THE VALUE CREATION MECHANISM OF DESIGN-LED EPC PROJECT CONSORTIUM

JiangTao Lao, ZhongFu Qin*

College of Civil Engineering and Architecture, Zhejiang University, Hangzhou 310058, Zhejiang, China. Corresponding Author: ZhongFu Qin, Email: qinzhongfu@zju.edu.cn

Abstract: The design-led EPC model has become a widely adopted engineering construction approach internationally. However, it still faces challenges such as the lack of clear understanding among consortium members regarding its value creation mechanisms, which significantly hinders its broader application. To address this issue, this study conducts an in-depth exploration of the value creation mechanisms among consortium members under the design-led EPC model. Focusing on the value creation processes of each consortium member in design-led EPC projects, this research systematically identifies the relevant elements and constructs value creation networks for both the design leader and the contractor. Through a literature review, the core elements of value creation within the consortium are identified, including enterprise needs, value creation behaviors, and the multidimensional value dimensions of EPC projects. On this basis, from the dual perspectives of fulfilling enterprise needs and enhancing project value, the study systematically investigates the specific value creation pathways of each consortium member. It further analyzes the hierarchical structure of value creation for both the design leader and the contractor, respectively building value creation network models for each. This reveals the internal logic and driving mechanisms behind the value creation processes of all consortium members.

Keywords: EPC; Design-led consortium; Enterprise needs; Value creation mechanism

1 INTRODUCTION

With the continuous evolution of international engineering construction management concepts, the EPC (Engineering, Procurement, and Construction) model has been increasingly adopted by many countries due to its efficient resource integration capabilities and the advantage of a single point of responsibility. The core of the EPC model lies in delegating key project phases—such as design, procurement, and construction—to a general contractor, thereby integrating the industrial chain and achieving risk control and benefit optimization throughout the project's life cycle.

Given the typically large scale and high technical complexity of EPC projects, it is often difficult for a single enterprise to independently undertake all EPC responsibilities. As a result, forming a consortium led by a design firm has become a widely adopted solution. However, in such design-led EPC consortia, the members assume different functions throughout the project life cycle, with their value creation activities spanning key phases such as design optimization, procurement management, construction execution, and overall project coordination.

Due to the inherent complexity and uncertainty in the field of engineering construction, along with the cognitive limitations of individual members, consortium participants often lack a clear understanding of the value creation mechanisms within the EPC model. This undermines the overall performance of the consortium. Furthermore, there is an insufficient understanding among consortium members of the value creation logic specific to design-led EPC models. The absence of a well-established value cognition system and the lack of a unified understanding of how EPC projects generate added value make it difficult for members to reach consensus during project management and decision -making processes.

2 LITERATURE REVIEW

2.1 Value Creation in Construction Projects

Early research on value enhancement in construction projects primarily focused on economic value—specifically, how to improve the overall value of a project through cost control and revenue optimization. Kabirifar et al. used multiattribute group decision-making techniques to analyze performance factors in large-scale residential EPC projects in Iran [1], finding that engineering design, project planning, and project control are critical to EPC project performance. Aldhaheri et al. employed structural equation modeling (SEM) to identify factors affecting the effectiveness of oil and gas EPC projects [2], establishing causal relationships and relative contributions among these factors. Ghasemi et al. [3], using a fuzzy mathematical model, demonstrated that company resources, organizational structure, applied methods and technologies, and EPC project cost from the client's perspective. Du et al. explored the causal relationships among the degree of partnership application [4], risk management, organizational capabilities, and EPC project performance, laying a solid foundation for contractor decision-making throughout project implementation.

Although current research on value creation in the EPC model is relatively extensive, it primarily focuses on scenarios involving single enterprises acting as independent contractors, with limited exploration of the EPC consortium model.

In particular, under the design-led EPC model, studies on the value creation mechanisms of consortium members are relatively scarce. There has yet to be a systematic construction of the internal relationships among consortium members' value creation behaviors, EPC project value enhancement, and enterprise development needs. As a result, the underlying logic of value creation remains unclear.

2.2 Influencing Factors of Value Creation by Construction Entities

The study of factors influencing value creation by construction entities is a key topic in the field of engineering management. Existing literature primarily analyzes these factors from the dimensions of economic returns, external environment, and cooperative relationships. Among these, economic return is the most direct driving force. Contractors often evaluate the necessity and feasibility of value creation based on the expected profitability of a project. For instance, Müller et al. found that a firm's profit expectations, cost-saving potential, and potential for additional revenue in EPC projects directly influence its willingness to engage in value creation [5]. Zhao et al. [6], focusing on opportunistic behavior by private enterprises in sponge city PPP projects, developed an evolutionary game model involving private enterprises, citizens, and the government based on stakeholders' perceived value. This model provides theoretical support for improving sponge city PPP projects. Wang et al. established a tripartite evolutionary game model involving the government [7], project owner, and construction firm, analyzing the strategic behaviors and influencing factors of each stakeholder in the development of the EPC model. Shen et al. [8], by constructing a trust-based system framework, revealed the deep interrelationships of trust, openness, and communication among stakeholders in EPC projects, and their impact on interface management performance. Jiang et al. explored the collaboration formation mechanism of EPC consortia in China's construction industry from the perspective of trust [9]. Their empirical findings indicate that trust positively influences the cooperative intentions between design firms and contractors. Contractors emphasize reciprocity, reputation, and communication as key elements for trust-building, while design firms place greater importance on reputation and communication. Ke et al. regarded contractual governance as the core of formal governance and trust as the core of informal governance [10]. By constructing a structural equation model, they examined the effects of both on construction supply chain collaboration and EPC project performance.

3 VALUE CREATION ELEMENTS AMONG MEMBERS OF DESIGN-LED EPC PROJECT CONSORTIUM

3.1 Demand Analysis of Consortium Members in Design-Led EPC Project Consortium

From a sociological perspective, demand is often regarded as an individual's internal motivation and inclination. Accordingly, this study defines the demand of consortium members in design-led EPC projects as the set of objectives they expect to achieve during their participation in project implementation. For consortium members, the ultimate goal behind all behaviors is typically to maximize the profits of their respective enterprises. This profit maximization is not limited to the direct economic returns of the current project, but also includes the enhancement of long-term benefits for the enterprise. These long-term benefits may involve improving corporate reputation, strengthening capabilities, or establishing stable partnerships with other firms to secure future project opportunities and increase long-term profitability. Therefore, this study defines the overall demand of consortium members as the increase in total enterprise profit.

The increase in total enterprise profit can be further divided into two dimensions: current profit growth and future profit growth. In EPC projects, the demand of consortium members goes beyond the pursuit of short-term economic gains. It involves accumulating resources and opportunities during the current project to support the long-term development of the enterprise. Thus, categorizing total profit into these two dimensions not only provides a comprehensive reflection of the multi-layered nature of enterprise demands, but also offers a theoretical foundation for designing various demand satisfaction paths, ensuring the completeness and robustness of such pathways.

3.1.1 Design-leading party demand analysis

As the core leader of the EPC project consortium, the design lead party is responsible for key functions such as project design, procurement, and project management. Its primary objective is to achieve cost control and value enhancement by optimizing design schemes, controlling procurement costs, and improving technical and management capabilities. This process involves not only enhancing the benefits of the current project but also establishing long-term and stable cooperative relationships with the construction party, the owner, and suppliers, thereby creating future market opportunities and potential returns for the Design-leading party.

Specifically, the increase in current profit for the design-leading party is primarily achieved through profit gains from the ongoing EPC project. This is not limited to cost optimization, but also includes economic rewards from the project owner or other external entities for improvements in project schedule, quality, and risk control. During the implementation of an EPC project, the design leader can significantly enhance the overall project value through technological innovation, management optimization, and efficient resource allocation, thereby driving profit growth. At the same time, future profit growth is also a core objective for the long-term development of the design leader. This future profit growth mainly involves two aspects: Enhancing the likelihood of winning future projects by improving social reputation, accumulating successful project delivery experience, and expanding strategic partnerships; Increasing profit margins in future individual projects through the continuous improvement of technical capabilities and management competence. In summary, the future profit level of the design leader is jointly influenced by four key

factors: corporate social reputation, long-term cooperative relationships, EPC project management capability, and professional design capability, as shown in Table 1.

Fable 1 Summary of En	n <u>terprise Needs of t</u>	ne Design-Leading	Party from the	Perspective	of Profit Maximization

No.	Enterprise Needs of the Design Lead Party
R1	Increase in overall corporate profits
R2	Increase in current corporate profits
R3	Increase in future corporate profits
R4	Increase in profits from the current project
R5	Optimization of current project costs
R6	Acquisition of external resource support
R7	Opportunities for future projects
R8	Increase in profits from individual future projects
R9	Enhancement of social reputation
R10	Establishment of long-term cooperative relationships
R11	Improvement of EPC project management capability
R12	Improvement of professional design capability

3.1.2 Construction party demand analysis

In a design-led EPC project consortium, the primary role of the construction party is to execute construction activities based on the design scheme, ensuring the smooth progress of the project as planned. At the same time, the construction party provides feedback during the construction process to assist in adjusting the design scheme, thereby ensuring the overall progress and quality of the project.

The construction party's enterprise-level demand analysis are similar to those of the design lead party, but there are certain differences. In terms of building long-term cooperative relationships, the construction party has less interaction with the owner and suppliers, so its demands are more focused on the actual execution and management during the construction phase. Regarding future project opportunities and the profitability of individual projects, the construction party's demands(R13) are primarily influenced by its construction management capabilities rather than being directly driven by the overall EPC project management or design capabilities.

Specifically, the construction party's demands are reflected not only in the execution process of the current project but also include enhancing its ability to secure and profit from future projects by improving construction management levels and strengthening social reputation. Additionally, a good social reputation and a track record of past projects will also help the construction party gain more market opportunities.

3.2 Analysis of Value Creation Behaviors of Consortium Member

3.2.1 Analysis of value creation behavior of the design-leading party

Under the design-led EPC model, the design lead party is responsible for formulating and optimizing the overall design scheme of the project, and leads the project's technological innovation and implementation planning. As the lead and core of the consortium, the design lead party not only coordinates design, construction, and procurement processes to ensure efficient connection between various project stages, but also effectively reduces project costs and improves engineering quality and management efficiency through design optimization, technological innovation, and resource integration. In this study, the procurement business of the EPC project is also handled by the design lead party, making its role in EPC project value creation more comprehensive. In addition to optimizing design, it must also focus on procurement management and technical support for the project. Through reasonable procurement management, the design lead party can not only reduce material procurement costs but also ensure the stability of material quality, while maintaining close coordination with construction progress. At the same time, the application of various innovative technologies helps the design lead party more accurately grasp the actual project situation, optimize dynamic adjustments in design and construction, and improve overall project efficiency. The introduction of green technologies such as modular construction and energy-saving materials can also effectively enhance the project's environmental benefits.

Moreover, a reasonable profit distribution mechanism, clear division of rights and responsibilities, and an effective risksharing mechanism are key to ensuring the stable operation of the consortium. As the leading party of the consortium, the design lead party needs to establish a scientific profit distribution mechanism within the consortium to ensure that the contributions and benefits of all participants are matched, thereby motivating all parties to actively invest resources and technology and maximize the overall value of the consortium. At the same time, through contractual agreements, clear division of rights and responsibilities, and the formulation of contingency management plans, a reasonable risk-sharing mechanism can clearly define each party's responsibilities in uncertain situations such as market fluctuations and project delays. This ensures reasonable risk allocation, enhances the cohesion and risk resistance of the consortium, and strengthens project stability, as shown in Table 2.

No.	Value Creation Behavior of the Design-leading Party
A1	Clarify client requirements
A2	Refine communication mechanisms
A3	Optimize design solutions
A4	Clarify consortium's internal authority and responsibility delineation
A5	Adopt innovative technologies
A6	Establish risk-sharing mechanisms
A7	Determine specifications and quantities of materials
A8	Coordinate design and construction
A9	Coordinate procurement and construction
A10	Institute rational consortium profit distribution mechanism

 Table 2 Summary of Value Creation Behavior of the Design-leading Party

3.2.2 Analysis of value creation behavior of the construction party

In EPC projects, the construction party, as the main executor of the engineering project, undertakes key tasks such as construction organization, quality control, and schedule management. Its core responsibility is to carry out construction according to the design scheme provided by the design lead party and continuously provide feedback on site conditions during construction to assist the design lead party in adjusting or optimizing the design scheme. This achieves coordinated control of project schedule, quality, and cost, ensuring the smooth implementation of the project. The construction party's value creation behavior is also reflected in optimizing its own construction management plans and improving construction processes. By reasonably allocating construction resources, strengthening site management, establishing standardized construction management systems or processes, and introducing intelligent management tools and smart construction equipment, the construction party can further improve construction efficiency and quality. Moreover, as an important member of the EPC consortium, the construction party can assist the design lead party in establishing a scientific and reasonable profit distribution mechanism to ensure that consortium. At the same time, the construction party should also participate jointly in the formulation of the risk-sharing mechanism to ensure the reasonableness of its risk bearing, as shown in Table 3.

	Table 3 Summar	y of Value	Creation	Behavior	of the	Construction Party	7
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No.	Value Creation Behavior of the Construction Party
B1	Coordinate design and construction
B2	Innovate construction technologies and optimize operational procedures
B3	Streamline construction management schemes
B4	Facilitate risk apportionment framework development
В5	Institute rational consortium profit distribution mechanism

3.3 Analysis of the Forms of Value Enhancement in EPC Projects

The value creation behaviors of consortium members not only bring direct value to the enterprises through the improvement of their own capabilities and accumulation of knowledge but also achieve indirect benefits by enhancing the overall value of the project. This process includes not only the direct economic benefits of the project but also the added value generated through various management practices, technological optimizations, and communication and collaboration. Considering the uniqueness of the consortium model, on the basis of the traditional five forms of value performance in construction projects—quality(V1), schedule(V2), safety(V3), cost(V4), and environment(V5)—it is necessary to further introduce the critical dimension of "reduction of contract disputes and claims(V6)" to

comprehensively reflect the characteristics of value enhancement in EPC projects during the value creation process of consortium members.

4 CONSTRUCTION OF THE VALUE CREATION NETWORK AMONG CONSORTIUM MEMBERS

4.1 Sorting Out Value Enhancement Paths from the Perspective of EPC Projects

The value enhancement of consortium members not only concerns the economic benefits of the project but also directly impacts its quality and social value. To achieve this, consortium members can adopt a series of strategic measures to optimize value creation throughout the entire project lifecycle. For example, by optimizing the design scheme, the design lead party can effectively control construction costs, improve resource utilization, and reduce waste during the construction process—while ensuring project quality. At the same time, the application of green building concepts and innovative technologies can mitigate adverse environmental impacts and enhance the social value of the project. Moreover, the value creation behaviors of consortium members are not isolated; certain behaviors exhibit conditional

Moreover, the value creation behaviors of consortium members are not isolated; certain behaviors exhibit conditional sequences and logical relationships. Take the optimization of the project design scheme as an example: such optimization must be based on an in-depth analysis of the client's specific requirements to ensure that the optimized design not only meets contractual obligations but also maximizes the interests of all relevant stakeholders. Only by fully understanding the core demands of the owner and integrating the project's technical, economic, and environmental requirements can the design scheme be effectively optimized, thereby enhancing the overall project value. This logical relationship reflects the layered nature of value creation—where the early-stage analysis and planning based on the owner's needs determine the subsequent optimization measures, and the implementation of those measures, in turn, influences the final project outcomes.

4.2 Sorting Out Value Creation Paths from the Perspective of Enterprise Demand Fulfillment

The fundamental goal of consortium members in promoting value enhancement within EPC projects is to maximize their own corporate profits. Therefore, this study aims to establish a logical connection between EPC project value enhancement dimensions and the demands of consortium member enterprises. During the implementation of EPC projects, consortium members engage in a series of value creation activities that not only effectively reduce overall project costs—bringing direct economic benefits to the enterprise—but also provide high-quality project services that help establish long-term and stable cooperative relationships with the owner and suppliers. This, in turn, enhances the social reputation of consortium members and strengthens their competitiveness in future markets.

In addition, the value creation behaviors of consortium members can fulfill enterprise demands not only through overall EPC project value enhancement, but also through direct impacts. For instance, the successful application of new technologies, innovative management models, or well-structured contract terms in the current project can be replicated and promoted in future projects, thereby reducing training and technology implementation costs for future endeavors.

Specifically, the behavioral paths of consortium members in meeting enterprise needs are not limited to the short-term gains of the current project. They also include enhancing technical or managerial capabilities, strengthening social reputation, and establishing long-term partnerships to secure greater future returns for the enterprise. Therefore, this study, from the perspective of enterprise value creation, further analyzes the value creation paths of consortium members.

4.3 Construction of the Value Creation Network Among Consortium Members

Based on the research presented in Sections 4.1 and 4.2—focusing on value enhancement in EPC projects and the fulfillment of enterprise demands from the perspective of consortium members—this study constructs the value creation networks of the design lead party and the construction party under the goal of maximizing corporate profit. Through an in-depth analysis of consortium members' value creation behaviors, combined with their specific needs within the project, the resulting networks are illustrated in Figures 1 and 2. It reveals how consortium members, during the implementation of design-led EPC projects, achieve growth in economic benefits by improving communication mechanisms and coordinating design and construction activities. These efforts also enhance their market competitiveness and meet the long-term development needs of the enterprise.



Figure 1 Value Creation Network of the Design-Leading Party



Figure 2 Value Creation Network of the Construction Party

5 CONCLUSION AND DISCUSSION

This research focuses on the value creation hierarchy of consortium members in design-led EPC projects, systematically identifying key elements and constructing value creation networks for both the design lead and the construction party. First, based on a review of the literature, the core elements of value creation were identified, including enterprise needs, key value-creating activities during project implementation, and the forms in which EPC project value enhancement is manifested. Second, from the dual perspective of meeting enterprise needs and enhancing project value, the study systematically analyzes the relationship between consortium members' value creation activities and their respective needs. It clarifies each member's contribution to both enterprise development and EPC project value, and explores their specific value creation paths. Finally, the hierarchical structure of value creation for the design lead and the construction party is mapped out, and their respective value creation networks within the design-led EPC consortium are constructed. This comprehensively reveals the value creation logic of both parties and their roles in project management and enterprise development.

However, the current analysis is primarily based on the individual perspectives of consortium members and lacks an indepth exploration of the collaborative mechanisms between them and the process of value co-creation within the consortium.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

This research received no external funding.

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