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Exploring the occurrence of transaction costs in the supply chain of prefabricated housing

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Abstract

Cost is identified as one of the critical barriers that prohibit the implementation of Prefabricated housing (PH). Unlike the previous studies mainly focused on the physical costs, this research aims to investigate a new dimension of costs-transaction costs (TCs), e.g. searching costs, negotiation costs, contract costs, etc., and explore how TCs occur through the whole supply chain of PH in order to reduce the frictions to PH.

Firstly, the supply chain of PH in China is built by explanation in terms of stakeholders, stages and tasks. Secondly, based on the TCs theory, the TCs along the supply chain are subsequently identified in each phase of the PH supply chain to build a generic framework of TCs. Results generated from this study will be the theoretical foundation for empirical study to improve the economic efficiency of the PH supply chain.

Keywords: Prefabricated housing; Transaction costs; Supply chain.

Introduction

Facing with the increasing pressure from the resource lacking and energy saving, sustainable ways to product housing are highly expected in the construction industry globally. There have been emerged recommendations for overcoming the resource and environmental challenges associated with the conventional construction means. Among these recommendations, use of modern construction methods such as off-site construction and prefabrication has become a promising one. In China, prefabrication is nowadays mostly applied in the field of housing development, which is normally described as Prefabricated Housing (PH). Prefabricated housing is the manufacture and preassembly of residential building components, elements, or modules before installation into their final locations (Goodier and Gibb 2007). The China Ministry of Housing and Urban-Rural Development (MOHURD, 2016) defined that PH should has the characteristic that more than 30% (calculated by volume) of the main structure and the building envelope are built by prefab components.

Over the last decade, the PH has seen its increasing adoption in the housing market of developed countries, given its benefits of improving the project performance in environmental, economic, quality and productivity aspects (Arif & Egbu, 2010; Schuler, 2003). Nowadays the UK, Ireland and Scotland are experiencing a significant boom in prefabricated houses. For instance, over 30% of the new homes built today in the UK are prefabricated; in Ireland and Scotland, prefabrication rate is projected to rise to nearly 70% in a few years. Some companies in Japan are producing over 70,000 prefabricated homes a year (Arif, Goulding, & Rahimian, 2012).

Despite the successful adoption of PH in developed countries, it is not as widespread in developing countries. As reflected from its projected market value, the PH share of China remains below 2% of its entire construction sector (Li, 2015). The promotion of PH in developing countries has come along with some problems, including cost control problems, transportation problems, supply chain problems, process efficiency problems, etc. (N. G. Blismas, Pendlebury, Gibb, & Pasquire, 2005). To solve these problems, the factors hindering the promotion of PH have been investigated by a number of researchers and practitioners. For instance, cost, lead-in time, and the shortage of knowledge on prefabrication are well documented in previous research (N. Blismas & Wakefield, 2009; N. G. Blismas et al., 2005; Chiang, Hon-Wan Chan, & Ka-Leung Lok, 2006; Goodier & Gibb, 2005; Kamar, Alshawi, & Hamid, 2009; Mao, Shen, Pan, & Ye, 2013). Among them, cost is identified as one of the critical barriers that prohibit the implementation of PH (N. G. Blismas et al., 2005; Jaillon & Poon, 2008; W. Pan, Gibb, & Dainty, 2007, 2008). Thus, there are a lot of previous studies have focused on the cost management to improve the implementation of the PH project (Chiang, Chan, & Lok, 2006; W. Pan & Sidwell, 2011), but few of them have considered the hidden costs in the whole development process. The actual costs of the PH project is comprised of not only production costs, but also transaction costs (TCs). TCs, are relative obscure when compared with actual construction costs (Q. K. Qian, Chan, & Khalid, 2015). TCs theory has been successfully applied in various industries to improve the economic performance. Facing with problems of PH in both practical and research fields, understanding, analysing and improve the whole process of PH through a TCs approach can be a feasible method to find solution.

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This study aims to identify the TCs through the whole supply chain of PH in order to reduce the frictions to PH. After understanding the supply chain of PH in terms of stakeholders, phases and the tasks, the TCs are identified along the supply chain in each phase. Results generated from this study will be the foundation for empirical study to improve the economic efficiency of the PH supply chain.

The transaction costs approach

The primary contention of TCs is that, in addition to the cost of production, there are also transaction costs between the parties (G. Winch, 1989). TCs are different than production costs; whereas production costs are the costs of transforming inputs into outputs, TCs arise from economic exchange. Transaction costs are termed *soft costs* by the Transportation Research Board (Schneck & Touran, 2010).

The concept of TCs has a broad range of definitions and empirical approaches (Allen, 1991; Barzel, 1985; Demsetz, 1968; North, 1990). TCs refer generally to costs of trade beyond the materials cost of the product, such as the costs of searching for projects, estimating, project partners, negotiation, monitoring, regulatory approval and dealing with any deviations from contract conditions (Antinori & Sathaye, 2007; Li, Arditi, & Wang, 2015). In other words, TCs are those costs that are beyond the direct costs of factor inputs into production but that are incurred in making a trade (Antinori & Sathaye, 2007). In this study, TCs in PH industry are specifically defined as costs in terms of risk, time delay, information search, searching costs, negotiation costs, contract costs and setting up costs as well as learning costs.

Offering a special lens to look at the transaction process and improve the governance of organization, TCs economic has received considerable attention by academics and has been applied to guide the practice in industries, such as stock, manufacturing and the construction industry. The TCs theory has been widely applied in the construction industry to solve problems: project management (Walker & Kwong Wing, 1999), the institutional governance (Lai & Tang, 2016; G. Winch, 1989), procurement management (Carbonara, Costantino, & Pellegrino, 2016), identification of TCs (Buitelaar, 2004; Kiss, 2016; Li, Arditi, & Wang, 2012; Mundaca, 2007b) and policy management (Mundaca, 2007a).

In PH project, new development process and extra tasks are involved that require the support of new rules and institutions, and in turn, cause TCs hidden. TCs do not contribute directly to the output of a development process, like land, bricks, concrete and trees, in other words the production costs. It is assumed that the fewer the transaction costs, the more smooth and efficient the development process (Webster, 1998). Therefore, from a perspective of cost efficiency, TCs can be seen as dead weight losses that have to be minimized in PH projects.

The supply chain of PH in China

To identify the TCs in PH project, it is important to understand the whole process of the PH development first. Here we describe the project development process as a supply chain. The term “supply chain” used here to define the stages through which the project is entirely developed from the conceptual idea to the final maintenance stage.

This study builds a generic supply chain of PH to elaborate the operation of the whole process. There are three critical elements of the PH supply chain, stakeholders, stages and the tasks.

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The descriptions of phases and tasks

According to the most cited definition of supply chain by Christopher (1992), this study defines the supply chain of PH as:

A business process associated with the flow and transformation of PH from conceptual phase to the operation phase, through upstream and downstream linkages, providing value in the form of products and services in the hands of residents.

In a PH project, different developers may have their own defined phases and major tasks in their own project or venture (G. M. Winch & Carr, 2001). Considering the status quo in China, the supply chain of PH project in China can be divided into five phases generally: 1) the concept phase; 2) the planning and design phase; 3) the manufacture phase; 4) the construction phase and 5) the sale and maintenance phase (see figure 1).

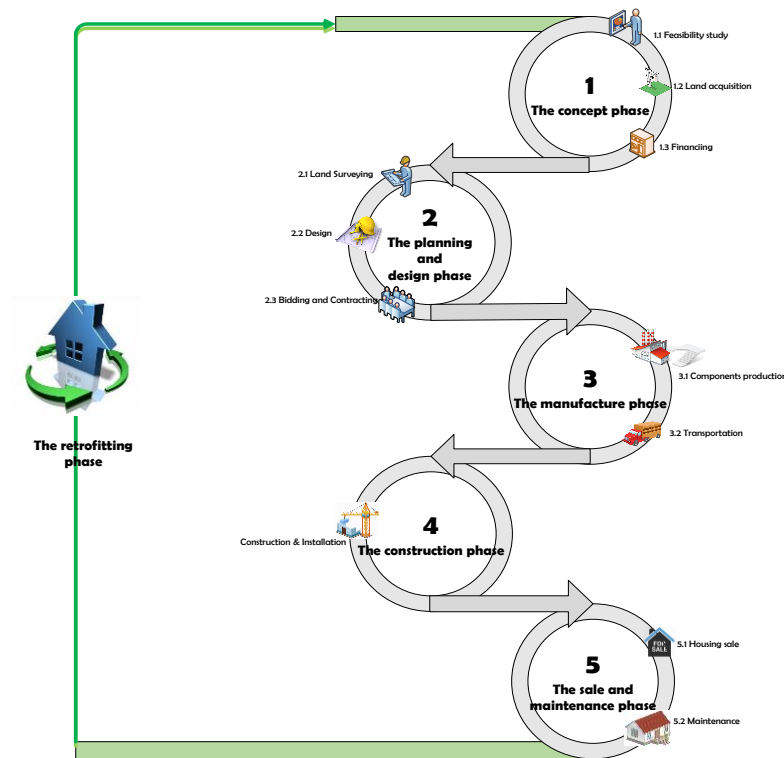


Figure 1. The generic supply chain of PH (by the author)

1. The concept phase

The main tasks in the concept phase including feasibility study, land acquisition and financing.

A feasibility study is the preliminary plan for developer to implement the project. Through this study, the developer can generate conclusions of whether the project is profitable with the assumed market value, taxations, construction cost, or the sale amount, discount rate of the future cash flows and etc.

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The land acquisition can be started if the feasibility study shows that the project is expected to run well on the aspect of environmental, economic and social. Since 2011, the central government decide that there are three major ways to acquire use right of lands, call for bids, land auction and public listing.

Task at the financing stage is looking for investment support. There are five types of financing methods for the real estate development in China based on how National Bureau of Statistics of China categorizes the “sources of funds” in the real estate sector: Land auction and public listing, government investment, bank financing, foreign investment, self-financing and other financing.

2. The plan and design phase

At the plan and design phase, there are four tasks including land surveying, design, bidding and contracting needed to be fulfilled.

Land surveying is one of the most important steps before the engineering design process. This is critical for the nature and the type of the building structure. The conditions of the site, both legal and physical, including geographical and geological factors, should be well investigated before making any decision for a project.

The design stage includes the preliminary design and detailed design. Developers usually hire architects at an early stage to work for the preliminary design. Detailed design for PH projects is more complicated than conventional projects. It inputs customers’ requirements and architectural design, and has two outputs. It is the basis for the manufacturing of prefabricated building elements whilst also producing blueprints for the construction.

The bidding and contracting phase can be organised by the developer on a public or private basis. The first major activity of the contractor is the preparation of tendering and contracting documents, while taking into the nature and requirements of the PH project.

3. The manufacturing phase

After the design is finalized with an architect, construction plans are sent to a factory where the prefab components of the building are erected. This is a new phase that does not exist in the conventional project (Y. H. Pan & Xiong, 2009). Accordingly, there are new stakeholders involved in this phase, such as the prefab components supplier and the logistics for the components transportation. Everything from walls and mechanical systems to painting and carpet can be completed on the assembly line.

Transportation of prefabricated components is the phase that connect the off-site manufacture and on-site construction.

4. The construction phase

Construction is the phase that the main construction activities are carried out and most of the stakeholders are involved. Tasks in this phase including the organization of the construction site, installation and construction work, project progress monitoring and management activities. In this phase, the general contractor is the one that responsible for the construction work and organizing the all the subcontractors.

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5. The sale and maintenance phase

The use right of building is partially transferred to customers after selling. Some real estate companies provide property management services for the residents as well such as safety guards, trash collections, elevator maintenance etc. The residents are charged a certain amount of money on each square meter of property they own.

The identification of stakeholders

The stakeholders in the supply chain of PH are listed in the table 1, and their contractual relationships are clarified as well. The development of PH in China is currently in a transforming stage, so the responsibilities and functions of stakeholders are essentially a mix of traditional and prefabricated.

Table 1. the stakeholders of PH projects

Stakeholder	Selected by	Has contractual relationship with
Developer	Government	General Contractor, Government, Land surveying agency, Supervision company, Consultant, Residents, Property management company
General Contractor	Developer	Developer, sub-contractors, materials supplier
Subcontractor	General contractor	General contractor
Government	-	Developer
Land surveying agency	Developer	Developer
Consultant	Developer	Developer
Supervision company	Developer	Developer
Prefab components supplier	Developer	Developer
Materials supplier	General contractors	General contractors, component supplier
Logistics	Developer	Developer or General Contractor
Financial institution	Developer	Developer
Residents	-	Developer, Property management company
Property management company	Developer	Developer, Residents

- **Developer**

Developers are linking with designers, contractors, government regulatory bodies and the public. They are the sponsors who could integrate resource on the supply chain and work as the main pulling power of PH implementation (Mao et al., 2013). Gibb and Isack (2003) highlighted the significant role of developer in PH-related decision making, who is recognized as the hub of structure, information and management in the supply chain of PH.

- **General Contractor**

In a PH project, general contractor is responsible for the assembly, construction, arranging the project timeline, managing the budget, and working with other stakeholders, including providing the adjusted technology proposal for architecture designer. Compared with conventional construction, the contents of contractors' work in the PH project are reduced, while the requirements on assembly techniques, on-site management ability and the R&D ability are improved.

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- Subcontractor

Subcontractors in PH projects are normally selected by the general contractor. Specialist subcontractors are engaged for technical or specialised works such as interior decoration, landscaping, and sewage systems.

- Government

Varying levels of government are stakeholders in a PH project. State and federal government bodies set standards for fire, safety and other residential and commercial building codes. Local government approves permits for new developments. The government is identified as the major driver for the advancement of PH development in China (Wu, Mao, & Liu, 2015).

- Land surveying agency

Land Surveyor measures and records property boundaries and the topography of the land covered by construction and engineering projects. Surveys are used to establish legal boundaries, prepare maps and exhibits, and are the basis for written descriptions of land tracts that satisfy legal requirements.

- Consultant

Professional consultants play essential roles in PH projects and provide an important link between developer, designer and the contractors. In China, consultants are more involved in the prior stages of projects development, like feasibility study consultant, design management and critique, development cost planning and control, and construction contract administration.

- Supervision company

The role is primarily to represent developer for ensuring the contractors' materials and workmanship are in accordance with design specifications and mandatory national construction quality standards.

- Prefab components supplier

The component supplier is a new role in PH project compared with conventional project. They produce the prefab components or units according to the requirements of the detailed design from the designer.

- Materials supplier

Material supplier provides all necessary materials for a project, including raw construction materials, semi-manufactured materials, decorative materials. In a PH project, the general contract will decide the materials supplier for on-site construction, while the component suppliers will select professional materials suppliers for the factory production.

- Logistics

The main task of logistics company in PH project is delivering the prefab components from the factory to the construction site with professional transportation and labour. Logistical aspects determine the project planning and an efficient supply of components is the main performance indicator of the process.

- Financial institute

For a construction project, the financial institutes can be a bank, a trust companies or an Asset-management companies. In China, bank loans continue to be the primary financing tool for most local construction projects.

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- Design institute

Design institute is responsible for the planning and design, cooperating with the contractors to improve the plan and the techniques. For a PH project, design is the precondition of procurement, manufacture and construction, which means that the design should be modularized and standardized. The importance of design institutes in PH project has been raised due to the higher requirements for integrated design.

- Property management company

Property management for PH project involves the processes, systems, and manpower required to manage the maintenance of prefabricated property. Compared with conventional residential project, property management company need to have more clear understanding about the function of the PH product as well as the information of prefab components. The role of property manage company in PH projects starts to be played from the pre-sale stage.

- Residents

Residents are people who buy the PH and have the property right of it. Not like people in developed countries who choose to build their house in prefabricated way, residents in China only have right to decide whether they will buy the prefabricated dwelling or not.

TCs in the supply chain of PH

Having get a clear understanding of how the supply chain of PH is formed and implemented, an exploration of how and when the TCs are occurring along the supply chain is followed.

Transaction costs are rarely measured in building development processes. If transaction costs are at all quantified by the different parties involved, they are usually put as a non-specified item on a balance sheet—like, for example, ‘administrative costs’. Here, this study uncovers those fuzzy and ignored part of the cost, and specifically identifies the transaction costs along the supply chain. This is a necessary step before the TCs can be measured. The TCs that are identified below are mostly research cost, information costs, analysis costs, decision costs, institutional-arrangement costs, evaluation cost, and so forth (K. Q. Qian, 2012).

Content in Table 2 to Table 6 list the tasks in each phase of the PH supply chain, the TCs during the process to fulfil the tasks, and the stakeholders who generate and bear these TCs.

1. The concept phase

Table 2. TCs in the concept phase

Tasks	TCs	Generated by	Borne by
Feasibility study	• Identify the project	Developer	Developer
	• Identify special partners with PH experience	Developer	Developer
	• PH Project Complexity and Risk Assessment	Developer	Developer
	• Consultant fee	Developer	Developer
	• Study costs	Developer	Developer
	• Decision making fee	Developer	Developer

Land acquisition	<ul style="list-style-type: none"> • Response to extra policy requirements on PH projects • Organize the land bidding • Preliminary land survey • Sign the contract • Permit costs 	Developer Government Developer Government Developer	Developer Government Developer Government Developer
Financing	<ul style="list-style-type: none"> • Find an appropriate financial institution • Provide convincing evidence to prove that the PH project has a good profitability; • Predict the market recognition of PH project. 	Developer Developer Financial institution	Developer Developer Financial institution

By the author

1.1 Feasibility study

To accomplish a feasibility study, labour costs and time are largely consumed to identify the project, stakeholders and all other information. For PH project, complexity and risk assessment is necessary at this stage since it has more complicated technologies that their staff are not familiar with. As the initial client of the PH project in China, developer invests more money, labour and cost to evaluate the project's profitability. In addition, costs for extra consultant with experts are also paid by the developer. And extra time, labour and cost are consumed by decision-making at this stage, because of evaluating and considering the adoption of prefab technologies.

1.2 Land acquisition

To acquire the construction land, the developer of PH project has some different tasks compared with conventional project. Bidding for the construction land requires not only the price but also the project conceptual design, with the support of the preliminary land survey. Besides, the government normally requires the proposed buildings to be built using prefabrication technologies, and certain prefabricated rate (like >5%) will be required. Then extra efforts are needed to be borne by developer to response to these extra requirements. There are also costs paid by the developer to get a construction land-use planning permit from the responsible Urban Planning Department and a land-use title certificate from the local branches of the Ministry of Land and Resources.

To promote the wider adoption of PH, the government also has to pay extra efforts. For instance, the local governments give priorities to enterprises that are using prefabricated technologies, which encouraged developers to build PH but decreased the income that government can get from land. In addition, both the land owner (mostly government) and the developer have to pay more on contract design, negotiation, decision and contract sign.

1.3 Financing

For PH project, due to its innovative characteristics, more efforts are needed to be paid by developers to increase the possibility to get investment or loan from finance institutions. A convincing evidence, such as feasibility study or economic report should be provided by the developer to prove that the PH project has a good profitability. Meanwhile, the financial institutions need to consider the extra risks of PH project when they do the assessment for a

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developer. It means that they also need to collect market data about PH and predict the market recognition of PH project.

At the end of the concept phase, there is a time and cost consuming task has to be finished, getting an approval of the project business proposal from the national or local Development and Reform Commission.

2. The plan and design phase

Table 3. TCs in the plan and design phase

Tasks	TCs	Generated by	Borne by
Land surveying	<ul style="list-style-type: none"> Select the land surveying agency Information collection and analysis 	Developer Land surveying agency	Developer Developer
Design	<ul style="list-style-type: none"> Select the design institute Professional consultant Frequent communication between the developer and the designer Permit costs 	Developer Developer Designer Developer	Developer Developer Developer Developer
Bidding and contracting	<ul style="list-style-type: none"> Organize the bidding for the general contractor Set up the PH project organization Assessment of the comprehensive ability of tenders Propose special technical solution for prefabricated parts Organized the construction team, including sign contract with sub-contractors Permit costs 	Developer Developer Developer General contractor General contractor Developer	Developer Developer Developer General contractor General contractor Developer

By the author

2.1 Land surveying

TCs at this stage appear on the aspects of land surveying agency selection and information analysis. For the information collection and analysis, the PH project has more restrict requirements on land situation, and different conditions affect the entire development plan and are worth analysing.

2.2 Design

Due to the adoption of prefabricated technologies in the project, the developer needs to select designer with special qualification that are required by the government. It is noticed that there are only few design institutes in China now have qualification to design for the PH project, means that higher designing fee will charged by these companies. At the design stage, external consultant is also necessary for market and economic analysis. Due to the complexity of components' design itself, more frequent communication between the developer and the designer are needed (Fagerlund, 2001). When the design is finished, the developer is responsible to obtain an approval of the construction project planning and design plan from the responsible Urban Planning Department.

2.3 Bidding and contracting

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a bidding process is organized by the developer to select the general contractor. Professional specialists in PH field are needed to be engaged to evaluate the bidding files. The tender documents from contractor include special construction schemes for prefabrication implementation, technical drawing, project specifications and other particulars. During this process, the contractor candidates need more time and experienced quantity surveyors to do the cost estimation. Once a contractor candidate is selected as the general contractor, there will be more negotiations between the contractor and the developer to design the specific contract items about the execution of the PH.

3. The manufacturing phase

Table 4. TCs in the manufacturing phase

Tasks	TCs	Generated by	Borne by
Component production	<ul style="list-style-type: none"> Hire skilled labour Technical instrument for manufacture Frequent communication between component supplier and the designer Regular supervision Component quality test 	Component supplier General contractor Component supplier Supervision company Developer	Component supplier Developer Component supplier Developer Developer
Transportation	<ul style="list-style-type: none"> Risk of delivery time delay Coordinating among the component supplier, logistic company and the general contractor 	Logistic company Component supplier	General contractor General contractor

By the author

3.1 Components production

The production of prefabricated component has higher requirements on the workers, therefore workers with experience on PH are needed. During the manufacturing process, technical instruction should be provided by the designer. Costs for it are already included in the payment for the designer from the developer. To maintain a high level of quality control, regular supervision and final quality test are all needed, and costs for it are eventually borne by the developer.

3.2 Transportation

Different with the construction materials transportation, the transportation of prefab components is more complex and professional. It has a higher requirement on loading, shipping and unloading process. Any delay in delivering precast components to a construction site will delay the construction processes and increase costs. On the other hand, early production of building elements when they are not needed increases the storage costs. Thus, there should be intensive communication among the logistics company, components supplier and the general contractor to make sure that the supplement can meet the needs of on-site working.

4. The Construction Phase

Table 5. TCs in the construction phase

Tasks	TCs	Generated by	Borne by
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Construction	<ul style="list-style-type: none"> • Insurance • Hire skilled labour • Education costs • Monitor the construction activities • Negotiation with stakeholders • Design change • Quality acceptance of the PH project • Permit costs • Risks 	<p>General contractor General contractor General contractor Supervision company General contractor Designer Developer Developer General contractor</p>	<p>General contractor General contractor General contractor Developer General contractor Developer Developer General contractor Developer</p>
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By the author

Construction is the period where most of the production costs occurred, along with TCs. For construction activities, insurances for property, labour and the projects are required by law. For the specific installation work, labour with high professional skills are needed, which means that the general contractor pays for hiring skilled labour or extra workers' education cost. All the extra costs are paid by the general contractor but will eventually be borne by the developer.

The designer of PH project will more frequently participant in the construction process to assist the on-site assembly work. The supervision company supervises and coordinates the production work both in the factory and on site, supervising the whole construction process in terms of schedule, quality, and cost. The inspection of the construction work is regularly carried out by the developer's representative, and the project supervising agency. The Quality and Safety Monitoring Office may conduct random on-site inspections. Besides, the general contractor also borne the force majeure risks, including the weather risks, policy risks and other risks, which may be borne by the general contractor or the developer.

The permit costs at this stage including a certificate of safety operation from the Safety and Quality Supervision Office of the responsible local Construction Commission, a construction permit from the local Construction Commission and a construction project planning permit from the responsible Urban Planning Department, with joint review and approval by other government authorities including: Environmental Protection Authority, Land Administration Authority, Construction Administration Authority and Fire Protection Authority.

5. The sale and maintenance phase

Table 6. TCs in the sale and maintenance phase

Tasks	TCs	Generated by	Borne by
Housing sale	<ul style="list-style-type: none"> • Identify the potential house buyer • Advertising fee • Contract signing • Permit costs • Taxation 	<p>Housing sale agent Housing sale agent Housing sale agent Developer Developer</p>	<p>Developer Developer Developer Developer Developer</p>
Maintenance	<ul style="list-style-type: none"> • Educate the public • Periodic maintenance 	<p>Property management company Property management company</p>	<p>Property management company Property management company</p>

By the author

5.1 Housing sale

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Housing sale agent is responsible for the sale of the PH project, but most of the TCs at this stage are paid by the developer. There are various activities at this stage can cause TCs, including: market survey, advertising, property sales brochures, site advertising and billboards, general publicity, gifts and other activities to support the contract signing. In addition, whenever the properties generate incomes the taxation comes along, which includes the business tax, city maintenance and construction tax, educational surtax, land added value tax, property tax and income tax.

5.2 Maintenance

When it comes to the maintenance stage, the property management company starts to take the responsibility to maintain the operation of the prefabricated building. Not too much transaction happens at this phase, therefore fewer TCs exist. The using of PH is a bit different with conventional housing, education on the aspects of indoor decoration, maintenance of bathroom and kitchen is necessary. Costs for the public education and buildings' periodical maintenance are borne by the property management company.

Discussion and Conclusion

To improve the governance of the supply chain of PH and to make the implementation of PH project more financially attractive, transaction costs during the whole development process of PH must be better understood and ultimately reduced. The list of TCs are identified by literature study in this study, and their nature are elaborated along the supply chain. There are some rules that can be concluded from the identification of TCs in the PH supply chain:

- About stakeholders: Almost all of the stakeholders have possibilities to generate redundant TCs during the implementation of PH, but not all the stakeholders bear the TCs. According to the contractual relationships, the developer and the general contractor are the roles that have more contractual relationships with others, they are therefore more likely to bear more TCs.
- About the phases and tasks: The conceptual phase and the construction phase are identified as the stages where majority of TCs occurred. It is because at the initial stage of a PH project, more preparation work such as market analysis, information collection, co-operator identification and consultants are needed, therefore more TCs appear. In the construction phase, most of the TCs appearing due to the fact that both the developer and the contractor are unfamiliar with the concept, technologies and other matters related to PH, such as forms of collaboration and working processes (Kiss, 2016)
- About the TCs identification: It is noticed that costs of permit and approval are throughout the whole supply chain of PH project. Without proper approvals, it is almost impossible to undertake a building project in China. Dealing with construction permits is a time-consuming and bureaucratic process in China. From planning, design, function, construction, pre-completion sales, to completion sales and registration, each one of these elements is subject to the approval and permission of different government authorities, from local to central level. Another finding is that communication costs take place in every phase, especially when there are any key changes in the nature, size and function of the PH project.

This study builds the generic supply chain of PH in terms of stakeholders, stages and tasks. Tasks of different stakeholders are described at five phases: the conceptual phase, the planning and design phase, the manufacture phase, the construction phase and the sale and maintenance phase. Based on that, the TCs items along the supply chain are identified, while the content of all TCs are explained and the stakeholders that borne the TCs are identified as well. It is noticed that the developer and the general contractor are the payers of most TCs although some of the TCs are not directly caused by them. It is also found that certain sources of transaction costs, for example permit costs and communication costs, can arise throughout the supply chain of PH project, while TCs like monitoring is more typical occurred in the manufacturing and the construction phase.

Providing a theoretical foundation for TCs understanding in PH field, this research is expected to help researchers go further to empirically explore the scale of TCs in the PH supply chain. In practice, it may also provide a guidance for enterprises to rethink the implementation of PH, giving the inspiration on strategies planning to reduce the TCs.

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