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Benefits of Early Stakeholder Involvement in Korean Railway Infrastructure Project

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Abstract

Purpose: In the Korean railway infrastructure process, contractors and operators are involved at a later stage, which results in significant inefficiency. This study examines the benefits of early stakeholder involvement in Korean railway infrastructure projects and provides practical guidelines. **Design, data and methodology:** Literatures and foreign cases are analyzed. Building on the new product development model, we derive propositions explaining the relationship between early stakeholder involvement and the performance of Korean railway infrastructure project. **Results:** Major propositions include that early involvement of contractor has a positive effect on the project performance by shortening the infrastructure construction period and that early involvement of railway operator has a positive effect on the project performance by improving the effectiveness of railway infrastructure. Four requirements for the success of early stakeholder involvement are addressed. **Conclusions:** This study suggests that early stakeholder involvement shortens the construction period and improves railway infrastructure effectiveness. Academic contribution is to present the framework on railway infrastructure projects as holistic interactions among stakeholders. Practical contribution is to provide railway policy makers and other business practitioners with policy guidelines to improve railway infrastructure project process and to recommend an open access to relevant data.

Keywords : Early Stakeholder Involvement, Railway Infrastructure Project, Contractor, Operator

JEL Classification Code: L92, M10, M38, R42

1. Introduction[1]

A railway infrastructure project is a costly and time-consuming large-scale project (Kang, Kim, & Kim, 2019). Under the circumstances of declining social overhead capital share in the government budget and steadily rising welfare costs, the private finance initiative, which is a way of utilizing private capital for the government's railway infrastructure project, has emerged as a viable alternative measure to revitalize the stagnation of railway infrastructure expansion (Kim, Kang, & Jin, 2017).

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In the current budget management system of the Korean government, the feasibility of a financial project or a private investment project is determined by the value-for-money test, and value engineering is carried out at the construction stage (Kim & Hong, 2017; Kwon, Youn, Yeon, Jang, & Ko, 2019). Value engineering, as the part of a project, is an activity geared toward performance improvement and cost-effectiveness, and takes place throughout all stages of planning, design, and construction. Although the value-for-money test should be conducted on the basis of the optimized design according to value engineering, the determination of the value of money of private capital in Korea is conducted in the following order: (i) value-for-money test, followed by (ii) value engineering.

In this context, the approval or rejection of a private public partnership (PPP) project is decided in a state of uncertainty about the nature and cost of the public sector comparator and private finance initiative, which serve as the criteria for the value-for-money test, followed by implementing the value engineering techniques to improve the design adequacy and project efficiency. Analogous to the bullwhip effect in the supply chain, an incorrect process setting in the initial stage leads to a series of grave errors throughout the project implementation, resulting in investment failure (Eadie & Graham, 2014; McIyor & Humphreys, 2004).

The new product development (NPD) model is a representative theory of the timing of stakeholder involvement (Aapaoja, Haapasalo, & Söderström, 2013; Brown & Eisenhardt, 1995). The NPD process, which involves a complex process over a long period of time with the involvement of multiple stakeholders, is an extensively researched topic. In particular, the NPD model provides a theoretical framework for the timing of involvement of external stakeholders, such as suppliers and clients, along with internal interactions. Suppliers and clients in the context of NPD play the role of construction companies and railway service operators (or users) when applied to a railway infrastructure project. As such, the implications of the timing of stakeholder involvement in railway infrastructure projects can be drawn from the theoretical suggestions of the NPD model.

The purpose of this study is to explain the benefits of the early stakeholder involvement in railway infrastructure project in light of the NPD model and to propose guidelines for Korean railway infrastructure projects. This research is organized in the following ways. First, previous studies and cases on early stakeholder involvement in infrastructure projects were analyzed. Second, an early stakeholder involvement model in railway infrastructure projects is presented, and the relationships between elements are explained through the NPD model. Third, the requirements for the success of early stakeholder involvement in the Korean railway infrastructure project are discussed.

2. Literature Review

2.1. Previous research on early stakeholder involvement in infrastructure project

For the implementation of a complex construction project, management is required in various fields such as proper project completion, compliance with contract terms, and quality control. As the timing of stakeholder involvement is determined to face various situations, there is no single model or approach regarding the timing of stakeholder involvement (Wondimu, Klakegg, & Lædre, 2020). However, compared to the conventional procurement method, methods to improve the project value and shorten the completion period are being discussed, with terms such as target costing, integrated project delivery, and early supplier/contractor involvement on the agenda (Aapaoja, Haapasalo, & Söderström, 2013; McIyor & Humphreys, 2004; Wondimu, Hailemichael, Hosseini, Lohne, Torp, & Lædre, 2016; Wondimu, Klakegg, & Lædre, 2020).

Integrated project delivery refers to a method of holistically operating a project by integrating the project delivery, the composition of participants, and the project operation method at each stage of the project, including planning, design, construction, and maintenance and management. In this approach, risks and rewards are shared, and stakeholders' interests are directly linked to the success of the project (Aapaoja, Haapasalo & Söderström., 2013). Although integrated project delivery, itself, does not use technical tools, the use of building information systems is known to greatly contribute to the efficiency of integrated project delivery (McIyor & Humphreys, 2004).

Early contractor involvement is a conceptual model that allows the contractor to participate directly in the project development process at an early stage. Currently, in the procurement process of infrastructure construction, research on the early involvement of diverse stakeholders, especially early contractor involvement, is actively underway. Although contractors have a wealth of construction-related knowledge and experience, they usually join the project team too late, resulting in inefficiency. Scheepbouwer and Humphries (2011) point out that early contractor involvement achieves value for money for the project sponsor through provisions such as early involvement of the contractor, selection of a contractor based on nonprice criteria, agreed risk management, risk-adjusted price, and owner's termination for convenience. The early contractor involvement strategy has been successfully used in countries such as the UK, Australia, and New Zealand, with various

benefits.

Aapaoja, Haapasalo and Söderström (2013) discussed the benefits of early involvement of all stakeholders in addition to contractors. Benefits include 1) a lower likelihood of developing poor designs, higher efficiency, and higher cost-effectiveness; 2) the faster the stakeholders know about the end users' needs, the more likely the operations are geared towards meeting their needs, leading to higher customer satisfaction.

Briefly, the benefits of early stakeholder involvement can be largely viewed from the perspectives of the client, constructor, and consultant (or designer). From the client's perspective, major benefits include project time reduction, early cost-related information, effective risk management, and innovation through cooperation. From the contractor's perspective, major benefits include risk reduction, improved buildability of design and more flexibility in the construction phase. From the consultant's perspective, direct benefits include early acquisition of construction-related knowledge and innovative advancement through cooperation. The major benefits of previous studies are summarized in Table 1.

Table 1: Benefits of Early Stakeholder Involvement

Beneficiary	Best driver	References
Client	Project time reduction	Eadie and Graham (2014), Mclyor and Humphreys (2004), Nichols (2007).
	Early knowledge of design and costs	Aapaoja, Haapasalo and Söderström (2013), Eadie and Graham (2014), Mclyor and Humphreys (2004), Nichols (2007), Scheepbouwer and Humphries (2011).
	Effective risk management	Eadie and Graham (2014), Nichols (2007), Scheepbouwer and Humphries (2011)
	Collaborative relationship	Aapaoja, Haapasalo and Söderström (2013), Eadie and Graham (2014), Mclyor and Humphreys (2004), Nichols (2007)
Contractor	Reduced risk	Eadie and Graham (2014), Nichols (2007), Scheepbouwer and Humphries (2011)
	Improved buildability of the design	Aapaoja, Haapasalo and Söderström (2013), Eadie and Graham (2014), Mclyor and Humphreys (2004), Nichols (2007)
	Flexibility during the construction stage	Eadie and Graham (2014), Mclyor and Humphreys (2004), Nichols (2007)
Consultant	Design improvement from technical know-how	Aapaoja, Haapasalo and Söderström (2013), Eadie and Graham (2014), Mclyor and Humphreys (2004), Nichols (2007)
	Innovation from understanding risks	Eadie and Graham (2014), Nichols (2007), Scheepbouwer and Humphries (2011)

*Note: Drivers are reorganized from Eadie and Graham (2014) and reinforced from other references.

2.2. The process of Korean railway infrastructure project

Diverse stakeholders are involved in the process of railway infrastructure projects in Korea, which are implemented through complex procedures. In Korea, a rail infrastructure project is implemented pursuant to the Act on Private Participation in Infrastructure and its Enforcement Decree, and concrete guidelines and procedures are provided in the PPP Basic Plan (Kim, Kang, & Jin, 2017; Kim & Hong, 2017; Kwon, Youn, Yeon, Jang, & Ko, 2019). PPP projects are subject to different procedures depending on the procurement method and project developer. PPP projects can be categorized into Build-Transfer-Operate (BTO) and Build-Transfer-Lease (BTL) projects according to the implementation method, and into solicitated and unsolicited projects according to the project developer. Build-Transfer-Operate refers to PPP projects in which the investment cost is recovered through the fees paid by facility users. Build-Transfer-Lease refers to PPP projects in which the investment cost is recovered through facility rents or fees paid by the central or regional governments. In a government-initiated project, the competent authority selects a project after setting up a project plan and conducting a feasibility analysis. In an unsolicited project, when a private entity proposes a project plan, the competent authority receives and reviews the proposal and, when deemed eligible, approves it as a PPP project.

The procedure for implementing PPP projects consists of the following steps. For solicited projects: (1) designation of eligible projects; (2) formulation and public notification of requests for proposals; (3) submission of project plans; (4) review and evaluation of business plans; (5) execution of concession agreement and designation of concessionaires; (6) approval of implementation plans and execution/completion of projects. Of these stages, "(1) designation of eligible projects" consists of several important sub-procedures, namely preliminary feasibility study, preliminary price for value testing for prospective government-financed projects, and feasibility analysis.

Unsolicited projects comprise the following steps: (1) submission of proposals; (2) review of proposals and designation of projects; (3) request for alternate proposals; (4) preferential treatment of the initial proponent and evaluation of proposals; (5) execution of concession agreements and designation of the concessionaires; and (6) approval of implementation plans and execution and completion of projects. The value-for-money test is performed in "(2) proposal review and project designation," which follows the same procedure as the feasibility analysis of solicited projects.

In unsolicited projects, proposals are formulated in concerted efforts by contractors, operators, and designers; that is, all stakeholders are involved in the initial stage of proposal submission. In reality, however, most stakeholders participating in a proposal do not necessarily share risks and benefits during project implementation. Therefore, participants other than the company leading the proposal have no incentive to continue to take interest in and put effort into further progress of the project.

The major stakeholders in PPP projects can be roughly divided into government and private sectors. The private sector can be subdivided into constructors, financial institutions, professional operators, and designers. Currently, the PPP project implementation process consists of sequential stages in which individual stakeholders are involved separately. Designers join the project team from the "preliminary feasibility study" stage of the process step "(1) designation of eligible projects" onward, whereas contractors get involved from the process step "(5) execution of concession agreement and designation of concessionaires" and operators from "(6) approval of implementation plans and execution/completion of projects." The government is the stakeholder involved throughout the project, from planning to completion. The timing of stakeholder involvement in Korea is presented in Table 2.

Table 2: Stakeholder Involvement of Korean Railway Infrastructure Project

Stakeholder	Concept Design	Pretest	Preliminary Feasibility Study	General Plan	Construction	Operation Test
Government	O	O	O	O	O	O
Engineering		△*	O	O	O	O
Contractor					O	
Operator						O

*Note: An engineering firm takes the formal role from the stage of preliminary feasibility study. Nevertheless, it starts to take a role at the stage of pretest by helping government's pretest.

2.3. Cases at foreign countries on early stakeholder involvement

The positive effect of early stakeholder involvement in the project has been discussed in a variety of fields (Brown & Eisenhardt, 1995; McIyor & Humphreys, 2004). Its effect is particularly pronounced for complex and time-consuming structures such as infrastructure projects. However, owing to the nature of infrastructure projects, large-scale quantitative analysis is a great challenge in most cases because of issues such as sensitive internal information or long-term data collection. However, small-scale case studies have empirically demonstrated the effect of early stakeholder involvement (Aapaoja, Haapasalo, & Söderström, 2013; Nichols, 2007; Scheepbouwer & Humphries, 2011; Wondimu, Klakegg, & Lædre, 2020). Nichols (2007) performed an in-depth analysis of the advantages of early stakeholder involvement by exhaustively analyzing U.S. cases of highway construction, and Wondimu, Klakegg and Lædre (2020) analyzed the effect of early stakeholder involvement by means of extensive interviews with people working in infrastructure projects in Finland.

By analyzing 44 case studies, West and Gransberg (2012) conducted a quantitative analysis of the effect of early contractor involvement. They conducted an extensive literature search, project cost data collection, and content analysis of case studies. The main analysis revealed that the greatest and second-greatest effects of early stakeholder involvement are mitigation of schedule risk and reflection of contractors' opinions in the design, respectively.

Based on these empirical findings, each country has established a system to provide early stakeholder involvement (Park, 2018; Scheepbouwer & Humphries, 2011). More than 80 countries around the world, including developed countries in the

EU, are actively conducting PPP projects for public facilities. PPP projects are used for fiscal soundness in advanced countries and national economies in developing countries in Southeast Asia and South America (Kim & Hong, 2017; Kim, Kang, & Jin, 2017; Park, 2018; Scheepbouwer & Humphries, 2011). In particular, the UK has been operating the PFI system since 1992, mostly using the project delivery method of Design-Build-Finance-Operate (DBFO), in which the private sector is responsible for all the project process steps, and the government uses facilities against payment. With the entire responsibility in the hands of the private sector, all stakeholders of the project are involved in it from the initial stage (Nichols, 2007). Two typical early contractor involvement systems (Scheepbouwer & Humphries, 2011) are presented as follows.

2.3.1. South Australian model

The PPP project for the South Australian Department of Transport Energy and Infrastructure are provided for early contractor involvement in two separate phases: “design development” and “design and construction” phases. Before the project began, a contractor or a designer-contractor consortium was selected on the basis of nonprice criteria. In Phase 1, the contractor develops a preliminary design under the involvement of the government, whereby compensation for work follows the cost reimbursement method practiced in typical consultancy services. Phase 2 begins when 70% of the preliminary design is completed. Phase 2 involved final price negotiations and construction completion. If no agreement is reached, the government can terminate the contract and competitively tender the remaining work.

2.3.2. U.K. model

The Highway Agency in the UK adopted the early contractor involvement in 2001, which is now applied to most PPP projects. ECI selects contractors by competitive performance assessment rather than the lowest price bid. The government and contractor collaborate on an open-book basis to establish a target price. The contractor is required to implement the design within the target price on the basis of a pain-gain share formula. The designer and contractor collaborate through the planning, design, and construction phases with a pain-gain share structure, in which profits and losses (i.e., savings and expenditures generated through collaboration) are distributed.

3. Early Stakeholder Involvement Model in Railway Infrastructure Project

3.1. Relationship between NPD and Railway Infrastructure Project

New product development plays a decisive role in achieving competitive advantage of firms. Thus, NPD is the core of corporate innovation with macro-level analysis and micro-level. Macro-level analysis analyzes differences in innovation patterns among countries or industries, whereas a micro-level analysis analyzes the innovative process within an organization. Brown and Eisenhardt (1995) presented an integrated theory of NPD by compiling a comprehensive compendium of literature in the field of product development. This theory explains the complex multifactorial mechanisms among the major factors of NPD, that is, components within the organization (project leaders, senior management, team composition, work structure), components outside the organization (suppliers, customers, markets), and performance.

The Brown and Eisenhardt model states that project team leaders, senior managers, and suppliers influence the process performance (speed and productivity of product development), whereas project leaders, senior managers, and customers influence the product effectiveness (product and company competitiveness and market alignment). Process performance and product effectiveness ultimately affect the financial performance.

The players in the NPD model and those in the railway infrastructure project can be matched as follows: First, in a railway project, the government plays the role of the CEO of the new product model. It is implementing the railroad project from the perspective of the whole country and makes strategic decisions about the progress of the project. This government’s role corresponds to the role of the CEO of a private company. The team leader is responsible for practical work in NPD. From the perspective of the railroad project, the engineering firm designing the project plays this role. Although the supplier is an external stakeholder of the company, it plays a key role in a smooth NPD by providing the components necessary for NPD. In the railroad project, the constructor plays a role in providing the necessary infrastructure for the railroad map. Consumers are positioned in the final stage of using the developed product. In the railroad project, the citizens who ultimately use the railroad service are deemed consumers, but the public’s participation in the progress of the railroad project is somewhat limited. Instead, the railway operator that will provide railroad services in the future plays a role in reflecting the consumers’ standpoint, thus playing the role of the consumer.

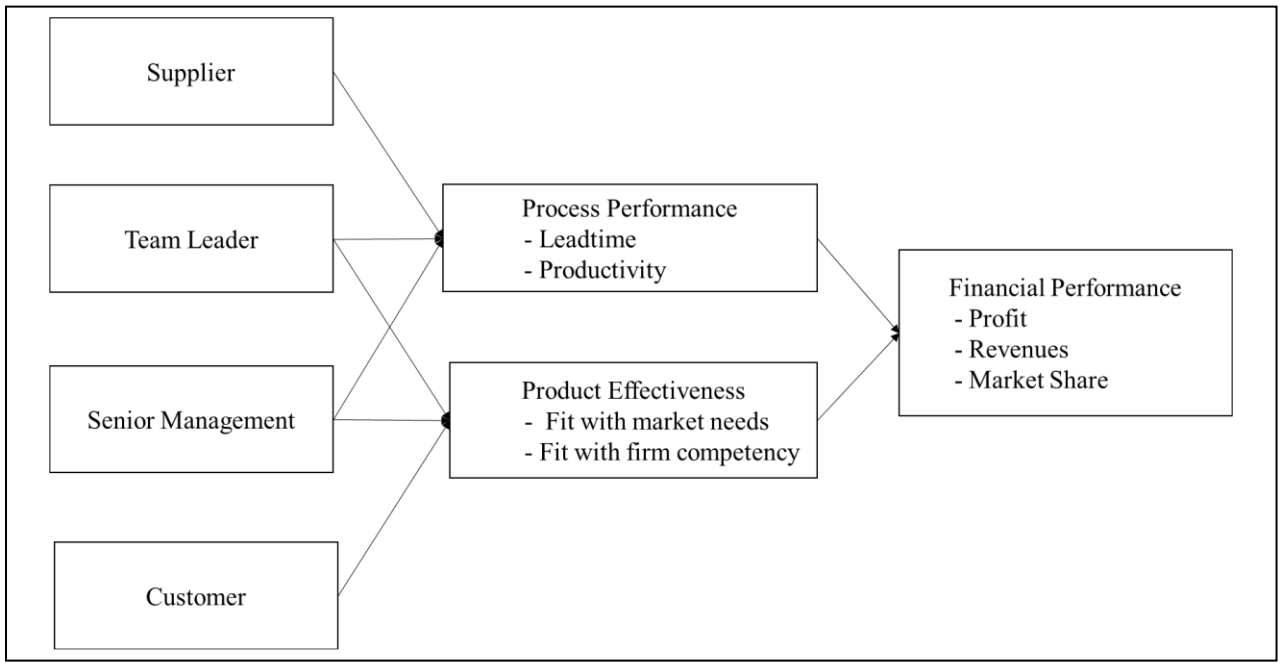

Figure 1: NPD Model (Modified from Brown & Eisenhardt, 1995)

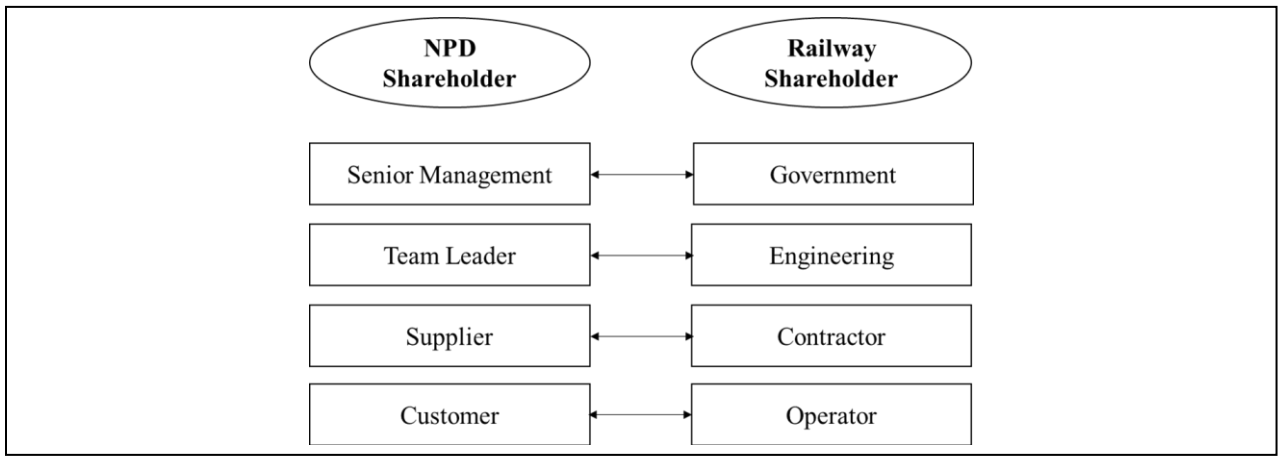

Figure 2: Matching NPD Stakeholders with Railway Infrastructure Stakeholders

3.2. Relationship among early involvement, construction period and project performance

The main focus of this study is to examine the timing of stakeholder involvement in PPP projects. From this perspective, we propose a model for the timing of stakeholder involvement, analogous to the NPD model. First, in the NPD process, suppliers are external agents with no affiliation with the company, playing the role of supplying components or parts to the company. Involving these supply network companies in the NPD process helps suppliers develop technical skills in their field of interest and improve their abilities to respond effectively to sudden or unusual requirements. More specifically, involving suppliers in the product design phase reduces complexity in a design project and speeds up the NPD process. From the perspective of the design team, potential problems they may face in the future can be identified in advance, making it much easier to address them.

This can be matched with the role of constructors in PPP projects. Constructors are external agents, not the owner of the railway infrastructure (the government in Korea) and provide constructed infrastructure, playing the role of suppliers in the NPD process. As in the NPD process, the early contractor involvement at the design stage of a PPP project can help contractors develop various preliminary knowledge necessary for the progress of infrastructure construction projects, and respond to policy

changes or changes in customer requirements more efficiently. In addition, with the reduced complexity of the overall design project, the uncertainty of the PPP project is reduced as well. Because the uncertainties that may occur later in the design stage can be detected at the pre-design stage, corrections can be made much more easily. This will greatly contribute to shortening of the infrastructure construction period, which is a primary indicator of process performance. Based on the above discussion, the following proposition is proposed:

Proposition 1: ***Early involvement of contractor in PPP projects has a positive effect on the project performance by shortening the infrastructure construction period.***

3.2. Relationships among early involvement of the railway operator, infrastructure efficiency, and project performance

Customer involvement in NPD affects product effectiveness, which is a measure of market efficiency or corporate competitiveness because customer involvement in NPD reflects accurate opinions on the formation of a product vision. The success of a new product is achieved by the support of the CEO, internal organizational linkages, and the merits of the product itself. Of these, the merits of the product itself are determined by its low price, high quality, and unique value it offers to customers(Cheng & Kim, 2021). From the company's perspective, improving the product's inherent value by identifying customer preferences and opinions at an early stage of NPD has a direct effect on product effectiveness. Thus, it is worthwhile for a company to involve potential customers at an early stage of NPD to discover the product's potential value for customers and to steer the NPD process in the right direction. It is of particular interest that early customer involvement has an indirect effect on the final product performance through variable product effectiveness, rather than a direct effect on the financial performance of NPD. This supports the reasoning that the expenditures associated with customer involvement are offset by the market success of the new product, which brings more gain than loss.

From the perspective of PPP projects, customers are comparable to railway operators in a narrow sense. In a broad sense, railroad service users are customers, but railroad operators directly use railroad infrastructure provided by contractors. In the long run, railroad operators must run businesses by reflecting customer needs, which allows the assumption that railway operators occupy the position of customers in PPP projects. As in NPD, early operator involvement is important for PPP projects to enhance the efficiency of investment in infrastructure by identifying the customer value perception of the new project at the earliest possible stage and reflecting it in the NPD process. Considering that the ultimate goal of infrastructure is to increase the effectiveness of its users, early detection and reflection of customer needs and preferences is essential for project success, and the early involvement of railway operators is an effective alternative to large-scale involvement of potential customers, which is difficult to undertake under the circumstances of infrastructure projects. In particular, in the course of railroad projects in Korea, railroad operators are often involved only much later in the test run period, which has a highly negative effect on railroad infrastructure due to failure in the timely identification of customer needs. Although the participation of railway operators may increase the overall construction cost or project operation cost, the positive effect of the improvement of the effectiveness of the railway infrastructure project through timely identification and appropriate reflection of customer requirements will be greater than the cost factor. Based on the above discussion, the following proposition is proposed:

Proposition 2: ***Early involvement of railway operator in PPP projects has a positive effect on the project performance by improving the effectiveness of railway infrastructure.***

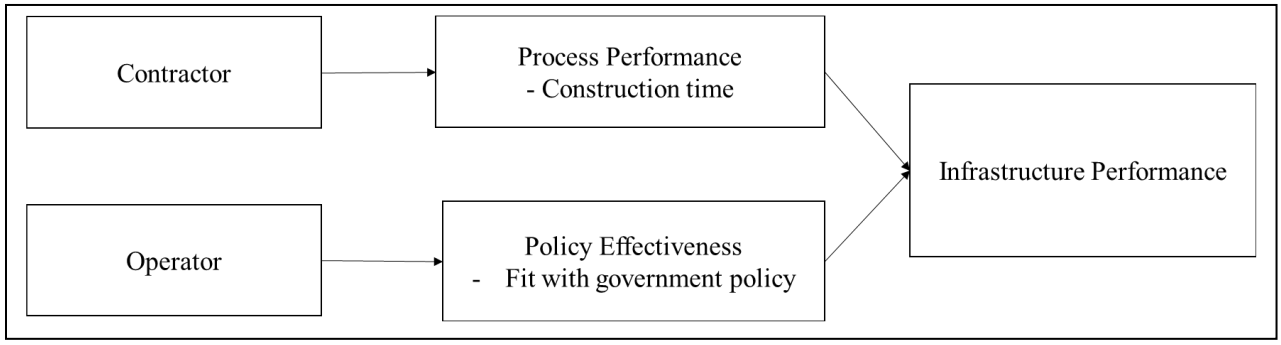

Figure 3: The Model on Early Stakeholder Involvement in the Railway Infrastructure Project

In general, it is difficult to collect large-scale empirical data on infrastructure project, because relevant data is considered as corporate secrets. Nevertheless, there are several empirical cases to support propositions.

Regarding the proposition 1, Thameslink program is a good example to show the benefit of early contractor involvement (Tunaley & Price, 2018). Thameslink Program is a ten-year program including extensive infrastructure enhancements and the delivery of 115 new trains. Key Output 1 (K1) is to allow 12 car operation between Bedford and Brighton by 2011 and to deliver new infrastructure capability by 2012. Key Output 2 (K2) is to provide the completed Thameslink service giving a further improved train service through the central London by 2018. On K1, contractors involved in design phase were not retained and did not participate in the actual construction. The change of contractors led to the loss of six months to the program. On K2, there was a commitment to allow contractors at design phase to stay on and to participate in the project. Early contractor involvement played an important role in building confidence around constructability and collaborative culture.

Regarding the proposition 2, Hong Kong MTR (Mass Transit Railway Corporation) case shows the benefit of early operator involvement in Railway (Anderson et al., 2017). MTR is a unique operator in that its role goes beyond traditional railway system. Due to Hong Kong's density, a majority of Hong Kong life takes place within the metro's reach and stations need to be in the midst of major facilities. Aligned with government, MTR has led on design of many projects, working with experienced operators and maintainers. The Operator's input ensures that operationally useful features are not removed from the project.

4. Guidelines for the improvement of Korean railway infrastructure project

4.1. AS-IS vs. TO-BE for Korean railway infrastructure project

This study presented a model to explain how the early involvement of contractors and railway operators in railway infrastructure projects affects the performance of railway infrastructure. The former contributes to the improvement of infrastructure performance by shortening the construction period and the latter by improving the effectiveness of the railway infrastructure. Contrary to the direction suggested by this model, contractors and railway operators in the current Korean project process are involved in the later stages, as shown in Table 2.

Therefore, it is recommended that the current railway infrastructure project process be changed toward a direction in which early involvement of constructors and railway operators can be ensured, which will result in shortening the construction period and improving infrastructure effectiveness, including consistency with the policy. Figure 4 illustrates a comparison of the current railway infrastructure project process and the ideal process.

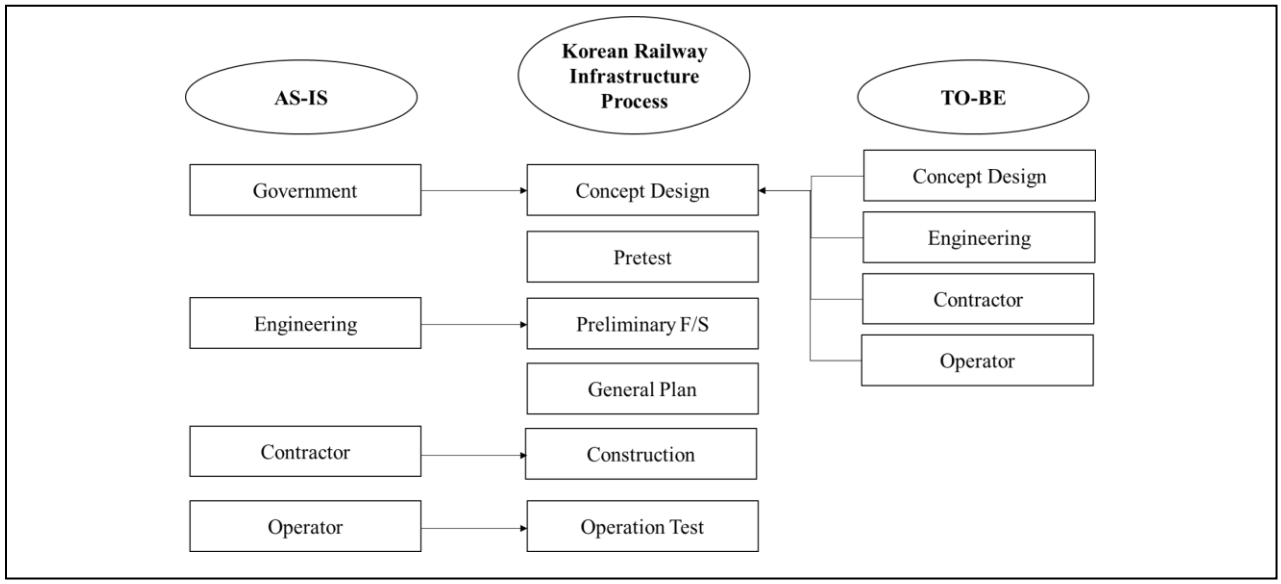

Figure 4: AS-IS and TO-BE for railway infrastructure process in Korea

4.2. Requirements for the success of early stakeholder involvement in Korean railway infrastructure project

Early stakeholder involvement in railway infrastructure construction can shorten the construction period and improve the effectiveness of infrastructure. Under the current constraints of the social overhead capital budget, which is declining due to the expansion of welfare needs, the railway industry has to continue to expand the railway infrastructure network, which requires large-scale financial resources. In the face of this situation, in order for the railroad infrastructure project to successfully compete with other project items such as welfare needs and other types of infrastructure construction, the utility created by the railroad infrastructure project must be enhanced. In this sense, early stakeholder involvement to ensure a shorter construction period and higher infrastructure effectiveness is indispensable for railway infrastructure projects.

However, establishing a collaborative relationship among all stakeholders at the outset is a significant strategic challenge. The conditions for successful early stakeholder involvement suggested by various non-Korean studies are described below, and these practical problems must be considered when implementing railway infrastructure projects in Korea.

First, stakeholders should be involved in the earliest possible stage (Aapaoja, Haapasalo, & Söderström, 2013; Scheepbouwer & Humphries, 2011; Wondimu, Hailemichael, Hosseini, Lohne, Torp, & Lædre, 2016). Because the railway infrastructure project is a complex project that involves a number of variables, the earlier the stakeholder involvement, the higher the effectiveness. Only when contractors with practical knowledge participate in the project at an early stage can the direction of the overall project be properly set, and excessive change costs due to subsequent design changes can be avoided.

Second, it is necessary to distribute risks and incentives among stakeholders (Eadie & Graham, 2014; Nichols, 2007). Large-scale projects carry many initial uncertainties and risks. Therefore, it is necessary to distribute these risks properly among stakeholders and to share benefits among stakeholders. If the stakeholders involved in the project have expertise and take risks in the areas where they can manage the risks, they can propose the most rational way to minimize the negative effects of those risks and maximize the future value. In contrast, if the risks assumed are beyond their capacity, they are likely to lead to moral hazard. And appropriate incentives or compensations can help stakeholders to take risk in a more voluntary way. In general, the imposition of penalties for problems posed is a mainstream tendency, rather than providing incentives for project improvement. Providing positive incentives for project improvement will create a win-win situation among all stakeholders.

Third, the project owner, that is, the government, should have competitive advantages and policy transparency in the procurement system (Scheepbouwer & Humphries, 2011; Wondimu, Klakegg & Lædre, 2020). A complex project is likely to trigger conflicts between stakeholders involved in the early stages and those involved in the later stages. That is, the stakeholders involved in an early stage have more information than those who joined the project team later, which can easily raise fairness issues. To solve these problems, the project owner must have the experience and capacity to manage procurement-related problems. In particular, a certain level of technical knowledge related to railway infrastructure is essential to flexibly deal with the contract terms that arise in future construction or operation.

Fourth, it is necessary to build a trusting relationship among the stakeholders (Aapaoja, Haapasalo, & Söderström, 2013; Eadie & Graham, 2014; McIyor & Humphreys, 2004). The information necessary for the progress of the project is valuable insider information among all stakeholders involved. This insider information can only be provided for project progress when stakeholders involved in the initial stage have trust in the project owner. To this end, it is necessary for the project owner to propose a process or system that can protect the rights of the stakeholders involved. Only when the participating stakeholders trust this system, it will be possible to retrieve the insider information necessary for project progress.

5. Conclusions

In this study, we discussed the benefits of early stakeholder involvement in railway infrastructure projects and measures required to achieve it. As described in foreign relevant studies, early stakeholder involvement in infrastructure projects is an optimal system with several advantages, but its practical application requires extremely time-consuming preparations. In railway infrastructure projects in Korea, engineering and design companies are involved at relatively earlier stages, whereas operators and constructors are usually involved only after the basic plan is set. Drawing on the theory of the NPD model, this study suggests that early contractor involvement shortens the construction period and that early operator involvement improves railway infrastructure effectiveness. We also discussed various considerations for the practical implementation of early stakeholder involvement.

A PPP project formally takes the form of the early joint involvement of constructors, operators, and designers. However, in most cases, individual stakeholders rarely share the risks and benefits of the project. At the early stage, contractors and operators

choose a light format in a legally non-binding manner. They and provide little information or efforts on the project design. At the later stage, they accept the status of the project "as is". As such, although early involvement is formally opted for, the reality is late involvement, and various devices are required for the effective implementation of early stakeholder involvement.

The study's academic contribution is to present the framework to consider railway infrastructure projects as holistic interactions among stakeholders rather than fragmented transactions among individuals. The majority of Korean railway infrastructure projects has been government-led projects in which individual stakeholders, such as constructors, operators, and customers, play their respective and independent roles. Under the current severe competition in business and other fields, it is essential to coordinate the capabilities of various stakeholders from a holistic perspective, going beyond optimizing individual participants (McIyor & Humphreys, 2004; Wondimu, Hailemichael, Hosseini, Lohne, Torp, & Lædre, 2016). In railway infrastructure project in Korea, it is necessary to go beyond the analysis of the individual's activities and to consider the interactions of all stakeholders.

The practical contribution of this study is to present policy makers and business practitioners with guidelines to improve the efficiency of Korean railway infrastructure process and to recommend government and affiliated organizations to allow open access to relevant data. To policy makers, the study emphasizes the role of the early involvement of diverse stakeholders and proposes government to change procurement process on railway infrastructure project. It is more important to take various measures to derive an appropriate implementation. Moreover, government may consider to allow open access to data on railway infrastructure project or to support a long-run research on the underlying mechanism. Due to the lack of data, researchers find it difficult to conduct empirical researches on railway infrastructure project. Although companies are reluctant to share data, government needs to provide them with incentives to open access, because it can help researchers to find valuable policy advice fit with Korean environments. To business practitioners, constructors and operators need to get actively involved in the project at the outset, presenting valuable information and opinions from the early phase. A more sophisticated system on risk sharing and incentive scheme would be a prerequisite for voluntary participation.

The limitations of this study and the further research from those limitations are as follows: First, it is necessary to discuss more thorough and specific measures to minimize the side effects of early stakeholder involvement. Although we suggested several practical ways to promote early involvement, they cannot cover huge amount of conflicts from various stakeholders. Conflicts involved in large-scale projects need to be more specifically examined and addressed (Oh & Youn, 2019).

Second, it is necessary to conduct empirical tests on major research propositions, using objective and real-world data. This study applied a theory applicable to railway infrastructure projects and discussed the related implications. Several cases are presented to show empirical validity of propositions. Nevertheless, the lack of large-scale empirical data has been a hindrance to a thorough empirical test. Because the data on long-run railway infrastructure project tends to be delicate internal information, researchers find it difficult to have an access to detailed data. When the government (or affiliated organization) allow open access to data on railway infrastructure projects, researchers may consider various research designs to conduct empirical validation of important propositions under the distinctive Korean environments. It has been a significant challenge to analyze the quantitative effects of policy changes, especially the effects of process changes (Park, Seo & Kim, 2019). A more sophisticated research methodologies such as experimental design or big data analysis may be helpful in overcome these concerns.

References

Anderson, R., Allport, R., Floyd, P., Cohen, J., Barron, A. Agarwal, A., Gupta, N. & Dominic P. (2017). *The Operator's Story: Emerging Findings(Case Study: Hong Kong SAR, China's Story)*. OECF ITF 2017, Leipzig May 2017.

Aapaoja, A., Haapasalo, H., & Söderström P. (2013). Early stakeholder involvement in the project definition phase: Case renovation. *ISRN Industrial Engineering*, vol. 2013, pp. 1–14.

Brown, S. L., & Eisenhardt, K. M. (1995). Product development: Past research, present findings and future directions. *The Academy of Management Review*, 20(2), pp. 343-378.

Cheng, Z.F., & Kim, G.B. (2021). The Effects of Brand Experience on the Perceived Value of Customers in China and Korea. *Journal of Economics, Marketing, and Management*, 9(3), pp. 1-9.

Eadie, R., & Graham M. (2014). Analyzing the advantage of early contractor involvement. *International Journal of Procurement Management*, 7(6), pp. 661-676.

Kang, S.W., Kim, D.H., & Kim, K.T. (2019). Cost overrun in construction of Railway infrastructure: Causes & implications. *Journal of The Korean Society for Railway*, 22(11). pp.1-8.

Kim, D.G., & Hong, J.J. (2017). *A study on the private investment projects in Korea and Japan: Policy implications and case study*. The Seoul Institute, 2017-OR-12

Kim, Y. K. Kang, J. H. & Jin, W.J. (2017). *Support on ensuring publicness for railway PPP projects*. KOTI MP-17-04.

Kwon, Y. H., Youn, H, H, Yeon, J.S., Jang, B.C., & Ko, K. H. (2019). *A manual on the procedure of public-private partnership projects in*

Seoul. The Seoul Institute, 2019-BR-21

Tunaley, M, & Price, D. (2018). *Thameslink: London bridge area partnership assessment*. JACOBS.

Mclvor, R. & Humphreys P. (2004). Early supplier involvement in the design process: Lessons from the electronics industry. *Omega*, 32, pp. 179-199.

Nichols, M. (2007). *Review of Highways Agency's Major Road Programme*. Report to Secretary of State for Transport.

Oh, M. K. & Youn, M.K. (2019). A Study on the Development Strategy of Logistics System in E-Commerce in China. *Journal of Economics, Marketing, and Management*, 7(4), pp. 1-5.

Park, H.S., Seo, Y.W. & Kim, G.B. (2019). Effects of the Characteristics of Founders and Governmental Support on Start-up Performance through Entrepreneurship and Network. *Journal of Economics, Marketing, and Management*, 7(4), pp. 20-32.

Park, S.J. (2018) *Enhancing the Publicness of PPP (Public-Private Partnership)*. Construction & Economy Research Institute of Korea.

Scheepbouwer, E., & Humphries A. B. (2011). Transition in adopting project delivery method with early contractor involvement. *Journal of Transportation Research Board*, 2228, pp. 44-50.

West, N. & Gransberg, D. (2012) Quantifying the value of construction contractor preconstruciton involvement. *First Australia and South Asia Structural Engineering and Construction Conference*. November 2012.

Wondimu, P. A., Hailemichael, E., Hosseini, A., Lohne, J., Torp, O. & Lædre , O. (2016) Success factors for early contractor involvement in public infrastructure projects. *Energy Procedia*, 96(2016), pp. 845-854.

Wondimu, P.A., Klakegg, O.J., & Lædre, O. (2020) Early contractor involvement: Ways to do it in public projects. *Journal of Public Procurement*, 20(1), pp. 62-83.