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Sustainable Management Activities: A Study on the Relations between Technology Commercialization Capabilities, Sustainable Competitive Advantage, and Business Performance

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Abstract: This study investigates the effects of sustainable management activities (knowledge management activities, quality management activities, and competitive intelligence activities) on technology commercialization capabilities, sustainable competitive advantage, and business performance. In addition, it examines the effects of technology commercialization capabilities on sustainable competitive advantage and business performance as well as the effects of sustainable competitive advantage on business performance. We surveyed 409 global firms for 30 days from 1 October 2018 to 30 October 2018 and performed a structural equation model analysis on the data collected. We limited the scope of the survey to employees working at the level of team leader or above in the R&D department. The results showed that quality management activities and competitive intelligence activities have a statistically significant positive effect on technology commercialization capabilities have a statistically significant positive effect on sustainable competitive advantage. Additionally, sustainable competitive advantage has a statistically significant positive effect on business performance.

Keywords: sustainable management activities; knowledge management activities; quality management activities; competitive intelligence activities; technology commercialization capabilities; sustainable competitive advantage; business performance; sustainability performance

1. Introduction

Today's business environment has undergone a transformation from labor-based to information-based industries so that only experts and technology can provide a competitive edge sustainable in the long term [1]. As society enters an age when knowledge is regarded as one of the most important assets, each organization within a company is well aware that its competitive advantage depends on its hired brainpower; thus, all organizations are investing heavily in intellectual capital [2].

A market's globalization, competition, and rapid technological advancement have a direct impact on business organizations that have to face competition both locally and internationally. According to



Lim, Ahmed, and Zairi [3], business organizations nowadays understand that they have to regard knowledge as an asset to succeed and that it is necessary to manage knowledge effectively. In fact, a majority of companies are reframing themselves as knowledge experts [4]. These organizations view knowledge management as an innovative management tool that enables them to take advantage of attention from both academia and industry.

Several researchers [5–7] are invigorating knowledge production and sharing among organizations, thereby creating new products and services and strengthening business performance. In other words, they have proposed a new approach to performance improvement relevant to the activity competence of business organizations that realize strategic profits. They argue that organizational capabilities can strengthen customer satisfaction and loyalty, lead to better decisions, and bring enhanced labor force and performance improvements. In this sense, developed business organizations can ultimately increase their market shares and profits by effectively utilizing intellectual capital that would bring new products and services to maintain their competitiveness in a fast-changing business environment and global market [5–7].

Moreover, business organizations apply quality management with the purpose of improving process achievements. However, as previously mentioned, to accelerate improvements and attain an advantageous position in business, an organization must make it a priority to gain and integrate new knowledge [8]. It is difficult for managers to design and execute the operation of quality management and thereby gain new knowledge. In other words, knowledge can be created through a variety of channels and on various organizational levels. Therefore, it is necessary to regard knowledge management and quality management as important while seeking smooth management within a company and competitive advantage, and to execute them simultaneously [8].

Quality management has functioned as a driver for social scientists to study management philosophy and analyze methods of applying it successfully [9]. According to Flynn, Schroeder, and Sakakibara [10], the goal of quality management is to attain customer satisfaction, improve management performance, and maintain process improvement and error prevention across all levels and parts of a business organization. In other words, a concerted effort is required to realize and maintain high-quality products based on quality management and to improve and maintain business performance.

In fact, people have been paying more attention to quality management since it proved to improve the performance of business organizations. It is widely accepted that efficient management requires business execution based on quality management, which is also indispensable for attaining sustainable competitiveness [8]. It is argued that quality management can improve the performance of existing organizational processes and that companies adapting to a dynamic market condition should also regard exploration and innovation as key tasks [11,12]. However, some have suggested that company organizations should seek out competitive intelligence, including new technology and capabilities for resolving upcoming problems and capitalizing on the trends in new resources while utilizing existing resources and performing knowledge and quality management [13,14].

As supported by the aforementioned discussions, the business environment has become increasingly unpredictable; thus, governments and companies are pursuing ways to determine environmental changes in their early stages to be able to react promptly [15]. To gain time for adapting to a changing environment, companies have to anticipate changes, and where they react to changes this will entail challenging consequences. This is why competitive intelligence has emerged and become an area of academia in an environment where anticipation has become difficult and competition intense [16]. Competitive intelligence helps company organizations adapt to the changing environment [13] and provide assistance so that they can navigate through difficult situations [14].

Competitive intelligence provides a framework in which integrated environmental analysis can be reflected in the decision-making processes, thereby improving them. As such, competitive intelligence has the potential to support companies in realizing their own and business targets [17]. Qiu [18] argued that companies may develop and maintain competitive advantages through competitive intelligence. Moreover, in a study on competitive intelligence, M-Brain [19] highlighted that most people responded

that they had experienced the benefits of intelligence and had gained high profits from investment in intelligence. Competitive intelligence activities have continued to increase as measured by companies' official intelligence structures, manpower, and membership in professional competitive intelligence associations for the past 10 years. Meanwhile, it was highlighted that competitive intelligence is one of the fastest growing areas in the business world [20,21].

Furthermore, competitive intelligence is utilized as a mechanism of company organizations to transform rival companies' intelligence into outward-looking behaviors. Such organizations may take more seasoned actions compared to rival companies [22]. Moreover, given the effect of competitive intelligence on innovative performance, organizations may become more seasoned in attaining immediacy, and the utilization of explorative intelligence may invigorate business performance [23].

However, in terms of innovative capabilities, many company organizations have highlighted that it is a very important research agenda to understand how new knowledge, intelligence, and quality improvement are reflected in industrial products in a market and whether there are benefits to technological innovation [24,25]. In other words, according to existing studies, commercialization of technology functions as a key competitive factor in company organizations that are based on technology and is an indispensable and important stage for them to benefit from technological innovation [26–28]. Accordingly, commercialization of technology is recognized as a process and activity through which company organizations may benefit from technological innovation. It is also a key factor that can be structured as a value that generates wide-ranging potential income, production, and utilization [29]. Furthermore, Mitchell and Singh [30] suggested that technology commercialization can be utilized as a process for gaining ideas and a complementary knowledge tool. They defined the process of technology commercialization in the development, production, and sale of sellable products in a market.

An examination of a company's sustainable management activities can provide a foundation for sustainable competitive advantages in the future [31,32]. It has the advantage of being able to evaluate specific meanings of sustainable companies along with market changes and to examine proper organizational reactions [33]. Therefore, it is very important to categorize, observe, and interpret several factors of management activities (e.g., knowledge management, quality management, competitive intelligence, etc.). A company's sustainable management activities are relevant to several stakeholders, provide an important resource that makes one lead the competition, and ultimately improve financial performance (e.g., return on assets, return on equity, cash flow, discount cost method, etc.) [33]. In other words, they promote competitive advantages that suggest a direction to move toward so that company organizations can prepare for changes and go forward into the future that they want [31,32].

An investigation into the origin of competitive advantage has revealed considerable changes for the past several years. From the perspective of industrial structure [34], theoretical development has incorporated a variety of aspects including resource capabilities in various time zones [35,36], capabilities in innovation [28], and organizational relations [37]. The benefits of competitive advantage in inter-organizational relationships have become an important area that attracts academic interest [32]. In other words, even though a great deal of work has been done using a quantum perspective [37], the perspective of sustainable management activities has been gaining more attention as a way to understand the process to strengthen competitive advantage [32].

As previously mentioned, the strategic direction of companies' sustainable management activities (e.g., knowledge management, quality management, competitive intelligence) refers to particular approaches that companies take to produce a superior and sustainable business performance [38]. Therefore, the strategic directivity of these activities reflects the managerial perception of social environments and the framework regarding reaction to conditions [39,40]. As such, the overall strategy of sustainable management activities can be seen as an intangible resource that reflects the direction that the management team has adopted to smoothly realize the core organizational targets. Moreover, such activities will be formed as a measure to evaluate the management's internal capacity and accommodate changing market dynamics [41].

A management team's decision regarding the overall marking strategy may establish objectives and direction for most other organizational activities [41]. They in part entail decisions regarding the supply of tangible resources and activate areas like a mixed decision on necessary marketing, investment of marketing assets in knowledge industries, management of intellectual resources, which is the subject of recruiting (knowledge management) [42], execution techniques and activities selected in the process of business execution for organizational processes and quality control (quality management) [43], a collection of information necessary for particular types, prediction of market changes, and organization reaction (competitive intelligence) [44]. As such, through a strategic decision on sustainable management activities by a management team, all activities on an organization level apply the same method of approach [41]. If the strategy is successful, this condition can be transferred to the organization of another function. At the same time, more departmental activities will be planned and executed in addition to supporting the strategy of sustainable management activities [41].

To date, most research has focused on the relevance and connectivity of business performance based on a company's differentiation, such as overall strategic options for the management team [34], its leadership, and competitive advantage [45,46], and the research outcomes have been positive. There is evidence that overall strategy on the differentiation of management's leadership and competitive advantage is related to marketing effect (including sales) [47,48] and market orientation [49]. Moreover, there is a suggestion that the differentiation strategy for competitive advantage (local or global) and low-cost strategy correspond to the outlook that can lead to a low-cost position in a particular market condition [50]. In other words, as market share increases, the quantity of products being sold also increases and it becomes possible to attain the economies of scale that enable low-cost production. Therefore, the differentiation strategy for competitive advantage can lead to an increase in market share that is potentially sustainable and to a low-cost position [41]. However, the important question is not just regarding competitive advantage but also about deriving the capacity for sustainable management activities that would maintain a competitive advantage over time and differentiate it in a meaningful way [41,50].

From this perspective, sophisticated company organizations may ultimately increase their market shares and profits by effectively utilizing knowledge management that can create new products and services to maintain their competitiveness in a rapidly changing business environment and global market [5–7]. Moreover, it may be necessary to make concerted efforts to realize and maintain high-quality products based on quality management and to improve and maintain business performance by continuously sustaining the process improvement and error prevention across all levels and parts of company organizations [9,10]. In addition, it is necessary to attain the potential of competitive intelligence that supports the realization of a company's own and business goals by providing a framework such that an integrated environmental analysis can be included in the decision-making processes in a company, thereby improving such processes [39]. This shows that the strategic directivity of the previously mentioned sustainable management activities is required [38]. In addition, along with a management team's perception of the social environment, it functions as a very important factor that can reflect a reaction framework [39,40].

In other words, companies transform into pursuing new knowledge and information in the market, which leads to quality improvement in commercialized products and ultimately to a process or activity through technological innovation from which profits can be made [24,25]. This means that the strategic directivity of a company's sustainable management activities can be composed of wide-ranging potential income generation, production, and utilization values [26–30].

As previously discussed, an examination of a company's sustainable management activities can provide a foundation to build sustainable competitive advantage in the future [31,32]. Moreover, it is reported that such activities have the advantage of enabling evaluation of distinctive meanings of a company with growth potential and an examination of proper organizational response along with market changes [33]. Therefore, it is possible to learn indirectly that business achievement can be

realized in several aspects, including resource capabilities through competitive advantage [35,36], innovative capabilities [28], and inter-organizational relationships [37].

In particular, global companies from developed countries such as the United States and the United Kingdom have steadily collected and developed materials and expertise on definitions, execution guidelines, model standards, and other practical matters concerning sustainable management activities [51,52]. At the same time, they have also made efforts to explore a larger market regarding foreign direct investment and to promote the formation of mutual investment relations with companies from other countries [53,54]. Moreover, medium-size companies and conglomerates in South Korea have also tried to apply successful cases of sustainable management activities from global companies abroad [55,56]. Technically speaking, it can be inferred that sustainable management activities by global companies from developed countries lead to technology commercialization and sustainable competitive advantage and ultimately have a positive impact on the value (performance achievement) of these companies [31,57–65]. In other words, sustainable management activities by global companies lead to accurate anticipation of future values and an increase of trust, ultimately creating business performance.

Nonetheless, existing studies have not been able to conduct proper empirical research that would devise such activities like knowledge management, quality management, and competitive intelligence to increase technology commercialization capabilities and to attain sustainable competitive advantage. In other words, no research has fixed the aforementioned as sustainable management activities and then examined their effect on technology commercialization capabilities and sustainable competitive advantage. Moreover, there is a lack of research on its cause-and-effect relationship with the final outcome variables, namely business performance, both financial and non-financial, from a variety of perspectives.

Furthermore, many existing studies conducted surveys with global companies and made an empirical examination. However, they have limitations in that most collected and utilized data on companies from only one country (e.g., South Korea) [66–69]. To overcome such a limitation, some studies analyzed global companies from two or more countries in Asia (e.g., China, Japan, etc.) [70,71] or Europe (e.g., the United Kingdom, Germany, etc.) [72]. However, there is also a relatively small number of such studies. Most existing studies have the limitation in that they broadly covered and conducted multifaceted surveys for global companies from Asia, Europe, North America, and Africa with the aim of generalizing their research outcomes but failed to make empirical verification.

Therefore, this study has the following research objectives. It examines the effect of sustainable knowledge management, quality management, and competitive intelligence activities by global companies from four countries (continents) including South Korea, the United States, the United Kingdom, and South Africa (all in the top 10 by worldwide GDP ranking for the past three years, except for South Africa) on technology commercialization capabilities. Moreover, it investigates the effect of three sustainable management activities on sustainable competitive advantage and business performance. It also determines the effect of technology commercialization capabilities on sustainable competitive advantage and business performance as well as the effect of sustainable competitive advantage on business performance.

In summary, this study hypothesizes that global companies' sustainable management activities can strengthen rules of competitive advantage, the decisional model for marketing, and decision support technology and lead the business environment toward a more positive direction. Moreover, the strengthened sustainable management activities may greatly help managers of the R&D department (including marketing managers) to facilitate segmented marketing, which diversifies products, services, and sale methods per customers' preferences, thereby minimizing future uncertainty. As such, this study examines the following research questions to meet its objectives.

Research questions

- ① What is the effect of sustainable management activities (knowledge management, quality management, competitive intelligence activities) on technology commercialization capabilities, sustainable competitive advantage, and business performance in a company?
- (2) What is the effect of technology commercialization capabilities on sustainable competitive advantage and business performance in a company?
- ③ What is the effect of sustainable competitive advantage on business performance in a company?

2. Theoretical Background

2.1. Sustainable Management Activities

Sustainable management activities refer to a variety of activities of accommodating economic and environmental development and opportunities derived therefrom and managing risks for companies to attain the goal of sustainability of humanity. These activities create values for shareholders in the long term [73]. In other words, these activities are companies' efforts to improve the quality of economic activities for environmental, economic, and social sustainability so that the subjects and objectives of management activities will not be limited to only the current generation but will also be sustainable to satisfy the desires of future generations. Moreover, companies use a variety of such activities to minimize risks and increase company values, including shareholder values [74].

This study focuses on the economic aspect of sustainable management activities. Economic activities refer to the tangible and intangible management activities companies perform to attain economic profits necessary for their survival. In fact, companies have to effectively utilize and allocate management resources so that profits can be created throughout the processes of all management activities, including preparation for producing products and services, production, and post-production processes. For companies to grow and develop sustainably, they must attain economic profits [75,76]. Furthermore, in sustainable management activities, company efforts to create profits do not only refer to efforts to grow the quantity of profits. Companies also have to make efforts to grow qualitatively in the process of profit-making. In other words, they need to make efforts to create profits as a management outcome by seeking to create new values and attain competitive advantage through technological innovation such as technology commercialization capabilities and sustainable competitive advantage while providing new product development and services to customers through R&D investment and quality improvement [29–32].

Therefore, this study utilizes three main factors as sustainable management activities in an economic sense: knowledge management, quality management, and competitive intelligence activities. In particular, these three sustainable activities are evaluated to be those that are required to draw superior and sustainable business performance [5–8,23,38]. In other words, these activities can present the right direction for company management to smoothly attain the key organizational targets. Moreover, they can form the foundation for evaluating the internal capabilities of a management team and adapting to the growing market's dynamics [41]. The next section will examine the concepts of these three sustainable management activities.

2.2. Knowledge Management

Knowledge management is multidimensional and is defined differently in terms of operations. For example, Chawla and Joshi [77] defined knowledge management as the process of identifying and analyzing the accessible knowledge needed to realize an organization's goals. Darroch [78] stated that knowledge management is related to knowledge acquisition, knowledge dissemination, and the usefulness of available knowledge. In addition, within a related organization's strategies and context, researchers have studied knowledge management as a process of acquisition, storing, understanding, sharing, and implementation of the measures and knowledge used in the learning process [79]. Bhatti and Qureshi [80] regarded knowledge management as an effort to seek out the intrinsic and extrinsic knowledge of individuals, groups, and organizations and to transform these resources into organizational assets that managers use to make organization of the knowledge and expertise of an organization's individual members and the sharing of that knowledge as a universal organizational resource. This includes rapidly communicating, sharing, reflecting, and applying the expertise acquired through work among organizational members and departments.

2.3. Quality Management

Quality management is a mainstream management method for enhancing customer satisfaction and competitive advantage by improving products, services, and business processes [81]. The origins of quality management can be traced back to statistical quality control developed by Walter Shewhart in the 1930s and popularized by William Edwards Deming and Joseph Juran in Japan in the 1950s [43]. The principles, tools, and methods of quality management returned to Western society in the 1970s and have held the attention of firms since the early 1980s [43]. Emphasis was initially placed on improving the quality of the manufacturing facilities of manufacturing companies. Subsequently, quality management spread to all organizational functions and departments across the manufacturing and service sectors [81]. Rungtusanatham, Ogden, and Wu [82] reported that the three factors that support the theoretical basis of quality management are based on the professional knowledge system (perception of systems, knowledge of change, knowledge theory, and psychology) researched by Deming [83], Anderson, Rungtusanatham, and Schroeder [84], and Hillmer and Karney [85,86]. The theoretical source strengthens the theoretical basis of the field of quality management [87]. Thus, as in the referenced literature, this study defines quality management activities as firm-wide, comprehensive management systems that use the participation of all members and overall methods across management activities for the long-term success of the firm. This includes performance, process, training, and employee management.

2.4. Competitive Intelligence

Competitive intelligence is defined as a process or practice (action) that helps executives make informed decisions and provides the firm with competitive advantages [88]. Du Toit [89] defined competitive intelligence as a strategic tool that facilitates the identification of potential opportunities and crises. Du Plessis and Gulwa [90] and Jenster and Søilen [91] also defined competitive intelligence as a strategic tool. These and other scholars consider competitive intelligence as a process that supports important decision-making. Other researchers have examined how competitive intelligence can be applied within a firm. Amara, Solberg Søilen, and Vriens [92] stated that competitive intelligence allows high-level executives, regardless of firm size, to make informed decisions on marketing, R&D, investment tactics, and long-term business strategies. Researchers have also described competitive intelligence as a value-added concept superior to business development, market analysis, and strategic planning. Vriens and Solberg Søilen [93] noted that competitive intelligence is a necessary factor in predicting whether the firm will fall behind competitors in the industry. Thus, this study defines competitive intelligence activities as the systematic process of collecting, analyzing, and using information on competitor activities and the firm's business environment through systematic and rational methods. These methods include predicting the external environment, protecting information knowledge, and exercising influence.

2.5. Technology Commercialization

Technology commercialization refers to a firm's capability to use technology in products [94]; this is the widely accepted definition of technology commercialization. For example, Mitchell and Singh [30] defined this concept as a process of acquiring ideas, reinforcing them with complementary knowledge, developing and manufacturing products for the market and, ultimately, selling products. This perspective views the management of technology commercialization activities as vital for successful product development and sales and securing competitive advantage. Technology commercialization emphasizes the internal investments of firms that use their own resources and abilities [95–97]. Thus, technology-based firms, which are characterized by high-risk and uncertain performance, add a strategic focus to their own technology commercialization that is focused on innovative activities [98]. Additionally, technology commercialization is emphasized in the management of related firm secrets and patents and the need to introduce new products faster than competitors. These activities enable firms to discover new market opportunities and gain competitive advantages ahead of competitors [99]. Thus, it is vital for firms to efficiently commercialize their advanced technology. Accordingly, this study defines technology commercialization capabilities as all activities and processes that create added value through the transfer, exchange, diffusion, and application of the developed technology. This includes the speed of commercialization, market scope, and technological breadth of the product (good).

2.6. Sustainable Competitive Advantage

Competitive advantage refers to the degree to which an organization can obtain a favorable position compared to its competitors [100]. Thus, competitive advantage, which is the product of management decisions, is composed of a variety of factors related to capabilities that enable a business organization to differentiate itself from competitors [101]. Previous literature has classified competitive advantage as competitive capabilities in terms of price/cost, quality, delivery, and others through consistent and flexible methods [101]. In another study on competitive advantage, Koufteros, Vonderembse, and Doll [102] described a research framework of competitive capabilities and defined it using five dimensions: ① competitive pricing, ② premium pricing, ③ customer-oriented value, ④ delivery reliability, and (5) production innovation. These dimensions were described by Tracey, Vonderembse, and Lim [101] and Li et al. [103]. Together, the dimensions of competitive advantage include price/cost, delivery reliability, production innovation, and marketization timing. Thus, this study defines sustainable competitive advantage as the process of securing an advantageous position compared to competitors by providing superior service value while improving convenience facilities, lowering costs, or justifying high prices. This value includes providing a high level of service to customers regardless of price, implementing a service model superior to competitors, supplying products or services that exceed the quality of current levels, and investing in marketing activities to a greater extent than competitors.

2.7. Business Performance

The measurement of business performance is based on financial performance indicators such as net profit margin, sales, market share, and return on investment (ROI) [104]. Powell [105] noted that there have been many attempts to measure business performance through the subjective survey evaluations of business organization members rather than through financial performance. Furthermore, financial performance has many limitations in that it measures business performance after the fact and cannot accurately reflect a firm's intangible value. Therefore, composite indicators that include nonfinancial performance data rather than single indicators based on financial performance are preferable [104,105]. Typically, as nonfinancial performance is subjective performance, the scope of measurement is broad and inappropriate as an indicator of short-term business performance. However, as nonfinancial performance is measured using long-term and diverse criteria, it can address the problems of financial performance [106]. Hence, the financial performance indicators used to measure a firm's short-term performance are typically expressed in terms of profitability. In addition, profitability is the most important and key criterion for evaluating the final business performance of a firm [107,108]. Thus, this study defines business performance as the degree of performance (numerical data) contributed by individuals, departments, and the entire organization. This includes both financial and nonfinancial performance.

3. Research Method

3.1. Research Model

This study investigates the effects of sustainable management activities (knowledge management activities, quality management activities, and competitive intelligence activities) on technology commercialization capabilities, sustainable competitive advantage, and business performance. Figure 1 shows the research model.



Figure 1. Research model.

3.2. Research Hypotheses

3.2.1. Knowledge Management Activities and Technology Commercialization Capabilities

The foundation of a firm's internal knowledge management is the data used to acquire new technologies and create products (goods); abundant data can strengthen future commercialization capabilities. Thus, a firm's existing knowledge management base seeks out knowledge, processes and absorbs that knowledge, and improves the firm's ability to generate new technical knowledge for problem-solving [109]. Additionally, knowledge management-based R&D helps a firm's leadership choose the correct path among numerous uncertain and unfamiliar options [64]. As the firm's technical knowledge expands, management can better understand the constraints or weaknesses of various

internal R&D directions, thus increasing the efficiency of the decision-making process. Therefore, firms with in-depth knowledge of a particular field can perform more efficient R&D processes that create innovation [110]. As a result, efficient R&D based on knowledge management leads to the development of new products (goods), the improvement of more suitable products (goods), and the acquisition of more creative technologies and integration capabilities [110]. Therefore, based on the previous literature, we set the following research hypothesis:

Hypothesis 1 (H1). *Knowledge management activities have a positive (+) effect on technology commercialization capabilities.*

3.2.2. Quality Management Activities and Technology Commercialization Capabilities

Increasing quality-oriented activities can soon form and spread a culture of quality within a firm [111]. Furthermore, if a culture of quality forms and spreads within a firm, the firm will increase its efforts to more systematically pursue quality management [112]. That is, by continuously supplying quality products (goods) in a timely manner through continuous quality improvement activities, the firm can ultimately establish customers' trust [113]. These quality-oriented activities lead to the continuous improvement of products (goods) and technological development. Moreover, firms perform scientific quality improvement activities to eventually improve process capabilities [62]. In turn, improved process capabilities encourage the development of creative technology, which can generate future value for the firm [62]. Therefore, based on the previous literature we set the following research hypothesis:

Hypothesis 2 (H2). *Quality management activities have a positive (+) effect on technology commercialization capabilities.*

3.2.3. Competitive Intelligence Activities and Technology Commercialization Capabilities

Today, firms face a dynamic environment resulting from globalization, informatization, and technological innovation [114]. In this dynamic environment, firms seize new opportunities and face new threats as they focus on competitive intelligence [115]. In other words, firms seek to create new knowledge and skills by understanding and adapting to this dynamic environment [116]. Specifically, while expanding their understanding of new changes in the environment through competitive intelligence activities, firms further enhance technology commercialization through continuous idea development and new product development [57,117]. Therefore, competitive intelligence activities accelerate progressive technological commercialization and break down difficult situations, ultimately leading to environmental changes [57,117]. Therefore, based on the previous literature, we set the following research hypothesis:

Hypothesis 3 (H3). *Competitive intelligence activities have a positive (+) effect on technology commercialization capabilities.*

3.2.4. Knowledge Management Activities and Sustainable Competitive Advantage

Scholars consider difficult-to-imitate knowledge resources developed within an organization a major source of competitive advantage [28,118]. Thus, knowledge management firms can create sustainable competitive advantage [119]. Knowledge management does not involve competition with other firms but, rather, the creation of competitive advantages from the firm's knowledge resources [63]. In addition, as explained in resource-based theories such as social complexity and causal ambiguity, inimitable factors further enhance a firm's competitive advantage [120]. As mentioned earlier, from the resource-based perspective that a firm's sustainable competitive advantage stems from its own knowledge resources, it is crucial to properly manage the firm's business resources on global networks [121]. Accordingly, knowledge is an important resource for firms. As the recognition of

knowledge as a source of competitive advantage spreads, sharing and diffusing knowledge resources enable firms to secure other competitive advantages [122,123]. Therefore, based on the previous literature, we set the following research hypothesis:

Hypothesis 4 (H4). *Knowledge management activities have a positive (+) effect on sustainable competitive advantage.*

3.2.5. Quality Management Activities and Sustainable Competitive Advantage

Quality management impacts an organization's overall performance and an organization's competitive advantage. An organization's competitive advantage improves through price/cost, delivery reliability, market orientation, and product innovation [31]. Previous research indicated that various elements of quality management influence competitive advantage. As a simple example, the empirical research of Powell [124] showed that quality management can strengthen competitive advantage. Oakland [125] defined quality management as a method to improve competitiveness that can also promote an organization's flexibility. Moreover, Naveh and Marcus [126] reported that the proper implementation of ISO 9000 standards can lead to competitive advantages with ISO 9000 certification. In fact, since quality management is used in firms' everyday activities and as a catalyst for change, it can lead to competitive advantages in management and operations [31]. Therefore, based on the previous literature, we set the following research hypothesis:

Hypothesis 5 (H5). *Quality management activities have a positive (+) effect on sustainable competitive advantage.*

3.2.6. Competitive Intelligence Activities and Sustainable Competitive Advantage

Information from inside and outside the firm and from a social competitive environment is collected ethically and legally, processed, and analyzed, producing new competitive information [127,128]. This competitive information plays an integral role in promoting competitive advantage [127,128]. Competitive intelligence helps executives understand changes in the market and industry and anticipate potential risks [129]. Thus, competitive intelligence allows firms regardless of size to make informed decisions concerning marketing, R&D, investment tactics, and long-term business strategies [92]. Competitive intelligence creates added value and is superior to new business development, market exploration, and strategic planning [130]. Previous literature noted that competitive intelligence affects important decisions throughout the entire firm environment and is a key factor in securing and implementing competitive advantages [58]. Therefore, based on the previous literature, we set the following research hypothesis:

Hypothesis 6 (H6). *Competitive intelligence activities have a positive (+) effect on sustainable competitive advantage.*

3.2.7. Technology Commercialization Capabilities and Sustainable Competitive Advantage

In a rapidly changing market environment, a firm's technology commercialization is a key success factor for survival [131]. That is, a firm must secure competitive advantages to survive in a rapidly changing market environment [61,132]. Firms use technology commercialization to enhance customer satisfaction by developing products (goods) that meet customer preferences and demands [133]. Companies achieve high levels of customer satisfaction by providing what the customer wants and needs. In an age of infinite competition, the key to competitive advantage is determining what customers want before competitors do. Thus, the key is to satisfy customers' desires [134].

Technology commercialization is considered a vital asset in securing and maintaining competitive advantage [131]. Moreover, technology commercialization that can help ensure that appropriate technology is available on the market and can be quickly developed and launched will increase a firm's competitiveness and its products' life cycles [61,132]. Supporting this argument, Chen [135] stated that the technology commercialization capabilities of new venture firms have a positive effect on business performance. Moreover, Hwang and Sung [136] suggested that an export firm's technology commercialization capabilities act as a major catalyst for enhancing competitive advantage. Therefore, based on the previous literature, we set the following research hypothesis:

Hypothesis 7 (H7). *Technology commercialization capabilities have a positive (+) effect on sustainable competitive advantage.*

3.2.8. Knowledge Management Activities and Business Performance

Barney [137] stated that a firm can increase its business performance by properly implementing knowledge management. Thus, knowledge management activities such as knowledge acquisition, creation, sharing, and transfer play an important role in improving management performance [138,139]. These scholars emphasized that firms seeking to increase their competitiveness must expand their investment in management activities to increase revenue, sales, and market share. Additionally, Seba and Rowley [65] and Zack, McKeen, and Singh [140] reported that knowledge management activities of business organization members and ultimately improve business performance. Therefore, based on the previous literature, we set the following research hypothesis:

Hypothesis 8 (H8). *Knowledge management activities have a positive (+) effect on business performance.*

3.2.9. Quality Management Activities and Business Performance

Scholars have already found that quality management directly affects firms' business performance. That is, quality management can increase a firm's market share [141–144], customer satisfaction [145–147], and financial performance [141,148–152]. As a result, firms can improve sales, return on assets (ROA), and market share [153] by investing in quality management. Therefore, based on the previous literature, we set the following research hypothesis:

Hypothesis 9 (H9). *Quality management activities have a positive (+) effect on business performance.*

3.2.10. Competitive Intelligence Activities and Business Performance

Firms survive through interactions with the external environment [154]. Furthermore, business performance can only be improved if the firm is linked to the external environment through business strategies [34]. Thus, a firm possessing clear insight and understanding of its external environment can effectively make decisions and establish strategies, thereby achieving a high level of competitive advantage [155] and rapidly improving business performance [60]. A firm must support insight and understanding of the external environment to successfully operate, and these factors can be secured through competitive intelligence activities [156,157]. A firm can perform competitive intelligence activities to make effective decisions and establish strategies positively impacting business performance. Therefore, based on the previous literature, we set the following research hypothesis:

Hypothesis 10 (H10). *Competitive intelligence activities have a positive (+) effect on business performance.*

3.2.11. Technology Commercialization Capabilities and Business Performance

In technology-based firms, technology commercialization is composed of new product development strategies and market success [25,158]. Thus, by introducing new technologies, firms can effectively respond to customer needs and changes in the environment. Through successful technology commercialization, firms can realize potential customer demand in terms of cost, speed, quality, and the newest technological attributes [97]. Previous studies report that firms improve product quality through technology commercialization capabilities and apply them to new technology and market trends. In addition, research suggests that technology commercialization can lead to competitive advantages and improved business performance [131,135,159–161]. From this perspective, the results of new technology commercialization activities vary widely depending on the scale of commercialization and the manner in which it is implemented [162,163]. Thus, in today's rapidly changing business firm growth and competitiveness. Therefore, based on the previous literature, we set the following research hypothesis:

Hypothesis 11 (H11). *Technology commercialization capabilities have a positive (+) effect on business performance.*

3.2.12. Sustainable Competitive Advantage and Business Performance

Possessing a competitive advantage implies that a firm provides at least one of either lower prices, higher quality, better reliability, or faster delivery compared to competitors. These capabilities increase the overall performance of the organization [164]. Competitive advantages can increase business performance, customer satisfaction and loyalty, and relationship efficiency. Thus, brands with high customer loyalty experience less competition in their target areas, thereby increasing sales and profitability [165]. Furthermore, organizations that offer high-quality products can switch to a premium pricing model and increase profit margins and ROI. Organizations with short time-to-market and rapid product innovation are emerging as market leaders improving both their market share and sales [103]. Therefore, based on the previous literature, we set the following research hypothesis:

Hypothesis 12 (H12). Sustainable competitive advantage has a positive (+) effect on business performance.

3.3. Survey Subjects and Data Collection

We conducted the survey for a total of 30 days from 1 October 2018 to 30 October 2018. The surveys were collected through Entrust Survey (http://entrustsurvey.com), a global survey sampling company. The surveys were provided in Korean and English. We surveyed a total of 409 global firms across Asia, Europe, North America, and Africa: 159 in Korea, 100 in the United States, 100 in the United Kingdom, and 50 companies in South Africa. We limited the scope of the survey to employees working at the level of team leader (or executive) or above in the R&D department. In particular, the reason why the number of samples of American, British, and South African companies collected by this global research firm was smaller than that of South Korean companies is as follows. As previously mentioned, the research subjects were employees with a rank of or above team leader (or executive board member) who worked in the R&D department in companies of middle or above standing. Therefore, this study utilized the maximum number of companies from which qualifying surveys can be collected. Table 1 summarizes the collected characteristics of the firms and respondents.

Firm Characteristics				Respondent Characteristics				
Category	Item	Item Frequency		Category	Item	Frequency	%	
Firm	Large enterprise	193	47.2	Respondent	Male	272	66.5	
size	Medium Enterprise	216	52.8	gender	Female	137	33.5	
	Services	22	5.4		20s	76	18.6	
	Finance	25	6.1	Pospondont	30s	190	46.5	
	Manufacturing	169	41.3	Respondent	40s	114	27.9	
	Construction	37	9	age	50s	27	6.6	
Firm —	Education	10	2.4		50s or Older	2	0.4	
	Medicine/Pharmaceuticals	41	10		Team leader	125	30.6	
	Sales/Distribution	28	6.8	Respondent	General manager	118	28.9	
	IT/Web/Communications	58	14.2	position	Head manager	35	8.6	
	Media/Design	11	2.7		Other (executives, etc.)	131	32	
	Other	8	2		High school graduate	17	4.2	
	Korea	159	38.9	Respondent	Technical college graduate	28	6.8	
Firm	US	100	24.4	education	College graduate	225	55	
location	UK	100	24.4		Graduate school graduate	137	33.5	
	South Africa	50	12.2		Other	2	0.5	
	1–5 years	21	5.1		Less than 1 year	6	1.5	
	6–10 years	62	15.2	Respondent	1–5 years	121	29.6	
Firm	11–15 years	70	17.1	topuro	6–10 years	151	36.9	
establishment	16–20 years	60	14.7	(curront	11–15 years	67	16.4	
period	21–25 years	48	11.7	employer)	16–20 years	41	10	
	26–30 years	33	8.1	employer)	21–25 years	13	3.2	
	30 years or more	115	28.1		25 years or more	10	2.5	

Table 1. General	characteristics	of the samp	ole (N	N = 409
			•	

3.4. Variable Measurements

Table 2 shows the operational definitions and measurements of the variables used in this study. We prepared the questionnaire items for all the variables with reference to the previous studies listed in the table while modifying and supplementing them according to the purpose of this study. In addition, we developed some of the items ourselves.

Variable	Operational Definition	Measurement Item	
		1. Promotion of learning activities among organization members	
		2. Rapid communication of information on executive decisions to departments	
Knowladza		3. Contribution to the overall performance of the firm by sharing specific knowledge with organization members	
management activities	Institutionalization of active creation and sharing of knowledge within business organizations	4. Reflection of information and knowledge on market trends and new products	
		5. Cooperation with related departments when promoting work	
		6. Quick reflection of information on executive decisions at work	
		7. Application of best practices at work	
Source: Seok, Han, an	nd Kim [166]	IN	
Scale: 11-point Liker	t scale (0 points: Very low-10 points: Extremely good		
		 Development and management of performance measurement indicators for internal operations 	
		2. Appropriate management through analysis of work performance	
Quality management activities		3. Active implementation of work improvement to increase performance	
	Continuous activities to improve the level of quality of the firm's goods	4. Active implementation of work process improvement to increase work efficiency	
		5. Operation of various programs for employee caree development	
		6. Employees' level of interest in work training	
		7. Collection and application of employees' opinions	
		8. Regular measurement of employee satisfaction and reflection in work improvement	
Source: Seok, Han, a Scale: 11-point Liker	nd Kim [166] t scale (0 points: Very low-10 points: Extremely good	d)	
		1. Specific understanding of supplier trends	
		2. Specific understanding of competitor firm activities	
		3. Specific understanding of buyer trends	
		4. Specific understanding of trends in technological innovation	
		5. Extent of employee pledges regarding information security	
		6. Thoroughness of computer system security	
Competitive	Systematic process of collecting, analyzing, and	7. Emphasis on the importance of information security	
activities	the firm's business environment	8. Help provided by competitive intelligence activities to maintain friendly relationships with suppliers	
		9. Help provided by competitive intelligence activities to effectively exercise influence over competitors	
		10. Help provided by competitive intelligence activities to maintain friendly relationships with social pressure groups	
Source: Kim, John, ar	nd Ravi [167]		

Table 2. (Operational	definitions	and measu	rements of	variables.
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Scale: 11-point Likert scale (0 points: Very low–10 points: Extremely good)

Variable	Operational Definition	Measurement Item
		1. Ability to implement product ideas in a timely manner
		2. Ability to develop products in a timely manner
		3. Ability to introduce products to the market in a timely manner
		 Ability to improve products tailored to demographically different markets
		 Ability to create new products tailored to demographically different markets
Technology	Various activities and processes that create added	6. Ability to improve products tailored to regionally different markets
capabilities	and application of developed technologies	7. Ability to create new products tailored to regionally different markets
		8. Ability to acquire technology to improve existing products
		9. Ability to integrate technology to improve existing products
		10. Ability to acquire technology to create new products
		11. Ability to integrate technology to create new products
Source: Seok, Han, an Scale: 11-point Liker	nd Kim [<mark>166]</mark> t scale (0 points: Very low–10 points: Extremely goo	d)
		1. Prioritization of high levels of service for customers regardless of price
		2. Securing of technology superior to competitors
		3. Securing of service model superior to competitors
		4. Supplying products at least one level higher than the current level
Sustainable competitive	Securing competitive advantages while determining whether the firm can maintain a lead	5. Supplying services at least one level higher than the current level
advantage	on competitors	6. More investments in marketing activities (advertising) than competitors
		7. More investments in marketing activities (promotion) than competitors
		8. Focus on brand awareness of products or services
Source: Lee and Park Scale: 11-point Liker	: [168] t scale (0 points: Very low–10 points: Extremely goo	d)
		1. Achievement of internal management goals in market structure in the last three years (2015–2017)
		2. Achievement of internal cost reduction goals in market structure in the last three years (2015–2017)
		3. Implementation of internal business innovation programs in market structure in the last three years (2015-2017)
Business	Performance contributed to individuals/departments/the entire organization	4. Improvement of internal competitiveness in the market in the last three years (2015–2017)
Performance	within a firm	5. Sales achieved in the last three years (2015–2017)
		6. Sales profit in the last three years (2015–2017)
		7. Operating profit achieved in the last three years (2015–2017)
		8. Net profit achieved in the last three years (2015–2017)
Source: Kim and Jun Scale: 11-point Liker	g [169], Han, Seok, and Kim [170] t scale (0 points: Extremely low–10 points: Extremel	y high)

Table 2. Cont.

4. Empirical Analysis

4.1. Reliability and Validity

We used the Cronbach's alpha coefficient for the reliability analysis of this study and conducted factor analysis through orthogonal factor rotation (Varimax) using the exploratory factor analysis

method. Tables 3 and 4 summarize the analysis results of all variables composed of knowledge management, quality management, competitive intelligence, technology commercialization capabilities, sustainable competitive advantage, and business performance. Based on the analysis, the alpha coefficient of all variables showed a minimum of 0.939 and a maximum of 0.971, indicating high reliability. Moreover, the loading of each factor ranged from 0.528 to 0.840, verifying the validity.

Variable	Measurement Item	Factor Loading	Eigenvalue	Variance (%)	Reliability (α)	
	Knowledge management 1	0.753				
	Knowledge management 2	0.653				
Knowledge	Knowledge management 3	0.778				
management activities	Knowledge management 4	0.66	5.637	22.547	0.939	
management activities	Knowledge management 5	0.714				
	Knowledge management 6	0.528				
	Knowledge management 7	0.689				
	Quality management 1	0.718				
	Quality management 2	0.736				
	Quality management 3	0.759	9.063			
Quality management	Quality management 4	0.723		26 252	0.054	
activities	Quality management 5	0.76		30.232	0.950	
	Quality management 6	0.761				
	Quality management 7	0.75				
	Quality management 8	0.724				
	Competitive intelligence 1	0.756				
	Competitive intelligence 2	0.711				
	Competitive intelligence 3	0.739				
	Competitive intelligence 4	0.665				
Competitive	Competitive intelligence 5	0.666	3 552	14 207	0.030	
intelligence activities	Competitive intelligence 6	0.792	5.552	14.207	0.939	
	Competitive intelligence 7	0.8				
	Competitive intelligence 8	0.582				
	Competitive intelligence 9	petitive intelligence 9 0.663				
	Competitive intelligence 10	0.649				

Table 3. Reliability and exploratory factor analysis (independent variables).

Table 1. Renability and exploratory factor analysis (parameters and dependent variables)

Variable	Measurement Item	Factor Load	Eigenvalue	Variance (%)	Reliability (α)
	Technology commercialization 1	0.781			
	Technology commercialization 2	0.746			
	Technology commercialization 3	0.774			
	Technology commercialization 4	0.774			
Technology	Technology commercialization 5	0.785			
commercialization	Technology commercialization 6	0.716	8.547	31.656	0.971
capabilities	Technology commercialization 7	0.740			
	Technology commercialization 8	0.774			
	Technology commercialization 9	0.745			
	Technology commercialization 10	0.733			
	Technology commercialization 11	0.771			
	Competitive advantage 1	0.646			
	Competitive advantage 2	0.602			
Sustainable	Competitive advantage 3	0.687	5.567		0.945
competitive	Competitive advantage 4	0.628		20.620	
advantage	Competitive advantage 5	0.661			
ud vulluge	Competitive advantage 6	0.716			
	Competitive advantage 7	0.721			
	Competitive advantage 8	0.658			
	Business performance 1	0.739			
	Business performance 2	0.689			
	Business performance 3	0.607			
Business	Business performance 4	0.652	6 400	24.028	0.056
performance	Business performance 5	0.820	0.490	24.036	0.930
	Business performance 6	0.819			
	Business performance 7	0.826			
	Business performance 8	0.840			

4.2. Confirmatory Factor Analysis

We conducted confirmatory factor analysis on all variables including knowledge management, quality management, competitive intelligence, technology commercialization capabilities, sustainable competitive advantage, and business performance. Table 5 shows the 'confirmatory factor analysis'

used in this study. According to the results, the factor loading (standardization coefficient) was 0.5 or more, and the composite construct reliability (CCR) was 0.7 or more. The fit index was confirmed to be $\chi^2 = 3384.072$ (df = 1240, χ^2 /df = 2.729, *p*-value = 0.000), Normed Fit Index (NFI) = 0.868, Comparative Fit Index (CFI) = 0.912, and Root Mean Square Error of Approximation (RMSEA) = 0.065. Therefore, the statistical values of all measurement models were considered appropriate for the structural equation model analysis [171].

Variable	Measurement Item	Standardization Factor	S.E.	C.R.	CCR
	Knowledge management 1	0.825	0.051	19.667	
	Knowledge management 2	0.808	0.041	25.893	
Knowledge	Knowledge management 3	0.865	0.047	20.339	
management	Knowledge management 4	0.825	0.050	19.187	0.778
activities	Knowledge management 5	0.794	0.047	19.349	
	Knowledge management 6	0.799	0.046	21.822	
	Knowledge management 7	0.863	-	Fixed	
	Quality management 1	0.826	0.037	21.513	
	Quality management 2	0.856	0.037	22.932	
0 11	Quality management 3	0.866	0.037	23.411	
Quality	Quality management 4	0.860	0.035	23.136	0.941
management	Quality management 5	0.854	0.042	22.817	0.841
activities	Quality management 6	0.859	0.042	23.047	
	Quality management 7	0.860	0.032	29.908	
	Quality management 8	0.902	-	Fixed	
	Competitive intelligence 1	0.800	0.046	19.512	
	Competitive intelligence 2	0.839	0.045	20.951	
	Competitive intelligence 3	0.824	0.047	20.442	
Commetities	Competitive intelligence 4	0.813	0.045	20.018	0.827
competitive	Competitive intelligence 5	0.636	0.051	14.204	
activition	Competitive intelligence 6	0.647	0.046	14.536	0.857
activities	Competitive intelligence 7	0.635	0.047	14.192	
	Competitive intelligence 8	0.850	0.045	21.378	
	Competitive intelligence 9	0.842	0.037	27.103	
	Competitive intelligence 10	0.830	-	Fixed	
	Technology commercialization 1	0.870	-	Fixed	
	Technology commercialization 2	0.885	0.040	25.693	
	Technology commercialization 3	0.881	0.040	25.381	
	Technology commercialization 4	0.888	0.038	25.842	
Technology	Technology commercialization 5	0.865	0.040	24.500	
commercializatio	n Technology commercialization 6	0.856	0.043	23.986	0.846
capabilities	Technology commercialization 7	0.864	0.042	24.434	
	Technology commercialization 8	0.860	0.040	24.239	
	Technology commercialization 9	0.830	0.042	22.621	
	Technology commercialization 10	0.863	0.041	24.367	
	Technology commercialization 11	0.857	0.042	24.031	
	Competitive advantage 1	0.809	-	Fixed	
	Competitive advantage 2	0.828	0.052	19.653	
Sustainable	Competitive advantage 3	0.831	0.053	19.761	
competitive	Competitive advantage 4	0.856	0.052	20.660	0 780
advantage	Competitive advantage 5	0.824	0.054	19.545	0.700
aaranuge	Competitive advantage 6	0.803	0.062	18.843	
	Competitive advantage 7	0.799	0.062	18.707	
	Competitive advantage 8	0.845	0.058	18.495	

Table 5. Confirmatory factor analysis.

Variable	Measurement Item	Standardization Factor	S.E.	C.R.	CCR
	Business performance 1	0.875	-	Fixed	
	Business performance 2	0.817	0.043	22.076	
	Business performance 3	0.826	0.045	22.444	
Business	Business performance 4	0.880	0.042	25.407	0.944
performance	Business performance 5	0.864	0.040	24.464	0.844
	Business performance 6	0.828	0.042	22.582	
	Business performance 7	0.866	0.041	24.633	
	Business performance 8	0.885	0.040	25.832	

Table 5. Cont.

Note: $\chi^2 = 3384.072$, df = 1240, *p*-value = 0.000, $\chi^2/df = 2.729$, NFI = 0.868, CFI = 0.912, RMSEA = 0.065.

4.3. Correlation Analysis

Table 6 shows the correlation analysis for this study. The correlation analysis showed significant correlation between knowledge management, quality management, competitive intelligence, technology commercialization capabilities, sustainable competitive advantage, and business performance at a level of p = 0.01.

Variable		01	02	03	04	05	06
Knowledge management	01	1	-	-	-	-	-
Quality management	02	0.801 **	1	-	-	-	-
Competitive intelligence	03	0.834 **	0.832 **	1	-	-	-
Technology commercialization	04	0.814 **	0.830 **	0.850 **	1	-	_
Competitive advantage	05	0.794 **	0.849 **	0.820 **	0.838 **	1	-
Business performance	06	0.768**	0.790 **	0.757 **	0.741 **	0.791 **	1
Mean		7.635	7.430	7.725	7.528	7.383	7.450
Standard Deviation (SE))	1.776	1.918	1.576	1.818	1.854	1.758

Table 6. Correlation analysis.

Note: * *p* < 0.05, ** *p* < 0.01. Note: Tolerance (min 0.133–max 0.262), VIF (min 3.820–max 7.522).

4.4. Structural Equation Model Analysis

We tested the hypotheses using structural equation model analysis; the results are as follows. First, quality management activities and competitive intelligence activities showed a statistically significant positive (+) effect on technology commercialization capabilities. However, knowledge management activities did not show a statistically significant effect on technology commercialization capabilities. Second, quality management, competitive intelligence, and technology commercialization capabilities showed a statistically significant positive (+) effect on sustainable competitive advantage while knowledge management activities did not have a statistically significant effect on sustainable competitive advantage. Third, sustainable competitive advantage showed a statistically significant positive (+) effect on business performance while knowledge management, quality management, and competitive intelligence activities and technology commercialization capabilities did not have a statistically significant positive (+) effect on business performance. Table 7 summarizes the results of the study.

Result Variables		Path		Path Coefficient	t	p	Hypothesis	Supported/Not Supported
	Knowledge management	\rightarrow	Technology commercialization	-0.039	-0.280	0.779	Hypothesis 1	Not supported
Technology commercialization	n Quality management	\rightarrow	Technology commercialization	0.345	2.843 **	0.004	Hypothesis 2	Supported
	Competitive intelligence	\rightarrow	Technology commercialization	0.631	8.676 **	0.000	Hypothesis 3	Supported
Competitive advantage	Knowledge management	\rightarrow	Competitive advantage	-0.277	-1.900	0.057	Hypothesis 4	Not supported
	Quality management	\rightarrow	Competitive advantage	0.591	4.479 **	0.000	Hypothesis 5	Supported
	Competitive intelligence	\rightarrow	Competitive advantage	0.320	3.657 **	0.000	Hypothesis 6	Supported
	Technology commercialization	\rightarrow	Competitive advantage	0.325	4.610 **	0.000	Hypothesis 7	Supported
	Knowledge management	\rightarrow	Business performance	0.320	1.831	0.067	Hypothesis 8	Not supported
	Quality management	\rightarrow	Business performance	0.079	0.469	0.639	Hypothesis 9	Not supported
Business	Competitive intelligence	\rightarrow	Business performance	0.085	0.784	0.433	Hypothesis 10	Not supported
performance	Technology	\rightarrow	Business performance	-0.081	-0.945	0.345	Hypothesis 11	Not supported
	Competitive advantage	\rightarrow	Business performance	0.484	4.862 **	0.000	Hypothesis 12	Supported

Table 7. Structural equation model analysis.

SMC (Squared Multiple Correlations) (R²)

Technology commercialization: 0.830 (83.0%), Competitive advantage: 0.855 (85.5%), Business performance 0.734 (73.4%)

 $\chi^2 = 3410.501$ (df = 1243, p = 0.000), χ^2 /df = 2.744 NFI = 0.867, CFI = 0.911, RMSEA = 0.065

Note: * *p* < 0.05, ** *p* < 0.01.

5. Conclusions

5.1. Summary of the Research

This study investigated the effects of sustainable management activities (knowledge management activities, quality management activities, and competitive intelligence activities) on technology commercialization capabilities, sustainable competitive advantage, and business performance. In addition, this study examined the effects of technology commercialization capabilities on sustainable competitive advantage and business performance. We also examined the effects of sustainable competitive advantage on business performance. We surveyed global firms for a total of 30 days from 1 October 2018 to 30 October 2018. We confined the survey's scope to members of the organizations at the level of team manager (or executives) or higher who were working in the R&D department. We surveyed a total of 409 firms: 159 in Korea, 100 in the United States, 100 in the United Kingdom, and 50 companies in South Africa. Based on the valid data collected on 409 firms, we performed a structural equation model analysis; the results are summarized as follows.

- ① Knowledge management activities did not have a statistically significant effect on technology commercialization capabilities. These findings did not support the results of Moorthy and Polley [64], SubbaNarasimha et al. [110], and Zheng et al. [109]. Thus, knowledge management-based R&D essentially helps the firm choose the correct path among uncertain and novel options [64]. However, because the firm's technical knowledge broadens as multiple directions of R&D are pursued by the organization's members, the firm may actually be at a disadvantage.
- ② Quality management activities showed a statistically significant positive (+) effect on technology commercialization capabilities. These findings supported the results of Gupta et al. [113] and Kannan and Tan [62]. Hence, quality-oriented activities lead to the continuous improvement of products (goods) and technological development. Moreover, firms perform scientific quality improvement activities to eventually improve process capabilities [62]. Improved process capabilities lead to the development of creative technology, which can generate future value for the firm [62].

- ③ Competitive intelligence activities showed a statistically significant positive (+) effect on technology commercialization capabilities. These findings supported the results of Aspinall [57] and Frishammar et al. [117]. In a dynamic environment, firms seize new opportunities and confront new threats as they focus on competitive intelligence activities [115]. Thus, while expanding their understanding of new changes in the environment through competitive intelligence activities, firms further enhance technology commercialization through continuous idea development and new product development [57,117].
- ④ Knowledge management activities did not have a statistically significant effect on sustainable competitive advantage. These findings did not support the research of Argote and Ingram [119] and Kearns and Lederer [63]. Thus, from the resource-based perspective that a firm's sustainable competitive advantage stems from its own knowledge resources, it is crucial to properly manage a firm's business resources on the global network [121]. However, knowledge is increasingly regarded as a source of competitive advantage for firms. This implies that the resulting knowledge resources may not act as a driving force to help secure other competitive advantages [122,123].
- ⑤ Quality management activities showed a statistically significant positive (+) effect on sustainable competitive advantage. These findings supported the research of Lakhal [31] and Naveh and Marcus [126]. That is, various factors of quality management, such as price/cost and delivery reliability, affect aspects of competitive advantage [31]. In other words, quality management is a method to improve competitiveness and can help promote the organization's flexibility [125]. Because quality management is being used as firms' everyday activities and a catalyst for change, it can lead to competitive advantages in management and operations [31].
- ⑥ Competitive intelligence activities showed a statistically significant positive (+) effect on sustainable competitive advantage. These findings supported the research of Bulger [58], Dishman and Calof [130], Heinrichs and Lim [127], and Hughes [128]. That is, competitive intelligence creates added value superior to new business development, market exploration, and strategic planning [130]. Previous literature has noted that competitive intelligence affects important decisions throughout the entire firm environment and is a key factor in securing and implementing competitive advantages [58].
- ⑦ Technology commercialization capabilities showed a statistically significant positive (+) effect on sustainable competitive advantage. These findings supported the research of Cooper [131], Hwang and Sung [136], Kaleka and Morgan [61], and Li and Liu [132]. That is, technology commercialization is a vital success factor for survival in a rapidly changing market environment [131]. This helps ensure that the appropriate technology is available in the market and can be quickly developed and launched. This further indicates that technological commercialization can increase the firm's competitiveness as well as its product life cycles [61,132].
- (8) Knowledge management activities did not have a statistically significant effect on business performance. These findings did not support the research of Barney [137], Seba and Rowley [65], Søderberg and Holden [139], and Zack et al. [140]. Thus, knowledge management activities such as knowledge acquisition, creation, sharing, and transfer play an important role in implementing superior management performance [138,139]. However, many global firms in the current era may face limitations in increasing business performance through profit, sales and market share if they possess only the necessary knowledge resources.
- ② Quality management activities did not have a statistically significant effect on business performance. These findings did not support the research of Curkovic et al. [149], Hendricks and Singhal [151], and Sankar [153]. That is, we infer that a considerable number of firms have introduced quality management in a state without a completely rooted quality management system. Consequently, it is likely that these firms did not achieve as high a level of business performance as expected. This indicates that there may be a number of areas that were not fully applied to product development, design, and production activities that the firm should

identify and comply with the customers' and stakeholders' demands and the applicable laws and regulations.

- ① Competitive intelligence activities did not have a statistically significant effect on business performance. These results did not support the research of Fehringer et al. [156] and Hill and Jones [60]. Thus, when a firm possesses clear insight and understanding of its external environment, it can effectively make decisions and establish strategies, thereby achieving a high level of competitive advantage [155]. However, competitive intelligence activities did not lead to improvements in business performance. Hence, a firm must support insight and understanding of the external environment to successfully operate. However, this indicates that for numerous global firms in the current era, it may be insufficient for a direct influence on business performance.
- ① Technology commercialization capabilities did not have a statistically significant effect on business performance. These findings did not support the research of Chen [135], Cooper [131], Ho et al. [159], Lichtenthaler and Ernst [160], and Wolff and Pett [161]. That is, by introducing new technologies, technology commercialization capabilities enable firms to effectively respond to customer needs and environmental changes [25,158]. However, while technology commercialization capabilities can be applied to knowledge related to new technologies and market trends, thus enhancing firm competitiveness, it may be difficult to directly improve business performance using technology commercialization.
- ② Sustainable competitive advantage showed a statistically significant positive (+) effect on business performance. These findings supported the research of Li et al. [103] and Matsuno and Mentzer [164]. Possessing a competitive advantage typically implies that a firm provides at least either lower prices, higher quality, superior reliability, or faster delivery compared to competitors. These capabilities increase the overall performance of the organization [164] and can directly improve sales and profitability [165].
- Competitive intelligence activities is the factor that effects technology commercialization capabilities the most. Such a research outcome suggests that companies have to prepare for their future in a systematic manner. Nowadays, we are facing a variety of movements that could trigger a shake-up of the competitive environment such as the commoditization of technology, changes in social values, elimination of trade barriers, and environmental disasters. They can be disasters for those who did not prepare for significant changes, but opportunities for those who did. Companies make reaction plans when changes occur, but they all tend to lay out similar strategies. This is a somewhat natural phenomenon, given that the situations that companies face are similar. However, there are always some companies that would act differently from others and demonstrate distinctive technology commercialization capabilities. It is not possible to build distinctive technology commercialization capabilities in a short time, which all companies are striving to attain. It is possible only for companies that have attained competitive intelligence activities through persistent preparation.
- Quality management activities is the factor that affects sustainable competitive advantage the most. Such a research outcome highlights product quality as a factor of sustainable competitive advantage in today's management. Moreover, targets for quality perception need to be set and measures to attain such targets planned and executed in a strategic manner at the management level beyond internal control. Managers need to take the lead in promoting quality improvement to make and execute such quality strategies. To do so, managers themselves must understand the importance of quality and quality strategies. Just like most other strategic management, a company may effectively become one with a sustainable competitive advantage when it comes to quality strategy if it can, first, choose a correct strategic direction; second, properly allocate resources and attain internal capabilities for executing strategies; third, systematically execute strategic programs; and, fourth, have an attitude of working passionately and efficiently.
- A sustainable competitive advantage is the factor that affects business performance the most. This research outcome shows that companies with such an advantage have a high standard

23 of 31

compared to other companies and outdo other companies in terms of profitability, market share, growth, and so on. Companies must learn and know ways to attain sustainable competitive advantage, in other words, ways to utilize core technology and resources strategically. To attain such advantage, companies need to correctly identify competitive elements that they have and utilize them effectively across the three stages of target, strategy, and infrastructure. However, companies do not have to have a competitive advantage across all competitive elements. In fact, it is impossible to maintain such advantage in all areas. Therefore, in this sense, companies need to first identify their distinctive elements and the relevant sustainable competitive advantage and determine a strategy to attain success accordingly.

5.2. Research Implications

We derived the following constructive implications from the results of this study. First, the importance of business organizations' strategic response capabilities lies in the visible contributions to sustainable competitive advantage and excellent profitability [172]. Therefore, in the business environment faced by the firm, R&D department managers (including marketing managers) must respond to uncertainties in products, manufacturing, and the market due to changes in the market and technology [173]. With increasing uncertainty, this implies that market response and perception capabilities are more important than ever when solidifying an organization's competitive advantage [172].

Second, among the tasks performed to gain insight into the uncertain social business environment, obtaining competitive information is of increasing importance [174]. Therefore, R&D department managers (including marketing managers) must be able to quickly access competitive intelligence within the organization [175]. Quick access to competitive intelligence enables firms to apply it in times of crisis, thus creating competitive advantages.

Third, for a firm to uncover and acquire competitive insights, R&D department managers (including marketing managers) must search for evidence related to the problems and situations they face, perform accurate analyses, and devise informed countermeasures [176]. In fact, scholars suggest that realizing competitive advantage in addition to excellent business performance requires R&D department managers (including marketing managers) to analyze the uncertain environment, gain related insights, and contribute to the overall development of strategies [177].

Fourth, R&D department managers (including marketing managers) must strategically use technology commercialization for internal operations as well as improving quality management, for example, by developing performance measurement indexes, management, and analysis [178]. To leverage technology commercialization, R&D department managers (including marketing managers) must acquire quality management and technology commercialization training indispensable for informed decision-making [179]. Furthermore, scholars suggest that firms should visualize their work processes through various marketing models to maintain competitiveness [180].

Fifth, sustainable management activity (knowledge management activities, quality management activities, and competitive intelligence activities) tools have been used to analyze the competitive environment and improve strategies and services [181]. This trend implies that the business environment leans more toward analysis as firms use competitive advantage tools, marketing decision models, and decision support technology [182]. Thus, the firm's enhanced management activities will help R&D department managers (and marketing department managers) in segmentation marketing (a marketing technique that diversifies products, services, and sales methods according to the customer base's tendencies) efforts, reducing future uncertainty.

5.3. Research Limitations and Future Research Directions

Although this study provides numerous constructive implications, it contains the following limitations. First, this study surveyed four countries, each on a different continent. However, it is somewhat difficult to generalize these global firms to each continent. Therefore, it is necessary to first examine global firms from a wider range of countries including China, Japan, Germany, and France and then examine the corresponding causal relationship.

Second, firms need strategic approaches to strengthen the capabilities of sustainable management activities (knowledge management, quality management, and competitive intelligence). Approximately 40% of the subjects in this study had a manufacturing-oriented business structure, which is a poor context for the creation of management activities. Global mid-sized and large firms typically form a structure that generates business performance based on their specific expertise and experience. Based on this, incentives are employed to strategically leverage management activities within the organization along with external knowledge. Therefore, this study has the limitation of an analysis of the causal relationships between technology commercialization capabilities, sustainable competitive advantage, and business performance according to the capabilities of the management activity subjects, regardless of firm size, sector, industry, or type of business.

Third, sustainable management activities (knowledge management, quality management, and competitive intelligence) require contracts to prevent the undesired spread of knowledge. Competitive knowledge workers can move to other companies at any time unless they own the firm. Furthermore, this tendency will accelerate in an individualistic society. Therefore, firms require strategies and incentives to retain these workers; future complex studies should reflect these various preceding factors through control variables.

Fourth, the validity of this study can be considered high as it surveyed team manager (or executive)-level employees or higher who were working in the R&D departments of mid-size and large global firms to examine execution-centered knowledge management, quality management, and competitive intelligence activities. However, to conduct a multidimensional analysis, future research should divide this classification into top executives, mid-level managers, and relevant expert groups.

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