

Research on the Key Path of Green Construction Implemented by Multi-Subject Cooperation in Construction Enterprises

Qianwen Wen*, Fanwen Kong

School of Management, Shenyang Jianzhu University, Shenyang, Liaoning, China

**Corresponding Author*

Abstract: Global change, mainly characterized by global warming, has had a huge impact on the earth system and social and economic development, and has become one of the major challenges to the survival and development of human society. And the world is also facing energy shortage, in this context, China in the seventy-fifth session of the United Nations general assembly "double carbon" strategic target, "double carbon" strategy advocating green, environmental protection, low carbon way of life, the construction of a resource-conserving and environment-friendly society is defined as a long-term strategic task in the medium-and long-term planning of national economic and social development. Construction as a domestic pillar industry, promote the transformation of industrial structure which is imperative. Among them, the promotion of green construction mode is of great significance to accelerate the transformation of the construction industry. This paper involves the related subject from the concept of green construction, determines the main collaborative target, analyses the relevant subject in the project planning, design, material selection and construction stage, explores the main path of green construction, so as to analyze the key path, on the basis for the government and enterprises to promote green construction way.

Keywords: Green Construction; Multi-Agent; Synergy; Key Path

1. Introduction

The world is in a crisis of ecological resources and the environment unprecedented in human history. The construction of a global ecological civilization requires the joint efforts of all countries in the world, and mankind needs to

raise awareness of resource and environmental protection. In the face of global challenges, all countries share a common destiny and need to work together to overcome difficulties. Nowadays, the pressure of energy shortage and environmental deterioration is increasingly prominent, and the huge energy consumption of the construction industry has become a global consensus. According to the "China Building Energy Efficiency Annual Development Research Report 2022" shows that in 2020, the global construction industry energy consumption accounts for 36% of global energy consumption, of which the building construction stage energy consumption accounts for 6% of global energy consumption, and the building operation accounts for 30% of global energy consumption; In 2020, the global construction and construction-related carbon dioxide emissions will account for 10% of the global total CO₂ emissions, and the building operation related carbon dioxide emissions will account for 27% of the global total CO₂ emissions.

According to the data, the traditional real estate construction model is becoming more and more difficult to sustain, and the implementation of green construction methods is an inevitable trend. The engineering construction problems, environmental protection problems, and the optimal utilization of resources and energy problems involved in the traditional construction process can be solved by green construction methods [1]; Analyzed the development path structure of green construction from the perspectives of direction elements, power elements, basic elements, supporting elements, benchmarking elements, and found the path characteristics of green construction development in policy guidance, system innovation, standard specification, technical map and typical demonstration [2]; analyzed the underlying

logic of green construction development from the perspective of man-machine material method and ring construction elements, and proposed the implementation path of green construction development from the perspective of the whole life cycle of construction [3]; In the context of industry 4.0, we will integrate technology and modern management methods for collaborative innovation, and then reconstruct the production organization mode and value creation mode of the construction industry, so that the construction industry can develop in a sustainable direction [4]. Existing literature for green building development has a certain research, but no scholars from the construction of the whole life phase of the subject synergy, in this paper, respectively, the green planning, green design, green material selection and construction three phases of the main path analysis, on the basis of summarizing the key path of collaborative implementation of green construction.

2. The Concept of Green Construction and Related Subjects Constitute

2.1 Concept of Green Construction and Related Main Components

The connotation of "green" in green construction, which not only reflects the concept of environmental friendliness, low-carbon, saving, environmental protection and sustainability, but also includes the connotation of symbiosis, health and harmony with human beings. [5]. Green construction refers to the whole process of project planning and design, material selection and construction, use and demolition, under the premise of ensuring the quality of building products, improve production efficiency and resource utilization rate through scientific management methods and innovative application of green technology, and reduce unnecessary resource waste and environmental pollution caused in the construction process as much as possible. To achieve sustainable development of engineering construction production activities. [6]. Green construction involves a large number of subjects. This paper obtains the composition and functions of relevant subjects from each stage of the green construction process, as shown in Table 1:

2.2 Coordination Goal

2.2.1 Quality goal

Quality is the most basic requirement of green building products, is the most concerned issue of stakeholders and consumers, directly related to people's lives and property safety, must strictly control the goal. At the same time, the quality goal is also the core element of the development and promotion of green building. The quality of green building products not only includes the aesthetic appearance of the building, the level of seismic performance, etc., but also includes the level of other green performance such as energy saving, emission reduction, recycling, noise reduction, etc.

2.2.2 Cost objective

In the process of green construction, the degree of cooperation among various subjects is low, and the accuracy of information transmission is low, which will produce unnecessary deviations and cause cost increase. The target control of green construction synergistic cost can be divided into two aspects: reducing cost and improving synergistic incremental benefit. In terms of cost reduction, the green construction method aims to improve the quality level, environmental protection level and safety level and speed up the construction progress with lower cost, mainly reflected in the green design stage and green construction stage. In the green design stage, the design unit and the construction unit and material suppliers, consulting units and other subjects through professional management systems and information systems to maintain professional and technical information interoperability, timely understanding of the market price of environmental protection building materials and the actual grasp of green construction technology, can make the cost budget of the design scheme can be effectively controlled. In the green construction stage, the use of building materials is strictly controlled according to the design scheme, and the deviation between the actual material expenditure and the planned material expenditure is corrected in time to achieve the purpose of saving resources and reducing costs.

In the aspect of synergistic incremental benefits, synergistic incremental benefits can be presented in various forms, and eventually tend to economic benefits and social benefits.

In the early stage of green design, the service life and regeneration performance of green building materials should be fully considered, the service life of the building should be extended, and the costs required for later operation and maintenance should be reduced. And green building materials waste can be treated as resources and then put into the market again to maximize resource utilization, thus reducing green construction costs. When the construction product is completed and

delivered, if the product quality reaches the green building star standard, the corresponding star subsidies can be obtained according to different stars, which reduces the construction cost in disguise. The long-term economic benefits such as brand effect, corporate reputation and so on brought about by the collaborative development of green construction industry chain also enable construction enterprises to achieve better development.

Table 1. Green Construction Related Main Body Composition and Functions

node	enterprise	function
Planning programming	Relevant government departments	Supervise the whole process of the project according to the requirements of national and regional policies and standards
	Estate enterprises	The initiator of the construction project shall coordinate with other enterprises in the construction industry and coordinate the whole process of construction and development
	Design organization	Carry out the scheme design, preliminary design and construction drawing design
	Consulting unit	Assist in the project preparatory work and provide professional suggestions
	Credit institution	Integrate resources, invest in the development and construction projects
Material purchase	Building materials enterprises	Provide the building materials and equipment required for the construction project
	Equipment supplier	
	Transportation enterprises	Transport the construction purchased materials and equipment to the site
Building operations	Survey unit	Responsible for the construction and management of the whole process of the construction, to ensure the quality and progress of the project construction
	General contractor for construction	
	Supervision unit	
	Decoration unit	Responsible for the interior and exterior decoration of the building

2.2.3 Progress goal

The progress goal is a dynamic adjustment process. Each subject should grasp the information about the progress of equipment and materials procurement, inventory status and the actual status of the project in real time, and make the production and construction process orderly and reasonably coordinated in the supply of equipment and materials, transportation process and construction site layout through a high degree of cooperation. When it is found that the actual schedule is

inconsistent with the schedule plan, find out the root cause of the problem in time and solve the problem, and work together to achieve the schedule target of the project, so as to prevent the time difference caused by the information asynchronism, resulting in the delay of the construction period and eventually the loss. At the same time, with the help of green construction technology, the use of technology to reasonably compress the construction period, control to achieve the maximum benefit target.

2.2.4 Safety objectives

Safety objectives are the basis for the realization of other objectives, and are the most basic requirements for construction production. In the whole construction process, ensuring the life and health of the staff is of great significance for improving the efficiency of green construction. It is necessary to conduct targeted safety education and training for the staff of various professional departments in advance, and only after passing the education inspection can the construction be carried out. During the construction process, regular training will be conducted according to the safety training and education plan. The project manager of the construction unit assumes the main safety responsibility, the technical chief engineer is responsible for the implementation and review of safety technology, and the full-time safety management personnel are set up on the construction site to be responsible for safety management and supervision. The construction unit, the construction unit and the supervision unit shall conduct regular inspections, inform the person in charge of the construction site of safety problems in time and rectify them in a timely manner, and cooperate with each other to complete the rectification within a limited period to avoid the fermentation of hidden problems. Staff perform their own duties, and timely communication to solve problems to ensure the safety of the entire construction process.

2.2.5 Environmental resource objectives

One of the main purposes of implementing green construction methods is to protect the environment and save resources. The main difference between the green construction goal and the traditional construction goal is that under the guidance of the concepts of environmental protection and resource conservation, the green construction goal is to realize the green construction process and build green buildings, and formulate feasible architectural design plans. Other subjects cooperate and supervise each other, and take into account environmental protection and resource conservation on the basis of ensuring the quality of the project. Promote the development of the entire construction industry in a sustainable direction, and promote the harmonious coexistence of man and nature.

3. Multi-Subject Implementation of Green Construction Implementation Path

3.1 Green Planning Stage

In the green planning stage include project investment, project scale, project use, project site selection, environmental assessment, benefit analysis, administrative approval, bidding and bidding, etc. In carrying out the above work, the principles of simplicity and efficiency, health and comfort, integrity and environment should be followed. [7]. In this stage, the collaborative subject is the construction unit, and other relevant subjects are: project investors and construction units, end users (consumers, users), relevant government departments, credit institutions (banks, creditors, etc.), design units, consulting units, and general construction contractors. As the initiator and organizer of the project, the construction unit should first clarify the construction purpose and target users of the construction project, cooperate with the consulting unit to conduct feasibility study, benefit analysis and environmental contribution assessment, and propose a recommended plan on the basis of determining the project feasibility. The investment unit and relevant units shall provide financial support after the project plan is evaluated and approved. After the implementation of the project funds, coordinate with the relevant government departments to handle the project approval, and issue the bidding documents to select the appropriate design unit construction general contractor.

3.2 Green Design Stage

Green design is an important stage to achieve green construction. [8]. The design unit is the collaborative subject in this stage, and the other relevant subjects are: the construction unit, the end user, the supervision unit, the general construction contractor, and the material supplier. First of all, the design unit needs to clearly define the green construction objectives of the construction unit and the needs of the building products to design the planning scheme and construction scheme, and adjust the design scheme according to the demands of the owners in green construction. When carrying out green design work, we should refer to the "Green Building Evaluation Standards" GB/T50378-2019, green

construction standards and other requirements to meet the green building design evaluation standards. The design unit shall actively communicate with the supervision unit, and the project supervision personnel shall be responsible for checking whether the project design meets the quality standards of construction projects or the quality requirements agreed in the contract. If there is any non-conformity, the design unit shall be required to correct it. At the same time, it is necessary to pay attention to the coordination between the design unit and the general construction contractor and the material supplier, the information management technology mastered by the design unit, the green construction technology level of the construction enterprise and the situation of green building materials in the market, and maintain good information interaction in order to achieve better green construction effects.

3.3 Green Material Selection and Construction Stage

Green construction includes construction planning, construction preparation, material procurement, site construction, project acceptance and other stages of work. [9]. The general contractor is the main executor of green construction, and also the central point of coordination and communication among enterprises. The smooth implementation of green construction depends largely on the behavior of the contractor. [10]. Therefore, the main body of cooperation between green material selection and construction stage is the general contractor of construction, and other relevant subjects are: construction units, material suppliers, design units, supervision units, labor subcontracting units, and the public. The general contractor should first clarify the construction demands of the construction unit, establish a reasonable information sharing mechanism with it, and implement effective supervision means. Secondly, it plays the role of "central node", keeps communication with the design unit at any time to adjust the design scheme as needed, coordinates with the supervision unit to ensure the project's duration, quality and cost, maintains contact with material suppliers to ensure the supply of green materials, promotes the process of labor subcontracting, and undertakes supervision work, and coordinates

with the public around the project on issues affecting the environment and life.

4. The Key Path of Multi-Agent Collaboration

Green construction is a complex system involving multiple fields and participants. Multi-subject collaboration plays an important role in better realizing the five collaborative goals of green construction and promoting the sustainable development of green building industry. Based on the above analysis, the following suggestions are proposed:

By using the above analysis, This paper makes clear that the five collaborative goals of multi-subject collaborative green implementation of green construction are respectively; Cost objectives, progress objectives, quality objectives, safety objectives, and environmental and resource objectives, These five goals affect each other throughout the whole process of green construction; And the multi-subject collaborative path of green planning, green design and green material selection and construction stage is combed, After its analysis, it is found that: in order to better achieve the goal of green construction collaboration, The various phases of green construction should have different collaborative subjects, Taking charge of the task of communication and coordination with other relevant subjects, At the same time, each subject should obey the value orientation and interest goal of the overall interests, Establish an interdependent and mutually beneficial relationship of cooperation.

4.1 Building an Integrated and Coordinated Green Construction Industry Chain

Building an integrated and coordinated green construction industry chain will have a positive impact on promoting green construction methods, improving the competitiveness of the entire industry chain, and accelerating the transformation of the construction industry from high-speed growth to high-quality development. The integrated and coordinated green construction industry chain is from the beginning of the project to the full cycle of construction operation. Through the coordinated development of the industry chain, the complete industry chain integrating design, real estate development, component production, building construction,

decoration, energy saving and environmental monitoring, housing sales, property operation management and other links forms an upstream and downstream interaction. With each nodal enterprise as the main body and the collaborative object as the production factors, such as resources, information, technology, etc., according to the endogenous logic of the green construction industry chain, through efficient collaborative mechanism guidance, close cooperation between enterprises can be realized, the allocation of various production factors can be optimized, the value creation of the industry chain can be maximized, and the expected growth of economic benefits, social benefits and environmental benefits can finally be realized.

4.2 Optimize the Organizational Structure of the Green Construction Industry Chain

The green construction industry chain requires a leading enterprise to stand in the whole process of the project to coordinate the construction of the project, the construction unit has a certain investment and financing ability and a certain understanding of the market trend, and in the traditional construction mode, real estate development enterprises also have a wealth of comprehensive management experience and leadership. Therefore, the establishment of a green construction industry chain collaborative organization model led by construction units can increase the trust of other relevant entities in the industry chain. Stakeholders in the industrial chain will be gathered together to establish a common recognized benefit distribution system, reward and punishment system, risk sharing system, etc., so that all parties have a higher participation, and the main body of the mutual coordination and supervision relationship. For example, matrix organizational structure can achieve the above goals. This organizational structure can clearly show the synergistic relationship between various stakeholders in the industrial chain, and at the same time, it can speed up information communication, solve problems in a more timely manner, and make the collaborative work between various subjects more smooth.

4.3 Build an Information Collaboration Platform to Promote Information Sharing

Improve traditional information management methods, build an "Internet +" information collaboration platform, improve the information literacy of employees, collect and organize design drawings, implementation construction progress, construction impact data, contract letters and other information and upload it to the cloud, so that project information can be updated in time and shared openly. Facilitate the rapid flow of project information. Each subject can check the progress of the project through the platform, which is conducive to the overall control of the project. When there is a problem, multiple subjects such as the owner, construction unit, construction unit, supervision unit and design unit will put forward suggestions according to their own professional capabilities. All subjects will participate in the whole process management of green construction at the same time, and communicate with each other through visualization and data, so as to improve the management and control level of the project.

5. Conclusions

By using the above analysis, This paper makes clear that the five collaborative goals of multi-subject collaborative green implementation of green construction are respectively; Cost objectives, progress objectives, quality objectives, safety objectives, and environmental and resource objectives, These five goals affect each other throughout the whole process of green construction; And the multi-subject collaborative path of green planning, green design and green material selection and construction stage is combed, After its analysis, it is found that: in order to better achieve the goal of green construction collaboration, The various phases of green construction should have different collaborative subjects, Taking charge of the task of communication and coordination with other relevant subjects. On this basis, suggestions are put forward to build an integrated and coordinated green construction industrial chain and optimize the organizational structure of the industrial chain. Each subject should obey the value orientation and interest goal of the overall interests, Establish an interdependent and mutually beneficial relationship of cooperation. This is conducive to the promotion of green

construction and the sustainable development of the construction industry.

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