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Exploring the Impact of Collaboration on Competitive Advantage in Construction Groups

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Abstract

This work was motivated by the premise that new competitive advantages in the international economy are increasingly enabled by the collaborative industrial system rather than working alone. Construction firms are transforming from contractors to integration service providers. However, existing studies on collaborative processes ignore the value attributes of the firm. This study aims to explore a comprehensive framework by complementing the value attribute perspective and empirically reveals the impact of six necessary collaboration factors on competitive advantage. Data of 192 respondents from seven leading Chinese construction Groups based in China are collected. The results show that the two macro elements (i.e., Value Reconfiguration and Strategy Congruence) act together on the remaining four endogenous variables of Resource Sharing, Information Sharing, Organizational Integration and External Integration. The realization of enterprise collaboration has a significant positive impact on the improvement of its competitive advantage, and 13 critical paths are identified in this paper. This paper provides a new perspective on the theoretical system of collaboration and practical guidance for enterprise to provide a higher-quality package of services.

Keywords: collaboration; competitive advantage; construction groups; value

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1. Introduction

The current international situation remains highly tense and turbulent, with intensifying global competition and an unstable market environment [1]. Enhancing eco-collaboration capabilities is an effective strategy for improving core competitiveness and thus generating greater value for companies [2,3]. This shift in the economic cooperation model is profoundly reshaping the construction industry. The traditional role of the contractor is evolving into that of a comprehensive service provider, integrating investment, design, construction, and operation and maintenance across the entire industry chain. The directive to "exploit synergies within companies and strengthen the ability to co-create benefits" has also been emphasized in Chinese national policy documents.

Group companies possess inherent advantages in this transformation compared to single-business companies, as they typically comprise subsidiaries with diverse business portfolios that span the entire construction value chain. However, in practice, subsidiaries operating across different disciplines often struggle to cooperate effectively [4]. For example, their expectations regarding the outcomes of collaboration frequently diverge [5], and issues

such as weak coordination capabilities and inadequate resource allocation are particularly prominent. Effective collaboration has become essential as profit margins shrink and competition intensifies, making competitive advantage critical to securing project bids. The lack of internal synergy within group enterprises thus emerges as a pressing challenge that demands immediate attention.

Numerous recent studies have reaffirmed that interorganizational collaboration can serve as a source of sustainable competitive advantage, especially in dynamic and uncertain environments [6]. Collaborative processes commonly discussed in the literature include not only the integration of tangible resources (e.g., finance, materials) but also intangible assets such as information, know-how, and trust-based partnership capabilities [7]. As the business environment becomes increasingly volatile, the emphasis on competitiveness has shifted from static resource possession to valued dynamic capabilities [8], which improve core competitiveness by promoting goal alignment, information sharing, managerial interaction, risks and rewards sharing [9,10].

However, these studies only complete the initial discussion around the collaborative elements (perspective of resources or capabilities). As competition in the construction market increasingly tends towards integrated service, it is insufficient to simply equate collaboration with elements integration or focus solely on elements. It is generally accepted that competitive advantage in the marketplace ultimately originates from delivering better customer value for equivalent cost (i.e., competitive strategy for differentiation) or equivalent customer value for a lower cost (i.e., competitive strategy for low cost) [11]. The value attribute is even more prominent for group-type enterprise, which is a business ecosystem of value co-creating by multiple actors. Therefore, understanding the value system is the cornerstone for companies to gain and maintain a competitive advantage.

However, to date, how value specifically affects collaboration, and how value-driven variables shape a group's competitive advantage have received scant scholarly attention. This, coupled with persistent inefficiencies in collaboration, suggests that a better understanding of collaborative process could be a missing link in the study of corporate competition. Therefore, this study takes large Chinese construction enterprises as the specific research object; it complements the literature by integrating a value–attribute perspective with six collaborative elements, and empirically explores their pathways to competitive advantage.

The remaining sections are structured as follows. The literature review, hypotheses development and conceptual framework are proposed based on relevant theories. Next, the data analysis and findings of current research are presented. In the end, we present theoretical and managerial implications, limitations, and future research suggestions.

2. Theoretical Background and Hypotheses Development

2.1. Literature Review

2.1.1. Competitive Advantage

Competitive advantage is defined as the attribute or ability to occupy a superior market position compared to other competitors in an effective 'competitive market'. Mainly divided into the Resource-Based View (RBV) represented by Barney [12], the Competence-Based View (CBV) represented by Porter, Prahalad [13], and the Dynamic Capabilities Perspective (DCP) by Teece [14]. Specific measurements include economic performance, market shares, and subsequently the growth rate of these indicators (RBV); innovation, partnership development and strategic thinking [15] (CBV). With the arrival of a more dynamic, complex and uncertain market, the focus developed from static resources/capabilities to dynamic capabilities [16], and from temporary to sustainable competitive advantage [17–19]. Indicators including

rapid response, strategic flexibility [17] and risk management capabilities [20] are used as expressions and measurements.

It is generally accepted that competitive advantage in the marketplace ultimately originates from delivering better customer value for equivalent cost (i.e., competitive strategy for differentiation) or equivalent customer value for a lower cost (i.e., competitive strategy for low cost). At the same time, new competitive advantages in the current international economy are increasingly enabled by the collaborative system rather than by working alone. Collaboration is identified as a major source of competitiveness, which was listed as among six "enablers" of competitive advantage in a white paper [21].

2.1.2. Collaboration

Collaboration is defined as a nonlinearity interaction among subsystems, which results in the effects of 1 + 1 > 2 that are beyond any of the individual [22,23]. In recent years, interfirm collaboration has been extensively used in mergers and acquisitions (M&As) [24], business alliances [25], and strategic partnerships studies [26,27]. It is proven to act as the glue by uniting firms and improving corporate resilience in unexpected disasters [28,29]. Some studies have also confirmed its significant positive impact on enterprise transaction costs [30], sustainable performance [31,32] and competitive advantage [33]. Hence, collaboration is critical in project-based construction corporations.

The collaboration processes have been discussed in theoretical and empirical studies, with the main focus on tangible Internal resource sharing [34,35] and External complementary resources integration [36], as well as intangibles, such as Information and knowledge sharing [37–39], Synergetic goals [40,41], and Trust [42]. A widely recognized collaborative framework typically includes information sharing, goal alignment, decision synchronization, resource sharing and incentive alignment. However, it is worth noting that multiple factors were considered at the same level, and the interactions have not been revealed in existing studies.

A series of theoretical and empirical studies have explored the collaborative models among participants in the construction industry across different national contexts. For example, an empirical study on contractor collaboration in the UK construction industry identified clear collaborative objectives, partner resources, and strong relationships as the key determinants of success [43]. A multi-case study in Sweden and the Netherlands empirically examined the impact of four collaborative models on short-term efficiency and long-term innovation in construction management [44]. A study of Malaysian contractors highlighted information sharing as one of the critical factors for successful collaboration within the construction supply chain [43]. Overall, existing studies focus on tangible aspects such as internal resource sharing [34,35] and the integration of external complementary resources [36], as well as intangible elements including information and knowledge sharing [37–39], goal alignment [40,41], and trust [42]. A widely recognized collaboration framework typically comprises information sharing, goal alignment, synchronized decision-making, resource sharing, and incentive compatibility. However, it is noteworthy that many of these factors have been treated at the same level in existing research, without revealing their interactive relationships.

It is concluded that the existing research on enterprise competitiveness and its relationship with collaboration has the following deficiencies. (1) In terms of the analysis index system, most studies do not distinguish the hierarchy among collaborative indicators, which makes it difficult for managers to understand the antecedents and consequences of competitiveness. (2) In terms of the research object, the research is almost geared towards unitary business firms. As emphasized, different organizations require different management approaches; the essential difference is that a group is a value co-creation ecosystem

with multiple actors. The existing framework is deficient in explaining the collaborative process and is less effective in guiding the practice of the group company. Therefore, it is imperative to develop a new framework suitable for groups. It has been proposed that the value network formed by data nodes can support the collaborative process of exchanging resources among subjects [45]. We argue that the collaborative process in construction groups entails value attributes.

2.1.3. Value Chain

Value chain refers to an integral functional chain structure consisting of a series of value-added activities linked together between sectors within an enterprise or multiple companies within an industry. For the construction group, it contains subsidiaries covering various business areas upstream and downstream of the industry, such as design-consulting-survey-design-construction-operate-maintenance. Specifically, a "smile curve" is drawn in Figure 1 to represent the value chain components of the construction group. Each node has a significant impact on the ultimate product value. Value chain links looped through data nodes and formed a network, providing support for collaborative processes that require network interaction among subjects to exchange resources [45].

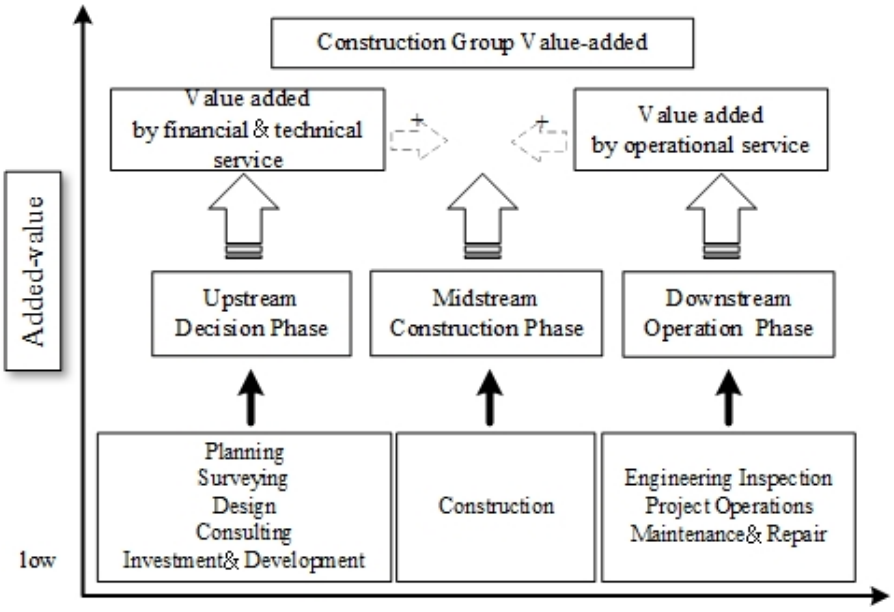


Figure 1. Value chain of construction group.

Regarding the sources of competitive advantage, classical theories such as the Resource-Based View (RBV) and the Dynamic Capabilities Perspective (DCP) have offered influential explanations, which emphasize non-substitutable resources [12] and the ability to perceive risks and adjust flexibly in dynamic environments [46]. However, these perspectives predominantly focus on single, unitary firms and do not fully account for the multi-actor nature of group enterprises. Large construction groups are characterized by multi-entity value co-creation, in which subsidiaries specializing in design, engineering, construction, operations, finance, and other functions, together with key external partners, jointly shape competitive outcomes. In this setting, collaboration is not merely about leveraging a single resource or capability but about orchestrating and reconfiguring a network of interdependent value-creation activities [47,48]. Hence, the value chain becomes a critical lens for understanding competitive advantage in groups, as it captures how dispersed nodes interact to generate value at the system level.

In this context, value chain theory provides a complementary perspective to existing explanations of competitive advantage. Enhancing business value through value reconfiguration is an important research direction. The specifics include the optimization process of value creation nodes within the company and the linkages with external actors [45]. Liu [49] proposed and verified methods for solving the node optimization based on an improved genetic algorithm (IGA). The application of a hybrid genetic algorithm to improve partner selection and node optimization has also been verified [50]. Under the context of risk uncertainty, an optimization model based on hybrid robust scenarios was conducted to improve resilience [51]. Based on the theory of strategic partnerships, some scholars focused on integrating the vertical value chain between the company and its key customers [49,52]. Therefore, two categories of collaborative elements from the perspective of value attributes were selected, namely Value Reconfiguration(VR) and External Integration (EI).

2.2. Hypotheses Development

2.2.1. Value Reconfiguration (VR)

The redistribution and placement of resources in the link lead to value reconfiguration. The core is the disaggregation of the firm into strategically significant activities or nodes [53]. Then, work activity assignment is optimized to subsidiaries along the chain by assessing the suitability of the core business and whether a comparative advantage. Some scholars have constructed the path model of value chain reconfiguration, including value chain boost, value chain integration, and value chain bond [45].

Value reconfiguration is widely recognized as a means of strengthening a company's competitiveness in global markets [54]. Especially under the impact of COVID-19, implementing reconfiguration has been proven to deliver greater resilience against disruptive global events [55]. At the firm level, through value reconfiguration, member enterprises focus on their core business and concentrate on production links in which they have comparative advantages. It helps participants to gain clarity on the resources needed to compete successfully in a particular industry. At the system level, in accordance with value transfer and technology transmission, cooperation networks are established between enterprises linked by production activities, achieving complementary coordination of resources and operations among enterprises at chain nodes, key value-added activities and business units. Value creation and value capture expand the access of the whole system to resources and opportunities [56]. Therefore, the following hypotheses have been proposed:

Hypothesis 1. *VR has significant and positive effects on Resource Sharing.*

Hypothesis 2. *VR has positive effects on Organizational Integration.*

Hypothesis 3. *VR has significant and positive effects on Competitive Advantage.*

2.2.2. External Integration (EI)

The core of an enterprise's value creation is the customer, and the foundation is the supplier. The issue concerning external integration with customers and suppliers being positively associated with the firm's performance has been widely validated [57,58]. Especially for PBF-like construction enterprise, it highly depends on clients' project demands, which are constantly changing [59]. Therefore, strong relationship skills (with suppliers, customers and other channel members) help to obtain current information regarding the target market trends [60,61], quickly and reliably respond to customer preferences [62], and obtain low input materials from suppliers. Maximizing integration into project surroundings is also a key measure to transfer business risks.

Stable and favorable relationships with stakeholders are an inimitable and irreplaceable resource and capability, which significantly reduce uncertainty in the international market [60], based on a comprehensive pre-planning [58]. Especially in the current fast-changing market demand and dynamic external environment, they facilitate timely access to the necessary information and resources to invest in local operations [63], thus leading to a more competitive chain [64].

Therefore, the following hypothesis has been proposed:

Hypothesis 4. *EI has significant and positive effects on Competitive Advantage.*

2.2.3. Strategy Congruence (SC)

The formation of strategic synergies stems from the issue of partnership choice in corporate M&A activities, which emphasizes the similarity of strategic objectives between alliance companies. Strong strategic alignment and common goals and objectives are a key prerequisite for partnership as well as parent–subsidiary management. Especially in international business, missing common goals among the partners will hinder the collaboration process [65] and will affect the performance of the supply chain. Bronder [66] define strategic alliances as a form of cooperation in which companies with common objectives cooperate by combining value chain activities in order to achieve a significant competitive advantage.

The most central issue between the parent and its member firms is relationship management, and the strategy congruence plays a bridging role. It facilitates the sharing of resources and activities [67] among subsidiaries, departments and business units by fostering trust and establishing smooth communication channels [68]. With a unified objective, all members clearly understand the Group's strategic intentions regarding integration and align their individual development directions to the Group. Strategic leadership at the macro level to promote greater involvement of all parties in the achievement of common goals, rather than pursuing their separate short-term opportunities. This enables the group to create greater value and effectively enhance its overall competitive advantage.

Therefore, the following hypotheses are proposed.

Hypothesis 5. *SC has a positive effect on Information Sharing.*

Hypothesis 6. *SC has a positive effect on Organizational Integration.*

Hypothesis 7. *SC has a positive impact on External Integration.*

Hypothesis 8. *SC has a positive impact on Competitive Advantage.*

2.2.4. Resource Sharing(RS)

The essence of collaboration is considered to be the process of multiple subjects sharing resources in a certain way [69]. Therefore, the industry chain collaboration is ultimately a synergy of resources. Resource sharing has been a widely known concept existing in various industries for a long time [70]. Resource sharing has proven to be a key mechanism for building successful inter-chain collaborative relationships [34]. Ansoff, the strategist who first applied synergy theory to economics and developed the concept of corporate synergy, pointed out that synergistic elements include own resources (e.g., manpower, equipment, capital, technology) and external resources (e.g., corporate brand, market channels, government channels)

The quality development of international engineering enterprises depends to a large extent on their ability to integrate global resources. Including tangible resources such as

manpower, equipment, technology, etc., and intangible resources such as corporate image, market channels, corporate standards, etc. The core view of the resource-based view theory is that a firm is a collection of bundles of resources, and that the effective use of resources is a decisive factor in a firm's competitive advantage [71]. As a key skill for companies, resource sharing helps to enhance their low-cost competitive advantage and risk management in international markets. The following hypothesis was therefore proposed:

Hypothesis 9. *RS have a positive impact on Competitive Advantage.*

2.2.5. Information Sharing (IS)

Information sharing describes the extent to which information is shared between member firms in an efficient and effective manner. The focus of this dimension is on the accuracy and timeliness of transmitting messages, and the openness to sharing among participants [72]. It helps speedy responses and pre-emptive action before risks occur, contributing to chain resilience [73]. The inherently complex nature of large construction groups requires information sharing to provide the necessary infrastructure for effective communication along the industry chain. It underpins the smooth flow of resources and thus enables participants to make collaborative decisions about logistics and financial flows [74,75].

Several scholars have also validated its value for enterprise chains through simulation or empirical evidence [76]. Therefore, value chain integration based on information sharing helps to reduce risks arising from information asymmetries and improve resource allocation efficiency, thus increasing market competitiveness [77]. The following hypothesis was therefore proposed:

Hypothesis 10. *IS has a positive impact on Competitive Advantage.*

2.2.6. Organizational Integration (OI)

The collaboration effect depends on the rules shared between the subsystems and the environment in which they interact, which requires organizational integration to regulate the process of value creation. Specific forms include intra-organizational process integration and inter-organizational collaboration integration [78]. The underlying principle is to ensure equal stakeholder participation in cooperation through 'neutral' leadership at the group level [79]. And then internally connected transactions are regulated by optimizing the organizational structure, restructuring business processes and establishing effective coordination mechanisms between business units. In a manner that optimizes the organizational structure and adjusts business processes, effective coordination mechanisms have been established between business units to regulate internal connected transactions. Good organizational integration helps to improve the efficiency of resource utilization and rationalize the sharing of risks, thus contributing to competitive advantage [80]. We state the following hypotheses:

Hypothesis 11. *OI has a positive impact on Resource Sharing.*

Hypothesis 12. *OI has a positive impact on Competitive Advantage.*

Figure 2 shows the theoretical framework proposed and tested in this article. In the collaborative process, two macro elements of VR and SC, act together on the remaining four endogenous variables of RS, IS, OI and EI. On the other hand, there are positive effects of six collaborative elements on competitive advantage, in which the four endogenous variables play a partially mediation role.

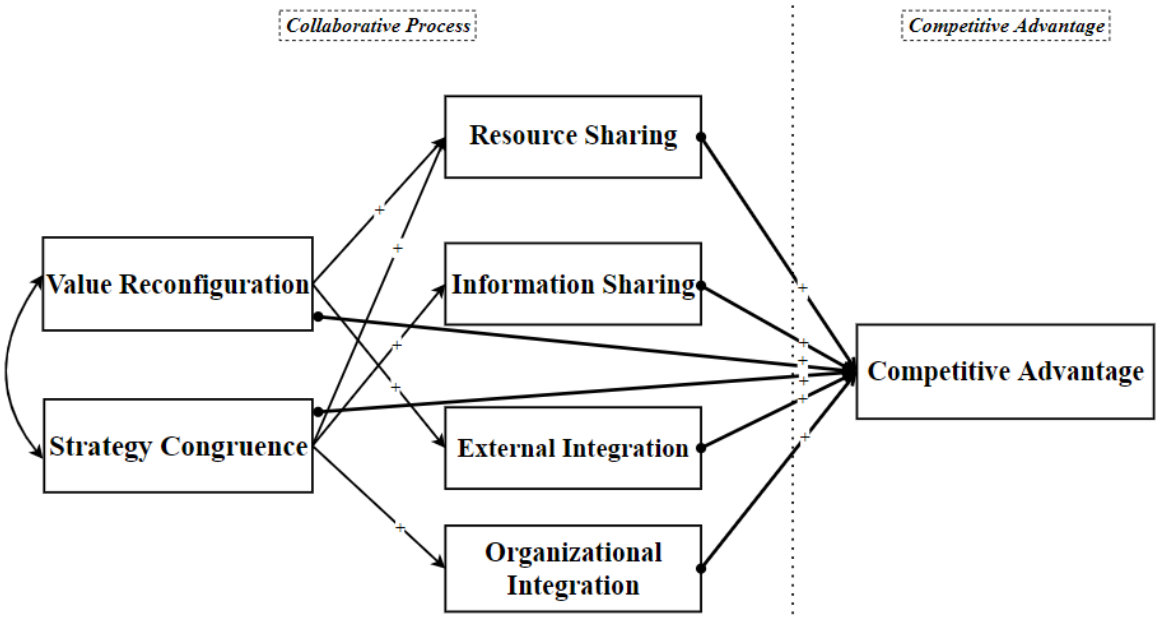


Figure 2. Initial conceptual model.

3. Methods

3.1. Analytic Approach

Structural Equation Modeling (SEM) is used in this paper to investigate the effect among variables. With its organic integration of factor analysis and regression analysis, the model is highly effective in constructing and analyzing complex social systems with complex relationships between multiple objectives. Moreover, SEM has been proven effective in dealing with survey-based construction management research and deduces insightful outcomes [81]. As a result, SEM was suitable to explore the impact of collaboration on competitive advantage in a large construction group. In this study, a covariance-based structural equation modeling (CB-SEM) approach using AMOS (version 28) was employed.

This study has developed a structured survey instrument, adapting the current measurement items to best suit this study context. Particularly, research around the issue of inter-company collaboration is relatively mature. Five items of Strategy Congruence (SC), Resource Sharing (RS), Information Sharing (IS), Organizational Integration, External Integration are sourced from existing measurement [59,82–84]. The Value Reconstruction Scale was first deduced from studies [45,85] and tested according to the Churchill [86] Scale Development Process due to the lack of matching validated instruments.

To further ensure content validity, a pilot survey was conducted with five scholars experienced in construction management and organizational collaboration. Based on their feedback, two modifications were made. First, the indicator IS4 ("Subsidiaries communicate with each other about market, product, technology, and outcomes") was deleted because experts noted that it overlapped conceptually with IS3 ("Subsidiaries will promptly inform each other of events or changes that may affect other organizations"), resulting in redundancy. Second, the item CA6 ("Our Group has a relatively low debt-to-asset ratio compared to competitors") was removed, since experts agreed that it reflected a financial performance indicator rather than a collaboration-related competitive advantage. In addition, several items with overly academic wording or ambiguous phrasing were reworded for clarity and practical operability. Table 1 shows the finalized measurement items, all of which would be evaluated using a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).

Table 1. Measurement items in the questionnaire.

Constructs	Codes	Measurements
Value Reconfiguration (VR)	VR1	Our Group understands the core business level of each subsidiary
	VR2	Our Group established relatively complete workflow for integrated business and adjusted it regularly
	VR3	Our Group understands owner requirements through comprehensive survey, user experience feedback
	VR4	Our Group can identify the key links that generate profit and sustain competitive advantage based on the engineering production process
	VR5	Our Group can adapt the roles and partnerships of subsidiaries to the production chain in order to structure a more rational business mix
External Integration (EI)	EI1	Our Group established suitable business transaction structure (e.g., commodity financialization: Trade high-speed rail for rice)
	EI2	Our Group established suitable business financing models (e.g., PPP, BOT mode)
	EI3	Our Group designed reasonable business cooperation model (e.g., Yawan High Speed Rail B2B model)
	EI4	Our Group established a local employee management system (hiring, assessment, promotion, etc.)
	EI5	Group made full use of local production resources such as special funds, materials and equipment
	EI6	Our Group explored new project opportunities by means of integrated resources
Strategy Congruence (SC)	SC1	Our Group can coordinate the subsidiaries to contribute to the overall objectives
	SC2	Our Group formulated an overall collaborative strategy and can rigorously implement it
	SC3	Our Group regularly assessed the strategy implementation of subsidiaries
	SC4	Our Group set clear objectives and task assignments for its subsidiaries
Resource Sharing (RS)	RS1	Our Group can rationalize the tangible resources in line with internal resource gaps (e.g., technology, personnel, equipment, production capacity)
	RS2	Our Group achieve full sharing of internal intangible resources between subsidiaries (e.g., corporate image, market channels, corporate standards)
	RS3	Our group's resource idle rate is low
	RS4	Our group has lower costs for internal resource mobilization
Information Sharing (IS)	IS1	Our Group established digital collaborative control platform
	IS2	Our Group emphasized the collection, storage, processing, transmission and utilization of information
	IS3	Subsidiaries will promptly inform each other of events or changes that may affect other organizations
Organizational Integration (OI)	OI1	Our Group formulated actionable rules for collaboration and widely disseminated
	OI2	Our Group formulated effective collaborative mechanisms between specialist businesses
	OI3	Our Group established balanced relationship of rights, responsibilities and benefits among subsidiaries
	OI4	Our Group has basic collaborative behavior restraints to regulate subsidiaries
Competitive Advantage (CA)	CA1	Our Group creates more value for owners at a lower price than competitors
	CA2	Our Group achieves low operating costs and transaction costs through economy of scale effect
	CA3	Our Group can provide owner-specific solutions and products
	CA4	Our Group integrates products and services to create customers value
	CA5	Our Group has a low contractual default rate compared to competitors

3.2. Sample and Data Collection

The questionnaire survey was selected to collect data. Collaboration is identified as a key strategic proposition for Groups [87]. Accordingly, employees familiar with corporate development strategies at large construction groups were selected for the survey. Ultimately, the formal survey covers the headquarters of large construction groups, includ-

ing 7 central enterprises: China State Construction Engineering, China Communications Construction, China Railway Group, China Railway Construction, Power Construction of China, China Energy Engineering, China National Chemical, and some local state-owned group-type enterprises. The respondents included middle and senior leaders of the mentioned companies, professional staff from the Supply Chain Management Department, as well as staff from the Strategic Planning Department, Asset Operations Department, Investment Department and other functional departments.

A total of 515 questionnaires were distributed to targeted employees in the headquarters of seven central state-owned construction enterprises and several large local state-owned group-type enterprises. Among these, 237 were returned (46.0%). To ensure data quality, responses were screened according to the following exclusion criteria: (i) respondents from small- or medium-sized enterprises; (ii) questionnaires with substantial missing values or incomplete answers; and (iii) low-quality responses, such as those in which the same option was selected throughout. Finally, 192 valid responses were retained for SEM analysis. According to Tabachnick and Fidell [88], a minimum sample size of 100–150 is adequate for factor analysis, while Kline [89] recommend at least 150 cases for models with multiple latent constructs. Therefore, our final sample of 192 provides sufficient statistical power for covariance-based SEM.

The sample distribution is shown in Table 2. In terms of the nature of enterprises, central and local state-owned enterprises accounted for the largest share, with 92.71%, in line with the requirements of this paper for group-type enterprises.

Table 2. Profile of surveyed respondents.

	Frequency	**Proportion**
Respondents	**192 (Total)**	**100% (Total)**
Nature of enterprise		
Chinese central state-owned enterprises	157	81.77%
Local state-owned group-typed enterprises	22	11.46%
Private group-typed enterprises	10	5.21%
Others	3	1.56%
Respondents' role		
Senior Management	45	23.44%
Middle Management	83	43.23%
General function managers	64	33.33%
Respondents' experience		
Below 5 years	21	10.94%
5–10 years	63	32.81%
10–15 years	64	33.33%
15–20 years	28	14.58%
Over 20 years	16	8.33%

Particularly, middle and senior managers are predominant, with 43.48% of middle managers (department managers and deputy managers), 23.19% of senior managers (Group Managing Directors, chief engineers, etc.), and 33.33% of general functional managers. The relevant working years are mostly distributed in the range of 5–15 years, accounting for 65.21%, with 23.19% working for more than 15 years and 11.59% for less than 5 years. In general, the conditions of management position and working experience are ideal to enable respondents to have an in-depth understanding of the overall development strategy of the company and to ensure the reliability of the questionnaire data.

4. Data Analysis and Results

4.1. Measurement Model

Before moving on to further multivariate analyses, we have checked the various multivariate assumptions with respect to reliability, multicollinearity and validity. The results show that the values of Cronbach's alpha are greater than 0.8 for all constructs, which indicates high stability and reliability, and there is no need to revise the scale [90]. The correlation results show that the absolute values between every two variables range from 0.3 to 0.7, which is in the moderate correlation range [90]. As correlation is also affected by other factors such as sample size and sampling error, validity is used for further testing, including content validity, convergent validity and discriminant validity.

Content validity refers to the ability of the researcher's subjective judgment to correctly measure or fully describe the characteristics of the measured variables. The key is whether the scale conforms to the basic theory and follows the development procedure. The scales in this paper are based on internationally authoritative, topic-appropriate and well-established studies, being thoroughly discussed and pre-surveyed by industry experts. The scale content is therefore rigorous, as shown in Appendix A.1.

Convergent validity was tested with a correlation coefficient, which requires a standardized factor loading of greater than 0.5 and a composite reliability (CR) value of greater than 0.6. The results showed that the factor loadings of all 31 questions were higher than 0.7, indicating high representation of questions. AVE values were greater than 0.5, and the CRs were greater than 0.8, indicating ideal convergent validity. As shown in Table 3.

Table 3. Test of the hypotheses.

Hypotheses	Structural Path	Standardized Estimate	*p*-Value	Inference
H1	VR → RS	0.630	***	Supported
H2	VR → OI	0.505	0.011	Supported
H3	VR → CA	0.153	0.201	Not Supported
H4	EI → CA	0.446	***	Supported
H5	SC → IS	0.418	0.025	Supported
H6	SC → OI	0.381	0.047	Supported
H7	SC → EI	0.364	0.049	Supported
H8	SC → CA	0.346	0.004	Supported
H9	RS → CA	0.318	0.007	Supported
H10	IS → CA	0.272	0.022	Supported
H11	OI → RS	0.308	0.049	Supported
H12	OI → CA	0.312	0.009	Supported

Note: *** $p < 0.01$.

Discriminant validity is a reflection of the structure of the measure and the presence of differences between latent variables. It is reflected by the square root of the Average Variance Extracted (AVE) of a certain variable being greater than the standardized correlation coefficient between the other variables. The results all meet the requirements, indicating that the variables are to some extent correlated with each other and also have discriminant validity, so the discriminant validity of the model data is ideal, as shown in Appendix A.2. In addition, discriminant validity was further assessed using the Heterotrait–Monotrait (HTMT) ratio. All HTMT values were below the recommended threshold of 0.85 [91], providing additional support for the discriminant validity of the constructs. The HTMT matrix is reported in Appendix A.3.

4.2. Hypothetical Test

4.2.1. Model 1: Enterprise Collaboration Composition

The internal causal relationships that constitute collaboration were tested in Model 1. The measurement and structural models showed satisfactory fit (IFI = 0.914 > 0.9, CFI = 0.911 > 0.9). All six hypothesized internal relations among collaboration elements were significant [92] ($|C.R.| > 1.96$; $p < 0.05$). Notably, VR → RS exhibits the largest coefficient (C.R. = 3.548, $p < 0.001$), indicating that value reconfiguration is strongly associated with enhanced resource sharing. Detailed coefficients are reported in Table 3.

4.2.2. Model 2: Impact of Collaboration on Competitive Advantage

The structural model shows acceptable fit (IFI = 0.904 > 0.9, CFI = 0.908 > 0.9). All five paths except H3 in Model 2, the T-values are greater than 1.96 and the *p*-values are all less than 0.05, indicating that SC, RS, IS and OI have a significant direct effect on competitive advantage. External Integration (EI) exhibits the strongest direct association with Competitive Advantage (CA) (β = 0.446, $p < 0.001$), followed by SC (β = 0.346, $p = 0.004$), RS (β = 0.318, $p = 0.007$), OI (β = 0.312, $p = 0.009$), and IS (β = 0.272, $p = 0.022$). In contrast, VR → CA is not significant (β = 0.153, $p = 0.201$). We conducted bias-corrected bootstrapping (5000 samples) to test mediation. VR exhibits significant indirect effects on CA via collaboration elements (VR → OI → CA; VR → RS → CA). Detailed coefficients are reported in Table 3.

Table 3 shows the hypothesis test results.

4.3. Path Analysis

Architecture. Collaboration influences CA through a combination of proximate levers—EI, SC, RS, OI, IS—and upstream enablers—VR. While VR does not directly predict CA, it exerts indirect influence by strengthening OI and RS (and, via OI, further enhancing RS). SC functions as an orchestration mechanism that aligns IS/OI/EI and contributes both directly and indirectly to CA.

Relative magnitudes (direct). The strongest direct path to CA is EI → CA (β = 0.446), followed by SC → CA (β = 0.346), RS → CA (β = 0.318), OI → CA (β = 0.312), and IS → CA (β = 0.272); VR → CA is not significant.

Robustness. Significant paths and indirect effects remain stable under 5000-sample bootstrapping. The impact paths and effects are shown in Tables 4 and 5, and a graphical representation is shown in Figure 3.

Table 4. Effect of collaborative factors on competitive advantage.

Factor	Path	Category	Impact Degree
VR → CA	VR-RS-CA	Indirect effects	0.201
	VR-OI-CA	Indirect effects	0.157
	VR-OI-RS-CA	Indirect effects	0.050
	Total effect		0.41
EI → CA	EI-CA	Direct effects	0.446
	Total effect		0.45
SC → CA	SC-CA	Direct effects	0.346
	SC-IS-CA	Indirect effects	0.114
	SC-OI-CA	Indirect effects	0.119
	SC-EI-CA	Indirect effects	0.162
	SC-OI-RS-CA	Indirect effects	0.037
	Total effect		0.78

Table 4. *Cont.*

Factor	Path	Category	Impact Degree
RS → CA	RS-CA	Direct effects	0.318
	Total effect		0.32
IS → CA	IS-CA	Direct effects	0.272
	Total effect		0.27
OI → CA	OI-CA	Direct effects	0.312
	OI-RS-CA	Indirect effects	0.098
	Total effect		0.41

Table 5. Summary of the effect relationships of collaboration on CA.

Paths	Direct Effect	Number of Direct Paths	Indirect Effects	Number of Indirect Paths	Combined Effect	Combined Effect Ranking
SC-CA	0.35	1	0.43	4	0.78	1
EI-CA	0.45	1	0.00	0	0.45	2
VR-CA	0.00	0	0.41	3	0.41	3
OI-CA	0.31	1	0.1	1	0.41	4
RS-CA	0.32	1	0.00	0	0.32	5
IS-CA	0.27	1	0.00	0	0.27	6

① Among the direct effects, External Integration (0.45) > Strategic Congruence (0.35) > Resource Sharing (0.32) > Organizational Integration (0.31) > Information Sharing (0.27). ② Of the indirect effects, Strategic Congruence (0.43) > Value Reconfiguration (0.41) > Organizational Integration (0.1). ③ To calculate the combined effect, Strategic Congruence (0.78) > External Integration (0.45) > Value Reconfiguration (0.41) ≈ Organizational Integration (0.41) > Resource Sharing (0.32) > Information Sharing (0.27).

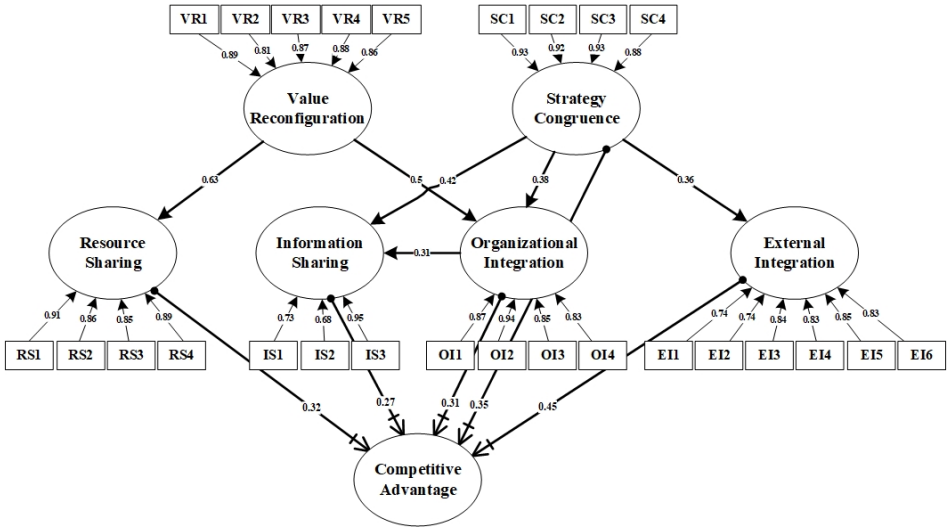


Figure 3. Model results of collaboration on competitive advantage.

5. Discussion

5.1. Validation of Collaboration–Advantage Model

This study tested a framework that integrates six collaboration elements—Strategy Congruence (SC), Resource Sharing (RS), Information Sharing (IS), Organizational Integration (OI), External Integration (EI), and Value Reconfiguration (VR), to explain how construction groups achieve Competitive Advantage (CA). The results demonstrate a hierarchical structure: (1) Upstream enablers: VR and SC primarily shape the collaborative environment: they positively impact CA by influencing the other collaboration factors; (2) Proximate levers: EI, SC, RS, OI and IS directly contribute to CA, with EI emerging as the strongest driver.

These findings resonate with the resource-based and capability-based views, which highlight internal alignment and external partnerships as critical enablers of firm performance [1,2]. In particular, the strong effect of EI underscores the importance of stable external partnerships and boundary-spanning integration, especially for group enterprises operating in globalized and uncertain markets. The validation of SC, RS, IS, OI, and EI further supports prior studies that link collaborative routines to enhanced organizational competitiveness [3,4], while also demonstrating their relevance in the distinctive context of large construction groups.

5.2. Mediation and Mechanism

A notable divergence from expectations is that VR does not directly enhance CA. Instead, its influence is transmitted indirectly through RS and OI. This indicates that strategic reallocation of activities and reconfiguration of value-chain nodes, while necessary, only yield competitive benefits when translated into effective coordination and resource mobilization mechanisms. This result nuances earlier assumptions that reconfiguration alone produces performance gains [54]. It shows that in conglomerate settings, the value of VR lies in creating enabling conditions rather than delivering immediate outcomes.

SC, in contrast, functions both as a direct contributor to CA and as an orchestrator of collaboration by aligning IS, OI, and EI. This dual role highlights SC's significance as the integrative mechanism that bridges strategic intent with operational routines. EI emerges as the most potent proximate lever, consistent with the notion that well-governed partner interfaces and external collaborations are essential for translating internal synergies into market-facing advantage. OI, meanwhile, plays a dual role: it not only strengthens RS but also directly contributes to CA, reinforcing its importance as the organizational backbone that converts upstream initiatives into tangible performance.

5.3. Implication for Theory and Practice

This study makes three key theoretical contributions. First, it validates widely accepted collaboration-performance linkages while structuring them into a hierarchical framework, moving beyond the flat lists of collaborative factors in much prior research. Second, it extends the collaboration literature by integrating a value attribute lens (VR), showing that value system reconfiguration influences competitive advantage by enhancing organizational and resource integration. Third, it specifies the boundary conditions of construction groups, which characterized by multi-actor governance and complex value chains structures, under which value attributes dominate. These insights contribute to refining RBV, CBV, and dynamic capabilities perspectives in the context of construction groups.

For managers, the results suggest a sequence of priorities. Strategic congruence should be the starting point, ensuring that subsidiaries' objectives align with the overall corporate mission. This alignment then facilitates organizational integration and resource sharing, which reduces redundancy and unlocks synergies. Information sharing should be institutionalized through digital platforms to improve responsiveness and coordination. Finally, external integration emerges as the most immediate lever for competitive advantage, stressing the importance of long-term partnerships, risk-sharing contracts, and client-focused strategies. Importantly, value reconfiguration should be treated as an enabling process, not an end in itself; it requires complementary organizational routines to yield tangible benefits.

In addition, qualitative insights from international leaders provide useful benchmarks for managers. For example, Bouygues enhances value reconfiguration by extending upstream into high–value materials, while Vinci leverages franchising and diversification to strengthen integration across its portfolio. Both cases illustrate that VR contributes

indirectly by enabling organizational and resource coordination, consistent with our quantitative findings. Likewise, Vinci's emphasis on cultivating repeat customers highlights the direct role of external integration in sustaining competitive advantage. These global practices reinforce the study's implication that collaboration levers must be pursued as a system, where upstream strategic alignment is operationalized through integration and sharing routines to achieve sustainable advantage

6. Conclusions

Collaboration remains a key driver of competitive performance. This study empirically examined how collaboration and value attributes jointly shape the competitive advantage (CA) of group-type construction enterprises. By integrating a value-attribute perspective with core collaboration elements, and validating the framework with covariance-based SEM on 192 valid responses from Chinese construction groups, three main findings emerge.

First, Value Reconfiguration (VR), External Integration (EI), Strategy Congruence (SC), Resource Sharing (RS), Information Sharing (IS), and Organizational Integration (OI), these six elements jointly determine group competitiveness, and their interactions form a hierarchical framework consisting of upstream enablers and proximate levers. Second, VR primarily contributes by shaping the collaborative environment, which indirectly enhances CA through OI and RS. While SC, RS, IS, OI, and EI serve as direct levers that support CA, with EI identified as the strongest immediate driver. Third, SC plays a dual role, not only directly enhancing CA but also orchestrating other collaborative processes by aligning information flows, internal integration, and external partnerships. OI serves as the organizational backbone, converting upstream changes into tangible performance outcomes.

The contribution of this study lies in advancing collaboration–performance relationships through a hierarchical mechanism model that connects value attributes with organizational routines and competitive outcomes. The findings refine RBV and CBV theories by clarifying how upstream enablers cascade through proximate levers to produce advantage in conglomerate settings. Managerially, the results suggest a sequenced approach. Strategic congruence should serve as the foundation, supported by organizational integration to unlock resource sharing. Information sharing should be institutionalized through digital platforms to ensure responsiveness and coordination. Finally, external integration emerges as the most immediate lever for converting collaboration into market-facing advantage.

Several limitations should also be noted. The findings are context-specific, being derived from large Chinese state-owned construction groups in a cross-sectional design. Generalization beyond this setting should be cautious. Environmental contingencies may moderate the collaboration–advantage link, but these dynamics were not captured here. Future research should broaden the empirical base by including firms from diverse geographies, ownership forms, and institutional contexts, and by adopting longitudinal and multi-level designs to assess the lagged and cross-level effects of value reconfiguration. Such work would strengthen the external validity of the framework and test its applicability across global construction enterprises.

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Institutional Review Board Statement: Ethical review and approval were waived for this study, as it involved only voluntary and anonymous questionnaire responses from adult participants employed in construction enterprises, without collecting any personal or sensitive information.

Informed Consent Statement: Participation in the survey was voluntary, and informed consent was obtained from all subjects prior to data collection.

Data Availability Statement: The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author(s).

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Appendix A

Appendix A.1

Table A1. Measurement Model Tests.

Constructs	Codes	Loadings
VR AVE = 0.617, CR = 0.890 Alpha = 0.909	VR1	0.801
	VR2	0.716
	VR3	0.785
	VR4	0.779
	VR5	0.775
EI AVE = 0.640, CR = 0.914 Alpha = 0.928	EI1	0.749
	EI2	0.751
	EI3	0.816
	EI4	0.81
	EI5	0.835
	EI6	0.833
SC AVE = 0.689, CR = 0.898 Alpha = 0.941	SC1	0.859
	SC2	0.721
	SC3	0.886
	SC4	0.844
RS AVE = 0.608, CR = 0.861 Alpha = 0.896	RS1	0.799
	RS2	0.769
	RS3	0.761
	RS4	0.789
IS AVE = 0.651, CR = 0.847 Alpha = 0.864	IS1	0.791
	IS2	0.73
	IS3	0.891
OI AVE = 0.701, CR = 0.904 Alpha = 0.934	OI1	0.851
	OI2	0.897
	OI3	0.818
	OI4	0.81

Appendix A.2

Table A2. Square Roots of AVE.

	VR	EI	SC	RS	IS	OI
VR	**0.617**					
EI	0.227 ***	**0.640**				
SC	0.308 ***	0.473 ***	**0.689**			
RS	0.487 ***	0.398 ***	0.425 ***	**0.608**		
IS	0.305 ***	0.449 ***	0.418 ***	0.507 ***	**0.651**	
OI	0.514 ***	0.435 ***	0.328 ***	0.526 ***	0.297 ***	**0.701**

Note: Bold numbers on the diagonal are square roots of AVE and other values represent the inter-construct correlations. *** indicates significance at the 0.001 level.

Appendix A.3

Table A3. Heterotrait–Monotrait (HTMT) Ratio.

	VR	EI	SC	RS	IS	OI
VR	1.000	0.846	0.781	0.740	0.805	0.849
EI	0.847	1.000	0.711	0.590	0.688	0.834
SC	0.781	0.711	1.000	0.699	0.705	0.848
RS	0.740	0.590	0.699	1.000	0.730	0.846
IS	0.805	0.688	0.705	0.711	1.000	0.772
OI	0.849	0.834	0.848	0.846	0.772	1.000

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