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A Study on the Core Competency of Specialized Company for Semiconductor Design of Korea

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한국반도체 설계전문기업의 핵심경쟁력 역량에 관한 연구

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Abstract The purpose of this study is to analyze the level of competitiveness of semiconductor design firms of Korea. The categories of competitiveness are divided into product development, accumulated technology, market-related competencies, human resources, and management system. The sample of 73 semiconductor design companies were used, and the analysis data were gathered by parallel with the questionnaire and the surveyor visited. For respondents, importance of competitiveness factor was prioritized using nominal scale and the competitiveness of each item is expressed based on 100 points. It was confirmed that there was a difference between the order of importance and the actual level of core competence. The ranking of the importance of core competencies is in the order of product development, technical capability, market-related competencies, human resources, and management system. However, in terms of actual competitiveness in each category, human resources were the best, followed by the management level. The product development and technology competencies were in order. The market-related competitiveness was found to be the most urgently raised. In order to increase the market related competitiveness, a new customer base must be developed and the information acquisition capability of the customer, and the ability to analyze their data needs to be improved.

Key Words : Semiconductor Design, Core Competency, Competitiveness Analysis, FEED, Fabless Firms

요 약 본 연구는 반도체 설계전문기업의 경쟁력수준을 분석하는 데 초점을 맞추고 있다. 해당 기업의 경쟁력은 제품개발, 축적기술, 시장관련능력, 인적자원 그리고 경영시스템 등의 범주에서 분석하였다. 분석대상은 73개 기업으로 하였고, 이들 기업의 자료는 설문지 수거와 직접 응답방식을 병행하여 수집하였다. 설문은 명목척도를 활용하여 경쟁력 범주에 대한 중요도 순위와 경쟁력 범주별 세부항목의 수준(100점 기준)에 대하여 응답하도록 구성하였다. 분석결과, 중요하다고 인식하고 있는 경쟁력 범주와 실제 간에는 차이가 존재하고 있었다. 경쟁력 범주에 대한 중요도 인식순위는 제품개발, 축적기술, 시장관련능력, 인적자원 그리고 경영시스템 등으로 나타났다. 그러나 실제 현실적인 경쟁력 수준은 인적자원역량의 경쟁력이 가장 높았고, 그 다음으로 경영시스템, 제품개발 및 축적기술 등의 순으로 확인되었다. 가장 경쟁력이 취약한 범주는 시장관련역량으로, 이 범주의 경쟁력 제고(고객층 발굴, 시장 및 고객정보수집, 관련 정보분석 등)를 위한 노력이 더욱 필요하다고 볼 수 있다.

주제어 : 반도체설계, 핵심경쟁력, 경쟁력분석, 설계전문기업, 팹리스 기업

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1. Introduction

Recently, sluggish exports by semiconductor companies have led to sluggish exports across the Korea. It is disproving that the proportion and phase of semiconductors are high. Currently, Korea's memory semiconductor industry has secured the world's No. 1 position and continues to maintain its status. However, it is time to check the competitiveness in the face of severe environmental changes at home and abroad.

Although the foundry capacity of system semiconductor consignment manufacturing has improved significantly, the fabless competitiveness of the design sector is falling behind that of China. In order to secure substantial leadership in the global semiconductor industry in the future, it is most important to secure the competitiveness of the system IC industry[1].

Korea's system foundry sales rose to the world's second-largest level, But the gap with Taiwan, which occupies the majority, is still significant. The fabless sector, which specializes in design without manufacturing facilities, is behind the US, Japan, Europe and China. As system semiconductors make up half of the semiconductor market, active investment is needed. The Korean government is still concerned about stagnant growth such as low market share ('18, 3.1%), lack of technology (80% of the US), and small scale (one of our top 50 fabless companies)[2].

Therefore, it is obvious that the competitiveness and status of advanced semiconductor countries can be maintained only if the competitiveness of the domestic system IC industry is enhanced. To this end, the competitiveness of design firms in charge of the design sector, which is a key part of the system IC industry, must be improved. It is pointed out that governments and device companies can make the vision of 'System Semiconductor 2030' a reality only if they present a more detailed action plan and ensure continuous implementation.

Our reality for design firms is that most of the design ventures that have weak management and competitiveness bases are having difficulty in promoting their business and securing their competitiveness[3]. Therefore, national support and policies for semiconductor design firms are urgently requested in time. Prior to this, the level analysis on the competitive capability of domestic semiconductor design firms should be preceded. This study focuses on the analysis of the level of core competency for semiconductor design firms.

2. Overview of Semiconductor Design Firms

It is a semiconductor design company that combines fabrication and less, which means manufacturing facilities[4]. Semiconductor design refers to the front-end design of a semiconductor for a specific function and the back-end design for the manufacture of a mask. Design firms can be classified as follows[5]:

① Fabless : Without semiconductor production plan, A company specializing only in semiconductor design and sales.

② Foundry : A company that produces semiconductors by receiving design drawings from semiconductor design firms.

③ IDM (Integrated Device Manufacturer) : A company with both semiconductor design technology and semiconductor production equipment.

As semiconductor technology development speeds up and the market grows, the division of semiconductor design (fabless) and semiconductor production (foundry) companies is accelerating. ASIC design specialists will improve ASIC product performance and accept accumulated system-level requirements to develop into ASSP specialists that can be used in multi-

ple products for mass production.

The semiconductor design company will improve the performance of the semiconductor product itself, accept the accumulated system level requirements, and develop into a semiconductor company that can be used in various products for mass production. The on-demand semiconductor design company (ASIC) will enter into a design agency contract with a large semiconductor manufacturer. If the design work of semiconductor manufacturers is so large that they cannot be self-divided, they often work with external design firms or start up their own design teams. Although system companies develop and commercialize semiconductors, they tend to focus on the products of the system. At this time, the performance of the semiconductor product depends on the system specifications.

Table 1. Classification of Semiconductor Design Companies

Type	Content	Company
Standard Product Design	Design your own products with standardized specifications	Telechips
ASIC	Design products on demand from an external system vendor	ADT
Layout Service	Designed to allow foundries to produce products by requesting the back end of the design from another company	Hanatec
IP Design / Supply	Design IP that can be used as standard function block	ADC(hips)
EAD Service	Develop design tools for product design and provide them to design companies	Synopsis
System Development and Sales	Companies developing systems using developed products	C&S
TEST Service	Companies that test to verify product reliability	Tesna
Chip Distribution	Developed Product Distributor	

References: Revised based on the study of K.H. Ahn and J.H. Lee(2005)[6].

And the design is done at the necessary site, and most of the time, the current design agency is used when entering other countries. These design agencies have the same kind of EDA tools as semiconductor manufacturers and use the same library.

It is a common trend that design firms have not only a simple semiconductor design agency but also have the ability to develop their own standardized semiconductors with high added value through unique design structure and optimal library development. Therefore, capturing opportunities to make custom-made semiconductors a standardized semiconductor and developing cooperative development with various system companies are necessary for growth strategies[7].

Standardized product design firms will develop into custom-designed semiconductor design and design agencies or organizations with significant technical accumulation in system design. Most of these companies have a considerable number of people who are familiar with specific fields, and have the ability to develop custom semiconductor chips or chip sets optimized for the field in a short time[8].

3. Framework of Analysis

The definitions and criteria for core competencies used in this study are based on the results of previous studies. Core competency is associated concepts(competence, capability, and resources) that have characteristics that differ both conceptually and empirically[9]. Core competence refers to the ability to form the core of a company, including the overall technology, knowledge, and culture held by its members. It does not simply mean that the company is doing well, but it is far superior to its competitors,

that is, its ability to provide a competitive advantage.

It is confirmed from previous studies that the core competence of manufacturing industry affects corporate performance[6],[10]. And it is obvious that the manager of a manufacturer needs to improve his knowledge and understanding of core competencies[11]. In particular, it is well known that the innovation capacity of technicians contributes positively to the technology management performance of technology-oriented companies[12]. The importance of technology (choice) in core competencies can be seen in previous studies[8][13]. One of the core competencies of the organization is human resources, and in particular, the quality (level) of human resources is directly related to the core competencies[14]. In the semiconductor industry, R & D capability and market orientation have a significant effect on product innovation performance in order to enhance customer value and competitive edge in technological innovation[15]. In addition, design competency, market creation(competitiveness) and ability to create knowledge are important as a competitive advantage in semiconductor design firms[16].

In this study, core competencies are divided into development, technology, market, management, and human resource competencies based on the results of the preceding studies, as shown in Table 2.

Table 2. Classification of Core Competencies

Var.	Define
P C	Competency by **Product** Development Process(Product Development Stage)
T C	Accumulated affecting the Product **Technology** Competence
M C	Capabilities that influence **Market** Development
H C	**Human Resource** Composition and their Capabilities
O C	Capabilities that affect **Organizational** Operations

The analysis subjects of this study were non-memory semiconductor design firms and 73 companies. Sampling should be randomized in consideration of statistical significance. However, since there are only a limited number of non-memory semiconductor design firms in Korea, we have focused on the member companies of the Korea Semiconductor Research Association.

Table 3. Sample Informations

Classification	Content
Population	Non-memory semiconductor design company
Sample Size	73 companies (valid samples)
Sampling	Significant Extraction
Sampling error	± 3.10% (95% confidence level)

In order to improve the reliability of statistical data, this data was collected in parallel with the questionnaire and the surveyor visited. The structured questionnaire was used for data collection, and the questionnaire centered on the characteristics of the company, the level of core competencies, and the success or failure factors of new product development. For respondents, importance of competitiveness factors was prioritized using nominal scale and the competitiveness of each item is expressed based on 100 points.

The sample is a total of 73 private companies, and the year of establishment mainly consists of companies established after 2000. The sales volume of companies in this study ranges from less than 10 billion won to as much as 100 billion won, which can be seen as a wide range. ooking at the number of employees, the largest distribution was found between 20 and 50, including a design firm with a small workforce(fewer than 10).

4. Results of the Analysis

Overall, the analysis of which part is re-

garded as the most important for the core competencies and the current level of competitiveness are shown in Table 4.

The ranking of the importance of core competencies is in the order of product development, technical capability, market development, human resources and management. It means that excellent product development and technical capability lead to market development. However, in terms of actual competitiveness in each sector, human resources were the best and management level was next. The product development and technology competencies were in order, and market development competencies were not high. Therefore, market development capacity should be raised most urgently.

Table 4. Overall Priority and Competitiveness

Var.	Priority (recognition)		Actual Competitiveness		Rank difference
	average	ranking	average*	ranking	
P C	1.47	1	83	3	-2
T C	2.30	2	82	4	-2
M C	3.05	3	78	5	-2
H C	3.20	4	90	1	3
O C	4.34	5	87	2	3

*:cutting below the decimal point with 100 points

As shown in Table 5, the most important competencies at the product development stage were product planning and architecture design. The results showed that the core competencies required in the product development stages can be seen in planning products that reflect market demands and connecting them seamlessly to development. However, in the actual product development stage, market-related core competencies were relatively insufficient. The same results can be seen in the previous study that the marketing capability of SMEs was not strategically constructed[17].

On the other hand, the actual core competence of product development(Architecture Design, Front-end Design, Back-end Design) was found to be relatively competitive. Competitiveness in sales after product development seems to be relatively good.

Next, the results of analyzing the level of technical competence are shown in Table 6. As a result of analysis, the importance of technical capability was in order of quality, price, development period, cooperation with external technology, and management of technical information. In practice, the level of technological competence is similar to the order of superiority perceived as important. On the other hand, it was confirmed that the competitiveness of external technical cooperation and technology management should be improved. It is well known that technical cooperation and networking with external organizations have a positive impact on performance[18].

Table 6. Technology Competitiveness Result

Var.	Priority (recognition)		Actual Competitiveness		Rank difference
	average	ranking	average	ranking	
Quality	1.30	1	84	2	-1
Price	2.10	2	83	3	-1
Develop Period	2.40	3	86	1	2
External Cooperation	3.85	4	80	4	0
Information Management	4.32	5	78	5	0

Table 5. Product Development Competitiveness Result

Product Development Stages		Priority (recognition)		Actual Competitiveness		Rank Difference
		average	ranking	average	ranking	
Market Analysis	Market Analysis	3.62	3	74	11	-8
	Product Planning	1.84	1	72	12	-11
Development	Architecture Design	3.50	2	89	2	0
	Front-end Design	4.40	4	80	7	-3
	Back-end Design	6.58	7	92	1	6
Verify	Sample Manufacture	7.89	10	80	7	3
	Product (Test)	8.61	11	79	10	1
	Revision	9.21	12	80	7	5
Production	Production	5.46	6	85	5	1
Sales	System Application	7.87	9	88	4	5
	Sales	4.57	5	82	6	-1
	Customer Service	6.69	8	89	2	6

An important recognition in market competence was found to acquire customer development and customer demand information, Table 7. Acquiring the development trends and information of competitors was also ranked at the top of the importance ranking, which confirms how competitive the key is to get information about customers and competitors in the market. In fact, the impact of involvement between suppliers and customers on product success is high in new product development[19]. Therefore, semiconductor design firms need to make efforts to enhance their market-related capabilities to secure their core competitiveness.

Table 7. Market Competitiveness Result

Var.	Priority (recognition)		Actual Competitiveness		Rank difference
	average	ranking	average	ranking	
Obtain Market data	4.18	4	75	6	-2
Data Analysis	5.33	7	72	7	0
Information: Competitors' development trends	3.35	3	79	4	-1
Customer Demand Information	2.26	2	84	1	1
Customer Development	1.87	1	80	3	-2
Sales Network Building	4.27	5	78	5	0
Service Mind	4.60	6	81	2	4

In today's world, the most important criterion for determining the competitiveness of an organization is the ability to attract talented people with high quality[20]. As shown in Table 8, the capabilities of the Back-end designer, H/W system engineer, and Technical marketing specialist were relatively good. In comparison, the core competencies of Front-end designers and Software programmers were insufficient. This is attributable to the stagnant growth, such as low market share ('18, 3.1%), lack of technology (80% of the US), and small scale (one of our 50 largest fabless companies).

According to a survey conducted by the Semiconductor Association('16 ~ '18), about 300 high-level design personnel are lacking annually.

The government is also working to develop future source technologies and foster convergence experts to secure mid- to long-term competitiveness in the domestic semiconductor, especially system semiconductor industry. Even semiconductor design companies need to recognize the level of design workforce as a key factor in corporate competitiveness and invest more in their talent development.

Table 8. HR Competitiveness Result

Human Resource Level(Quality)		Average		Competitiveness	
		Personnel (N)	Ratio(%)	/100	Ranking
Front-end Designer	A*	2.28	28	80	4
	I**	1.45			
	B***	1.63			
	Sum	5.36			
Back-end Designer	A	1.85	25	86	1
	I	1.36			
	B	1.67			
	Sum	4.88			
H/W System Engineer	A	1.64	22	85	2
	I	1.88			
	B	1.94			
	Sum	5.46			
S/W(F/W) Programmer	A	0.43	18	77	5
	I	1.38			
	B	1.66			
	Sum	3.47			
Technical Marketing Expert	A	1.21	19	82	3
	I	1.44			
	B	0.84			
	Sum	3.49			

*Advanced **Intermediate ***Beginner

In management competence shown as Table 9, the CEO's leadership was recognized as the most important, and it was recognized as having the greatest strength in terms of competitiveness. Subsequently, the funding and operation capability, the level of Unity in the organization, and the network with external companies were recognized as core management related competencies. On the other hand, the core competencies of these variables were found to be normal.

The IT systemization and business standardization level of these companies was relatively good. However, the capacity of Internal Unity, PR & IR, and External Network is not high, so the company needs to strengthen its activities. The labor-management relations at these companies are relatively smooth, which means that there is a high possibility of mutual cooperation in future capacity building.

Table 9. Manag't Competitiveness Result

Var.	Priority (recognition)		Actual Competitiveness		Rank difference
	average	ranking	average	ranking	
CEO Leadership	1.25	1	90	1	0
Funding & Operating Capacity	2.38	2	79	5	-3
Internal Unity	2.85	3	76	6	-3
PR & IR	5.54	5	72	8	-3
IT System (ERP, SAP, SCM etc)	6.12	7	87	2	5
External Network	4.84	4	75	7	-3
Public Policy	8.24	9	70	9	0
Work Standard	7.20	8	86	3	5
Industrial relations	5.78	6	82	4	2

5. Conclusions

This study examined the importance of core competencies and the actual core competencies of 73 semiconductor design firms. The categories of core competencies were analyzed by product development, technology, market, human resources and management

system. It was confirmed that there was a difference between the order of importance and the actual level of core competence.

In order of importance as core competencies, product development, accumulation technology, market capability, human resources, and management system appeared. However, in the actual situation of core competencies, human resources and management systems were ranked high, followed by product development, technical competencies, and market competencies.

The competency of product development and technology of the semiconductor design company was found to be relatively good. However, the capability of product planning and technical information management were not yet sufficient, and supplementation of these area is necessary.

The lack of marketing capability seems to be due to the fact that most of the design firms are in small and medium-sized companies, and they lack technical marketing specialists and investment capacity. In particular, the acquisition and analysis of market-related data needs to be supplemented urgently. Therefore, the government should make efforts to support policies that increase the marketing capabilities of these companies. In a corporate position, there is a need to take a strategic approach to strengthening the capability to market products developed on the basis of excellent research and technical skills.

The core competencies of human resources were relatively good, but the capabilities of S/W and Front-end design were still lacking. And In terms of management, the core competencies in CEO leadership, IT system, and Work standardization were relatively good and can be viewed as positive. Based on the main results of this study, we hope that further research will continue in the direction of enhancing the core competencies of semiconductor design firms.

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