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Dynamic Outsourcing Development for Sustainable Competitive Advantage in a High-Tech Backend Semiconductor Equipment Firm

Hyun-Joon Jo [1,2], Timothy Connerton [2] and Hyun-Jung Kim [1,*]

[1] Seoul Business School, aSSIST, Seoul 03767, Korea; jasonjo@stud.assist.ac.kr
[2] Business School Lausanne (BSL), CH-1022 Chavannes (VD), CH-1022 Chavannes, Switzerland; timothy.connerton@bsl-lausanne.ch
* Correspondence: hjkim@assist.ac.kr

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Abstract: In a high-tech backend semiconductor business where a market environment changes sharply and requires competitiveness of high technology, one of the most important criteria is to establish an optimal strategy for outsourcing development so a firm can achieve a sustainable competitive advantage. Many studies have investigated sustainable and successful strategies for the selection and management of outsourcing suppliers, whereas, this study focuses mainly on analyzing the most affecting factor for outsourcing development in the perspective of dynamic capability by using the Delphi Analytic Hierarchy Process (AHP) method. For the analysis of affecting factors, 4 dimensions are defined: technology, organization, environment, and process. The research result shows that the sustainability of the productive skill in the technology dimension is adopted as the most affecting factor for outsourcing development among the defined 4 dimensions of an outsourcing supplier's capability. With this research, a high-tech firm can measure the level of each dimension and each factor in developing outsourcing service providers. Then the firm can develop an appropriate outsourcing provider who contributes to the firm's sustainable competitive advantage. This study also provides a practical and strategic framework of a high-tech firm's outsourcing development in variable market situations and changeable conditions of transaction.

Keywords: sustainability; dynamic outsourcing development; competitive advantage; technology; environment; organization; process; Delphi AHP

1. Introduction

As the market environment for high-tech business is always fluctuating with uncertainty, diversity, and complexity, it is getting more crucial for firms to have sustainable competitiveness by utilizing external resources as well as developing internal resources [1]. Outsourcing management helps firms to have a competency by the utilization of external resources which are not the core businesses in many areas like materials, facility management [2,3].

The typical study for outsourcing is to obtain the advantage of cost competitiveness by the cost-effective resource management which brings economic advantages for the outsourcing firms by the transaction cost analysis [4,5]. Some studies focused on the perspective of having competitive advantages by improving performance in cost and quality point of view, however, it was shifted to various aspects like social and environmental factors for sustainable outsourcing [6–14].

As the market is being transformed with uncertainty and fast changes, outsourcing development has occurred in an unpredictable market environment, by integrating transaction cost economics (TCE) and resource-based view (RBV), which helps find a way to move outsourcing development in

a right direction [7]. In addition to the TCE and RBV, the more agile and active way of outsourcing is evolved with the concept of dynamic capability view (DCV) which complements the RBV's static characteristics for the dynamic process of outsourcing, leading to the successful result of utilizing external resources [8–10]. DCV is evolved from the operating level capacity to the enhanced level which focuses on a value creation in a long-term survival [8].

With this context, in a high-tech business area like a semiconductor backend equipment field, the sustainability of technological outsourcing development is crucial to meet the fast change of the market environment. As the speed of the market change is very fast, the approach of the study should focus more on a dynamic viewpoint with a sustainable long-term base DCV, rather than a comparatively static concept with TCE or RBV [9,10].

It is a matter of survival whether a high-tech firm can be successful or not on the investigated critical factor with the DCV perspective as the business environment is rapidly changeable. So, the purpose of this research is to define and investigate the critical factor and to propose the most weighted factor which helps a high-tech firm achieve the competitive advantage in outsourcing development.

It is important to find and select critical factors for outsourcing development under a highly competitive situation [11]. Many other researchers studied competitive outsourcing [12–14]. For example, a study on competitive outsourcing focused on how core enterprises make decisions in a supply chain structure regarding integration and decentralization, and whether core enterprises outsource the no-core business when the third-party has no cost advantage [12]. It shows a TCE approach perspective. Another study describes that a maintenance service outsourcing is a strategic measure to improve business performance, which enables enterprises to obtain highly specialized external services at a reasonable cost to optimize resource allocation and enhance competitiveness [13]. It can be regarded as a TCE and RBV approach.

However, this research is focused on finding the main factors in a dynamic capability viewpoint and provides the comparison data to give a priority by the framework through the Delphi AHP method which can be adopted in a high-tech firm case. The research way of AHP and Delphi AHP are widely used for the research method, and AHP is the hierarchy analysis of several attributes, whereas, this study used Delphi AHP is to get the idea for factors and attributes from an expert group. This research is based on the case of a high-firm that needs the idea of expertise, so the Delphi AHP is selected for the research method.

Generic firms which are not for a high-tech business may not need this kind of DCV approach as they can be sufficiently explained by the TCE or RBV approach, whereas, for the high-tech business field, the practical activities of finding the right factors in a technically changeable market situation are needed.

As this study investigates such a case in a high-tech backend semiconductor equipment firm, in the case for other industries or for other divisions, the importance of the low-level factors can be sorted differently by considering each firm's circumstances and characteristics. Eventually, this research can provide the framework for a firm to find a most important factor in outsourcing development.

The main problem when a firm needs to develop outsourcing service providers is that a firm's first priority of outsourcing development focuses more on the low cost rather than on other factors like quality, technology, process, etc. It is critical that a firm needs to increase the business volume and margin to survive in a severely competitive market, however, it can be more crucial to make it successful with a long-term base in the perspective of sustainability [15,16].

The hypothesis is formulated so a firm need to investigate a critical factor in outsourcing development, and also verified by proceeding the survey and the examination by the expert group using the Delphi AHP method. The aim of this research is to provide a framework by finding most appropriate dimensions and factors through a specific research method when a firm develops outsourcing service providers for a firm's sustainable competitive advantages.

Outsourcing development does not always benefit a firm, but it can cause issues for the core advantages, like a unique knowhow for the technology can be transferred to outsourcing service

providers. However, in this study, we focus on the benefits when a firm develops outsourcing in a dynamic capability perspective [17].

This research after the introduction is organized as follows; Section 2 provides a theoretical background for TCE, RBV, and DCV for understanding the terminology used in this article. Section 3 explains how this research is designed according to the defined procedures. Section 4 develops the research framework by surveying and calculating the result by the Delphi AHP method resulting from the research design. Section 5 provides the discussion and conclusion of the study with the suggestion of the future study with this frame.

2. Theoretical Background for TCE, RBV, and DCV

In order to understand the factors for the outsourcing management in this research, it is significant to recognize the concepts of TCE (transaction cost economics), RBV (resource-based view) and DCV (dynamic capability view) [1]. In traditional studies, scholars described outsourcing as the decision to manufacture or buy intermediated goods from external services or the entrusting process to an external firm for internal manufacturing for non-core business [18]. When a firm needs to have competitiveness in a dynamic market situation, the firm needs to consider one of the factors of DCV, innovation [19]. The concept of outsourcing has been proposed in various perspectives for building a successful outsourcing relationship and for motivating outsourcing suppliers, which are mainly about the economic perspective, TCE, and capability perspective, RBV [16].

As the winning strategy for economic and capability can be a part of the factors for outsourcing development in a complex and uncertain outsourcing environment, it does not commit the competitive advantage in a long-term base success. Outsourcing development is a strategic decision where business processes are developed by outsourcing suppliers with better capabilities as well as the cost perspective for the competitive advantages which are sustainable and effective [20–22]. So, in outsourcing development, there should be an understanding of which way the firms will consider, like TCE as a cost perspective, RBV as a capability perspective, and DCV as a sustainability perspective [23,24].

Firstly, TCE, theory of traction cost economics, was made to describe the make or buy choice. The purpose of outsourcing in the beginning stage of research is to take advantage of cost-effective resources which can bring benefits to outsourcing suppliers like flexibility and innovation [5,25]. It is an interdisciplinary undertaking that joins economics with aspects of organization theory and overlaps extensively with contract law [26]. TCE provides a clear guideline where the firm will proceed with an in-house transaction, and help to decide to change to the external market [16]. It is the concept of cost perspective, so the transaction is performed by the minimum costs where the priorities are on the effectiveness of cost and quality for the decision of outsourcing development [15,27,28].

Secondly, RBV is another concept for outsourcing, and it focuses on the special resources which are perceived as a strength or weakness of a particular firm. This perspective describes that firms can expand their boundaries by connecting to outsourcing partners, which enables them to access technologies, machinery, procedure, and so on [16,29]. Whereas, the TCE is to control the resources to share any technologies which could be the core of outsourcing companies. TCE and RBV can be combined when outsourcing activities are done in their value chain [15,30]. High-tech firms tend to integrate or acquire the needed resources by the strategic contract with other firms like the type of outsourcing [5,31]. From this viewpoint, the capability-based RBV can be explained as a strategy of outsourcing and organization behaviors [32,33]. By outsourcing activities, firms can improve their values by making better relationships with outsourcing suppliers, developing new markets, and acquiring the competitive market position, as well as achieving cost effectiveness [8,34–36]. In the outsourcing development strategies, like cost-lead or capability-lead, it provides the key discussion that resource should be outsourced from outsourcing providers considering the firms' situation [37–39].

Finally, DCV is evolved from RBV, and complements the static perspectives of RBV, and focuses on the dynamic process of connecting external resources by the supporting of internal resources. It explains the way of influence on the outsourcing development with firms' resources and capabilities

actively for the long-term success [8]. RBV focuses on the resources itself, whereas DCV emphasizes the process of the resource configuration efficiently in an integration perspective [40,41]. In spite of the importance of TCE and RBV in the outsourcing business field, lots of research describes that there should be further studies to improve the static characteristics in the active point of view in a variable market demand [42]. It is needed for a firm to reconstitute the core competencies to increase the value according to the easily changeable market environment [2]. So many researchers have studied the dynamic capabilities, DCV, to cope with the volatile situation for a sustainable competitive advantage for the firms. RBV focuses on the capabilities itself; however, DCV considers the process of selecting the resource configurations by the integration and coordination [40,43]. Dynamic capabilities change the level from operation capacities to value creation which is critical for long-term organization. DCV set up in the outsourcing development process is an important factor which affects the successful result by explaining the outsourcing performance [43].

The factors of this study mainly come from the idea considering the perspective of DCV because this high-tech market needs the sustainable development of outsourcing to manage long-term competitive advantages in a highly changeable environment [44]. So, it will focus more on the characteristics of the dynamic capabilities view in a way of integration and coordination rather than RBV or TCE which deals with the static resource itself and with the lowering cost [1,5,7]. This study will prove the most prioritized factor for the dynamic outsourcing development by the pairwise comparison of the factors by the Delphi AHP method.

3. Research Design

3.1. Research Design Description

This research is designed and configured with seven steps (Figure 1). It is necessary to investigate the background of this research because it explains why this study is needed and how it contributes for a firm to find success factors in outsourcing development. The following preliminary study helps to understand the meaning of words being used in this study. The literature review is a step to know the defined and sorted dimensions and factors to recognize the meanings by each analytic perspective. The research design is to configure the steps of the study that are essential to design the research. When the result comes out, the analysis is performed to find the meaning and the implication of the result, and it can suggest further studies that could not be covered in this paper.

1. Research background

   As the high-tech business field is changing rapidly, it is more needed to investigate the success factor of the dynamic capabilities when a high-tech firm develops outsourcing.
2. Preliminary Study

   It is to understand the terminology approaching outsourcing factors, which are TCE, RBV, and DCV.
3. Literature review

   It describes the definitions and concepts of dimensions and factors in each level, to recognize of the meaning and the relations of TCE, RBV, and mainly DCV for dynamic perspectives.
4. Research design

   It shows the research modeling and the analysis for each factor, and describes how the factors are defined in the dimensions through the literature review.
5. Result analysis

   After the survey with the 18 experts, the outcome is analyzed to prioritize the dimensions and factors which are most important to develop the outsourcing supplier.

6. Discussion and Conclusion

   It shows how the sustainability factor is prioritized in the variable market situation, and how it could be adopted in the real case. It also proposes the framework to be utilized in another case.

7. Further Study

   It describes the validity of this research, and shows the implication and proposition of further study after this research.

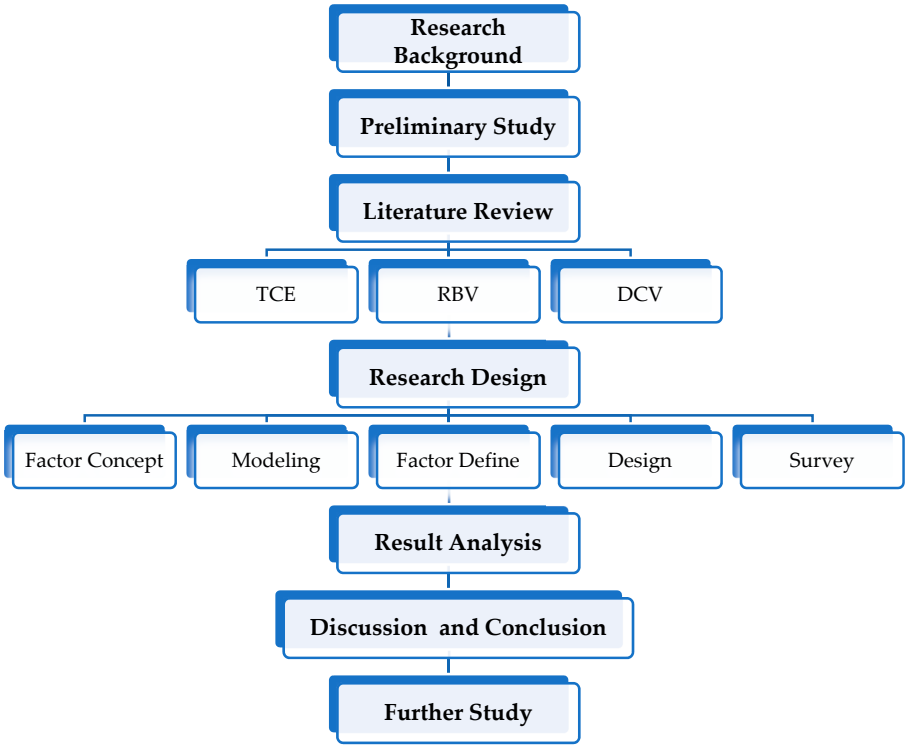

Figure 1. Research design.

3.2. Meaning of Factors for Outsourcing Development

In an outsourcing development perspective, this study investigated the concept of 4 dimensions which are technology, organization, environment, and process. They are defined as major dimensions in outsourcing development as they are substantial elements which are based on the concepts built on technology, organization, environment (TOE) framework [45,46]. These three factors are adopted as the affected dimensions to develop outsourcing effectively and innovatively.

This framework is extended to the dimension of process which is another important element for outsourcing for a pairwise comparison with other dimensions. It includes important factors in the process dimension [21,47]. The sub factors are defined and investigated in empirical perspectives when the survey is proceeded with the expert group in an outsourcing business field.

3.2.1. Technology

It is one of the key dimensions when a firm considers outsourcing. A cost is not the only reason for outsourcing even if an item can be manufactured in-house with a low price. Sometimes a firm can outsource a critical item even though it is less expensive in-house production from a strategic point of view [48,49]. In this case, the technical skill and the way of working of the service providers are important criteria for outsourcing a firm's decision for the development of outsourcing service providers [50,51]. The technology in outsourcing development consists of innovation, improvement, and creation in technical skill, and of flexibility, sustainability, and attainability in productive skill (Table 1).

Table 1. Technology dimension.

Dimension	Factors	Sub Factors	Description	Related Literatures
Technology	Technical Skill	Innovation Improvement Creation	Innovative for client's demand Improving for client's demand Creative for client's demand	[48,49]
	Productive Skill	Flexibility Sustainability Attainability	Flexible support Sustainable support Attainable support	

3.2.2. Organization

In developing outsourcing, the outsourcing firms should be aware of the characteristics of the outsourcing service providers. It can be managed by a team or an individual base, however, the organizational control of outsourcing is needed to achieve the effective outsourcing result [52]. The organization in outsourcing development consists of leadership, self-motivation, and system in team-based characteristics, and of experience, diligence, and obedience in individual-based characteristics (Table 2).

Table 2. Organization dimension.

Dimension	Factors	Sub Factors	Description	Related Literatures
Organization	Team	Leadership Self-motive system	Team with strong leader Self-motivated team Systematic team	[7,52]
	Individual	Experience Diligence obedience	Support with experience Diligent support way Accept all the requirements	

3.2.3. Environment

As the high-tech market is always a volatile and uncertain situation, insight or knowledge of the environment is important in outsourcing partners. To achieve an overall satisfaction of outsourcing, operational and financial performance should be advanced by the integration of factors in the market variables of sales and relationship, like customers and competitors [53,54]. The environment in outsourcing development is configured as supportive, cooperative, and responsible in a behavior for customers, and as aggressive and conservative in a behavior for competitors [55,56] (Table 3).

Table 3. Environment dimension.

Dimension	Factors	Sub Factors	Description	Related Literatures
Environment	Customers	Supportive Cooperative Responsible	Supportive for any request Cooperative for the demand Support with responsibility	[6,53,54]
	Competitors	Aggressive Conservative	Aggressive to competitor Conservative to competitor	

3.2.4. Process

It helps the outsourcing company better identify the efficiency in their supply chain internally and externally when understanding quality and performance issues. So, it needs more investigation to extend the scope of the quality process in outsourcing to consider supply chain operations [57,58]. The

process in the outsourcing development is defined as accurate, efficient in the level of quality for client demands, and as agile and elaborate in the level of speed for client demands [59,60] (Table 4).

Table 4. Process dimension.

Dimension	Factors	Sub Factors	Description	Related Literatures
Process	Quality	Accurate Efficient	Focus on accuracy of quality Focus on efficiency of quality	[57,58,61]
	Speed	Agile Elaborate	Support with very promptly Support with big effort	

With the study for the definition of several factors for outsourcing development, the research design model is configured to proceed the Delphi AHP method (Figure 2). The dimensions and factors are defined considering DCV, and the surveys are performed to gather ideas from the expert group.

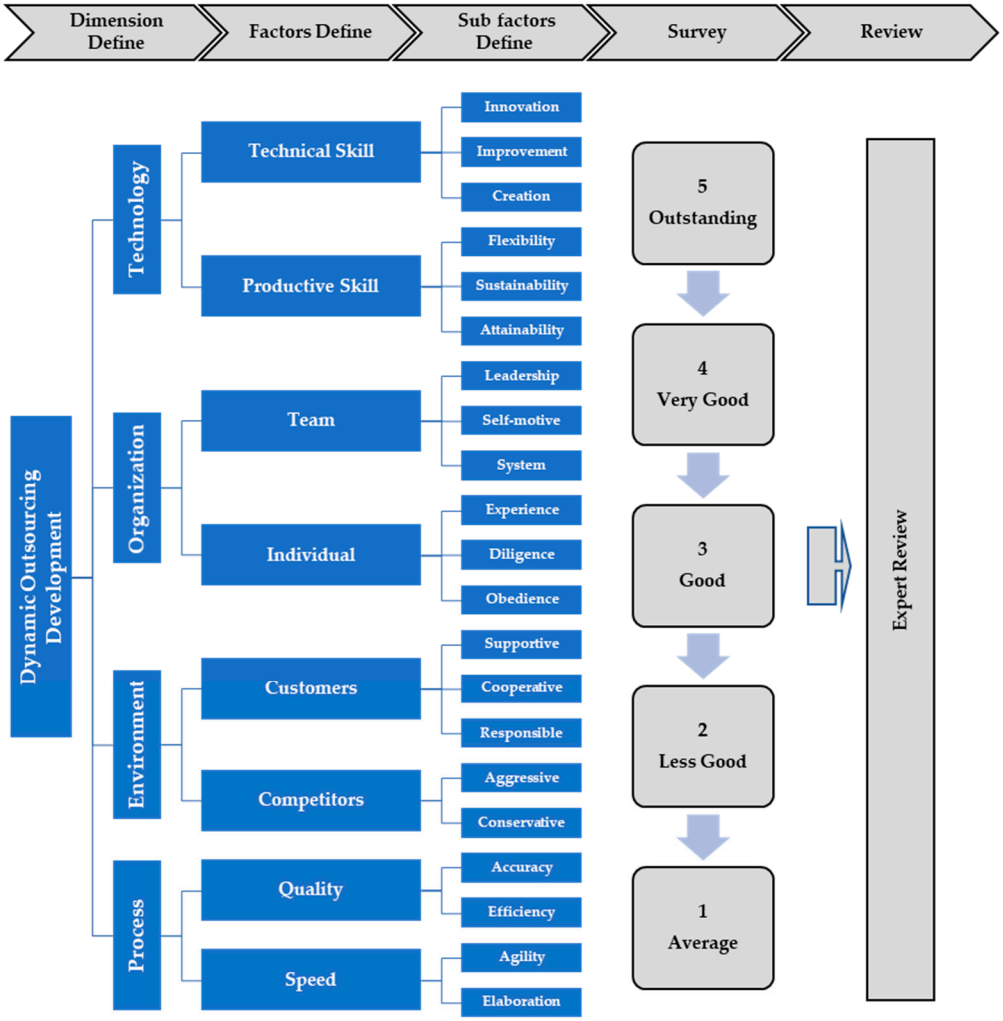

Figure 2. Research modeling.

3.3. Research Process

It is a quantitative approach to examine each dimension and factor by the pairwise comparison. The Delphi AHP method is a systematic and interactive research way which relies on the selection of the correct answer by the expert group who has knowledge on the given topics [62].

Data on the prioritized factors of dynamic outsourcing development were collected from the perspectives of outsourcing service providers to use the Delphi AHP method. Each factor is defined in DCV perspectives by the precedent literature review and compared to prioritize the most important factors in high-tech firms by performing the survey in the expert group that has worked in a high-tech backend semiconductor equipment firm more than 10 years (Table 5).

Table 5. Demographics of expert for the survey.

Category	Experience	Invited Experts	Answered Experts
Client	More than 20 years+	5	5
	15–20 years+	3	3
	10–15 years+	1	1
Service Providers	More than 20 years+	5	4
	15–20 years+	3	3
	10–15 years+	2	1

In the survey, at the first level, 4 dimensions are pairwise compared, and then factors are compared in each dimension. Each sub factor is also compared in each factor area. The input value is calculated according to the geometrical average after the survey, so the weight for each dimension and factor level is valued and prioritized.

There are two categories of target experts invited to join in the Delphi AHP survey which are clients and service providers. Some of the experts did not answer and there could be a limitation of objectiveness, however, the result was meaningful as it has a consistency to find the most reasonable factor of outsourcing development in high-tech firms by using the Delphi AHP method.

4. Results

4.1. Result of Dimensions and Factors

The result shows that technology is the most weighted one as 0.5006 among the defined four dimensions—technology, organization, environment, and process. The reason is that the respondents who joined this survey are working in high-tech firms where technology is the critical factor to develop outsourcing. The next critical dimension is the process as 0.2846 as the process should be kept controlled to support clients' high demand of quality and speed. The dimensions for the environment and organization are weighted comparatively low as 0.1187 and 0.0961, however, they should not be neglected dimensions but should be considered (Table 6).

Table 6. Delphi AHP result for dimensions and factors.

Dimension	Dimension Weight	Factors	Factor Local Weight	Factor Global Weight	Factor Global Rank
Technology	0.5006	Technical Skill	0.2262	0.1132	3
		Productive Skill	0.7738	0.3874	1
Organization	0.0961	Team	0.6967	0.067	6
		Individual	0.3024	0.0291	8
Environment	0.1187	Customers	0.6619	0.0786	5
		Competitors	0.3381	0.0401	7
Process	0.2846	Quality	0.6429	0.183	2
		Speed	0.3517	0.1001	4

In the technology dimension, both technical and productive skill of outsourcing service providers are compared, and the productive skill scored 0.7738 as a factor local weight which means the expert

groups believe it is more critical for outsourcing service providers to support clients with the productive skill rather than technical skill in the technology dimension.

In the organization dimensions, team and individual are compared by selecting which characteristics of outsourcing service providers are better when working with clients. The result shows that team-based working is better with the factor weight 0.6967 than the individual-based working with the factor weight 0.3024.

In the next environment dimensions, customers and competitors are compared which is more important in the environment of the outsourcing service providers. The result shows that the factor of the customer environment is more important with the factor weight 0.6691 than the competitor environment with the factor weight 0.3381.

In the next process dimensions, quality and speed are compared which is critical to support clients' demand in process perspectives. The result shows that the factor of the quality of working is more crucial with the factor weight 0.6429 than the speed of working with the factor weight 0.3517. The reason is that a high-tech firms' requirement on the quality has more importance than the speed of working.

The local weight shows a prioritized factor in each dimension, and the global weight is calculated by multiplying with the dimension weight which factor is most important among all the eight factors in each of the four dimensions that the sum of all of them is 1.000.

Eventually the factor global weight is calculated by multiplying dimension weight and the factor local weight, which can help to give rankings for each 8 factors. So, the factor of the productive skill in the technology dimension is the most important in the factor level.

4.2. Result of Sub-Factors

The factors and the sub factors are investigated, the weight and values for local weight and global weight are calculated. It shows that the most weighted sub-factor is the sustainability in productive skill in the technology dimension (Table 7).

Table 7. Delphi AHP result for factors and sub-factors.

Dimension	Weight	Factors	Factor Local Weight	Sub-Factors	Sub-Factor Local Weight	Sub-Factor Global Weight	Sub-Factor Global Rank
Technology	0.5006	Technical Skill	0.2262	Innovation	0.1244	0.0141	18
				Improvement	0.6285	0.0712	4
				Creation	0.2471	0.0280	11
		Productive Skill	0.7738	Flexibility	0.2360	0.0914	3
				Sustainability	0.6706	**0.2598**	**1**
				Attainability	0.0934	0.0362	9
Organization	0.0961	Team	0.6967	Leadership	0.2628	0.0176	16
				Self-motive	0.1208	0.0081	19
				system	0.6164	0.0413	7
		Individual	0.3024	Experience	0.6715	0.0195	14
				Diligence	0.2362	0.0069	20
				obedience	0.1463	0.0043	21
Environment	0.1187	Customers	0.6619	Supportive	0.5061	0.0398	8
				Cooperative	0.1865	0.0147	17
				responsible	0.3074	0.0242	12
		Competitors	0.3381	Aggressive	0.5521	0.0222	13
				Conservative	0.4479	0.0180	15
Process	0.2846	Quality	0.6429	Accurate	0.6688	0.1224	2
				Efficient	0.3133	0.0573	6
		Speed	0.3517	Agile	0.6833	0.0684	5
				Elaborate	0.3167	0.0317	10

It describes that the other sub factor, the accurate is rank #2, which means the accurate quality is also a very important sub factor in the process dimension in outsourcing development of high-tech firms.

In addition, flexibility ranked #3 in this survey, then it means that the outsourcing supplier should have the flexibility in a volatile market environment to meet the vendor's various and unexpected demand.

This research implies that sustainability is the most crucial sub factor in the productive skill of the technology dimension for dynamic outsourcing development (Table 7). The global ranking for sustainability is #1 with the weight, 0.2598 from the total global weight 1.0000 among all 21 sub factors. It means that among all the defined and investigated sub-factors and factors in the dimensions, the sustainability of the productive skill is the most important factor when the high-tech firm considers to develop the outsourcing service providers.

5. Discussion and Conclusions

This research implies that the sustainability is the most crucial sub-factor in the factor of productive skill of the technology dimension for dynamic outsourcing development A high-tech semiconductor backend equipment manufacturer in a real world need to consider the factor of sustainability in productive skill when developing outsourcing. We could know that there are lots of subjective and objective items to have the sustainability of competitive advantages for the high-tech firm to consider when investigating a proper outsourcing provider because demands from the volatile and high-tech market do not stay just in a static situation but change rapidly and unexpectedly.

This research provides a framework for high-tech firms to consider when developing an appropriate outsourcing supplier with the process of defining and investigating the dimensions and factors from dynamic capabilities perspective in that variable market circumstances.

As an example, by utilizing this framework using Delphi AHP, it can be analyzed that one of high-tech firms of semiconductor backend equipment could develop a suitable outsourcing supplier in the dynamic perspective. The firm could set the procedure of outsourcing development for factor investigation to include the expert-survey analysis, and then have the result of the investigation by prioritizing the factors using this research method. To sustain the competitiveness, it is considered the long-term business improvement in dynamic perspective, so the result shows that the experience got the highest point, and could be considered as a most important factor in that case.

This framework can be applicable to other business fields by expanding the dimensions and factors as the demand for the outsourcing development in a high-tech market is various and an increasing situation. In addition to that, further studies can be followed and improved by referring this framework and by considering each firm's different perspectives of the business field, size of firm, and outsourcing type.

This research result can be utilized as a framework in outsourcing development considering the different situations and environments of the firms. It can be prioritized which factor should be considered firstly, and which factor is less important with an efficient way. The values are investigated and calculated by the Delphi AHP method. This study also shows that it is important to control and manage the accurate quality in the process dimension as an outsourcing service-provider of high-tech firms.

On the other hand, there is a limitation in this research. As this study is investigated by having ideas from the experts who work in high-tech firms like the semiconductor backend equipment market, it can be limited to validate to other industries, however, it is meaningful that this framework can support how factors and sub factors can be pairwise compared to developing the outsourcing service providers by prioritizing each factor.

Future research can be performed in other business areas with the expert group by using the improved framework to find crucial dimensions and factors, while this study focuses on factors and dimensions for the outsourcing development in a high-tech business field. However, in addition to a high-tech business field, it will be interesting to investigate factors by adopting and improving this framework in several other business cases for a firm to acquire sustainability and a competitive advantage.

Additionally, there is an issue of make-or-buy that the original equipment manufacturers (OEM) should select strategically the way of the manufacturing process whether they do it by themselves or outsource it to the third-party manufacturer [17,60]. In a case of high-tech business, there is a consideration that a core business should be owned or could be outsourced. From the RBV perspective, the cost effectiveness and the benefit can be improved by the activities of the outsourcing development, however, the technological knowledge can hardly be transferred to the third-party manufacturer. In further researches, the research framework of this study can be improved by considering the RBV-based decision in a perspective of make-or-buy.

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