similar in nature were packed into one single contract, while a project with a large amount of expenses was divided into several different contracts. Project estimates also formed a baseline for letting and comparison of contract prices. On the other hand, contracts provided the most accurate information on project costs, which, combined with the actual contract payments and changes, were used to update the program costs dynamically. The contract amounts and payment schedules were also required in preparing the monthly and quarterly funding plans. Integration of the two processes enabled program managers and participants to access the same and complete information. This was also necessary for the subsequent development of the computer program to aid the management of the two processes.

- C3A integrated financial and contract management system: The large amount of information generated in financial and contract management made it necessary to use a computer program to facilitate information processing. Twenty-five commercial

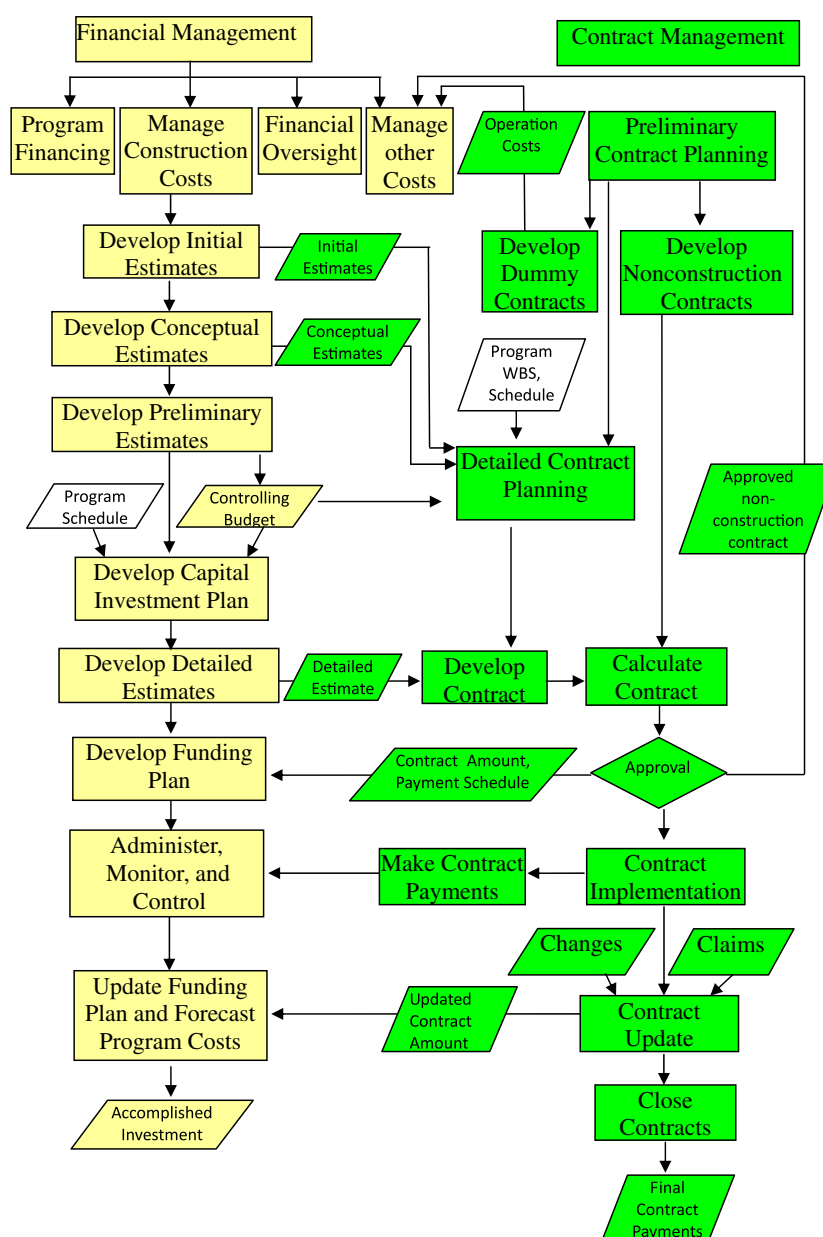


Fig. 5. Information flow between financial and contract management processes



computer programs with cost and contract management functions were analyzed, but none of them met the specific procedural and reporting requirements for the Expo construction. Therefore, a web-based program, called C3A (contract, cost, communication + administration), was developed for the financial and contract management of the Expo program.

The design of C3A started with requirement analysis, including the identification of the users and analysis of their functional requirements. The Unified Modeling Language (UML) was used to model the relationship between users and system modules as well as the components for each module. The users of the system included system administrators, relevant government authorities, program managers, and others. Each user group had different rights of access to the system. The browser/server/database (BSD) was chosen as the system architecture, where the client uses an Internet browser to retrieve and input project information. The web server processes the client's requests based on preset rules and exchanges information with the database server, which acts as the bridge between the client and the database server. The database server responds to the web server's requests and performs data management functions such as ensuring data integrity, consistency, and independence. Besides the BSD architecture, another option is the client/server (CS), where most of the application is performed on the client side (Sadoski and Rogers 1997). However, performance of such a system will deteriorate significantly if the number of users exceeds 100 (Sadoski and Rogers 1997). Therefore, the CS architecture does not meet the requirements of the Expo program, where users far exceeded 100 in number.

A screenshot of the C3A system (in Chinese) is shown in the background of Fig. 6. This screen is for an authorized user to view individual project progress and financial information. The user can choose a project to view from the program WBS on the left side of the screen. From October 2007 to April 2010, the program had generated monthly and annual financial plans, created 2,862 contract-related documents, completed 2,063 fund allocations, and sent out 3,193 group messages. The system was also used for contract circulation and approval by different authorities. By assisting the integration of the financial and contract management processes, C3A helped meet

the challenges previously discussed. At construction sites, the project managers often had to make prompt decisions regarding design and construction changes. In the expedited process, the project managers could approve a change and directly enter the pertinent information into the C3A, including the causes and nature of the changes, the scope of the changes, price information, and contracts affected and amendments to existing contracts. Such information could quickly reach the owner's representatives for review and endorsement. The contractors who were affected by the changes could also review the C3A records for the accuracy of the information and report any mistakes. Such changes were summarized monthly to generate updates on program spending and forecast future costs. The information was also necessary for making adjustments on progress and final payments and ensuring accountability in decision making.

## Summary, Conclusion, and Future Improvements

Mega events often have significant short-term and long-term impacts on the hosting cities. Behind such events are construction projects that build the supporting facilities as well as infrastructures for urban redevelopment. However, there is a paucity of information on organizing construction for hallmark events. Based on the Shanghai Expo construction program and other similar cases, this paper provided an analysis of the common characteristics of construction for hallmark events, the challenges related to financial management created by these characteristics, and possible techniques and methods to address these challenges.

Eight common characteristics of construction for hallmark events were identified in this paper, including project complexity, tight schedule, large number of diverse participants and stakeholders, complicated funding structure, large amount of shared and operational costs, high risks in program implementation, involvement of public money, and premature financial goals. The challenges of financial management associated with these characteristics are grouped into four areas: cost overruns, accountability and transparency in financial management, lengthy processing time for financial matters, and overwhelming financial workload for

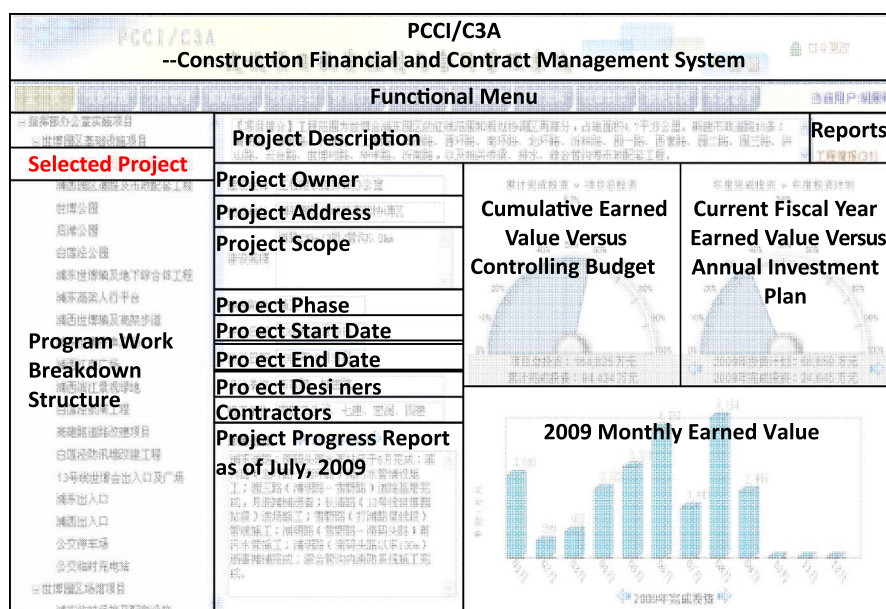


Fig. 6. Screenshot of C3A program

existing organization and staff. Some techniques used in the Expo construction program may have assisted in addressing, or at least alleviating, these challenges, including (1) reengineering the management process for simplification; (2) integration of the financial and contract management processes; (3) the use of automation (a custom-made computer program in the Expo construction case) in the generation, circulation, and storage of financial and contractual information; and (4) assignment of low priorities on certain projects to provide a buffer for the time and financial goals. Point 4 is not elaborated in this paper due to size constraints. These techniques and tools were found to be helpful in the Expo construction program.

Despite its complexity and tight schedule, the Shanghai Expo construction program was completed before the Expo opening. The construction program created a redeveloped city district with permanent landmark buildings, new infrastructures, parks, and land for future development. According to the audit results disclosed in 2011, the actual cost for the construction program was US\$2.95 billion, exceeding the original goal by US\$259 million, or 8.8%. The audit report also reveals the main causes for the cost overruns, which include funding support for foreign participants who did not raise enough funds, scope changes, the use of new technologies, and the escalation of construction materials and labor prices (Xu and Yang 2011). No unlawful activities were detected in the auditing process. Although there were cost overruns, the auditing report concluded that they were reasonable. Therefore, the construction program was generally regarded as successful. Its success can be partially attributed to the integration of the financial and contract management processes, assisted by the C3A computer program. However, lessons were also learned from the Expo construction, which may be applied to the management of construction for future mega events.

The first lesson is that sufficient time should be provided for program planning and design. Due to the tight schedule, the design and construction stages of many projects overlapped. Unclear project definitions and design flaws caused a large number of changes that drove up construction costs. The second lesson is that a constructability review should be emphasized for complex construction programs. Such a review should not only focus on the technical issues but also cover broader organizational and managerial issues such as, for example, the availability of transportation facilities and spaces, accommodation of the large number of workers, production capacities of material and equipment suppliers. Starting a large number of construction projects simultaneously can affect the supplies and demands of the market and cause price surges. The third lesson is that a consistent and uniform cost classification system should be developed for building and infrastructure construction. Cost control requires frequent comparisons of the cost items between conceptual estimates and initial estimates, between preliminary estimates and conceptual estimates, and so on. This is possible only if a comparable reference framework is maintained across the project life cycle. Unfortunately, in the Expo program, the cost estimates at different stages of project development were prepared by different parties who used different cost classification systems. Moreover, the cost classification systems in China also vary in different provinces and municipalities. This made it difficult to compare project costs at different stages and between different contractors. The fourth area that could be improved is the use of standard procedures and practices in construction program management. China has completed a large number of mega construction programs in recent years and has more planned, but there exist insufficient studies and efforts that develop a standard body of knowledge for managing projects and programs in the Chinese context. In particular, there is a lack of standards in

workflow and construction reporting. This drawback, combined with the lack of a standard cost breakdown structure, creates barriers to developing a standard commercial software package for contract and cost management.

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