On Component-Based Industrialization Construction Costs Valuation

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Abstract. Focus on the problems of a higher industrialization construction cost that hinders its promotion, this paper set industrialization construction installation cost as the object, firstly, it studied the composition of industrialization construction cost from the perspective of theory, then it combined the practice project to analyze the main reasons of a higher price of prefabricated component and product material . After this, it tried to establish the cost valuation system suitable for industrialization construction, then it compared the difference of cost valuation between traditional construction and industrialization construction, so as to provide references for the formulation of government compensation policy and enterprises' cost control on prefabricated component production in the field of industrialization construction cost.

1. Introduction

The 56th Letter of Ministry of Housing and Urban-Rural Development (2016) explicitly states that industries and regions should set corresponding quotas for construction industrialization and modernization as complements to the existing bill and quota system. All provinces and cities are striving to establish additional quotas for prefabricated concrete components so as to improve the situations where industrialization construction costs are evaluated without foundation.Though industrialization construction currently enjoys political and technical advantages in our country, it is still faced with great economic limits in the market economy if it wants to develop further. Han Xiaokui deems that cost budgeting should be conducted before design schemes are determined. He thinks that primary costs of copious components in industrialization housings include mold amortization costs and transportation costs. He also explains that in designing process, it is necessary to compare different compacts of different schemes on mold reuse and transport efficiency so as to improve price-quality ratios of products①. Wang Shuang, through case comparison, discovers that production and transportation costs of PC components cause a substantial increase in industrialization construction costs. The domestic prefabrication rate is 15—20% and expenses of construction and installation increase by 20—50%②. Wang Tao predicts that industrialization construction in Beijing can gain cost advantages nine years after establishment③.

To solve the problem of high construction costs which hinder developments of industrialization construction, it is of great importance to reflect on the current bill valuation system and to develop a valuation platform that is suitable for industrialization construction. Construction industrialization employs new technological processes, prefabricated components and parts as well as new contracting modes, which can directly or indirectly bring about changes in valuating methods and ranges of construction and installation costs. Whereas, construction and installation costs are mainly calculated in the method of BOQ in which branches and columns in the bills refer to traditional architectural technologies. Thus, as for industrialization construction, to adopt to new technological processes and construction modes, ways and items of BOQ must be immediately adjusted and changed. In the beginning, the thesis theoretically displays different classification of BOQ of both industrialization construction and traditional construction. Then the thesis selects cases and compares economic indicators of industrialization construction and traditional construction. Based on this, the thesis

intends to build a bill valuation mode that is appropriate for industrialization construction. Besides, the thesis also analyzes the composition and developing trends of industrialization construction and installation costs, with the aim of providing reference information for governments to set compensation policies on industrialization construction costs and for relevant enterprises to conduct cost control.

2.SI System in Industrialization Construction

A Dutchman N.John comes up with the skeleton system which gives birth to SI System. SI System is a sustainable system that is formed at the developing stage of industrialization construction. The system separates the skeleton system from the infill system and realizes a standardized production of components. “S” includes load-bearing structures (beams, plates, columns and bearing walls) and public pipelines, with service life usually no shorter than 50 years. “I” represents non-bearing walls, interior decorations, doors, windows, kitchen equipment, bathroom equipment, interior pipelines that should make changes according to requirements, with service life usually ranging from 5 to 30 years. Although it is hard to completely separately consider skeleton and infill in real-life design and construction, the concepts of SI System can take effects in quantity measurements and cost valuation in industrialization construction --- separating skeleton from infill means separating itemizing from valuating.

3. Valuating Methods of and Composition Analysis on Industrialization Construction and Installation Costs

Construction and installation costs are construction costs in a narrow sense, which are calculated from the perspective of business deals. Contract prices that are determined during tendering and bidding, construction and installation costs at the construction stage and completion settlements all belong to construction costs in a narrow sense. Currently in our country, construction and installation costs are calculated by means of BOQ in which bills should be subdivided and itemized at first and then bills of items and other items should be valuated. The valuated prices plus stipulated fees and taxes is the unit construction and installation cost. The sum of multiple unit construction and installation costs is the construction and installation cost of a single project. The main difference between industrialization construction and traditional construction is service life of components. Industrialization construction utilizes various components which can be divided into two types according to different service life --- S system and I system. Exterior structures of industrialization housings are equipped with public vertical drainpipes while the interior adopts sectional descending board to realize same floor drainage. Besides, wires of appliances are separated from the major structures. In addition, wet working methods are seldom applied on site and assembling situations are frequent. These changes require us to develop a cost valuation mode that adapts to industrialization construction. Table 1 compares compositions and valuating methods of construction and installation costs of industrialization construction and traditional construction.

Table 1 Comparison of BOQ Valuating Methods of Industrialization Construction and Traditional Construction

Valuating Method of traditional construction			Valuating Method of industrialization construction		
Subdivided and Itemized Project Costs	Construction Projects	earthwork project	*Skeleton-System Project Costs		Description
		foundation treatment project		Foundation project	Cast-in-situ
		pile foundation project, blacklaying project concrete and reinforced concrete project		Main structure	assembly-type concrete structure, steel structure or composite structure (prefabricated or cast-in-situ choices should be made according to actual situations)
		doors and windows project		floor	Prefabricated assembly
		roof and water-proofing project		stairs	Prefabricated assembly
		thermal insulation project		earthwork project	
	Decoration Projects	floor decoration project	*Infill-System Project Cost	exterior retaining part system	include retaining walls, roofs, doors, windows, water-proofing, thermal insulation, exterior wall decorations
		wall column surface decoration project		interior public part system	include public tubular wells and public partition walls
		ceiling project		interior decoration part system	interior division walls, interior doors and raised floors
		painting and coating project		kitchen part system	integrated kitchen include frameworks of kitchen, wallboard, water-proof bases, ceiling, standard interfaces and pipelines, electric appliances in kitchen (cooker hoods and sterilizers), ventilation systems.
		Other decoration project		bathroom part system	integrated bathroom include frameworks of bathroom, wallboard, water-proof bases, ceiling, standard interfaces and pipelines, electric appliances and parts in bathroom (tubs, basins and toilets)
		demolition project		storage part system	wardrobes and lockers
	Installation Projects	Electrical devices and installation project, intellectualized construction		Device part system	pipelines of drainage system, sanitary ware system, water supply system, kitchen ware system, central heating system and fresh air system
		Ventilation and air-conditioning project, fire protection project		Intelligent part system	devices suitable for the old, fire protection, internet and wiring, home intelligent terminals
		draining, heating and gas projects		Supporting part system of communities	parking facilities, exterior municipal supporting facilities, garbage storage and disposal facilities, landscaping and buildings
Procedure Item Costs	Scaffolding Costs		Procedure Item Costs	Scaffolding Costs	The project duration of industrialization construction is shorter, which decreases using time of rented molds and thus decrease rental charges of molds.
	Concrete mold and support costs			Concrete	the on-site casting work decreases, so mold

			mold and support costs	costs substantially decrease. Support costs of prefabricated components increase.
	Vertical transportation costs		Vertical transportation costs	the more parts and semi-finished products, the more vertical transportation costs
	entering and existing fees and installation and dismantlement fees of large machinery		entering and existing fees and installation and dismantlement fees of large machinery	with heavy work of on-site lifting and assembling, the requirements for parameters and accuracy of tower cranes are more strict.
	construction drainage and precipitation costs		construction drainage and precipitation costs	leveled
	safe and civil construction costs and other procedure item costs		safe and civil construction costs and other procedure item costs	industrialization construction mainly utilizes finished or semi-finished products. The on-site work of storing and handling raw materials decrease. Temporary facility costs decrease.
			Detailed design cost	Construction companies should carry out a detailed design for construction drawings, so as to satisfy demands of components and parts that are produced in factories.
			Placement cost of prefabricated components	Prefabricated components and parts are bulky, so they need lifting equipment and bigger storage space.
Other items	provisional sum, provisional estimate, day man and general contracting service fees	Other items	Provisional sum	For project changes less, the provisional sum can decrease in proportion.
stipulated fees and taxes	social insurance fees, housing funds, sewage costs and value-added taxes	stipulated fees and taxes	stipulated costs and value-added taxes	Some factories have began collecting value-added taxes. It is suggested to use integrated unit prices to valuate.

As can be seen from the table 1, the valuating methods of industrialization construction and traditional construction are different regarding:

（1） Traditional construction can be divided into various projects according to different disciplines, including construction, decoration and installation. Depending on whether carrying loads and different service life, industrialization construction can be divided into skeleton system and infill system. Industrialization construction in its true sense range from skeleton-system to infill-system construction. Most of its components and parts permit mass production and on-site assembly. However, since our country is endowed with vast territory, antiseismic requirements and industrialization developments in different regions differ. Therefore, the promotion of industrialization construction should be conducted by stages. Prefabrication rates at every stage can be regarded as the reference indicator. At the first stage, laminated floors, stairs and balconies are incorporated into industrialization components. Decorative components, including interior and exterior wall plates, are put into mass production in order to improve qualified rates of devices and intelligent systems and to achieve “the goal of making prefabricated buildings accounting for 30%

of newly-built buildings" proposed in the Central City Conference. At the second stage, with antiseismic requirements fulfilled, prefabricate beams and columns of load-bearing systems and carry out antiseismic treatment against junctions of prefabricated components. At the third stage, after assembling parts of load-bearing components, further improve prefabrication rates. Components of kitchen, bathroom and storage room that are mass produced should be assembled on site, which realizes construction industrialization in a real sense. The installation cost valuating system of industrialization construction should also be developed by stages. BOQ valuating of industrialization construction should be conducted from coarse to fine. Whereas, there is neither a special quota system of industrialization construction nor a reference standard to valuate industrialization construction costs. Although cost management centers in different regions try to explore various prefabricated components as additional quotas, production and technologies of industrialization construction has its own characteristics which require suitable and systematic valuating methods and systems. For example, Sichuan Province considers assemble-type prefabricated concrete components as purchased finished products. Material costs of prefabricated components range from RMB 1700 to 2800 every cubic meter. Transportation fees and installation fees are quoted by construction companies. However, how factories responsible for prefabricated components consider fixed-asset depreciation and how production scales are determined can both influence costs of prefabricated components to a great extent.

（2） Because of changes in technological processes, the BOQ system of cast-in-situ construction should be modified so as to adapt to developments of industrialization construction. It is suggested that certain bill items, such as prefabricated components and parts of main body, should be added, for example, components like common prefabricated beams, laminates, columns, walls beside stairs. Besides, exterior maintenance, interior public equipment, interior decorations, kitchen, bathroom, storage room and community equipment should be included into the industrialization construction portfolio and separately listed as bill items. When projects are implemented, it is suggested to increase design fees (when receiving construction drawings, construction companies should arrange designers to extract components that can be produced in prefabricating factories and to consider on-site assembly sequence and installation processes), placement fees of prefabricated components and parts, supporting fees of prefabricated components and parts (prefabricated components and parts are usually bulky and involve great storage space, lifting equipment and supporting systems). All in all, the valuating system of traditional construction is based on construction technologies while that of industrialization construction sets prefabricated components or parts as primitive objects and regards them as semi-finished products to conduct valuating. For instance, the unit price of a prefabricated column includes costs of concrete, reinforcing bars, embedded lifting point, sleeve, mold amortization, mechanical power and mechanical wear, installation cost, transportation cost and so on.

（3） Under the circumstance of comprehensive promotion of value-added taxes replacing business taxes, it is recommended that a valuating system of comprehensive unit price should be gradually implemented and fully line up with foreign construction valuating systems. In business tax mode, prefabricated components and parts have be charged for value-added taxes when leaving factories. On this basis, business taxes are calculated according to turnovers, so taxes are calculated repeatedly. Educational surcharges and construction taxes are temporarily included into administrative expenses of comprehensive unit prices. Manufacturers have paid value-added taxes of components and parts before they leave factories. Therefore, construction companies can see construction and installation costs as input tax credits. The credibility is beneficial to decreasing unit prices of prefabricated components or parts while value-added taxes replacing business taxes is beneficial to decreasing industrialization construction costs.

4.Suggestions for Industrialization Construction Cost Valuating

Four suggestions for Industrialization Construction Cost Valuating:

（1）Industrialization construction consists of many components and parts. Valuating modes that suit industrialization construction should separately list out components and parts, instead of focusing on construction process to list out items and add up values according to traditional bills. On this basis, it is necessary to think through characteristics of industrialization construction and installation and include design fee, supporting fee and placement fee of prefabrication components into bill items. Only in this way, the fees can be correctly classified when incurred. Foundations that can support itemization and valuation of industrialization construction can provide unifying calculating methods and platforms for both parties.

（2）There is no doubt that industrialized prefabricated components are more expensive than traditional cast-in-situ parts, but industrialization construction is a global trend. Currently governments in various regions are encouraging and promoting industrialization construction as well as establishing preferential policies for enterprises manufacturing prefabricated components. Policymakers must take into consideration cost compensation. Since prices of lands, labors and materials in different regions vary from each other and manufacturing facilities have different types and brands, fixed costs of different prefabricating factories vary. Thus the thesis suggests that governments should estimate fixed costs of prefabricating factories, scientifically define depreciating methods and life, appropriately determine annual average outputs and compensate for certain fixed costs so as to relieve factories' burdens. Besides, it also suggests that prefabricating factories should fight for supports from governments in the process of industrialization promotion and appropriately consider depreciated values of fixed assets when investing unit construction cost.

5. Conclusions

The thesis carries out a fundamental research on industrialization construction costs of components or parts and explains differences of quantity measurements and cost valuations of industrialization construction and traditional construction. It believes that the valuating systems of industrialization construction should be developed by stages; that the deepening replacement of business taxes with value-added taxes helps decrease industrialization construction costs. On the other hand, the high prices of industrialized prefabricated components result from amortization fees of fixed assets. To appropriately determine depreciating methods and forecast prospective market sales can exert great influences on amortization fees. The views proposed in the thesis serve as a reference for governments to formulate compensation policies on industrialization construction costs and for enterprises that produce prefabricated components to conduct cost control.

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References

[l] Han Xiaokui. The thinking of practice on housing industrialization [J]. ZheJiang Construction , 2(2014):59-61

[2]Wang Shuang. The cost comparison between the housing industrialization and the traditional construction[J]. Construction and budget,7(2014):26-29

[3]Wang Tao. Comparative study on the cost between housing industrialization and traditional construction methods [J].Journal of Engineering Management,4(2015):49-53

[4]Nahmens I， Bindroo V． Is Customization Fruitful in Industrialized Homebuilding Industry[J]．Journal of Construction Engineering and Management，2011，137

[5] Azman M N A， Ahamad M S S， Majid T A， et al． Statistical evaluation of pre-selection criteria for industrialized building system （IBS）[J]． Journal of Civil Engineering and Management，2013，19（sup1）：S131-S140．

[6]Stehn L．Applicability of lean principles and practices in industrialized housing production[J]．Construction management and Economics，2008，26（10）：1091-1100．