Original Article

Current status and future prospects of research and development operations in traditional and complementary and alternative medicine manufacturing small- and medium-sized enterprises: a 2014 company-based survey

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\textbf{Abstract}

Background: Small- and medium-sized enterprises (SMEs) have played key roles in the economic growth and technical innovation of traditional and complementary and alternative medicine (T&CM). Research and development (R&D) are critical activities for industrial progress. This study aimed to characterize the current status of SME R&D activities and to explore manufacturers’ perceptions of R&D expansion.

Methods: Records of the distribution of T&CM SMEs and R&D resources detailed in the 2014 Statistics of Korea T&CM Industries survey, a previously conducted survey on the industrial status of the T&CM field, were reviewed. Data on the perceptions of R&D activities were investigated through a company-based survey covering 285 T&CM-manufacturing SMEs.

Results: Greater than 99% of the 13,636 T&CM manufacturers at the time of the study were SMEs employing less than 50 workers. Natural cosmetics manufacturing SMEs (NC SMEs) had the highest R&D expenditures. NC SMEs rely heavily on internal R&D operations, which may contribute to their strong need for R&D collaboration with public research institutions and expanded T&CM-promoted R&D programs. “Digestive system disorders” are the main target diseases for current herbal and dietary supplement manufacturing SMEs and herbal medicine manufacturing SMEs. These SMEs tend to view their own product-related business as a priority for future R&D investment.

Conclusion: This study represents the first attempt to assess SME perceptions of R&D activities. The findings herein can inform the design of sustainable programs that support R&D by reducing the gaps between the perspectives of T&CM product makers and policymakers.

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1. Introduction

Small- and medium-sized enterprises (SMEs) are the backbone of Korean industry. They are a vital source of jobs and comprise the primary driving force of technology development. Countries actively strive to nurture and support SMEs as engines for boosting their national economies. Because of the immense emphasis that has been placed on the health industry worldwide over the past 20 years, a diverse array of manufacturing-based SMEs has been established in South Korea, including businesses based on health foods, medicines, medical devices, and cosmetics. The industry of traditional medicine (TM) and complementary and alternative medicine (CAM) has markedly grown in conjunction with the recent shift toward patient-oriented care in medicine.

Research and development (R&D) is generally thought to be essential for organizational competition, innovation, and improvement. For firms to stay “alive” and remain competitive, they must innovate by implementing multidisciplinary technologies. However, because SMEs may not possess all the multidisciplinary technologies that are required to develop new products and often lack the resources for independent R&D investment, they tend to bolster their limited R&D resources with government-sponsored programs or interfirm R&D partnerships and collaborations. Using these approaches, SMEs must decide on the most efficient way to enhance their technologies, either through internal R&D activities or external R&D partnerships, particularly within the R&D cooperation framework. Internal R&D operations require extensive technical and scientific manpower and R&D infrastructure. In comparison, external R&D uses outside resources; thus, it can be an economical way to exchange knowledge, resources, and organizational learning. However, external R&D also carries potential disadvantages related to intellectual property rights.

Today, industries worldwide are faced with a new era of global competition, and manufacturers are forced to achieve world-class status to compete effectively in the global market. In recent years, Korean firms have tended to engage in high level R&D activity. In particular, small firms have been actively increasing their R&D expenditures. According to data from a survey of Korean SMEs in biotechnology, government R&D support was closely associated with the SMEs’ R&D activities. The scale of the traditional and complementary and alternative medicine (T&CM) industry is much smaller, and its infrastructure is even less developed, than that of the biotechnology industry. Furthermore, government T&CM funding sources are limited.

To gain a better understanding of the current status of R&D and assess the perceptions of SMEs regarding R&D expansion, the present study conducted a survey of 285 T&CM manufacturers in South Korea. We explored differences in the performance and R&D investments of the SMEs and assessed their employees’ perceptions regarding specific factors essential for R&D expansion. The results of the present study help to shape the current understanding of R&D performance among Korean T&CM manufacturers, and offer important implications for policymakers interested in the sustainable growth of the T&CM industry.

2. Methods

2.1. Data sources

The data on the number of employees and the R&D resources of the domestic T&CM enterprises were collected from the 2014 National Statistics of Korea T&CM Industries survey, which was conducted by our institute, the Korea Institute of Oriental Medicine. The statistical data covered all domestic T&CM enterprises. The data quality was approved by Statistics Korea. The data on SME R&D, the diseases targeted by T&CM products, and prospective T&CM businesses were collected from a series of questionnaires administered during our study.

2.2. Questionnaire

A company-based survey was conducted using a semistructured questionnaire with two main sections. The first section of the questionnaire asked the participants to characterize R&D in their firm (e.g., the presence of an internal R&D department, the amount of R&D resources, the target diseases of their products). The second section assessed the respondents’ perceptions about their own T&CM products as well as R&D expansion (e.g., the future growth of the T&CM business and the government support needed for R&D expansion). We consulted an expert panel to establish the content validity of our survey. A draft of the questionnaire was pilot-tested with relevant stakeholders until each domain was completely described via adjustments based on our panel’s recommendations. Prior to conducting the survey, we confirmed that the questions were clear, understandable, and presented in logical order. For example, for the question regarding the potential target diseases of currently manufactured products, the disease-related answer choices were originally cited from the International Classification of Diseases and Related Health Problems, 10th Revision (ICD-10). The disease-related terminology was adjusted to include more understandable terms according to the panel’s recommendations. One example is the use of “infectious disease” rather than “certain infectious and parasitic diseases, ” which is used in the ICD-10. In addition, certain symptoms that were difficult for laypersons to classify, or that resulted from multiple lesions (e.g., liver disease, pain, brain/nervous systems disorders), were added to the questionnaire as a result of the pilot test. To collect accurate data, certain questions had multiple answer choices.

2.3. Participants

The questionnaire was administered by the FROMM Research Company (http://www.frr.kr), one of the largest third-party survey research providers in South Korea. We designed the survey to include a target sample of SMEs, which included SMEs with less than 50 workers, by applying proportional quota sampling. Eligibility was limited to company representatives or individuals in equivalent positions. The participants received an email with our questionnaire and a letter of invitation in January 2014. The individuals who were willing to participate in the survey provided informed consent. After the
survey was completed, the respondents’ replies were sent to us via mail or fax. A total of 1000 T&CM-manufacturing SMEs were randomly selected from our inventory of Korean T&CM companies to be part of the study sample. Of these, 285 companies (response rate = 28.5%) participated in the survey and were included in the final analyses.

2.4. Definitions

2.4.1. Small- and medium-sized enterprises

Different countries adopt diverse criteria for defining SMEs. In the United States, the Small Business Administration sets small business criteria based on industry, ownership structure, revenue, and number of employees (which can be as high as 1500 in some circumstances, although the cap is typically set at 500). In Europe, the following three parameters are used for defining SMEs: (1) microenterprises can hire up to 10 employees, and their annual turnover or annual balance sheet total cannot exceed €2 million; (2) small enterprises can hire up to 50 employees, and their annual turnover or annual balance sheet total cannot exceed €10 million; and (3) medium-sized enterprises can hire up to 250 employees, and they can have either an annual turnover not exceeding €50 million or an annual balance sheet total not exceeding €43 million. In general, South Korea defines a small business as having less than 50 employees and an SME as having 50 to 300 employees. In this study, T&CM-manufacturing SMEs were defined as businesses with less than 50 employees because T&CM companies are much smaller in size than those of other major sectors in South Korea, and 13,586 of 13,636 T&CM-manufacturing companies in South Korea (99.6%) have less than 50 employees. Furthermore, 97.7% of T&CM-manufacturing companies in South Korea have fewer than 10 employees (Table 1). Thus, we lowered our employee limit to enable the exploration of detailed characteristics. In addition, large T&CM enterprises often produce non-T&CM products. For example, Yuyu Pham Inc. Seoul, which employed 287 workers in 2013, manufactures both traditional and conventional medicines.

2.4.2. T&CM-manufacturing SMEs

The T&CM-manufacturing SMEs included herbal and dietary supplement manufacturing (HDS), herbal medicine manufacturing (HM), T&CM-related medical device manufacturing (MD), and natural cosmetics-manufacturing (NC) SMEs. Because there is currently no clear definition of HDS, the concept was cited from the United States National Health Interview Survey. The term “herbal medicines” describes a range of pharmaceutical-type preparations (e.g., botanical and plant-derived drugs) and homeopathic remedies that have been approved by the South Korean Ministry of Food and Drug Safety (formerly the Korea FDA). Herbal medicines may contain a mixture of natural plant-derived and synthetic or semisynthetic substances. SMEs were classified according to the Korea Health Industry Statistics System, which was developed by the Korea Health Industry Development Institute, and the ninth revision of the Korean Standard Industrial Classification (KSIC-9), which was developed by Statistics Korea, with modifications. Briefly, the HDS SMEs (KSIC-9 code 21000) included SMEs that produce pharmaceuticals, medicinal chemicals, and botanical products using any type of herbal substance as a core active substance. This category included manufacturers that produce either Korean traditional or Western herbal medicines. The MD SMEs (KSIC-9 code 27100) included SMEs that produce instruments, apparatuses, or similar products intended for diagnosing, preventing, or treating diseases based on T&CM knowledge and principles. The natural cosmetics manufacturing SMEs (NC SMEs; KSIC-9 code 20433) included SMEs that produce cosmetics or personal skin care products using plant-derived ingredients.

3. Results

3.1. Distribution of domestic T&CM enterprises and their R&D expenditures

According to the 2014 National Statistics of Korea T&CM Industries survey, the total number of T&CM product-manufacturing firms was estimated to be 13,636 in 2014, and SMEs accounted for more than 99% of this total number of firms. The proportion of firms that employed less than five workers was 95.9%. With respect to T&CM products, the majority of the SMEs produced HDS, followed by HM, NC, and MD. The NC firms had the highest percentage of large enterprises while accounting for less than 1% of all the T&CM firms (Table 1). The T&CM SMEs employed fewer R&D researchers than the T&CM large enterprises. The HDS firms that belonged to the large enterprises group employed 8.9 researchers on average, the highest average of the T&CM firms. The mean number of researchers employed by the T&CM SMEs ranged from 2.9 to 5.9, whereas the mean number of researchers employed by the T&CM large enterprises ranged from 6.0 to 8.9. Among the SMEs, the ratio of R&D investment to sales was the highest in the NC firms (24.5%), followed by 11.6% in the HDS firms, 10.5% in the MD firms, and 6.6% in the HM firms. The NC SMEs also invested US$861,000 annually, which was the largest R&D expenditure of the T&CM firms. In the large enterprises, the ratio of R&D investment to total sales did not correspond to their actual R&D costs. HDS manufacturing large enterprises invested approximately US$3 million, the largest amount reported, but their ratio of R&D investment to total sales was the lowest of the groups studied (4.1%) (Table 2).

3.2. Characterization of R&D in T&CM SMEs: a company-based survey

The survey asked the participants about the R&D operations for improving the T&CM products at their SME. These R&D operations were classified into three types: internal R&D only, external R&D only, and combined R&D (internal and external R&D). The majority of SMEs performed internal R&D, including 93.3% of the HDS SMEs, 67.6% of the HM SMEs, 90.9% of the MD SMEs, and 89.5% of the NC SMEs. Of these, the HM SMEs had actively collaborated on R&D operations with other firms or institutes (20.9%). Except for the proportion of the NC SMEs that performed external R&D activities (5.25%), the application

marily from plant-derived materials. The HM SMEs (KSIC-9 code 21000) included SMEs that produce pharmaceuticals, medicinal chemicals, and botanical products using any type of herbal substance as a core active substance. This category included manufacturers that produce either Korean traditional or Western herbal medicines. The MD SMEs (KSIC-9 code 27100) included SMEs that produce instruments, apparatuses, or similar products intended for diagnosing, preventing, or treating diseases based on T&CM knowledge and principles. The natural cosmetics manufacturing SMEs (NC SMEs; KSIC-9 code 20433) included SMEs that produce cosmetics or personal skin care products using plant-derived ingredients.
Table 1 – Distribution of T&CM manufacturing SMEs by number of employees.

| T&CM firms     | Total       | SME sum | Less than 5 | 5–9 | 10–19 | 20–49 | Large enterprises (greater than 50) |
|----------------|-------------|---------|-------------|-----|-------|-------|-------------------------------------|
| Total (% of T&CM firms) | 13,636       | 13,586 (99.6) | 13,080 (93.9) | 254 (1.9) | 144 (1.0) | 108 (0.8) | 50 (0.4) |
| HDS firms (% of HDS firms) | 13,356       | 13,326 (99.8) | 12,972 (97.1) | 182 (1.4) | 103 (0.8) | 69 (0.5) | 30 (0.2) |
| HM firms (% of HM firms) | 148         | 136 (91.8) | 61 (41.2) | 37 (25.0) | 15 (10.1) | 23 (15.5) | 12 (8.2) |
| MD firms (% of MD firms) | 65          | 63 (96.9) | 23 (35.4) | 21 (32.3) | 12 (18.5) | 7 (10.7) | 2 (3.1) |
| NC firms (% of NC firms) | 67          | 61 (91.0) | 24 (35.8) | 14 (20.9) | 14 (20.9) | 9 (13.4) | 6 (9.0) |

The values are presented as the number (percentage) of T&CM companies located in South Korea. In this study, SMEs represent manufacturers employing less than 50 workers. Large enterprises represent manufacturers employing greater than 50 workers. The shaded column includes the sum of the SMEs that employed less than 50 workers. The numbers in parentheses represent the percentage versus total firms in each group.

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HDS firms, herbal and dietary supplement manufacturing firms; HM firms, herbal medicine manufacturing firms; MD firms, T&CM-related medical device manufacturing firms; NC firms, natural cosmetics manufacturing firms; SMEs, small- and medium-sized enterprises; T&CM, traditional and complementary and alternative medicine.

Table 2 – Comparison of R&D resources of T&CM SMEs and large enterprises.

|                      | SMEs                      | Large enterprises | SMEs | Large enterprises |
|----------------------|---------------------------|-------------------|------|-------------------|
|                      | HDS | HM | MD | NC | HDS | HM | MD | NC |
| Ratio of researchers to total workers (Researcher/worker, %) | 7.0% | 12.8% | 21.9% | 28.9% | 10.2% | 3.9% | 4.8% | 1.7% |
| Average no. of researchers per firm | 2.9 | 3.2 | 4.0 | 5.9 | 8.9 | 8.5 | 6.0 | 6.0 |
| Ratio of annual private R&D investment (R&D cost/total sales, %) | 11.6% | 6.6% | 10.5% | 24.5% | 4.1% | 6.3% | 6.0% | 15.0% |
| Annual average R&D costs per firm (US$, thousand) | $341 | $218 | $312 | $861 | $3002 | $713 | $1,663 | $3132 |

These figures exclude the firms that did not perform R&D. In this study, SMEs represent manufacturers employing fewer than 50 workers. Large enterprises represent manufacturers employing greater than 50 workers.

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HDS firms, herbal and dietary supplement manufacturing firms; HM firms, herbal medicine manufacturing firms; MD firms, T&CM-related medical device manufacturing firms; NC firms, natural cosmetics manufacturing firms; SMEs, small- and medium-sized enterprises; T&CM, traditional and complementary and alternative medicine.

Fig. 1 – Current R&D modes in T&CM SMEs. SMEs represent manufacturers employing less than 50 workers. HDS SMEs, herbal and dietary supplement manufacturing SMEs; HM SMEs, herbal medicine manufacturing SMEs; MD SME, T&CM-related medical device manufacturing SMEs; NC SMEs, and natural cosmetics manufacturing SMEs; R&D, research and development; SMEs, small- and medium-sized enterprises; T&CM, traditional and complementary and alternative medicine.
of “external only” R&D was relatively low overall: 0.7% of the HDS SMEs, 1.5% of the HM SMEs, and none of the MD SMEs performed “external only” R&D activities (Fig. 1). The participants were also asked whether their SME had a separate R&D department within their organization. Of the 20 NC SMEs, 19 firms (95.0%) indicated that they had a separate R&D department. In comparison, of the 178 HNC SMEs, only 88 firms (49.5%) had a separate R&D department (Fig. S1).

3.3. Effectiveness of the SMEs’ own T&CM products against their target disease

Fig. 2 shows the target diseases of the SME products, either currently on the market or under development, that were recognized by the participants. “Digestive system disorders” accounted for the greatest proportion of responses among both the HDS (25.8%) and HM SME participants (37.3%). However, the second most commonly identified target disease differed among the groups. The HDS SME participants selected “heart diseases” (18.5%), whereas the HM SME participants selected “respiratory diseases” (28.0%). From a disease-related industry perspective, it was fitting that the NC SME participants perceived “dermatitis/wounds” as a critical target disease. Medical devices have a wider range of applications to patients than cosmetics, which can only be applied to the skin. However, it was unexpected that half of the MD SME participants selected “pain” as a target disease.

3.4. Promising T&CM businesses or industries for R&D investment

The survey asked the participants about worthwhile R&D investments for the future. As shown in Table 3, the majority of the participants working at HDS SMEs responded “health functional foods” (45.9%), followed by “pharmaceutical products” (18.8%) and “convergence products” (6.8%). In the present study, “convergence products” refers to a new category of T&CM products created by merging existing T&CM products into different types of technologies. The majority of participants working at HM and NC SMEs indicated that “pharmaceutical products” were useful R&D investments (47.1% and 51.9%, respectively). The R&D investments most commonly selected by the MD SME participants were “healthcare services” (35.8%) and “medical appliances” (30.8%). In this study, healthcare services were defined as businesses that provide: (1) inpatient or outpatient testing or treatment of human diseases and/or (2) drugs or medical devices to treat human diseases.10 On average, more than 10% of the participants chose not to answer the R&D investment question (“none” = 13.8%), which may imply their pessimistic view of T&CM R&D investments.

3.5. Government support for sustainable R&D promotion

The participants’ responses to questions regarding the use of government or public research institutions (PRIs) to promote sustainable R&D development are summarized in Table 4. Regardless of the type of T&CM firm, the participants preferred receiving infrastructural support in the form of equipment to receiving technical or knowledge information support from PRIs. SMEs predominantly wanted the government to increase both the number of national R&D projects and research funding. The proportion of NC firm participants who wanted government increases in R&D was particularly high (60.0%). As for technical support, the participants indicated a preference for R&D collaboration with PRIs (32.6% of the HDS SMEs, 46.7% of the HM SMEs, 25.0% of the MD SMEs, and 45.0% of the NC SMEs) over technology transfer from PRIs (16.9% of the HDS SMEs, 28.0% of the HM SMEs, 8.3% of the MD SMEs, and 10.0% of the NC SMEs).

4. Discussion

4.1. Current SME R&D situation

In South Korea, SMEs account for 99.9% of Korean enterprises and provide 87.7% of the country’s total employment. However, similar to those in other countries, many South Korean SMEs are microenterprises employing up to four people (85.5% in 2006). Although the classification criteria for SMEs (less than 50 workers) and large enterprises (greater than 50 workers) in our study differed from that described above, our T&CM manufacturers tended to have a relatively low percentage of researchers. In 2010, the percentage of researchers employed by Korean manufacturers with less than 99 employees was reported to be 23.9%. This percentage steeply decreased to 12.2% in companies employing 100 to 299 workers. Among T&CM manufacturers, the percentage of researchers was 7.0% in the HDS SMEs, 12.8% in the HM SMEs, 21.9% in the MD SMEs, and 28.9% in the NC SMEs. Industrial and commercial organizations require a relatively large number of researchers who work in teams to identify and solve complex problems. Therefore, the small proportion of researchers in T&CM companies is likely to limit their ability to promote business expansion.

4.2. Current T&CM R&D situation

Because most SMEs have insufficient R&D funds, lack the latest science and technology information, and have difficulties employing qualified researchers, their ability to quickly find R&D supportive partners is critically important. A number of studies have evaluated outcomes according to the use of internal or external R&D as well as the factors that influence a company’s decision to engage in this manner. Nakamura and Odagiri19 use the terms “in-house R&D” and “procured R&D” to explain the determinants of a firm’s choice between performing internal and external R&D. They refer to in-house R&D as the firm’s initiation and fulfillment of a research project internally. In contrast, they refer to procured R&D as being procured from outside the firm. Procured R&D can be further classified as commissioned R&D, joint R&D, or technology acquisition (i.e., licensing-in).19 As shown in Fig. 1, we found that the majority of the T&CM SMEs in the present study relied heavily on internal R&D (93.3% of the HDS SMEs, 67.6% of the HM SMEs, 90.9% of the MD SMEs, and 89.5% of the NC SMEs). With the exception of the HM SMEs, external or combined R&D accounted for at most 10% of the SMEs’ R&D expenditures.
Fig. 2 – Potential target diseases of currently manufactured products. Disease categories are based on the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10), with modifications (World Health Organization, 1992). The Roman numerals in parentheses indicate the relevant ICD-10 codes.

The term “Malignancies” was denoted as “anticancer drug” on the Korean version of the questionnaire.

HDS, herbal and dietary supplement; HM, herbal medicine; MD, T&CM-related medical device; NC, natural cosmetics; SMEs, small- and medium-sized enterprises; T&CM, traditional and complementary and alternative medicine.

Table 3 – Promising T&CM products and businesses for R&D investment.

| Total (percentage) | HDS SMEs (percentage) | HM SMEs (percentage) | MD SMEs (percentage) | NC SMEs (percentage) |
|--------------------|------------------------|----------------------|----------------------|----------------------|
| Pharmaceutical products | 101 (28.9) | 39 (18.8) | 48 (47.1) | 0 (0) | 14 (51.9) |
| Medical appliances | 13 (3.7) | 6 (2.9) | 3 (2.9) | 0 (0) | 4 (30.8) |
| Health functional foods | 125 (35.8) | 95 (25.9) | 28 (27.5) | 1 (7.7) | 1 (3.7) |
| Convergence products* | 34 (9.7) | 14 (6.8) | 11 (10.8) | 1 (7.7) | 8 (29.6) |
| Healthcare services† | 22 (6.3) | 8 (3.9) | 6 (5.9) | 5 (38.5) | 3 (11.1) |
| Others | 6 (1.7) | 6 (2.9) | 0 (0) | 0 (0) | 0 (0) |
| None‡ | 48 (13.8) | 39 (18.8) | 6 (5.9) | 2 (15.4) | 1 (3.7) |

The values are presented as the number (percentage) of participant SMEs. The questions allowed for multiple answers.

HDS firms, herbal and dietary supplement manufacturing firms; HM firms, herbal medicine manufacturing firms; MD firms, T&CM-related medical device manufacturing firms; NC firms, natural cosmetics manufacturing firms; R&D, research and development; SMEs, small- and medium-sized enterprises; T&CM, traditional and complementary and alternative medicine.

* “Convergence products” in this context refers to a new class of T&CM products created by merging existing T&CM products into different types of technologies.

† “Healthcare services” refers to businesses that provide inpatient or outpatient testing or treat human diseases and dispense drugs or medical devices for treating human diseases. This definition is taken from TheFreeDictionary (http://www.thefreedictionary.com/).

‡ “None” refers to both nonresponse and negative responses to the question.

TM is highly prevalent in South Korea. In a 2011 survey, 66.6% of the respondents indicated that traditional Korean medicine is reliable. Additionally, 69.3% of the respondents had visited TM clinics at least once in the previous 12 months. Patients suffering from musculoskeletal diseases (e.g., back pain and sprains) most frequently visited TM clinics. Regardless of this trend, digestive system disorders were the most common potential disease targets for the products manufactured by the HDS and HM SMEs. Priority may have been given to the digestive system because majority of the products manufactured by the HDS and HM SMEs are administered by oral ingestion. In addition, they can be generally purchased without a prescription at local retail stores or pharmacies, and do not depend on T&CM clinic utilization patterns or insurance claim-based disease frequencies. Acupuncture, the most well-known T&CM therapy, is commonly used worldwide to relieve pain. Various physical therapy-assisting devices similar to acupuncture needles have been developed and applied for the treatment of pain management. Seven major medical devices were developed in 2012, including mox-
ibution devices, acupuncture needles, low-frequency electric stimulators, cupping machines, lancets, blood pressure pulse analyzers, and skin resistance measuring devices (arranged in production order). Five of these devices are used for pain relief in T&CM clinics. Thus, it was reasonable for the MD SMEs to indicate “pain” as the primary target disease of their products (Fig. 1).

4.3. Desirable T&CM R&D strategies

Searching for promising novel products and identifying businesses that show potential are very promising entrepreneurial activities. Prior to launching new R&D projects, a firm should strongly weigh businesses that lead to high profits and benefits within the framework of its resources in terms of funding, staffing, training, and skills. Because business transformation (i.e., making a fundamental change in business products or services) is risky, costly, and may require restructuring, it is not a commonly employed strategy, particularly in small companies. Instead, the SMEs favored business expansion with identical or similar lines of products or services. As shown in Table 3, the respondents strongly regarded business related to their own sector as the most promising focus for R&D investment. The most promising prospective businesses or products indicated were: pharmaceutical products by the HM SMEs (47.1%), medical appliances by the MD SMEs (30.8%), and health functional foods by the HDS SMEs (45.9%). However, the NC SMEs showed a great interest in pharmaceutical products (51.9%). The beauty industry has often used the term “cosmeceutical,” which is a combination of the terms “cosmetics” and “pharmaceutical.” The hybrid word was first introduced in 1984 in reference to substances that exerted both cosmetic and therapeutic benefits. Currently, this term is frequently used to emphasize the effects of medicinal products, such as antiaging creams and sunscreens, on aesthetics. It was thus presumed that the T&CM NC SMEs reflected this evolving trend toward the medical field as a considerable opportunity.

Because internal R&D is limited by high costs, slow results, and lack of infrastructure, SMEs are expected to recognize a robust need for R&D collaboration with PRIs and the expansion of T&CM R&D-promoting programs (Table 4). Our survey found various R&D investment/total sales ratios, ranging from 6.6% to 24.5%. Only the ratio of the NC SMEs was slightly greater than the average ratio (Table 2). Korean T&CM cosmetics, commonly known as hanbang cosmetics, are one of the most represented cosmetics items on the global market. These products for improving skin conditions are scientifically formulated with multiple herbs based on traditional Korean herbal medicine, which ensures the synergistic efficacy and safety of the products. Hanbang cosmetics have contributed to Asia becoming a hub for cosmetics innovation, and they are quickly becoming a role model for the global cosmetics industry. A high level of R&D investment likely played a key role in establishing these SMEs as leading companies producing world-class cosmetics. The 21st century has ushered in a widespread trend toward healthy lifestyles and the use of natural products worldwide. People increasingly rely on T&CM in addition to conventional medicine. Moreover, the United States, Europe, China, Japan, and Korea have aging societies. The elderly populations in these countries prefer to utilize T&CM to improve their health and treat chronic diseases. Market globalization has accelerated the development of new products, and technological developments are taking place at a swift pace. It is advantageous for small businesses to quickly respond to the rapidly changing demands of consumers. R&D is the most powerful means by which companies can prepare for unpredictable future demands. Thus, this study is significant because it is the first study to address the current R&D status of Korean SMEs and assess manufacturers’ perceptions of R&D in T&CM.

Table 4 – Government or PRI support needed for sustainable R&D promotion in SMEs.

| Type of support                      | Total HDS SMEs (178) | HM SMEs (75) | MD SMEs (12) | NC SMEs (20) |
|--------------------------------------|----------------------|-------------|-------------|-------------|
| Technical support                    |                      |             |             |             |
| Troubleshooting and consultation on  | 72 (22.5)            | 23 (30.7)   | 4 (33.3)    | 5 (25.0)    |
| technical difficulties               | 40                    | 30          | 18          |             |
| Technology transfer from PRIs        | 54 (16.9)            | 21 (28.0)   | 1 (8.3)     | 2 (10.0)    |
| and collaboration with PRIs         | 105 (32.6)           | 35 (46.7)   | 3 (25.0)    | 9 (45.0)    |
| Knowledge-information support        |                      |             |             |             |
| Provision of state-of-the-art S&T information | 82 (27.0) | 36 (48.0) | 2 (16.7) | 7 (35.0) |
| Provision of business assistance programs | 80 (27.0) | 35 (46.7) | 3 (25.0) | 5 (25.0) |
| Network organization between SMEs and PRIs | 90 (28.3) | 36 (48.0) | 3 (25.0) | 6 (30.0) |
| Infrastructural support              |                      |             |             |             |
| Utilization of research equipment within PRIs | 101 (31.5) | 33 (44.0) | 3 (25.0) | 9 (45.0) |
| Utilization of PRI laboratories and facilities | 91 (27.0) | 35 (46.7) | 3 (25.0) | 5 (25.0) |
| Expansion of national projects and funds | 108 (33.1) | 33 (44.0) | 4 (33.3) | 12 (60.0) |
| that promote T&CM R&D investment     |                      |             |             |             |

The values are presented as the number (percentage) of participant SMEs. The questions allowed for multiple answers. HDS firms, herbal and dietary supplement manufacturing firms; HM firms, herbal medicine manufacturing firms; MD firms, T&CM-related medical device manufacturing firms; NC firms, natural cosmetics manufacturing firms; PRI, public research institution; R&D, research and development; S&T, science and technology; SMEs, small- and medium-sized enterprises; T&CM, traditional and complementary and alternative medicine.

4.4. Study limitations

The present study has several limitations. First, the questionnaire response rate (28.5%) was low, which may be attributed to the survey method used. To ensure data credibility, we only included company representatives or individuals who were in equivalent positions. This approach may have also reduced
the response rate because it decreased the number of individuals who were eligible to participate. In addition, many of the representatives may have been reluctant to disclose their perceptions of their employers, despite the assurance of anonymity. Additionally, our data collection was carried out via mail and fax. Postal surveys typically have lower response rates (approximately 20%) than other types of surveys. Second, the SMEs varied in size as a result of the low response rate. Stratified samples were randomly selected based on Neyman’s allocation method, but we were unable to recruit the envisioned sample sizes. Third, the survey was T&CM manufacturer based; therefore, our findings may not be representative of the general T&CM enterprise population.

Fourth, our results may have been affected by selection bias. We were unable to distinguish certain SMEs straddling two or more business groups. If the SMEs dealt with HDS and HM, or HM and NC, we sorted them into one of the two groups based on their sales volume and flagship product.

In conclusion, SMEs are the main businesses through which innovation and technology development are currently pursued. Businesses must train their workers more proficiently and invest more in R&D than ever before. Our study aimed to analyze the current R&D activities of T&CM SMEs and assess the promising types of R&D investments recognized by them. Of the respondents, the NC SMEs were the most actively invested in private R&D budgets. Additionally, we found that all the assessed SMEs prioritized their own products in terms of future R&D investment. Our findings are valuable because SMEs are engines for industrial development, and R&D is a key component of technical innovation in T&CM. The results of the present study can be used to design sustainable programs that support T&CM R&D by diminishing gaps in the perspectives of T&CM manufacturers and policymakers.

Conflicts of interests

The authors have no competing interests to declare.

Authors’ contributions

MA and EJP participated in the study design, data analysis, interpretation, and drafting of the article. SK, SH, and KHK contributed to the data analysis and manuscript writing. JMWW participated in editing the article and reviewing the manuscript. All of the authors read and approved the final manuscript.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.imr.2017.08.006.

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