The Procurement Strategy for Railway Construction Projects

THE PROCUREMENT STRATEGY FOR A RAILWAY CONSTRUCTION PROJECT

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***ABSTRACT*:** High standard and quality infrastructure plays an essential role for the welfare and economic activity, and the demand for the railways system, which is a fundamental transportation infrastructure, is increasing for its efficiency and generous impact on environment. The railway construction project, on the other hand, requires an expensive cost especially in urban area, and the financial resource for a project is limited in many cases. Hence, it is critically important to increase the value for money in each project to meet the increasing and various demands for a railway service in a limited finance resource. One of the effective ways to increase the value of a project is to save the cost while maintain its function and quality.

The purpose of this research is to analyze and introduce the procurement strategy for a railway construction project by taking an example of East Japan Railway Company (JR-East) in achieving the cost saving in a construction project. This paper finally shows how the cost saving methods work in the value chain of a construction project and how in-house engineers play theirs role in increasing the value of a project. It is engineer's responsibility to assure the quality and function and save the cost of a project at the same time in order to deliver an infrastructure in a competitive market. Engineers working for an infrastructure project have to be conscious of social and engineering views in managing a project.

KEYWORDS: Railway Project, Construction Management, Privatization

1. INTRODUCTION

This paper analyzes the procurement strategy of a railway construction project from the engineering and social points of view by taking an example of a privatized railway company (JR East). The objective of this research is to provide an insight to manage the cost and increase the value of an infrastructure project.

JR-East was privatized in 1987 as a part of the restructuring of social systems, and now mainly operating in the Tokyo metropolitan area. After the privatization, JR-East introduced various methods to increase the value of a project and provide its railway service in a competitive market.

It is necessary for managers to adapt their strategy to the change of social and economic situations around a project. In this sense, taking advantage of privatization, JR East has changed its decision and management system for its capital programming to optimize the administrative resources. Thus, management of a construction project changes consequently. The idea and method of "Construction Management" played a quite important role in providing appropriate solutions for the situation.

1.1 Corporate Information

In accordance with the provision of the Law for Japanese National Railways Restructuring, the Japanese National Railways (JNR) was privatized into six passenger companies and one freight company on April 1, 1987. East Japan Railway

Company (JR East) is the largest passenger railway company in Japan and serves the Tokyo metropolitan area and the eastern part of the main island of Japan. JR East operates 7,526.8 km railway line (including 1,052.9km high speed line), 1,699 stations, and serves more than 16 million passengers daily.

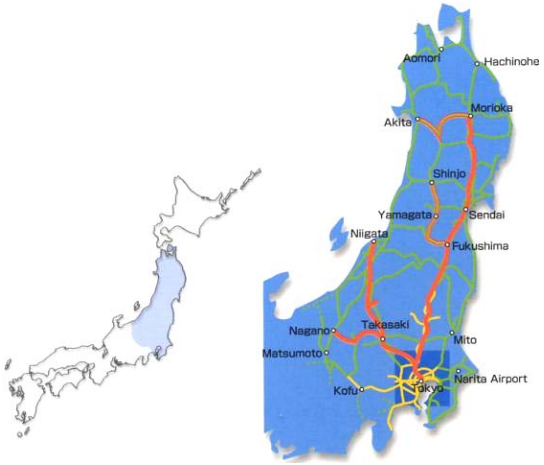


Figure 1.1 Operating Area of JR East

Table 1.1 shows the financial highlights of JR East. The company inherited a part of the large debt of JNR in exchange for the operating assets when it was privatized. This debt was so huge that repaying the interest is one of the major financial burdens. Therefore, it is critical for the company to reduce the debt by effectively controlling its investment activities. However, capital investment is a source of cash flows in the future, and indispensable to compete in the market. Therefore, managers are required to save the cost and increase the value of a project.

Table1.1 Financial Highlights in the FY 2005(M$)[1]

Income Statement	
Operating revenue	17,408
Operating income	2,207
Net income	1,305
Depreciation	2,207
Free Cash Flow	2,627
Balance Sheet	
Total Asset	58,011
Long-Term Debt	33,392
Shareholder's equity	11,322

[1] exchange rate: $1=¥110 in this paper

After the privatization, JR East invested its administrative resources on infrastructures both to cope with the transportation demand and to increase its revenue.

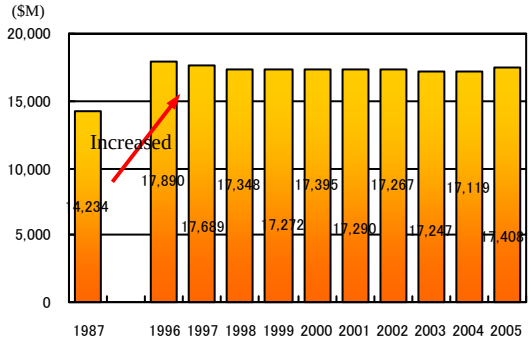


Figure 1.2 Operating Revenue (1987-2005)

1.2 Construction Project

JR East is involved not only in the railway operation, but also in other business such as retail sales, shopping centers, hotels, real estate development, etc. These businesses have synergistic effects with the railway business, and make the company diversify its portfolio and projects.

Figure1.3-4 shows examples of construction projects. There are two clear trends for recent projects. They are "highly-developed use of space" and "effective utilization of existing infrastructures". Limited space in urban area and expensive cost in acquiring land lead a project more complex than before. For instance, previously, a station-development project is mainly planned to make the use of space around the station. Nowadays, however, there is little space around a station. Therefore, engineers have to consider the effective use of the upper space of a station or railway track when they

develop a station. Figure1-3 shows an example of this case. This project provides vertical use of a station by building an artificial ground on the railway track. The station expands its facilities on the second floor and provides comfortable space for railway passengers. This project also builds traffic plazas for automobiles and buses on the third and forth floor to mitigate the traffic congestions and make the station convenient for transit.

Figure1.3 Station-Redevelopment Project

Another example is shown by Figure1-4. This project builds a new railway line, which connects the existing commuter lines, mitigates the congestion, and gives flexibility and direct through service in operating the railway system. The new line is built by using the viaduct of its high-speed rail (Shinkansen) around Tokyo. Typically, building a new railway line is difficult due to the expensive land cost. Using the existing viaduct, however, this project can be realized.

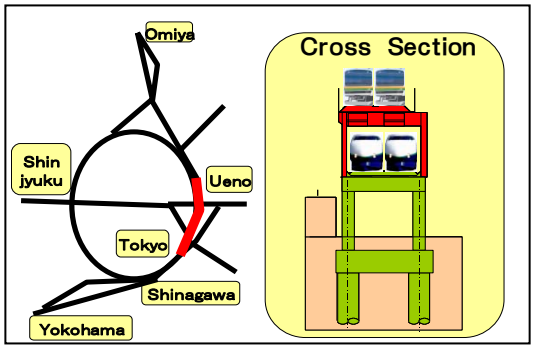


Figure1.4 Building a New Line on an Existing Viaduct

These trends make the railway projects complex and highly technology integrated. Highly developed use of space and effective utilization of existing infrastructures significantly improve the administration and railway service at the same time. Promoting these projects, however, requires a high level of management and organizational effort for cost saving.

2. INVESTMENT ON PROJECT AND VALUE CHAIN

Figure 2-1 shows the amount of investment on construction projects. This figure indicates the investment doubled from 1987 (privatization), and continues around $2,000 M recently. As stated in the previous chapter, construction projects tend to be complex and highly technology integrated especially in the Tokyo metropolitan area, and this fact drives projects to expensive construction cost. Consequently, cost saving management becomes a key in handling an investment.

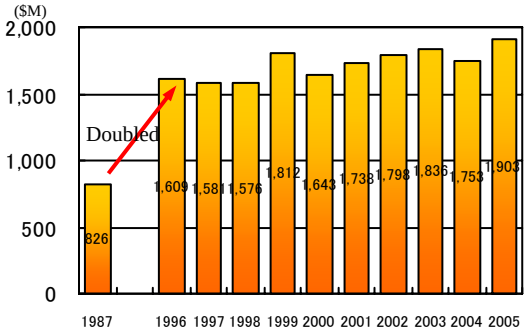


Figure2-1 Investment on Projects ($M)

The cost saving methods is mainly divided into three categories.

(1) Cost saving activity covering from the planning to execution phases in a construction process. One of the effective activities is the Value Engineering (VE), which results in remarkable effects in saving the cost of a project.

(2) The contract and bidding system to improve the delivery of a construction works in an engineering market. As a private company, JR

East is tying to use the effective contract method by taking advantage of the expertise in an engineering market.

(3) The R&D. In-house engineers innovates the project by using and creating a new design or engineering to meet the specifics requirements of a project.

Figure 2-2 summarizes the cost saving method in the value chain of a project.

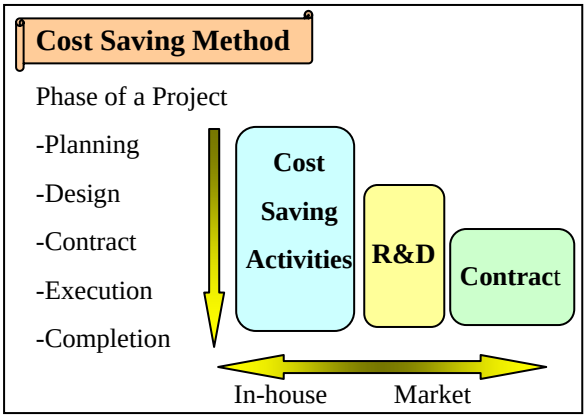


Figure 2-2 Cost Saving Method in Vlue Chain

Thus, each method is located strategically in the value chain of a project covering the planning to the completion phases. It is essential to apply an effective method in a certain phase of a project. Similarly, taking advantage of market expertise is useful on top of internal effort.

3. COST SAVING AVTIVITY

Costs saving activities are classified into two methods. One is “Cost Saving Proposal”, and the other is “Value Engineering (VE)”. These two methods have difference. The cost saving proposal is an individual (including a team of a few people) activity by taking a voluntary method. Each engineer is encouraged (not obligated) to propose a cost saving throughout a project. VE, on the other hand, is an organizational effort to increase the value of a project by taking a systematic method. The manager set a target for cost saving in promoting a VE, and engineers are forced to reach the target.

These two activities are, in common, continuous efforts throughout a project. As the project proceeding, the information becomes clear and accurate. Then, there is room for new or alternative idea, which saves the cost of a project (cf. Figure3-1). In general, the effect of cost saving is significant in the upper stage of a project because of its flexibility. Some idea, on the other hand, can be applied only after a certain stage since it requires accurate information or decision. In this sense, it is quite important to keep the pressure to save the cost throughout all stage of a project.

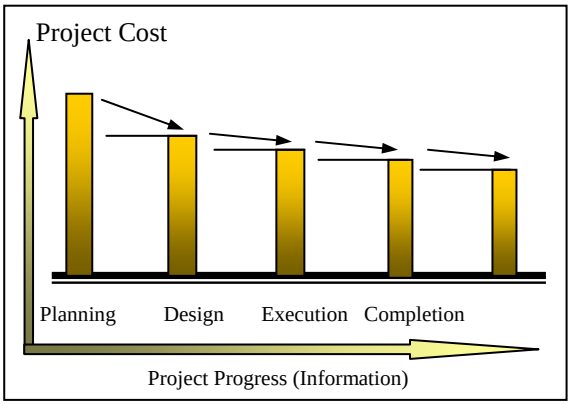


Figure3-1 Project Progress and Cost

3.1 Cost Saving Proposal

As a cost saving proposal, all engineers are encouraged to propose an idea to save the cost of a project. There is no perfect design or execution plan, and thinking an alternative idea is essential in refining it. In this sense, proposing an alternative idea gives opportunities not only for saving the cost but also for improving the performance of a project. The process of cost saving proposal is:

(1) Propose (write) an idea on a format

(2) Evaluated and ranked by a committee of managers

(3) If adapted, the proposer will be rewarded with a premium and commendation.

The cost saving proposal is not aimed only for the actual outcome (= cost saving) but also for the improvement of the ability of engineers. Thinking and discuss an alternative idea trains the engineers and brings out their potential talent.

One proposal might have little impact, but cumulative effect is significant both for the cost saving of a project and the engineering performance of an organization in a long term. Figure3-2 shows the number of proposals and the amount of cost saving, and indicates continuous effect by this activity (around 3-5% saving effect for total cost).

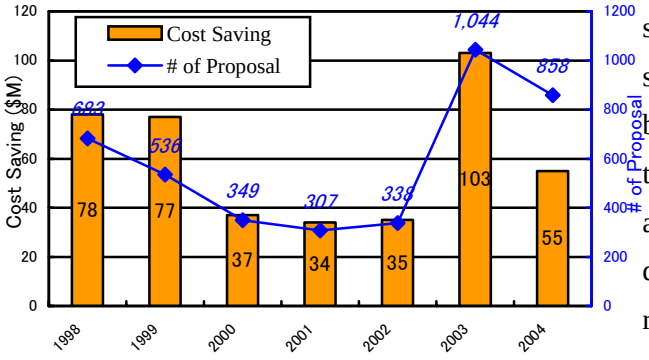


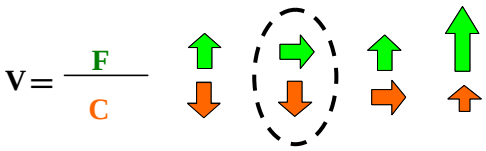
Figure 3-2 The Effect of Cost Saving Proposal

3.2 Value Engineering

Value Engineering (VE) is one of the management technologies originally developed in the manufacturing industry. VE focuses the relationship between the function and cost. The essence of VE is to improve the "Value" by saving the "Cost" while maintaining (improving) the "Function".

Value (V)= *Function (F) / Cost (C)*

VE typically has four patterns to increase the "Value" as shown in Figure3-3. JR East, however, mainly takes the second pattern to make the process simple and cost focused.



V: Value

F: Function (Requirement from Customers)

C: Cost (Life Cycle Cost)

Figure 3-3 Value, Function, Cost

In contrast to the cost saving proposal, VE is a task forcing and organizational activity. The manager chooses a project for the VE activity by considering the scale of a project and needs for cost saving, and determines the target (percentage of cost saving). After the selection of projects, engineers build a team for VE activities and use the VE techniques to achieve the target. The outcome of VE activities is actually realized in the project plan, design, and execution. In addition, engineers write a report of the VE activity to record and share the experience within the organization.

Figure 3-4 shows the result of VE activities, and indicates the steady progress of the VE activity. The organizational target for cost saving is set to achieve at least 3% of total cost.

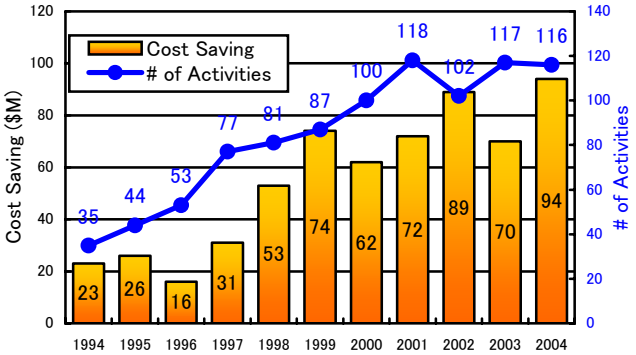


Figure 3-4 The Effect of VE Activity

JR East also developed a new VE method suitable for a construction project. That is "Intensive VE" which has five steps while the standard VE has ten steps in its process.

Since the VE originally developed in the manufacturing industry, it has detailed steps to analyze the value and propose an alternative idea. The construction project, however, requires more efficient and quick process than the mass production system of manufacture.

Table 3-1 compares the standard ten steps and intensive five steps in VE process. The intensive VE takes the core steps, and arrange them to work effectively in the fast and non-repeated process of a construction project.

Table 3-1 Standard VE and Intensive VE

Step	Standard VE (10 steps)	**Intensive VE (5 steps)**
Definition	Collect the Information	**Collect the Information**
	Define the Function	**Define the Function**
	Organize the Function	
Evaluation	Analyze the Cost	**Analyze the Cost**
	Evaluate the Function	
	Select the Target	
Proposal	Propose Ideas	**Propose Ideas**
	Evaluate (General)	
	Refine the idea	**Refine the idea**
	Evaluate (Detail)	

It is also important to provide effective training programs throughout the VE activities. Since the VE is organized based on the management technique, it is critical to understand the underlying theory and concept in order to effectively use the VE methodology. In this sense, there are various VE training programs according to the level of engineers (e.g. newcomer engineers, managing engineers, instructors).

4. CONSTRUCT SYSYTEM

The next effective method is the contract and bidding system. The contract connects the project owner and contractors with right and obligation.

The contractor has an obligation to complete the construction work as written in contract documents (e.g. design drawings, specifications), and have a right to receive the payment. There exists various way to design the contract, and it is essential to shape the contract with engineering consideration to achieve a high performance in a project.

In designing a contract, we have to consider the both owner and contractor's points of view. Porter (1998) explains the long-term profitability of a firm based on the five forces in the market value chain. The combination of these five forces will determine the dynamics of competition, and how a firm will assess its position in a competitive market. Figure 4-1 describes the five forces around a contractor in the railway construction market.

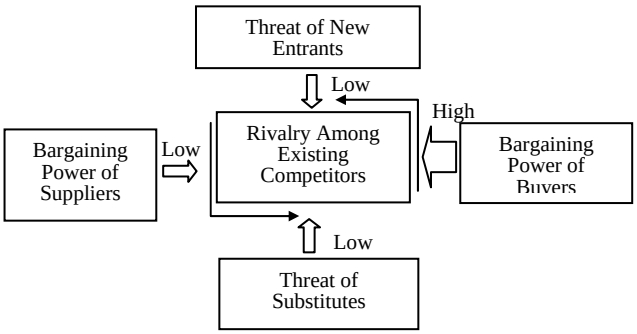


Figure 4-1 The Five Competitive Forces

In general, the owner has a strong bargaining power to the contractors, and the owner tends to force "low price" in a contract through the negotiation and severe bidding. This is not an appropriate solution because forcing a low price results in low attractiveness of the market, and contractors gradually shift their focus to the other markets. The decline in the attractiveness of market discourages the competition, and leads to the low performance (high cost, low quality). Hence, the owner has to design the contract to provide a proper incentive to the contractors while saving the cost of the construction work.

4.1 Negotiation Based Contract

One effective solution is the negotiation- based contract. Before the privatization, JNR usually took the bidding system, by which in-house engineers estimated the price of the construction work, wrote the request for proposal, and made bidding. Normally, a contractor who offered the lowest price won the bid and made the contract.

This process is clear in the meaning that the price is the only criterion in the selection. The ability of a contractor, however, is difficult to evaluate, and the expertise of the owner and the contractor is not integrated but separated. Therefore, in-house engineers had to take a lot of effort to estimate the proper price of the contract and to supervise the quality of work.

After the privatization, JR East takes the negotiation-based contract. The process is:

1. The owner makes a request for proposal (without estimation).
2. The contractors submit the estimate and execution plan.
3. The owner discusses the price based on the execution plan with the contractor who offers the lowest price. This discussion includes the breakdown of the price and alternative execution plans. The owner negotiates and examines the proposal to improve the performance of the contract.
4. If they reach to an agreement, then made the contact. Otherwise, the owner begins another negotiation with the contractor who offers the next lowest price.

In this process, the owner assures the accountability in the selection of a contractor since the lowest offer won the first negotiation. In addition, this process is effective to improve the performance of the contract. It is possible, in this process, to integrate the expertise of the in-house and contractor's engineers. The engineers can complement through the negotiation, and satisfy the requirements each other.

Furthermore, the owner can enrich the expertise about the construction cost and execution plan by taking this contract system. The reinforced ability helps the owner to plan a project, improve its performance, and increase the bargaining power in the market.

4.2 VE-Contract

In addition to the negotiated contract, "VE contract" is effective to increase the value of a project by utilizing the expertise of a contractor. In this VE contract, the owner appoints the VE contract on top of the standard contract for a construction work. In this VE contract, engineers in a contractor have a right to propose alternative design or execution method to save the cost estimated from the original contract design and document. If the proposal is regarded as effective, it will be adapted, and the contractor can take the 50% of the cost saving. The evaluation of the proposal is similar to the VE processes. The criteria are:

- Maintaining the original function
- Clear difference from the original design
- Clear cost saving effect by the proposal

This VE contract is effective because the contractor has strong incentives to propose an alternative idea (50% of cost saving can be the net profit). The project owner also enables to save the cost and improve the value of the project by taking the expertise of market.

5. RESEARCH & DEVELOPMENT (R&D)

Lastly, innovation is the key to save the cost and improve the performance of a project. The new technology or design effectively works to achieve the target of a project. Therefore, a project owner has strong incentive to invest in the R&D especially in the case that the owner repeatedly uses the same kind of technologies.

The point is that this R&D in a project is different from the general ones. First, in principle, this R&D has a clear target (e.g., to save the X% of the total cost, to shorten Y% of total construction period, etc.). This R&D is a project based activity, and needs to promote in order to meet the specific requirements from the project. Therefore, this R&D effectively uses, modifies, and advances existing technology rather than develop from the beginning.

Next, the cost of this R&D has two ways to recover the initial investment (development cost). One is the cost saving effect in a project. The other is the royalty from the technology. If a new technology is effective and widely applicable, it will be patented. The patent is quite useful to protect the intellectual right and recover the development cost. If the technology is widely used, it will be improved through the practical use, and the royalty becomes a large sum. In case of JR East, around twenty R&D activities are promoted, and the sum of royalty though the R&D activity is shown in the Figure 5-1, which indicates that the R&D works not only to save the cost of a project but to provide an extra income (royalty) to the company.

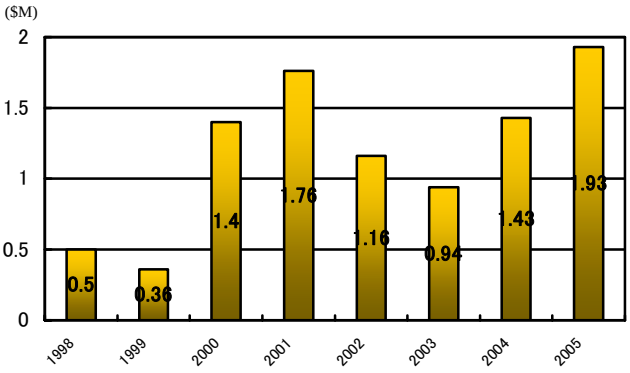


Figure 5-1 The Royalty From the R&D Activity

Finally, the R&D is important since JR East is a project owner and railway operator. Therefore, in-house engineers have to consider the life cycle cost and performance. This consideration requires the experience as a railway operator. Moreover, the railway market is limited in a sense, and the construction firms or manufacturers have relatively little incentive to invest in the railway R&D. Hence, the project owner has to take the initiatives in this field.

Figure 5-1 and 2 show examples of the R&D, which achieved to save around 30% of construction cost compared to the conventional technologies.

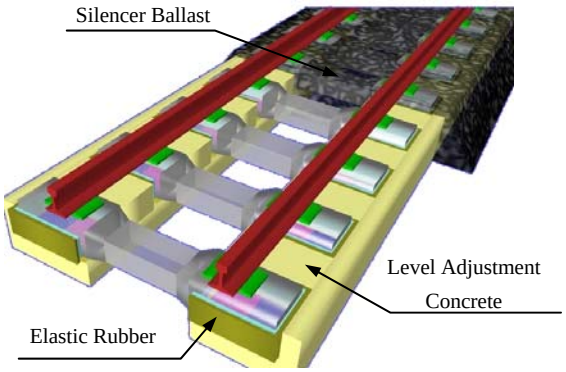


Figure 5-1 Solid Track with Elastic Sleeper

- Using the elastic rubber at the bottom face of the concrete sleeper and silencer ballast around the track, the noise and vibration are drastically absorbed.

- The sleepers are supported with reasonable level adjustment concrete rather than expensive concrete slab.

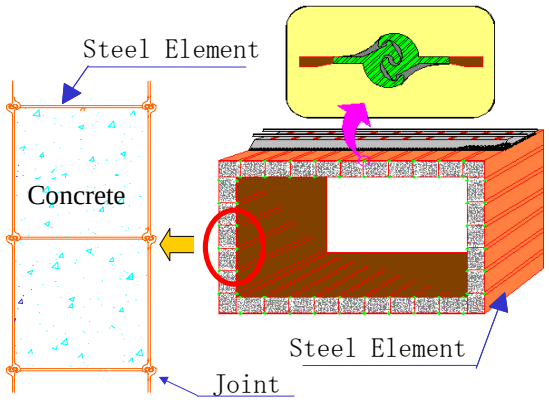


Figure 5-2 Jointed Element Structure Tunnel

- Using a special joint, which rigidly connects the steel elements, the RC tunnel structure (under a railway track) can be divided to the small elements.
- Execution of small elements has little impact on the surface (railway track), and requires low cost and short period in construction.

6. IN-HOUSE ENGINEER

Throughout the above cost saving process, in-house engineers heavily contribute to each activity. In promoting a project (planning, design, contract, execution, completion), there exist plenty of room to improve. The cost saving is not simply targeted to lower the cost but also refine and improve a project itself.

Consequently, it is quite important for a project owner to educate excellent in-house engineers, and accumulate the expertise with the organization. The issue is that experience plays a quite important role in the ability of an excellent engineer, and it takes time to educate. Therefore, having in-house engineers requires a certain cost for a project owner. In general, however, a project owner who has a steady amount of projects finds advantages for having in-house engineers. For a long term, it is essential to establish an education system and accumulate the experience as an organization. The points are:

- Build a specialized organization for a project to intensively collect the information and experience.
- Determine an objective index for the evaluation of project skill, and set a target for it.
- Allocate engineers from the project and educational points of view.

In the case of JR East, there are about 1,500 construction engineers within the company, and each engineer has its own specialty. In case of a civil engineer, for instance, the project skill is mainly divided into three fields (Planning, Project Management, and Design) and evaluated with 5 levels. Each engineer is encouraged (and obligated) to cultivate one's skill at least to reach the level 3 in the specialized field in a training period (4-5 years). In general, they have to reach the level 5 (highest level) in one's specialty and level 3 in other field within 10 years. In cultivating the skill, on the job training (OJT) is the most effect way, thus a project manager has to direct the subordinate engineers from the project and educational points of view.

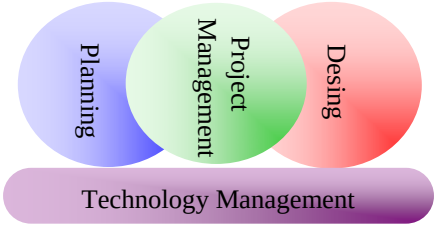


Figure 6-1 Three Fields of Specialty

7. CONSCLUSION

This procurement strategy for a railway construction project developed after the privatization. The advantages of the privatization are:

- Clear corporate mission and policy
- Strong leadership of administration
- Flexible system in management
- Motivation of employees

These factors promote the cost saving process and the effect results in 10-20% in saving the construction cost in general.

I hope this construction management paper can be a part of the reference to a project owner, who has a mission to maximize the use of the administrative resources and to improve the value of a project

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