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How does the improved DB mode degrade the complex integrity of infrastructure mega-projects? Evidence from the Hong Kong-Zhuhai-Macao Bridge project in China

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Abstract Complex integrity is one of the main characteristics of infrastructure mega-projects (IMPs). Cost, technology, risk, duration, environmental impact, and other uncertain complexities are interrelated and constitute a challenging and complex management problem. At present, there is no unified understanding of or solutions to these complex integrity problems. This study analyzes the complex integrity of the island-tunnel subproject of the Hong Kong-Zhuhai-Macao Bridge (HZMB) project and proposes an improved design-build (DB) mode in which the owner provides a preliminary design and has the right to form and manage consortium. This improved DB mode creatively degrades the special complexities that arise from multiple dimensions. On this basis, it is an efficacious way to grasp the main contradictions, integrate the effective resources, and degrade the complex integrity in multiple dimensions and at multiple levels so as to effectively deal with the complexity management of IMPs.

Keywords Hong Kong-Zhuhai-Macao Bridge project, island-tunnel subproject, complex integrity, complexity degradation, the general contracting mode of design-build, the design-build consortium

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1 Introduction

The infrastructure mega-projects (IMPs) refer to those projects that involve a wide range of activities and a great deal of construction and are recognized as the type of projects that have the closest relationships with the public (Flyvbjerg, 2014; Sheng, 2018; Zeng et al., 2017). Generally, the state (government) is the major decision-maker and investor (Haynes, 2011; Sheng, 2018). The most important features of IMPs are huge scales, long life cycles, complex environmental conditions, far-reaching impacts on the social and economic developments of a region, and various partnerships (Flyvbjerg, 2006; Sheng, 2018; Zeng et al., 2017).

In the area of IMP management, the growing interest is obvious from research organizations and activities that define IMP management to multiple dimensions, particularly complexity. Complexity has been an important topic of discussion in IMPs research and practice, which lies at the core of defining what is an IMP, and to what extent such projects require a different approach (Bosch-Rekveltd et al., 2011; Imbeah and Guikema, 2009; Lessard et al., 2014). And complexity is important to understand the relationship between the owner, the contractors, the governments and various stakeholders, such as management choices, institutional context, resource allocation, and technological innovation, etc. (Sheng, 2018; Zeng et al., 2017). Understanding the IMP's complexity is key to properly allocation resources, and to degrade complexity to improve project performance and management capacity (Flyvbjerg, 2014; Sheng, 2018).

Since complexity itself is hard to pin down, this study focuses on the relationship between various complex factors and properties associated with IMPs, such as the legal and institutional gap, the shortage of comprehensive management capabilities, the traditional organizational inertia, and the imperfect supervision policies, etc. These

complex project features interact with each other to form an integral complexity that is difficult to degrade, as Sheng (2018) claims that complex integrity is an inherent attribute of an IMP. Further, based on the case analysis, this study proposes a combined design-build mode and management method for understanding contributors to complexity – the “complex integrity.”

The main contribution of this study is the analysis of complex integrity of the island-tunnel subproject of Hong Kong-Zhuhai-Macao Bridge (HZMB) project, including the conceptual distinction between project complexity and complex integrity. Then, this study connects complex integrity with an improved design-build mode, which is developed here to degrade the complexity from micro, meso, and macro dimensions. The third contribution is to select the island-tunnel subproject of HZMB as a case study, which has a strong typicality and practicality.

On the whole, this study uses the improved design-build mode, including the preliminary design provided by the owner, the consortium with special requirements and the new design-build management method, to cope with the complex integrity of island-tunnel subproject of HZMB project from multiple dimensions. This mode should also be useful in other IMP management, and enable organizations managing numerous IMPs to better rationalize the allocation of resources.

This study starts with an overview of the complexity in IMP as identified in the literature. In the following section, we discuss the research methodology and data collection and present a case of the island-tunnel subproject of HZMB. Then, this study analyzes the successful pathway to cope with the complex integrity in IMPs. Finally, the concluding section gives the main implications of this study for IMP managers and organizations and discusses the opportunities and limitations of the approach identified.

2 Literature review

Complexity has been considered as an important driver of project management mode choices. Baccarini (1996) defines complexity as many varied interrelated parts in a system, while Vidal et al. (2011) view complexity as a “property of the system that makes it difficult to understand.” Vidal and Marle (2008) claim that complexity can be viewed as numerous and diverse elements which are strongly interrelated. Davies and Mackenzie (2014) treat complexity as the outcome of a project system. Pich et al. (2002) express complexity in terms of information adequacy. Girmscheid and Brockmann (2008) propose four different types of complexity, the overall project complexity, and the task, social and cultural complexity. Lessard et al. (2014) claim that complexity can be associated with the relationship between various project features and properties such as difficulty, outcome variability and nonlinearity, and (non-) governability.

To comprehensively cope with the complexity, it is helpful to identify its characteristics. Baccarini (1996) proposes differentiation and interdependence to distinguish organizational and technological complexity. Girmscheid and Brockmann (2008) propose that managers in IMPs can reply to overall and task complexity by a functional organization with decentralized decision making, to social complexity by trust and commitment, and to cultural complexity by sensemaking processes. Albrecht and Spang (2014) treat project complexity as an important role in determining the organization-specific ideal level of maturity and accommodating the relationship between project management maturity and project performance. Based on these views of complexity, Lessard et al. (2014) propose the HoPC, a combined structural and process-based theoretical framework, for understanding project complexity. Lu et al. (2015) propose the TO method of measuring project complexity with hidden and direct works by modeling the dynamic emergence process. Qureshi and Kang (2015) use the structural equation modeling technique to identify and model the organizational factors to handle project complexity in a more regulated fashion.

Recent literatures on the topic of complexity in relation to the IMPs have made advances by analytically reforming the core concept of complexity into more specific concepts. While most scholars and practitioners have been following the significance of complexity and its relationship with performance in IMPs over a long period of time, coping with complexity still remains challenging. Current efforts in this field are focus on some specific complexities, (e.g. political complexity, culture complexity, social complexity, environment complexity, etc.) and the conceptual framework associated with some specific or single field (e.g. organization, task, process, institution, etc.) (Baccarini, 1996; Brady and Davies, 2014; Chapman, 2016; Fang and Marle, 2013; Hongyun, 2005; Kodeih and Greenwood, 2014; Lessard et al., 2014; Lu et al., 2015; Pitsis et al., 2014). There is a clear need for a brief expression of the concepts under the whole umbrella of complexity. It is important to pay attention to the relationship among those complex factors, which refers to the completeness and integration of complexities in the whole life cycle of an IMP. As Sheng (2018) underline, complex integrity is an indispensable challenge for IMPs, and it is hard to degrade by traditional methods.

3 Case study

Through a multi-angle qualitative case study, this study tries to explore complex integrity influences on the management mode of IMPs. The case of island-tunnel subproject of the HZMB project is selected to investigate how the improved DB mode degrades the complex integrity in an IMP. The main reasons for selecting the

subproject are that we have unusual research access to the core organizations in relation to the project, and that we realize this subproject is the key to the success or failure of the HZMB and it demonstrably indicates the complex integrity.

The main source of data in this case study is interviews with various project managers, stakeholders, local authorities, politicians and representatives of various interest groups, such as the top managers of HZMB Authority, the construction and design companies engaged in the subproject, etc. In addition to the interviews, the official technological reports and management documents and investigations are examined, in order to improve the accuracy of our data and the robustness of the conceptual insights. Articles from selected newspapers are also examined to acquire the different view of the project, as well as the academic papers published by the engineers and managers.

The HZMB project, started construction in December 2009, includes many construction subprojects, such as the road construction project, the bridge construction project, and the island and tunnel construction project, etc. (Zhang, 2017; Zhang and Sheng, 2014). The HZMB is about 55 km long; it connects Hong Kong, Zhuhai, and Macao and goes across the Lingdingyang Sea. Among the HZMB project's many subprojects, the island-tunnel project, which includes the immersed tunnel, the east and west artificial islands, and the connecting bridges, is one of the most important projects (Zhang and Zhu, 2012).

Being one of the most difficult immersed tunnel projects in the world, the technologies involved in the project, such as the combination of the islands and tunnel, the design of long-distance ventilation and safety, the prefabrication of the large immersed tubes, the transport and sedimentation of the tubes under the complex ocean conditions, the connection of tubes under high water pressure, the watertightness and durability of the joints, and the uneven settlement control of the subsea tunnel's soft soil foundation, are very complex (Zhang, 2017; Zhang et al., 2012). Moreover, the construction of the artificial islands is also very challenging: for example, the engineers need to deal with problems about the treatment of reinforcement in the deep soft soil, the control of settlement among different parts of the islands, the connection with the immersed tunnels, and the reliability and durability of the islands during the operation stage.

In addition, under the background of "One Country, Two Systems," the HZMB project faces differences and conflicts in the laws, regulations, and management procedures of the mainland, Hong Kong, and Macao of China (Chan, 2003; Chen et al., 2017a; Qiu et al., 2017). At the same time, the fact that the Hong Kong and Macao governments are highly autonomous further increases the difficulty of managing and coordinating the project. For such an infrastructure mega-project, the different property rights and interests and legal systems make it more difficult

to implement unified construction and management (Qiu et al., 2017).

The HZMB project, as a major complex project, has many complex characteristics, such as the 6.8-km subsea tunnel, the high cost (about 13.1 billion CNY), the deep and complex seabed, the high technical standard, the dynamic construction environment, the high standard of environmental protection requirements, the high risk of sea construction, the tight schedule, and so forth. These complexities are interrelated and interact with each other, making it difficult to find one management paradigm to solve all the complex issues. Faced with this complex integrity, an improved, prerequisite general contracting mode of design-build (DB), in which the owner provides a preliminary design and has the right to form and manage the construction consortium, has been adopted to degrade the complex integrity of the island-tunnel project.

3.1 The improved DB mode

Complex integrity is an inherent attribute of an IMP which increases the difficulties of managing such a project (Sheng, 2018). It refers to the completeness and integration of complex technologies and activities embedded in the whole life cycle of an IMP and the diversity of technologies and construction activities in IMPs (Flyvbjerg et al., 2003; Sheng, 2018), both of which make an IMP far more difficult to manage than a simple construction project. Since the integration of technologies and construction activities and the diversity of the complexity are deeply embedded and fused within the IMP itself, the complexity of an IMP, thus, cannot be decoupled or degraded by a simple combination. It is required to develop a new management paradigm to deal with this complex integrity.

What constitutes the complex integrity in the island-tunnel subproject of HZMB project? The factors, including the socio-political environments, the high standard of construction requirement, the complexity of technologies, and the uniqueness of design, are interacting with and are influenced by each other. First, the subproject is deeply embedded within three administrative governments which create distinct social, political, institutional, and cultural environments for the implementation of the construction activities (Chen et al., 2017a; Qiu et al., 2017). In addition, the fact that the designed age of the HZMB project is up to 120 years requires the design and construction of the island-tunnel project to meet high standards of quality requirements. On one hand, the HZMB project is faced with cross-border, duration, cost, and high level of quality constraints. On the other hand, given the specific management mode design of the project, the implementation and management capabilities of the project team are also vitally crucial for the successful delivery of the project. For instance, the island-tunnel project, which involves the construction of artificial islands, a tunnel, and a bridge, is a

subproject of HZMB project whose integrated complexity makes it a huge challenge for any construction enterprise to implement its construction activities within the required time scale. On the basis of an overview of all the potential bidders, no one in the construction market could independently complete the island-tunnel project without the technological assistance of other companies. Thus, the only solution for the project team (here, the HZMB Authority) of the island-tunnel project was to ask potential bidders to establish a technical consortium or a technical alliance which allies all the professional bidders to fulfill the DB contract.

Taken the DB mode, the general contractor not only has to know and grasp the design work and progress but also has to understand and control the construction work and ensure that it progresses on schedule. The dynamics of communication and control in relation to the progress of the design and construction is helpful to the overall optimization of the design and construction plan, which is conducive to improving the quality of the project. The island-tunnel project is the key to the successful delivery of the project. Because of the unforeseen factors and uncertainty within the natural environments, the construction period could not be met if the traditional DB mode was adopted in this project. So, an improved DB mode is used in the island-tunnel project, in which the owner provides a preliminary design and has the right to form and manage the construction consortium. Adopting the improved mode, the design and the construction elements can interact with each other to ensure the progress of both. In other words, the construction work can start after the part of the design work is completed, while the construction work can in turn optimize the design work (Zhang et al., 2012).

Since the nature of the improved mode, the designers and contractors are under the auspices of the general contractor (the main DB contractor), allowing the channels of information and communication to be much smoother and project knowledge to be fully shared (Cheng et al., 2016). In this case, the number of design changes can be effectively reduced. The island-tunnel project includes two parts, the tunnel, the bridge and the island projects, characterized by high level of technologies and a diverse range of engineering interfaces. The complexity of the technologies and the diversity of the engineering interfaces increase the need for cooperation between construction and design teams. For example, the prefabrication of engineering pipes, the floating transportation of pipes, and the concatenation of pipes under high pressure conditions all require the interaction of design and construction activities because the artificial islands and immersed tunnels being located in a deep soft-soil area, the emergence of complex geological conditions, and the differences in base settlement; all of these tasks require cooperation between the designer and the contractors.

As discussed above, the improved DB mode can

effectively reduce the interaction difficulties between different types of engineering (i.e. highway, bridge, water transportation). More importantly, in the improved mode, there is only one tender in the contracts, offering the optimal condition where the contractors are supervised and controlled by the general contractor: for instance, in the HZMB project, there are four design teams and five construction areas managed by the general contractor. This management mode in IMPs might overcome some limitations in the project team's capabilities and reduce the owner's intervention in the work of the general contractor.

The adoption of the improved mode for the project was based on an assessment of the cross-border nature of the project; the constraints of duration, quality, and cost; and the dynamic capabilities of the project team. The improved mode can be considered as an effective way to reduce the complexity of the construction and management of the HZMB project, especially in its subproject, the island-tunnel project. However, during the construction process, the project team will encounter more and more complex problems: how to implement the dynamic and flexible design, optimize the design plan, and eliminate unreasonable changes; how to incentivize the general contractor to promote technological progress and improve the quality of the IMP. Questions will continue to emerge as construction progresses. Thus, the successful delivery of the HZMB, with its specific design, project implementation, and management optimization, depends on the management of the improved DB mode by the HZMB Authority (the owner). In sum, to achieve the project goals, the owner (i.e. the HZMB Authority) first needed to design its own DB mode after considering the condition of the market environment, industrial regulation, and other macro-level of economic conditions. The specific contract design can assist the project teams to successfully implement the improved mode, which is the main carrier to guarantee construction and reduce conflicts.

The improved DB mode in the island-tunnel project is a new mode where the owner provides a preliminary design and has the right to form and manage the construction consortium. Several of the professional construction companies, which undertake supervision or consulting tasks, are also included in the project team to further enhance the capability of the owner to cope with the complex nature of the project. The improved mode eliminates the impact of traditional project construction procedures and the specific qualification system in the Chinese context on the HZMB project. At the macro level, the DB model degrades the complexity of the IMP at the legal, societal, and governmental dimensions. At the mesoscopic level, cooperation between the design and construction consortiums largely solves the problems regarding the disposition of social resources and rebuilds the project team structure. At the micro level, the complexity of management is degraded by the on-site

coordination between design and construction, which remedies the defect of Chinese construction industries.

There are some differences between the improved mode adopted in the HZMB project and the traditional DB mode used in other projects. Specifically, the differences lie in the provision of preliminary design and assistance of forming and managing the construction consortium. This improved DB mode is designed on the basis of its own characteristics, which is more conducive to achieving goals of the IMP.

The main advantages of this improved mode are as follows, as shown in Table 1:

(1) The general contractor is a cooperative consortium of international construction companies which have a high reputation and are known for their good performance in design and construction management. This consortium includes personnel who have foreign design and construction experiences and other professional consultants; this increases their competitiveness and ensures their performance. The Chinese contractors can integrate their resources and experiences and then exploit their existing engineering knowledge on the HZMB project, while the foreign contractors can inject their advanced technologies and construction concepts to improve the overall performance.

(2) The improved mode for the island-tunnel project emphasizes the relative independence between the design leader and the design team in the consortium. On one hand, this arrangement allows full use to be made of the favorable factors in the improved mode; on the other hand, it complies with the regulations set by the national and local construction standards and with industrial requirements.

(3) The new DB mode offer opportunities for designers and contractors to be deeply embedded with each other. This embeddedness can allow designers and contractors to communicate more smoothly and to be interactively influenced by each other at the same time. To be more specific, the contractors can offer their construction experiences and advice to designers in order to constructibility review.

In general, the island-tunnel project has adopted an improved DB mode with a cooperative consortium established by a diverse range of construction companies. These construction companies have their own interests and organizational culture, which have brought some challenges to the coordination and integration of the project during all stages. The conflicts between different organizations can result from their different organizational cultures, different cognitions, different experiences and perceptions of the IMP, and so forth.

3.2 The design-build consortium for the island-tunnel project

As discussed above, the improved DB mode used in the

island-tunnel project can reduce the project complexity to some extent. However, the mode can also lead to some new problems, such as allocation of key resources, cooperation between different organizations, conflicts between different organizations, and the legitimacy of this mode in the Chinese context. More specifically, there is no law that can guarantee the implementation of the mode contract in the Chinese context, which means that there is a void in the institutional settings. Both the governments and the industrial unions need to set up a regulation or industrial standard to meet the new demands of this new mode in the construction of IMPs. Furthermore, the construction market for the improved mode is not mature, which creates new market niches for new companies to enter. There are no qualified contractors, professional subcontractors, designers, consultants, or other construction service providers in the construction market with experience of this improved mode. The difficulties in establishing a mature consortium make it hard for companies to cooperate. Also, the diverse range of contractors within one consortium can result in organizational conflicts because of the different interests, different cognitions, and different cultural backgrounds of the contractors.

Therefore, the HZMB project has further reduced the complex integrity by setting up a DB consortium by allying competitive and experienced contractors. There is no an agreed definition of a construction consortium in the current academic community. Some scholars argue that a consortium is constructed by more than two organizations to provide equity and resources to establish a semiautonomous legal independent entity (Geringer and Louis, 1989; Geringer and Louis, 1991). Some scholars insist that a consortium can be considered as a special type of strategic alliance as its members complement each other to provide more choices and build their competitive advantages (Ozorhon et al., 2007; Ozorhon et al., 2008). According to the distribution of management authority, we argue that consortiums can be divided into three types: 1) consortiums with one dominant member; 2) consortiums with fair management authority; 3) consortiums with independent members (Mohr et al., 2016; Tsang, 2016). The DB consortium for the island-tunnel project belongs to Type 1: It is led by a leader company and has other members. As the dominant member of this consortium, the leader acts as the link between the rests of the members. Through implementing the communication mechanism between the parent companies and subsidiaries, the consortium can further degrade the complex integrity. The organizational structure and task division of the DB consortium is shown in Fig. 1.

The management task for the consortium can be divided into two parts: design section and construction section. All the construction activities are under the unified coordination of the major general manager but are conducted independently. The general managers are supervised by the hierarchical management. The management has set up an

Table 1 The main advantages of the improved DB mode

The improved DB mode		The owner provides preliminary design and has the right to form and manage the design-build consortium	
Specific requirements	Bidding stage: based on preliminary design	The design-build consortium with specific construction and management requirements	Requirements for the design-build consortium
	Propose the construction survey, and the design plan Propose the study of DWD, and then verify the plan Propose the optimizing design	Leader of the consortium, design leader of the consortium: they both the large-scale construction and design projects An international design company A CMC company focusing on	
Construction stage: based on the contract documents	Carry out the DWD Link the designers and contractors, and improve, optimize the whole IMP	To ensure the relative independence of the design International design partners undertake the evaluation of the construction drawings	
Characteristics of risk	Risk for the owner	A CMC company evaluates the construction plan Reduce the total risk towards to the owner from the general contractor's fault	
Risk for bidders	Undertake the risk of tendering offer without work drawings	Reduce the risk from the owner's mistakes from their unprofessional management and decision. They share the interest and risk with high level of distribution on the risks.	
Comparative advantages of different plans	Compared with Plan A Compared with Plan B	They have complementary advantages, have set up the principle of scientific management on HZMB project. The competitiveness of the construction consortium is much stronger, and it is more suitable for the high standard of the HZMB project. It can enhance the comprehensive ability and ability to resist risks, and help solve the technical problems.	Compared with Plan C Compared with Plan D

Note: 1. CMC company means a construction management consulting company; DWD means design of work drawing.
2. Plan A is "the owner only provides the functional requirements, without requirements for the bidders"; Plan B is "the owner provides preliminary design and the bidders offer bidding price after the completion of the construction drawing design"; Plan C is "the designer or constructor forms a consortium independently and lead the construction of the project"; Plan D is "an independent company (i.e. the contractor) undertakes the entire design and construction tasks".

international design evaluation department, a management consultant department, and a construction management consulting department. These three departments in the island-tunnel project undertake the evaluation of the design plan and the construction plan independently, trying to reduce the impacts from outside and to ensure reliability of the project implementation. To ensure the efficiency of the members within the consortium, the management mode of the consortium is based on “meta-synthesis, management line, and management methods.” As shown in Fig. 2, the main line of target management is the main means of administration and economic management. The comprehensive integration of quantitative management, standardized management, cultural management, and a variety of advanced and applicable management techniques and methods means that the various relationships within the organization are coordinated to improve the efficiency of the organization and ensure the full realization of

organizational goals.

In the island-tunnel project, the consortium agreement, distribution of management rights, and work plan are in form of paperwork to try to avoid misunderstanding among members in the consortium: this is called the integrated management plan of the island-tunnel project. All rights and duties, the distribution of voting, resource allocation, and investments are well written in the plan. The plan also includes all the mechanisms to solve potential conflicts between different members, thus removing barriers to the improvement of efficiency in the HZMB project.

3.3 Design and construction linkage, construction drive design

The improved mode has been adopted in the island-tunnel project, which has been assessed and decided by the HZMB Authority. Given the industrial and institutional

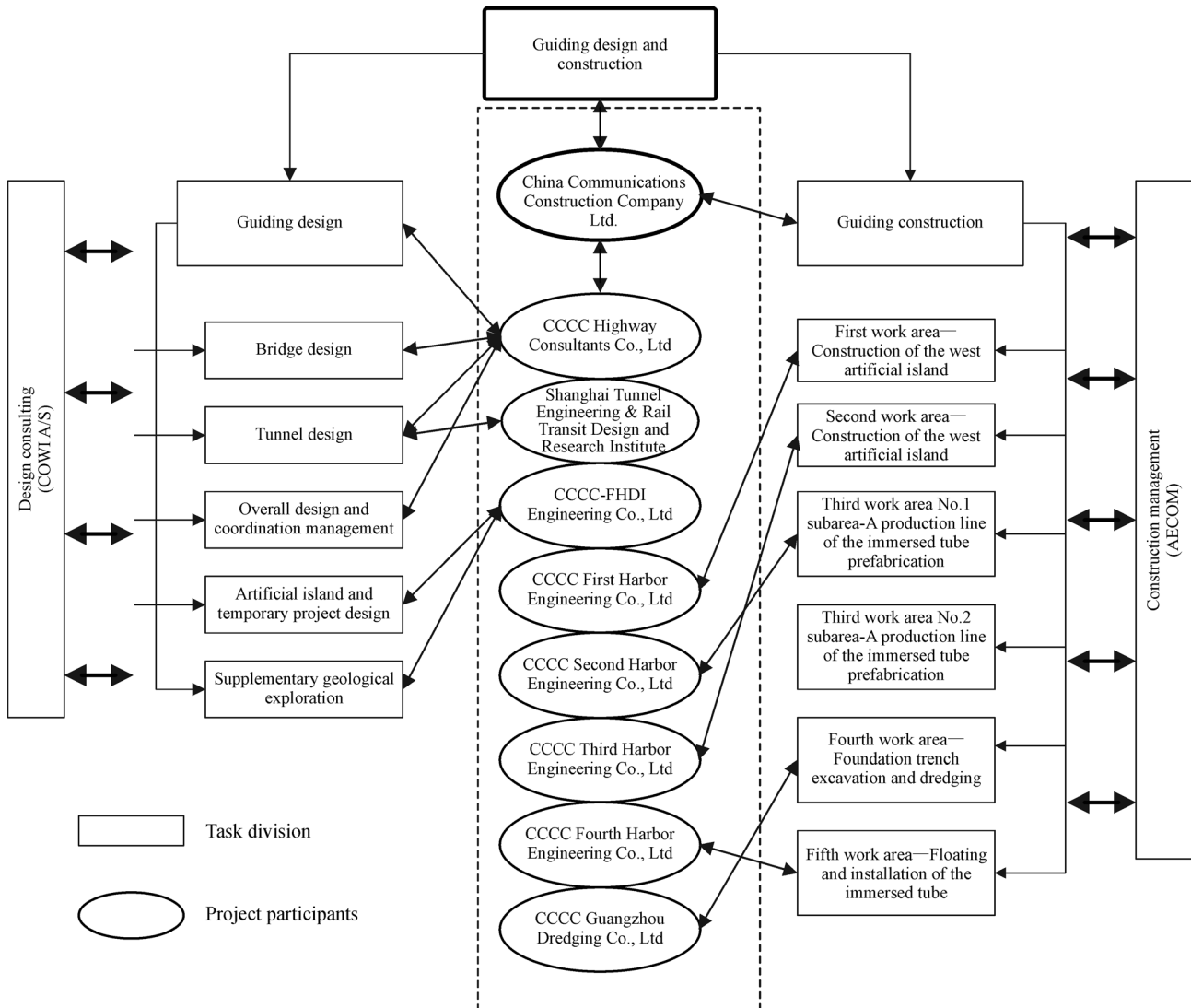


Fig. 1 Organization composition and task division of the design-build consortium in the island-tunnel project

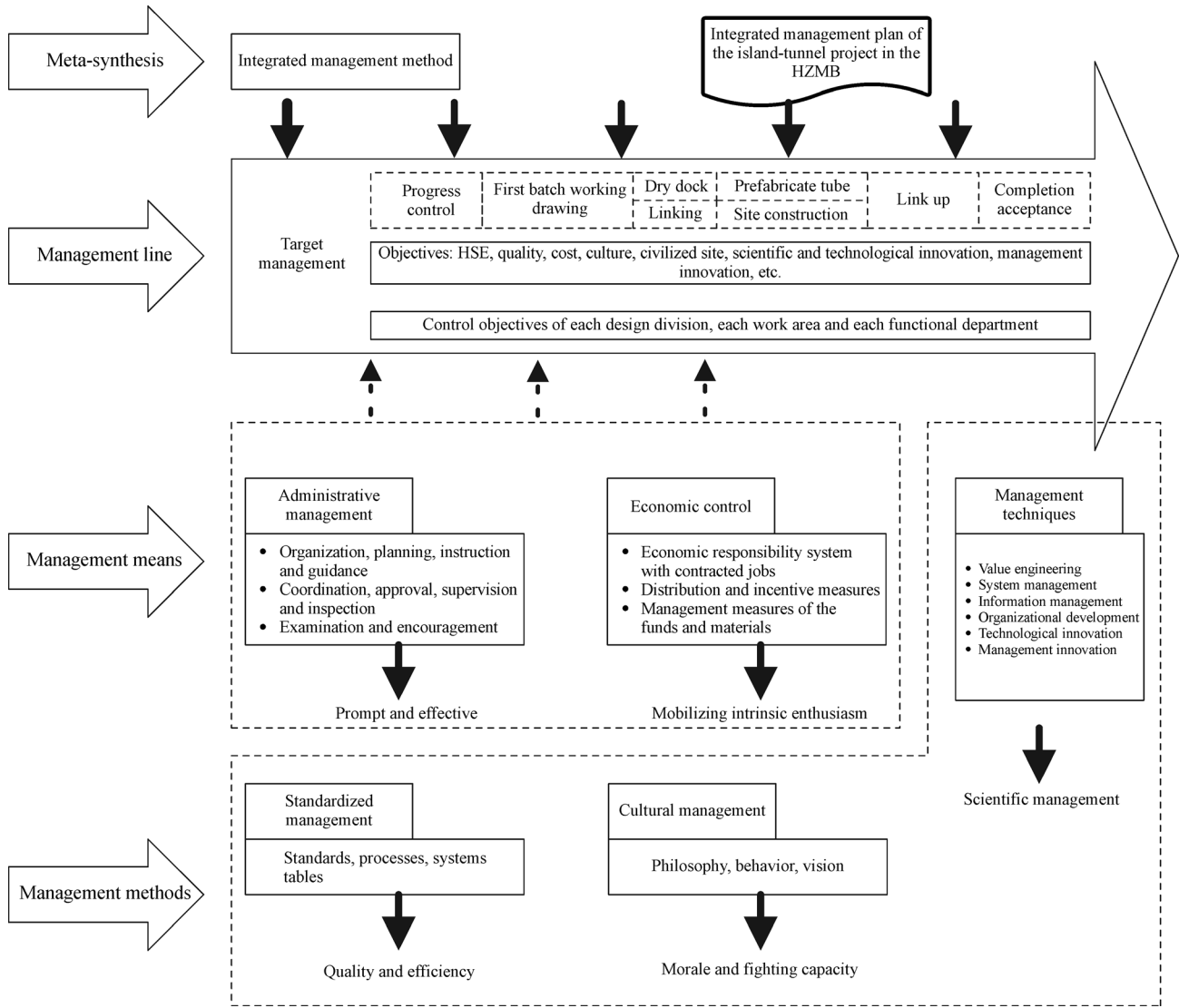


Fig. 2 Integrated management mode of the design-build consortium in the island-tunnel project

environments and the nature of the structure of this project, the mode is the most suitable for the project team to reduce the complex integrity. Compared with traditional project management, the improved DB mode for the island-tunnel project offers designers and contractors more opportunities to communicate with each other. The design and construction activities interact with each other, creating a new mechanism for the optimization of design and construction work. The modified DB mode also blurs the line between the design and construction stages by connecting the design and construction activities together. The interaction between designers and contractors, the cooperation between designers and contractors, and their mutual influences are the new features that emerge in the new DB mode (shown in Fig. 3).

The island-tunnel project involves four design divisions and six construction areas, with a large range of

construction content and a high correlation between construction activities. The operating, technical, and environmental conditions facing this project are complex, with rapid changes of information and a large flow of knowledge. The project also requires a high level of systematic communication, together with a high level of management complexity. In addition, it is essential to overcome the obstruction of these distinct work areas, the cultural conflicts between Chinese and foreign companies, and the political differences among the three governments. According to its basic functions, it is also required to meet the special needs of emergency events. It faces the new challenges that come from communication and coordination issues among the design and construction activities. To deal with these challenges, the project has a standardized, process-oriented management structure (shown in Fig. 4).

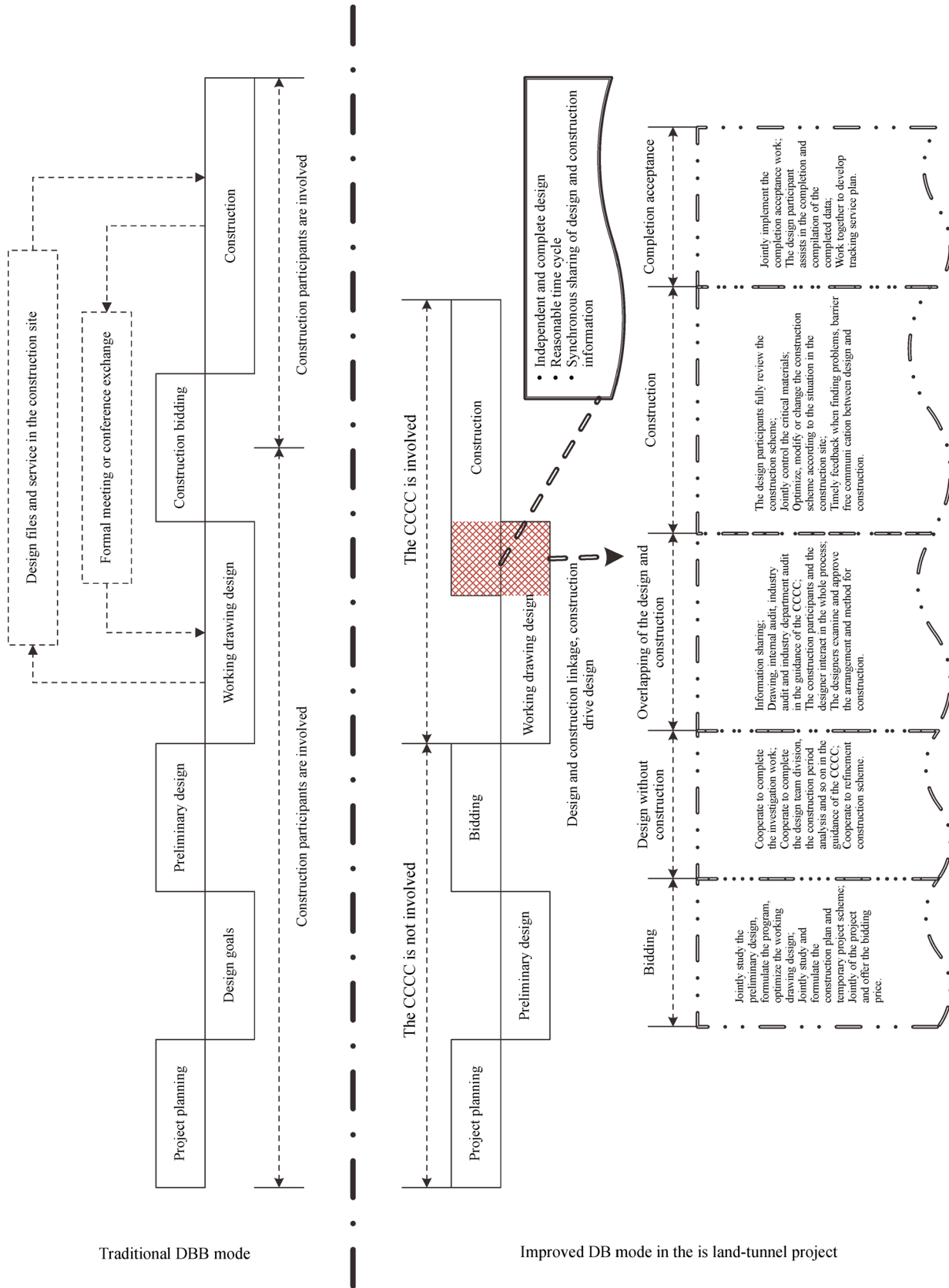


Fig. 3 Comparison of the improved DB mode and the traditional mode

The core feature of the improved DB mode for the island-tunnel project is that the contractors can effectively engage in both construction and design activities. The effective linkage between design and construction not only improve the quality of the project but also reduce the management interfaces, improving the feasibility of the design program. This reduction of conflicts during the design and construction stages can effectively degrade the complex integrity.

project is the key subproject for the successful delivery of the whole project. The immersed tunnel, nearly 6 km in length, is the world’s only deep immersed tunnel and is the one of the largest and most difficult immersed tunnels ever constructed. The HZMB Authority adopted an improved DB mode with a certain preliminary design scheme and selected the DB consortium. It set up a DB consortium and a supervision consortium to engage in the design and construction stages. The linkage between design and construction activities makes it possible for contractors to engage in design activities to reduce design changes, which degrade the complex integrity at the macro, meso, and micro levels. The HZMB Authority has applied systematic complex thought and integrated management to

4 Conclusions

As an integral part of the HZMB project, the island-tunnel

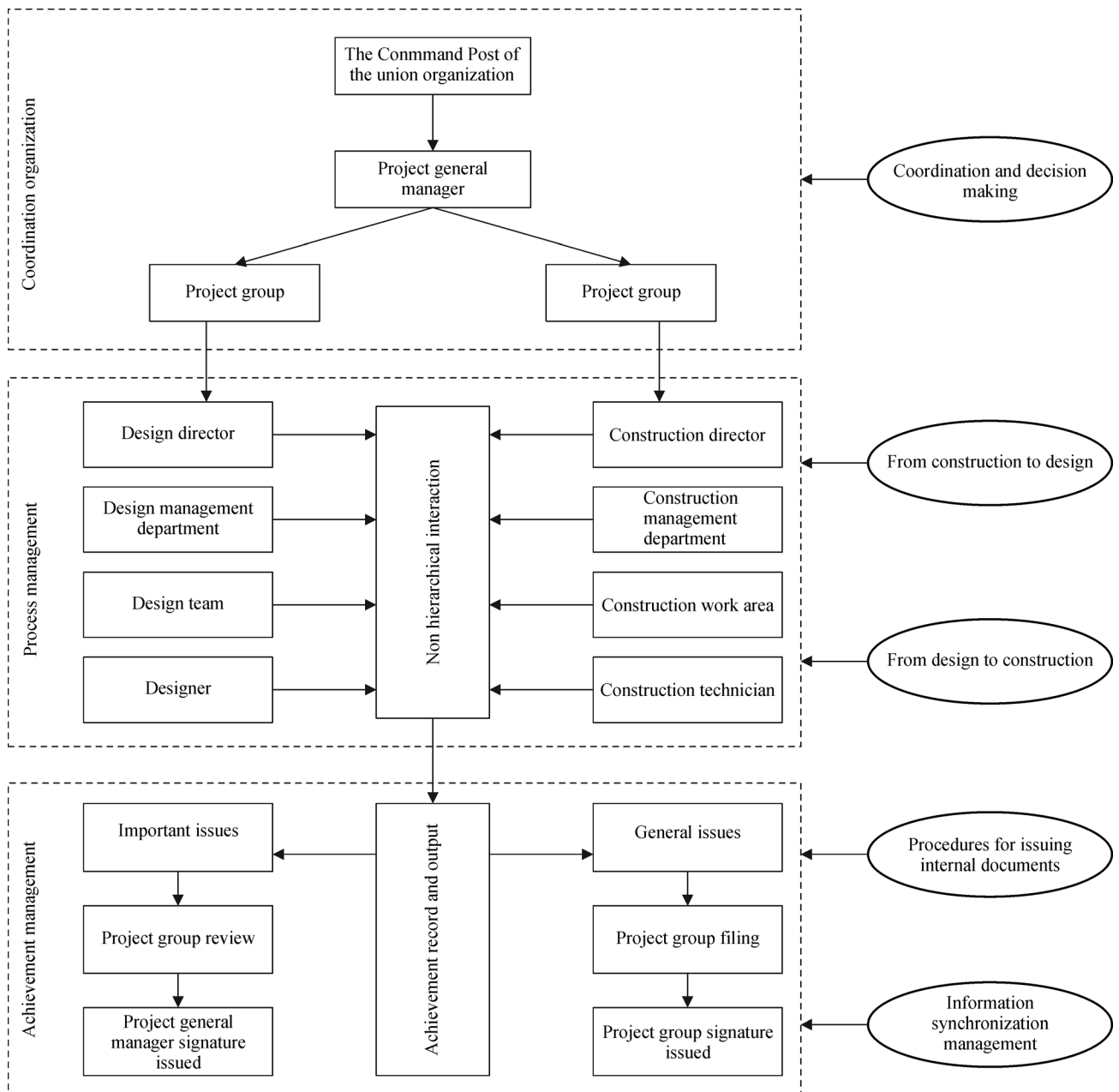


Fig. 4 Design and construction linkage, construction drive design

solve the legal and institutional voids, remedy the shortage of comprehensive management capabilities, dissolve the traditional organizational inertia, and deal with imperfect supervision policies.

The improved DB mode for the island-tunnel subproject of the HZMB project is a special construction mode built under the Chinese context, combining the Chinese situation with international practices and thoughts. With the implementation of the improved DB mode in the HZMB project, the related regulations, standards, and contact templates are being renewed and completed by the policymakers in the Chinese government and construction industry. As a matter of fact, the improved DB mode of the island-tunnel project is a process that transfers the risk from governments to management. It highlights the importance of the application of systematic complex thought and integrated management in IMPs.

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