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# Korean Engineering Firms' Competitiveness Change for the Last Decade

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**Abstract:** Recently, there has been a steady decrease in the proportion of the construction sector among Korean engineering firms. Thus it is essential for Korean engineering firms in the construction sector, which lack experience in overseas ventures, to identify and improve their competitiveness for successful overseas expansion. Therefore, in this study, changes in Korean engineering firms' capabilities for the last decade were analyzed to promote entry into overseas road and water resource engineering markets. Competency factors that require urgent improvement were derived based on Importance-Performance Analysis (IPA) as a tool for quantitative measurement. As a result, the factor that shows low performance compared to the importance is an overall understanding of the target country in the road and water resource areas. Knowledge of regulatory issues on design, the ability of time management software, and knowledge of the regulatory problems on construction safety are also insufficient. This study can be used as a research methodology to identify competitiveness that Korean engineering firms have to strengthen when they advance into overseas markets in roads, water resources, and other areas.

**Key words:** Korea Engineering Firms, Global Competitiveness, IPA

## 1. INTRODUCTION

The number of Korean engineering firms is 7,124 as of 2020, of which the construction sector accounts for 53.1%. However, <Table 1> shows a steady decrease in the proportion of the construction sector for the last decade. It shows the limits to the development of the construction sector in the Korean engineering market [1].

**Table 1.** Status of the construction sector for the last decade [1]

**(Unit: number, %)**

| Division | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Number of firms** | 2,878 | 2,973 | 3,091 | 3,019 | 3,196 | 3,361 | 3,016 | 3,283 | 3,509 | 3,784 |
| **Composition ratio** | 59.3 | 58.7 | 58.2 | 58.5 | 57.5 | 56.9 | 55.0 | 54.6 | 53.7 | 53.1 |

Due to long-term market uncertainty, there has been a growing need for Korean engineering firms that are highly dependent on the domestic market to make inroads into overseas markets [2]. However, 11 Korean engineering firms included in the Top 225 International Design Firms in 2021 are still low in sales compared to U.S. (76) and Chinese (24) firms, and continuous efforts need to be made to enter international markets [3].

Therefore, this study aims to investigate Korean engineering firms' competitiveness changes for the last decade and identify the competitiveness needed to advance into overseas markets. In addition, the research scope is limited to the road engineering market in the transportation sector, which has a large market size <Table 2>, and the water resource engineering market, which has high growth potential [4].

**Table 2.** International Market Analysis [3]

**(Unit: $ Billions, %)**

| Area | Transportation | Petroleum | Buildings | Power | Industrial | Water | Other |
|---|---|---|---|---|---|---|---|
| **Size** | 17,488 | 14,795 | 13,519 | 8,476 | 4,196 | 2,871 | 10,966 |
| **Ratio** | 24.2 | 20.5 | 18.7 | 11.7 | 5.8 | 4.0 | 15.1 |

## 2. RESEARCH FRAMEWORK

The research procedures are shown in <Figure 1>: First, competitiveness factors for each business stage were selected using research reports and related data to derive the competitiveness factors required for overseas expansion; second, a focus group interview was conducted regarding the competitiveness factors selected for engineering-related experts to verify the competitiveness factors, and a survey of experts working for Korean engineering firms was carried out using a seven-point Likert scale; third, the importance and performance of road and water resource areas were compared for the last decade; and fourth, Importance-Performance Analysis(IPA) was performed to standardize and verify the survey responses. Based on these findings, this study presents low competitiveness for Korean engineering firms in the road and water resource areas.

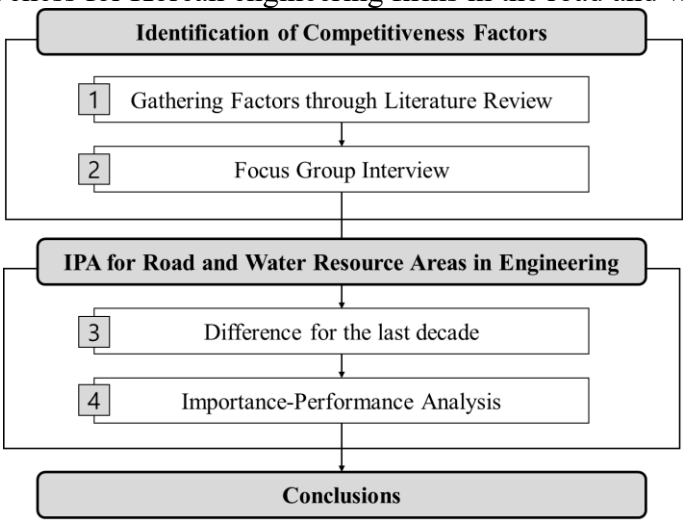


**Figure 1.** Research Flow Chart

## 3. METHODOLOGY AND RESULT

### 3.1. Gathering Factors through Literature Review

In order to derive the competitiveness factors required for Korean engineering firms to advance into overseas markets in the road and water resource areas, seven fields were divided based on the data from related research and institutions. These are shown in <Table 3>, and 72 detailed factors were selected accordingly.

**Table 3.** Competitiveness Reference List

| Ref. | Author | Qual. Mang. | Cost Mang. | Time Mang. | Design Mang. | Envir. Mang. | Safety Mang. | Procu. Mang. |
|---|---|---|---|---|---|---|---|---|
| [5] | Kim and Hwang (2006) | ● | ● | ● | | | ● | |
| [6] | Lee and Choi (2009) | | | | ● | ● | ● | ● |
| [7] | Project Management Institute (2009) | ● | ● | ● | ● | ● | ● | ● |
| [8] | Hong et al. (2010) | | ● | ● | | | ● | ● |
| [9] | Kim et al. (2012) | ● | | | ● | ● | ● | |
| [10] | Kang et al. (2012) | | ● | ● | ● | | ● | ● |
| [11] | Byun and Kim (2012) | | ● | ● | ● | | ● | |
| [12] | Kim et al. (2016) | ● | ● | ● | | | | ● |
| [2] | Kwon and Cho (2017) | ● | ● | ● | ● | | ● | |
| [13] | Park, Hwan-Pyo (2018) | ● | ● | | ● | | | ● |

Note: Mang. Stands for Management

### 3.2 Focus Group Interview

Next, a focus group interview (FGI) with engineers and engineering experts of Korean firms was carried out, and the necessary factors were set as competitiveness factors. For the purpose of emphasizing the perspectives of the engineering industry practitioners, interviews were conducted twice in July and September 2011 with five engineering researchers from academic Institutes and 14 engineers with 10 to 25 years of professional experience. Phase was classified by adding 'Design management' and 'Procurement system' to the five management elements of construction work [14]. In addition, it was confirmed that the competitiveness factors are suitable for use by reviewing them in 2021. A summarized in <Table 4>, 33 factors were selected using the FGI.

**Table 4.** Result of Competitiveness Factors Using FGI

| Phase | Code | Competitiveness Factors |
|---|---|---|
| Quality Management & Inspection | A-1 | Understanding of regulatory issues on quality management |
| | A-2 | Quality management standards |
| | A-3 | Rework management guidelines |
| | A-4 | Preparation of Bill of Quantity (BOQ) |
| Cost Management | B-1 | Budget planning & management |
| | B-2 | Interim payment management |
| | B-3 | Preparation of conceptual/detail estimation |
| | B-4 | Economic analysis skills |
| | B-5 | Understanding on local cost data (RS means, etc.) |
| | B-6 | Understanding on Cost standard (uniformat, CSI, etc.) |

| | | |
|---|---|---|
| Time Management | C-1 | Master schedule/Project milestones development |
| | C-2 | Ability of time management software |
| | C-3 | Schedule update & corrective actions |
| | C-4 | Understanding on activity definition/sequencing |
| | C-5 | Long Lead item management |
| Design Management | D-1 | Design concept development |
| | D-2 | Site survey/Investigation |
| | D-3 | Design documents development/comprehension |
| | D-4 | Value engineering procedure/techniques |
| | D-5 | LCC analysis skills |
| | D-6 | Preparation for RFDC (Request for design change)/change order |
| | D-7 | Understanding of regulatory issues on design |
| | D-8 | Application of new technology |
| | D-9 | Understanding of design components |
| | D-10 | Ability for information technologies (BIM, Simulation, etc.) |
| | D-11 | Computer software application (Ms office, CAD, etc.) |
| Environment Management | E-1 | Environmental design review capabilities |
| | E-2 | Understanding on environment certification (LEED, Green-roads, etc.) |
| | E-3 | Understanding of regulatory issues on environment management |
| Safety Management | F-1 | Understanding of regulatory issues on construction safety |
| | F-2 | Conform to safety standards |
| Procurement System | G-1 | Understanding of the country's ordering systems (ordering, contracting and bidding) |
| | G-2 | Understanding on state regulation (Brooks act.) |

<Table 5> shows that the survey was conducted on road and water resource experts working for Korean engineering firms. The questions were grouped into two categories for each application area: (1) how important the particular competitiveness factor was for road and water resource areas in Engineering, termed "Importance," and (2) how the performance level of engineering skills was for the particular area, termed "Performance." Each question was measured on a seven-point Likert scale.

**Table 5.** General survey items

| Division | 1st survey | 2nd survey |
|---|---|---|
| Period | 2011. 11. 1. ~ 30. (1 month) | 2021. 11. 1 ~ 30. (1 month) |
| Number of respondents | 56 | 47 |
| Response rate | 83 % | 81 % |

To investigate the internal consistency of the recovered survey results, an internal consistency analysis was conducted using Cronbach's Alpha values. It can be said that a value of 0.6 or higher is reliable in exploratory research, a value of 0.8 or higher in basic research, and a value of 0.9 or higher in applied research that requires important decisions [15]. As shown in <Table 6>, the Cronbach's Alpha value for the recovered questionnaire results ranges from 0.914 to 0.979, which the analysis results using the survey results are reliable.

**Table 6.** Cronbach's Alpha of Survey Results

| Classification | | Importance | Performance |
|---|---|---|---|
| Road | 2011 KOR. Engineering Firm | 0.962 | 0.977 |
| | 2021 KOR. Engineering Firm | 0.979 | 0.914 |
| Water Resource | 2011 KOR. Engineering Firm | 0.936 | 0.950 |
| | 2021 KOR. Engineering Firm | 0.978 | 0.969 |

### 3.3 Difference for the last decade

Except for the factors 'A-1 Understanding of regulatory issues on quality management' in the road importance graph and 'E-2 Understanding on environment certification' of the road performance graph in <Figure 2>, all other factors show higher importance and performance compared to the past. This result suggests that Korean engineering firms' performance has increased further in the road engineering area compared to the past. However, the importance and expectations have also increased as much as the improved performance.

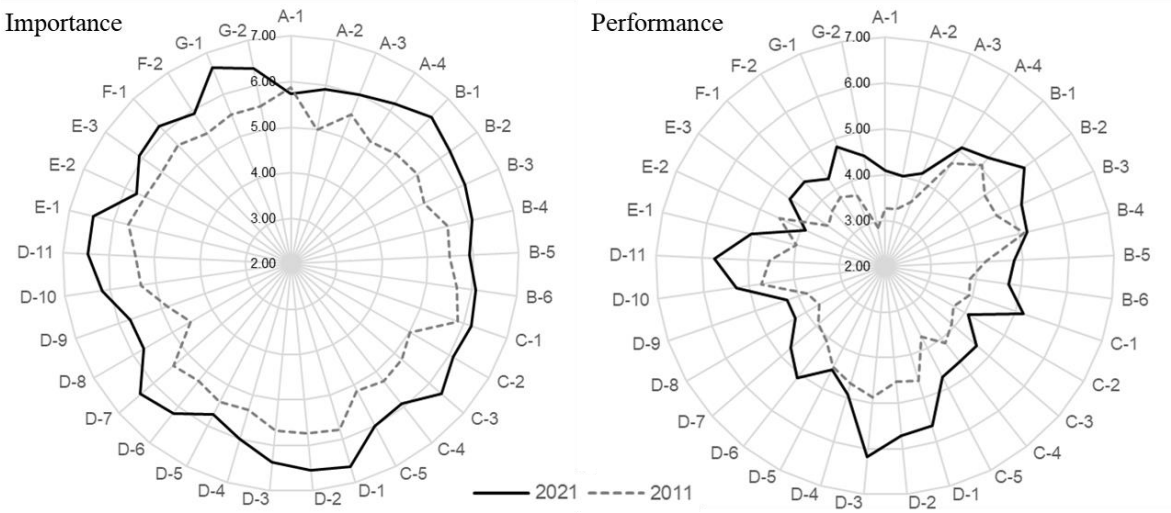


**Figure 2.** Comparative Difference in Road Engineering Area

The water resource importance graph of <Figure 3> shows that the current importance has been set higher compared to the past in all factors except for 'A-1 Understanding of regulatory issues on quality management'. On the other hand, the water resource performance graph shows that in most factors, the performance has increased compared to the past, but the performance was lower than that in the past in relation to ten factors, including 'B-4 Economic analysis skills' and 'D-10 Ability for information technologies'. These results indicate that although Korean engineering firms' current importance and expectations have increased further compared to the past in the water resource area, some of the performance fails to keep pace with them.

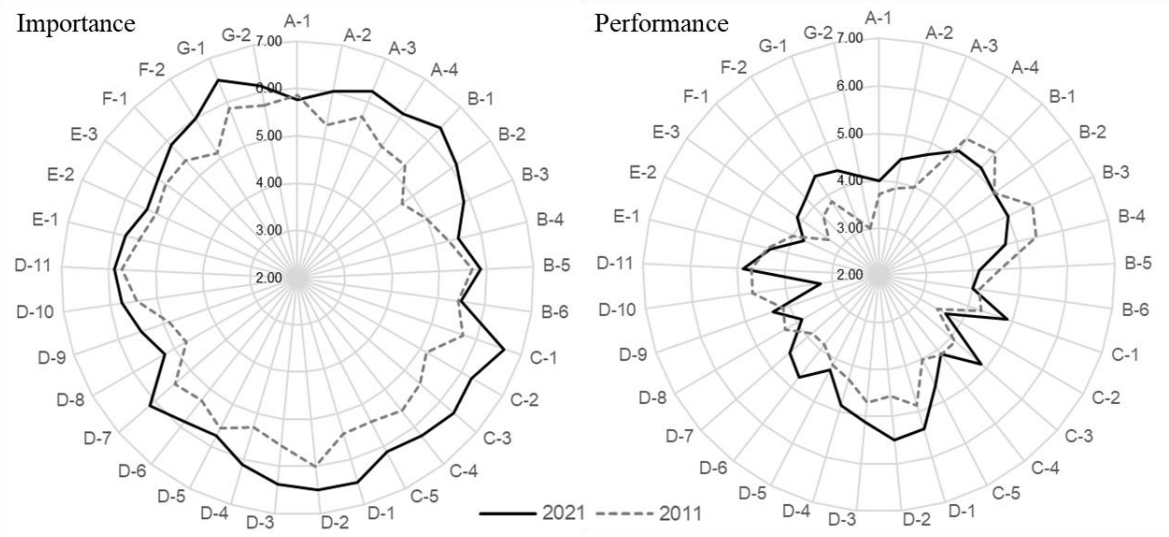


**Figure 3.** Comparative Difference in Water Resource Engineering Area

### 3.4 Importance-Performance Analysis (IPA)

The IPA is widely used as an analytical technique for deriving competitiveness reinforcement factors in various areas in order to analyze the importance and performance of key attributes of products or services for the purpose of deriving improvement priorities. The IPA, a two-dimensional grid, is divided into four quadrants when mean values are applied for determining the crosshair point.

Quadrant 1 (Keep up the Good Work) is an area where the performance is as high as importance, so it is desirable to maintain the current level of competitiveness. Quadrant 2 (Concentrate Here) is an area that requires urgent improvement in the future as the performance is low compared to importance. Quadrant 3 (Low Priority) is low in both importance and performance and has an attribute that does not require further efforts in the present circumstances. Quadrant 4 (Possible Overkill) is an area in which the performance is high compared to importance, and it is necessary to put efforts into other areas <Figure 4>. Meanwhile, it is possible to analyze the characteristics of all four quadrants in order to derive the competitiveness required for Korean engineering firms to advance into overseas markets. However, only Quadrant 2 with the highest priority was taken into consideration in this study.

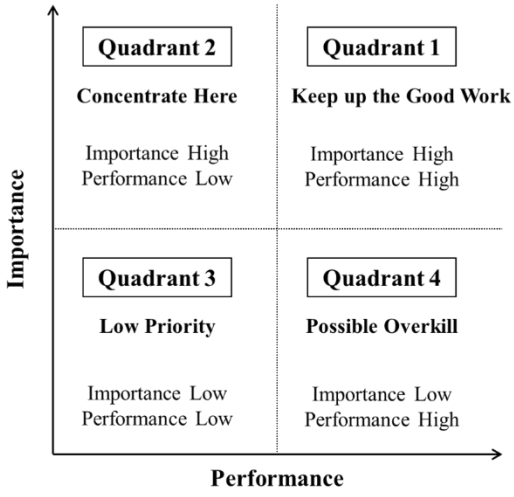


**Figure 4.** Importance-performance grid [16]

As shown in <Figure 5>, five factors appeared via the IPA for entry into overseas road markets in Quadrant 2 area. The competitiveness factors to be improved due to a significant difference between importance and performance include 'C-3', 'D-7', 'F-1', 'G-1', 'G-2', and the factors that require urgent improvement in the order of <Table 7>. In conclusion, it is necessary to understand the country's ordering systems and related regulations to advance into overseas road engineering markets.

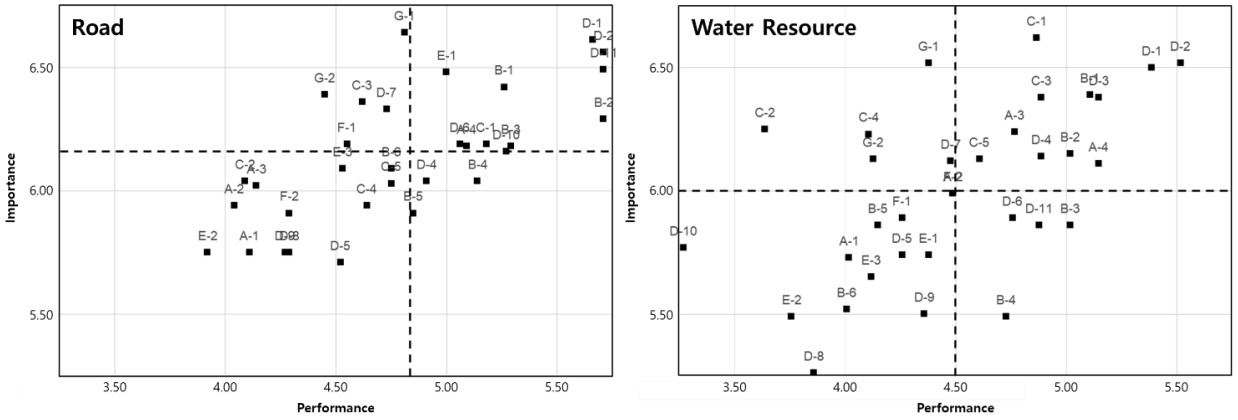


**Figure 5.** Importance-performance Grid

**Table 7.** Competitiveness Factors in Quadrant 2 for Road Engineering

| code | Competitiveness Factors | Importance | Performance | GAP |
|---|---|---|---|---|
| G-2 | Understanding on state regulation (Brooks act.) | 6.39 | 4.45 | 1.94 |
| G-1 | Understanding of the country's ordering systems (ordering, contracting and bidding) | 6.64 | 4.81 | 1.83 |
| C-3 | Schedule update & corrective actions | 6.36 | 4.62 | 1.74 |
| D-7 | Understanding of regulatory issues on design | 6.33 | 4.73 | 1.60 |
| F-1 | Understanding of regulatory issues on construction safety | 6.19 | 4.55 | 1.64 |

<Figure 5> shows the results obtained via the IPA to derive the improvement competitiveness factors of Korean engineering firms entering the overseas water resource markets. Five competitiveness factors appeared in the Quadrant 2 area that needs urgent improvement. The competitiveness factors for which Korean firms have to achieve competitive advantage in the water resource area include 'C-2', 'C-4', 'D-7', 'G-1', 'G-2', that need improvement are shown in <Table 8>. The analysis finds that the ability to understand information about the country and control the business is of utmost importance in order to make inroads into overseas water resource engineering markets.

**Table 8.** Competitiveness Factors in Quadrant 2 for Water Resource Engineering

| code | Competitiveness Factors | Importance | Performance | GAP |
|---|---|---|---|---|
| C-2 | Ability of time management software | 6.25 | 3.64 | 2.61 |
| C-4 | Understanding on activity definition/sequencing | 6.23 | 4.11 | 2.12 |
| G-1 | Understanding of the country's ordering systems (ordering, contracting and bidding) | 6.52 | 4.38 | 2.14 |
| G-2 | Understanding on state regulation (Brooks act.) | 6.13 | 4.13 | 2.00 |
| D-7 | Understanding of regulatory issues on design | 6.12 | 4.48 | 1.64 |

## 4. CONCLUSIONS

This study was carried out to identify the competitiveness required for Korean engineering firms to enter overseas road and water resource engineering markets. As a result, low performance compared to the importance is an overall understanding of the target country in road and water resource areas. Knowledge of regulatory issues on design, the ability of time management software, and knowledge of the regulatory problems on construction safety are also insufficient. The derived competitiveness factors are essential to make inroads into overseas engineering markets. Korean firms will have to improve their competitiveness and prepare to achieve an advantage in entering the overseas engineering markets in the future.

This study is expected to be used as a research methodology to identify the competitiveness that Korean engineering firms have to strengthen when they advance into overseas markets in roads, water resources, and other areas.

In future research, an expert survey is to be conducted on Korean engineering firms in various areas, and customized analysis for specific countries needs to be done to advance into the market of those countries.

## ACKNOWLEGEMENTS

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