# Risk Analysis and Research of Construction Supply Chain

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**Abstract.** Supply Chain Management (SCM) is increasingly being used in various departments as a result of the development of global economic integration and manufacturing globalization. The construction industry is massive and the complexity of its supply chain poses some risks. According to research findings, the right information sharing, effective program monitoring, open communication channels, good corporate reputation, timely purchase of insurance, and use of innovative technology is a key weapon for dealing with construction industry supply chain risks. When selecting risk response measures, supply chain managers should prioritize risk avoidance, risk control, risk retention, and risk transfer. This article describes the internal and external hazards of the construction supply chain. Statistic and analysis of related papers. It also describes the concept and definition of construction supply chain risks, as well as a systematic review of relevant domestic literature. The risk research gap of construction supply chain is analyzed and provides a basis for future empirical research.

**Keywords:** Construction, supply chain management, risk, literature review.

## 1. Introduction

### 1.1. Research background and significance

The construction sector includes a variety of tasks including building infrastructure, homes, decorating, and installing. It serves as a significant economic engine for the country. The need for supply chain risk management in construction emerged between the turn of the 20th and the beginning of the 21st centuries. The supply chain for the building has a role in product supply. Services to encourage the construction industry's high-quality growth. Because most construction projects take a long time to complete, have complicated building processes, require a substantial investment, a large workforce, and expensive materials, among other factors. The supply chain becomes multi-pointed and multi-forked as a result, increasing overall risk. If supply chain risks in the construction industry's subsystem are not appropriately managed, it will stymie project progress; quality cannot be assured; contractor management expenses will rise; profit will be lost, and so on. As a result, it is critical to examine and outline risk management strategies throughout the building supply chain.

### 1.2. Research content and framework

The author of this paper made the following contents on the basis of a large number of previous literatures: first of all, the paper on the construction supply chain risk is analyzed statistically. Secondly, described the concept connotation and characteristics of the construction supply chain. Next the paper summarized and subdivided the risks of construction supply chain. The author the main methods for identifying construction supply chain risks and focus on the characteristics of each and the advantages and disadvantages of the analysis. After that we describes the domestic corresponding methods of existing construction supply chain risks. Discuss the countermeasures for risks in different situations and author's own thinking. Finally, based on the current situation of the domestic construction industry. This article will look at the supply chain perspective, summarize known risks and management measures in the construction industry and make some outlook for the risks that may arise in the future.

## 2. Supply chain risks in the construction industry

This article uses the CNKI database searched all research papers on construction supply chain risks. All academic papers in national that contain these terms in their titles, abstracts, keywords and topics were searched. The deadline for publishing articles is set for December 31, 2022 and a total of 108 papers were identified. After additional screening and reading of the abstract and full text of each paper, a total of 102 papers on construction supply chain risks were found. The distribution of these papers by year is shown in the figure:

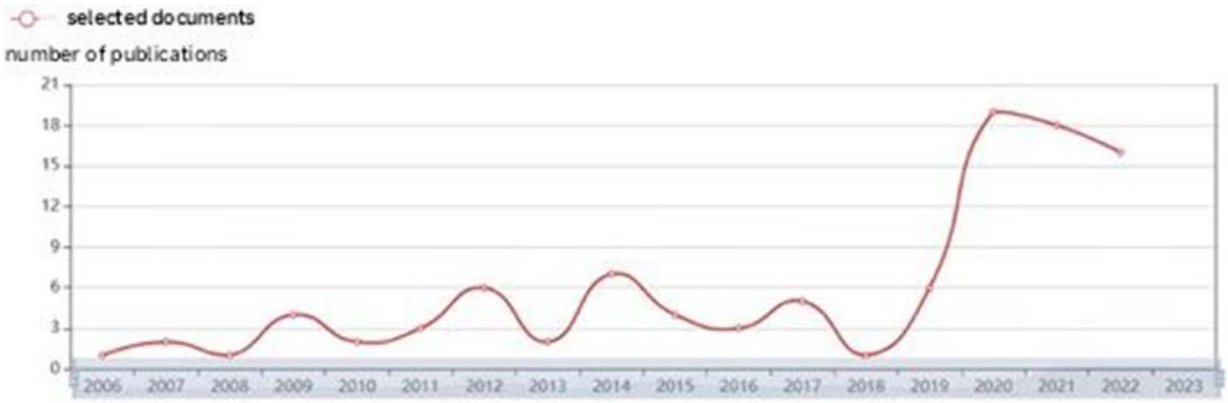



**Figure 1.** 2006-2022 Number of papers related to construction supply chain risks quantity line chart

Fig 1 shows that building supply chain risk at the beginning of this century is a new area of research. The number of published papers is small, but since 2019, the number of papers has increased significantly. This may be related to the impact of the global COVID-19 pandemic. The downturn in the global market for the construction industry and the increasing difficulty of enterprise operation. In particular, upstream supply chain enterprises represented by building materials suppliers are difficult to continue operating, global supply chains have become more fragile. As a result, it is more and more important to study the risk of construction supply chain which is mainly aimed at dealing with supply chain disruption. The number of related papers has increased dramatically in recent years, it shows that the research field of construction supply chain risk has received extensive attention from domestic scholars. Therefore, summarizing the construction supply chain risk related papers has important theoretical and practical value.

Based on 102 literatures retrieved from CNKI, this paper systematically reviews the risks of construction supply chain, including the definition and classification of construction supply chain risks, research methods and theoretical applications of construction supply chain risks, analysis and comparison of internal and external risks in the construction supply chain, thereby clarify the development of the field, provide a solid literature foundation for future research in this field.

## 3. Risk analysis of constrution supply chain

### 3.1. The concept of supply chain in the construction industry and risk implication

The construction industry supply chain is a special part in the supply chain system. These years have witnessed three stages of change in the definition of supply chain. Initially, supply chains were thought of a subsystem in manufacturing by most people [1]. In the late 1980s, a group of academics broadened the definition. They stressed the external environmental factor of the enterprise and the coordination of the various parts. Graham C. Stevens an American scholar was a typical representation of such idea [2-3]. In the very late 20th and early 21st century, the network chain relation between the core enterprises and the surrounding enterprises in the supply chain was taken seriously. Ma proposed that supply chain was a whole functional network [4]. To sum up, the construction industry supply can be translated to an organic network. The network takes specific

needs of the project as a starting point and is central to total contract construction enterprise, connected by various kinds of information chains, ecosystems of gadgets, financial flows. Sub-contractors, engineering consulting companies, suppliers of civil construction equipment, design firms, material providers, owners are its participants. Some uncertainties are not conducive to the operation of the whole system. They can be called risks of the construction industry [5].

### 3.2. Kinds of risk

According to the characteristics of building industry, Wang et al. divided construction industry supply chain into inner risks and external risks [6-7]. External risks mainly include macroscopic policy risks: natural risks and market risks. The internal risks are broken down into four categories: management, material resource, information and system risks. In this paper, countermeasures of inner and external risks will be discussed. The following is a brief description of different risks included.

(1) Policy Risk: Huang et al. believed that the risk can be concluded as a series of uncontrolled factors covering all respects of the business. These factors are usually brought by policies and regulations related to construction and changes in the macro environment [8-9].

(2) Natural Risk: Ding et al. hold the view that activities doing severe harm to the economy can be called natural risks [10-11]. Usually, natural disasters cause these activities. Here are mainly refers to anomalous climatic phenomena and geological hazards such as floods, tsunamis and earthquakes.

(3) Market Risk: The risks mainly refer to aberrations in supply and demand, together with highly competitive market. Cao points out that supply chains are guided by market demand. Also, the intensification of the market competitions fueled uncertainties of consumer's preferences and needs [12].

(4) Management Risk: Sun emphasizes that inadequate management contributes to a growing number of uncontrollable elements in the supply chain [13]. For instance, breakdowns and poor willingness in communication lead to the discontinuity of the project schedule; gaps in construction quality plus period make project quality drops and the operation of supply chain nodes remains fragmented; negligence of the supervision company may also result in disordered logistics in the supply chain.

(5) Material Resource Risk: Sun measures the risk by suppliers' on-time delivery rate, products passing rate and order fill rate. The efficiency of the supply chain can be influenced by the indicator level [14].

(6) Information Risk: Such risk can be triggered by the information transfer. Chen believes that tiny information errors may be constantly amplified when workers are passing along information. This is because construction supply chains feature extensive services and a great number of nodes [15]. Such phenomenon can be concluded as bullwhip effect.

(7) System Risk: The risks are categorized as system redundancy, lack of flexibility in the supply chain, poor credit of co-operations and so on by Wang et al [16].

### 3.3. Risk management

#### 3.3.1. Overview of risk management measures

Lyu and other scholars point out that measures aimed to different risks in the supply chain can be divided into four general categories in a macroscopic level, risk aversion, risk control, risk retention, risk transfer. A single specific risk prevention measure is essentially a single or multiple embodiments of these four types of preventive measures [17-18].

#### 3.3.2. Methods for dealing with external risks

Policy risks have an adverse effect on the operation of the supply chain macroscopically. Zhao et al. proposed that construction firms and logistics companies should increase the focus on the macroscopic policies and micro-level precautions in order to avoid such risks effectively. Moreover, they also believe that strengthening the study and the practice on the latest professional norms is a sensible choice [19]. In fact, research into dealing with such risks is limited. This paper presents some

measures which have something in common with the countermeasures for construction risks. For one thing, the contractors should actively communicate with the local government. Also, they are supposed to understand specific transportation policy adopted during the time frame, plus red lines that cannot be crossed in the supply chain operation. For another thing, warning mechanism and precautions should be worked out after the policy information is transferred to employees responsible for different parts of the supply chain.

In terms of handling the natural risks, Li et al. group the risks into three categories: abnormal climates, adverse geological conditions, lack of superior geographic position. To weaken the first two risks, the engineering project insurance is proposed. The insurance enables managers to transfer force majeure to the relevant third parties. Besides, Li believes that careful geography investigations should be carried out in the beginning of the planning process of a project. And managers are supposed to formulate a site location strategy so as to secure a proper geographic position [20].

Jie Wang et al. put forward that the Marketing Department in the enterprise should play a guiding role in addressing the market risk. That means that the Marketing Department is responsible for conducting market research on the tastes of customers and customer behavior. Meanwhile, building up market-research departments in the enterprises in supply chain is advised to minimize adverse risks from the market [21]. Wang and others offer their ideas from two viewpoints, one industry chain and the other market products. Specific measures included: the construction firms develop towards the upper level; building materials enterprises should be founded; managers are supposed to improve the supply chain management system; the government should institute a number of incentives and put more stringent regulations in place, and promote new construction techniques. The prefabricated element supplier should make attempts to develop the latest technology [22].

### 3.3.3. Comprehensive prevention for the inner risks

Management risks should be prevented from a number of angles. Firstly, supply chain managers should improve the managing ability. For example, they are responsible for obtaining information about the whole chain operation. Also, these managers should carefully deal with coordination of people and resources in order to advance the organizational efficiency. Secondly, the construction firms should grasp opportunities to step up changes with suppliers and outside partners. Last but not least, the enterprise of supply chain should set proper objectives and work out reasonable production schedules. Such measure is aimed to bring resources advantages into full play. Efficiency and performance should also be stressed during the process.

Effective precautionary measures targeting at material resource risks can help to ensure the process of the project and control costs. The tactics are as follows: administers' overall quality should be enhanced; logistics companies should implement production logistics intellectualized monitoring and transfer to an integrated logistics management system under supply chain.

In the face of information risk, information risk assessment can promote the establishment and improvement of information transmission architecture, establish the architecture capability framework and core business processes. Strengthen daily supervision through internal control mechanisms, strengthen the implementation of risk control measures in combination with confidential inspection and other means. Duplicate problems found in the confidential inspection, verify the rationality and effectiveness of strategies and systems, and to improve and revise. Enable preventive management ensure business continuity at the same time. Review and authenticate information. Further examination of the information that has already been screened, determine its authenticity and reasonableness. The enterprise shall check the information for errors in fact and time, whether it is logical, whether the source unit number of copies of data and index, etc. are complete. Through an external messaging architecture, companies need to strengthen communication, ensure the accuracy and timeliness of information. Minimize losses from the bullwhip effect in the face of the bullwhip effect. People can strengthen collaboration across the supply chain; building partnerships based on mutual trust; forming a fast, effective and lightweight consumer response mechanism; shorten the lead time with scientific inventory management methods [23].

As for the system risks, numerous scholars offer various countermeasures by different point of

view. Cao et al. argue that risk retention produces positive effects on the supply chain when the risks hang over the system. Key measures to prevent such risks include: design multi-tier supply chains to maintain certain flexibility, maintain par stock level, develop a smooth two-way flow of information, make necessary organization structure reengineering according to the characteristics of different projects, remove the drudgery, and so on [24]. Mei and other scholars take the perspective of "trust", They study the precautions regarding to co-operation in the construction supply chain. Their ideas are listed as follows: enhance the comprehensive strength of the construction firms, improve contract mechanism with various nodes enterprise in supply chain, set a good corporate image, maintain sound corporate reputation, promote information sharing between enterprise and enterprise or among enterprise and government, establish and consummate the laws and regulations [25].

## 4. Conclusion

The paper first describes the use background of supply chain management (SCM). And then presents the importance of construction supply chain risk management and the fundamental connotation of the supply chain in the building industry. Thereafter, the paper lists common risks in the construction supply chain both from an internal perspective and an external one. Next, precautions for various specific risks in the construction supply chain are offered according to a number of different scholars' perspectives. This paper investigates and analyzes systematic preparedness measures targeted at construction supply chain risks. This can help managers further optimize the supply chain operation, and enhance their comprehensive competitiveness.

In this paper, the authors reach two principal conclusions after making systematic document reviews.

(1) Although sometimes scholars' views on preventive methods seem to be quite different from one to another. It is commonly agreed that sharing of correct information, effective monitoring of supply chains, smooth communication channels, good reputation for the enterprise, adequate insurance, novel applications of new technology are keys to dealing with various construction supply chain risks.

(2) Risk aversion, risk control, risk retention and risk transfer are the main macroscopic tactics to address risks in the supply chain. Managers are supposed to give priority to taking these measures when faced with different types of risks.

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