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Comparative Study of Technological Trend between DAIKIN and Panasonic in the Field of Air Conditioner

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Abstract--This research focuses on patent applications filled in Japan, in the business field of air conditioner for home use. In spite of the saturated Japanese market, only two companies, DAIKIN INDUSTRIES, LTD and Panasonic Corporation, have been increasing domestic market share of air conditioner in recent years. In this study, we visualized technical purposes as a system diagram. We made a comparative evaluation on the difference of technical strength of these two companies. Moreover, we evaluated the correlations between the number of patent applications of each company and the score of consumer needs collected by questionnaire survey. We surveyed how each company applies for patent applications for consumer needs by monitoring and tried to propose a new concept for evaluation patent portfolio, we believe that the patent portfolio should have a proper matching with the consumer needs portfolio.

I. INTRODUCTION

Air conditioner has been necessary goods and contributed to the improvement of living standard everywhere in the world. Air conditioner can be classified into room air conditioner at home and packaged air conditioner for building use. Asian countries has the largest market of air conditioners. Also, it is expected that the production capacity will be increased in the future. With the exception of North America, the occupied ratio of the number of shipped room air conditioners is larger than that of shipped packaged air conditioners in the world. The market volume of air conditioner in the world is also expected to be increasing in the future. The various functions of air conditioner have achieved energy saving together with keeping comfort, and these functions have been developed based on the consumer needs. Japan has been taking a leadership of technical development represented to the number of patent applications, the number of technical reports, and maintained a leading position of sales of air conditioner in the world. However, technological competition, especially in the new function, will be getting more competitive globally in near the future [7].

The number of shipped air conditioner for home use in Japan from 1996 to 2012 is around 7 million units [10]. It means domestic market of air conditioner is saturated. In spite of the saturated market, only two companies, DAIKIN INDUSTRIES, LTD which is a specialized manufacturer of air conditioners, and Panasonic Corporation which is manufacturer of having broad electronic business development, have been increasing domestic market share of

air conditioner in recent years.

The points expected by consumers when purchasing air conditioner are three items, such as price, technical performance and energy saving performance [3].

Panasonic had a top share, around 16% of room air conditioner in Japan for many years until 2002. As of 1999, DAIKIN had 10% share of room air conditioner in Japan and started selling “*Ururutosarara*,” which is air conditioner with a no water supply humidification function. Later, Daikin had been increasing its share to approximately 17% in 2003 and became a leader instead of Panasonic [8]. On the other hand, Panasonic started selling an air conditioner with automatic cleaning function at the end of 2005. DAKIN also started selling air conditioner with automatic cleaning function in 2007, and in 2008 Panasonic started selling air conditioner with atomization device pertaining to humidification function what we call “*nanoe*.” The inference from these facts was that technology development competition about multifunction of air conditioner has been intensified by each company. How could two companies manage research and development of air conditioners which consist of various functional technologies? Previous researches related to air conditioner for home use in Japan are [1], from [3] to [9] and [11]. These previous researches include patent application, consumer needs, energy saving, problems around the heat pump, dehumidification, and market factor. However, they have not described on specific technical strength of DAIKIN and Panasonic.

Patents are an objective measure of R&D activities because a patent will be examined and eventually granted by the patent office. Furthermore, a large amount of technological information is contained in patents [2].

In this study, we visualized technical purposes as a system diagram. We made a comparative evaluation on the difference of technical strength of these two companies. Moreover, we evaluated the correlations between the number of patent applications of each company and the score of consumer needs collected by questionnaire survey. We surveyed how each company applies for patent applications for consumer needs by monitoring and tried to propose a new concept for evaluation patent portfolio, we believe that the patent portfolio should have a proper matching with the consumer needs portfolio.

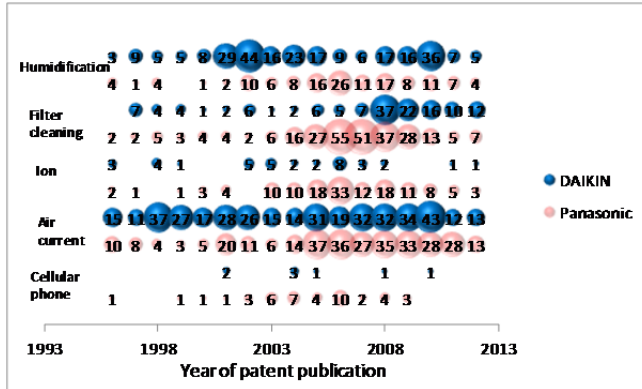


Fig. 1. The changes in the number of patent applications of each company pertaining to 5 specific keywords

II. METHODOLOGY

This section describes the methodology of research framework about how to specify the mother group, how to compare with technological trend of each company by analysis of patent information and how to evaluate the correlations between the number of patent applications of each company and the score of consumer needs by questionnaire survey.

A. Specify the mother group

Before comparing with technological trend of each company by analyzing patent, this section discusses how to choose method of population and some results of analyses which are provided in the process to specify the mother group.

For searching published unexamined patent application, this research used JP-NET for patent data base. Published unexamined patent application is suitable for analyzing technological trend of each company. However, it shall be noted that the time lag of at least 18 months between the first patent filing and the publication of the patent application. Table 1 shows retrieval keywords in this research.

TABLE 1 RETRIEVAL KEYWORDS

Target period	1996.01.01~2012.12.31
Applicant	DAIKIN INDUSTRIES / Panasonic or Matsushita Denki-Sangyo
The whole sentences	Air conditioner
	Humidification
	Filter cleaning
Summary sentences	Ion
	Air current
	Cellular phone

5 specific keywords are extracted to express a characteristic and the function of the air conditioner of each company by preliminary interviews of an employee of DAIKIN and a salesperson in household appliance general merchandising store, and also by looking the product's explanation of the each company's homepage and product catalogue.

Fig. 2 shows the changes in the number of patent applications of each company pertaining to 5 specific keywords. As you can see Fig. 2, DAIKIN applies for a lot of patents related to humidification and air current more than

Panasonic. On the other hand, Panasonic applies for a lot of patents related to filter cleaning, ion and cellular phone. It can be assumed that humidification and air current are related to basic function, and filter cleaning, ion and cellular phone are related to multifunction of air conditioner. Additionally, each company is affected by the other's technical development shown in the patent applications, and performs competitive technical development and applies for patents especially pertaining to humidification and filter cleaning.

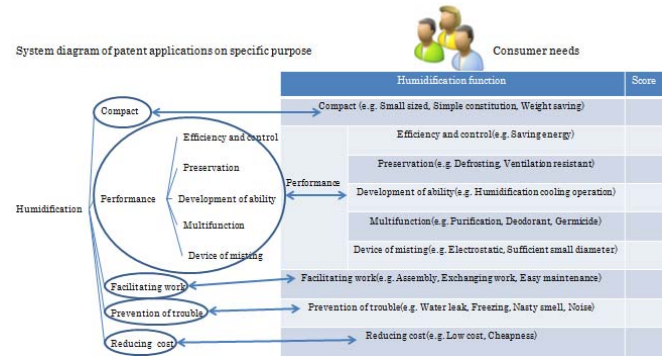


Fig. 2. The way of making questionnaire (Humidification)

We can assumed that technology functions pertaining to humidification and filter cleaning are core technical advantages of each company, because each company's products are corresponded to the needs of the consumer considering aspects of that the recent domestic market share in air conditioner turned big change. Therefore, this research focuses on these two functions for the mother group to compare with technological trend of each company by analyzing patent information. Table 2 shows the mother group of this research.

TABLE 2 MOTHER GROUP

Summary sentences	DAIKIN	Panasonic
Humidification	220	102
Filter cleaning	141	248
The sum total of patent applications	361	350

B. Method to compare with technological trend of each company by analyzing patent

Specific purposes are extracted by analyzing "problems to be solved by the invention" and "means for solving the problem" describing in patent specifications. Then we visualized technical purposes as a system diagram. Each System diagram of patent applications on specific purpose is shown as from Fig. 3 to Fig. 6, and is explained more detail in the next chapter.

C. Search procedure about relation between the number of patent application of each company and consumer needs of air conditioner for home use

After comparing with technological trend of each company by analyzing patent, we evaluated the correlations between the number of patent applications of each company and the score of consumer needs collected by questionnaire

survey. We surveyed how each company applies for patent applications for consumer needs by monitoring and tried to propose a new concept for evaluation patent portfolio.

According to system diagrams of patent applications on specific purpose, we made a questionnaire about consumer needs originally. Fig. 2 shows the way of making questionnaire. Query of the questionnaire and evaluation criteria are as follows.

Query of the questionnaire: “Please evaluate each item about a humidification function and a filter cleaning function on purchasing a room air conditioner.”

Scores of evaluation criteria: 1 = very unimportant, 2 = unimportant, 3 = neither, 4 = important, 5 = very important.

In addition, the items of specific purpose to use by questionnaire survey are 9 items pertaining to humidification, 13 items pertaining to filter cleaning function, 22 items in total. This survey was implemented in questionnaire format to 102 people over the Internet in March, 2013.

We try to measure it whether the number of applications of each company is connected with market share. If company researches and develops technologies for the high level of the consumer needs and appears for the large number of the patent applications, the filling activities are connected with market share. Conversely, company researches and develops technologies for totally low level of the consumer needs and appears for the large number of the patent applications, the filling activities are not connected with market share.

III. RESULTS AND DISCUSSION

First, this section describes the result of the technical advantages of each company by compared with technological trend of each company by analyzing patent information. Secondly, we showed the result of this questionnaire survey and relation between the number of patent applications of each company and consumer needs. Finally, we put forward 4 hypotheses by considering the aspects of each result.

A. Compare with technological trend of each company by analyzing patent information

System diagram of patent applications on specific purposes can be made by grouping specific purpose of each company. Fig.3 and Fig.5 show system diagram of patent applications on specific purposes pertaining to humidification and filter cleaning. Each function can be largely classified into 5 categories of specific purpose respectively. Furthermore, specific purposes of humidification performance, filter cleaning performance and easy maintenance of filter cleaning also can be divided to 5 categories more detail. We defined categories and items as follows (from Fig. 3 to Fig.6).

As you can see Fig. 4 and Fig. 6, each category has a difference of the extent of specific purpose. We can assume that humidification performance, filter cleaning performance and easy maintenance of filter cleaning have particularly wide extent of items.

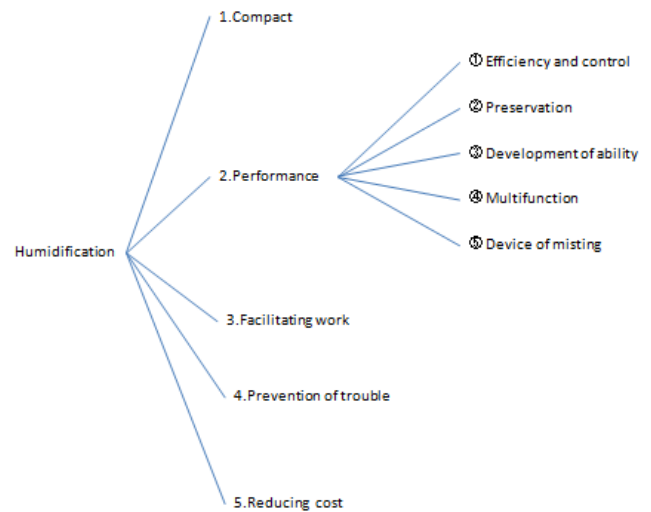


Fig. 3. System diagram of patent applications on specific purposes (Humidification)

Fig. 7 and Fig. 8 show the changes in the number of patent applications specific purposes of each company pertaining to humidification function and performance respectively. Comparing with the changes in the number of patent applications on specific purposes of each company, we can assume that DAIKIN has technical advantages about prevention of trouble, reducing cost, efficiency & control and development of ability. On the other hand, Panasonic has technical advantages about multifunction and device of misting what we call “nanoe.” That can be inferred that this technology related to ion generation device and ion generator using it.

Fig. 9, Fig. 10 and Fig. 11 show the changes in the number of patent applications on specific purposes of each company pertaining to filter cleaning function, performance and easy maintenance respectively. Comparing with the changes in the number of patent applications on specific purposes of each company, we can assume that DAIKIN has a technical advantage about assembly. Furthermore, it has clear that DAIKIN has additional technical advantage about dust box by reading patent specification pertaining to dust removing. On the other hand, Panasonic has technical advantages about compact, prevention of trouble, reducing cost, efficiency & control, cleaning capability, multifunction, appearance, automatic cleaning and other maintenances.

When we compare each item in chronological order, the time between product release and patent applications are almost the same, except “nanoe” device. It can be inferred that this device of misting technology comes from household appliance technology of other products, because Panasonic is manufacturer of having electronic broad business development.

Table 3 shows technical advantages of each company’s. DAIKIN has technical advantages of almost all the humidification function and some specific filter cleaning functions, especially dust box. On the other hand, Panasonic

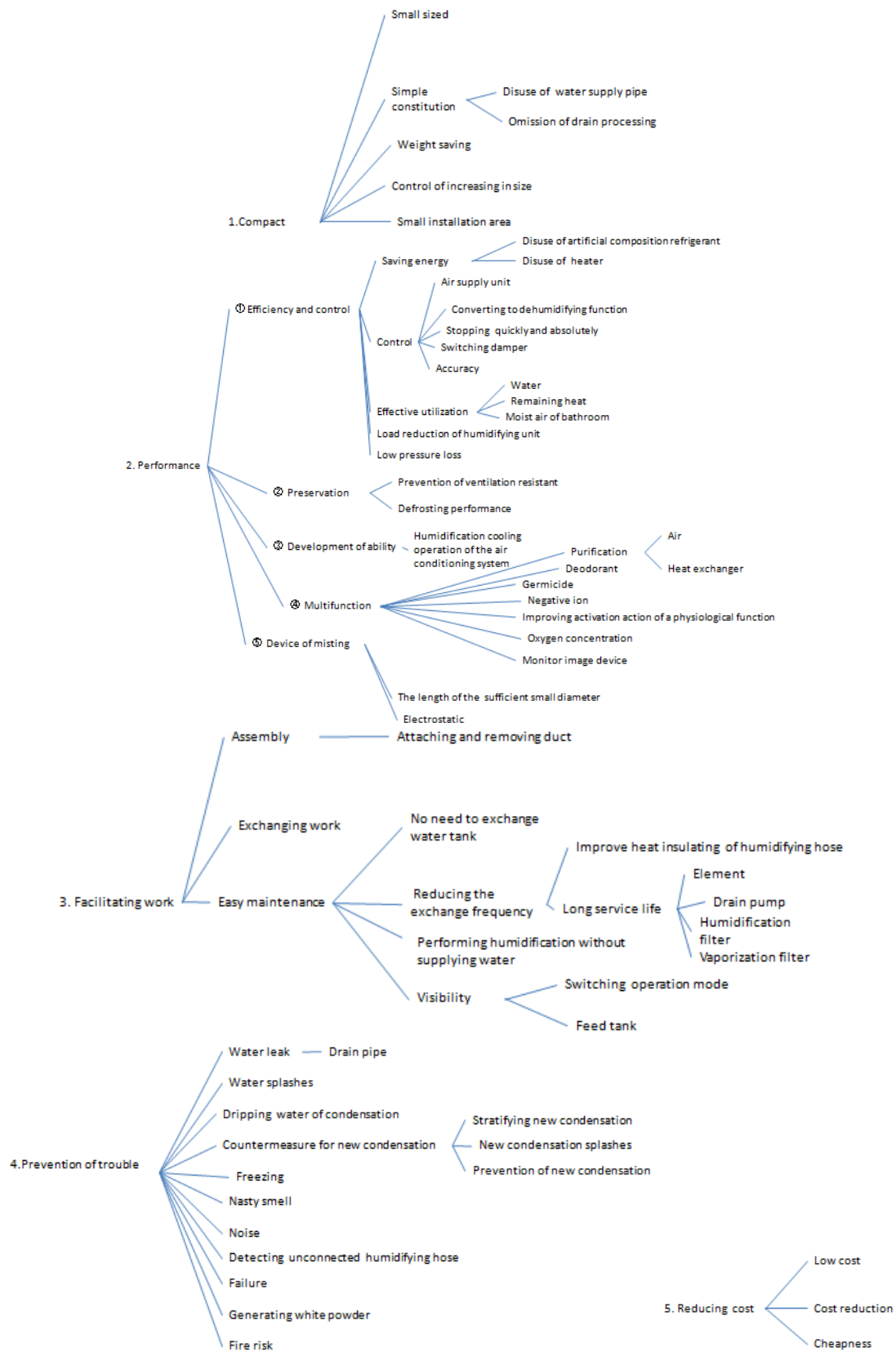


Fig. 4. Adding detailed information to system diagram of patent applications on specific purposes (Humidification)

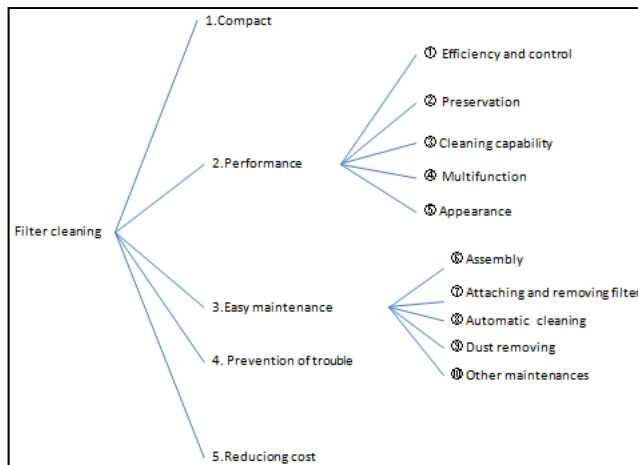


Fig. 5. System diagram of patent applications on specific purposes (Filter cleaning)

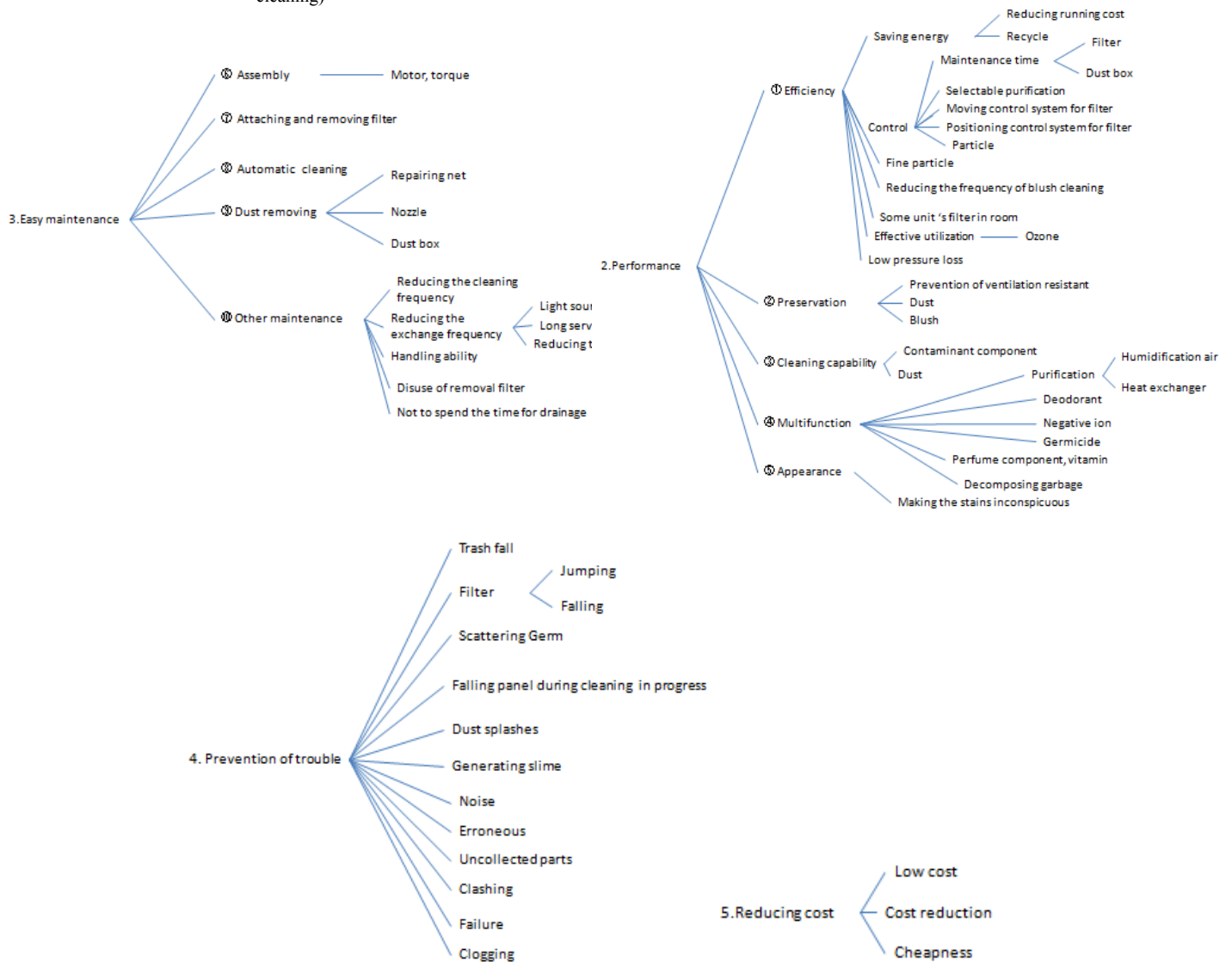
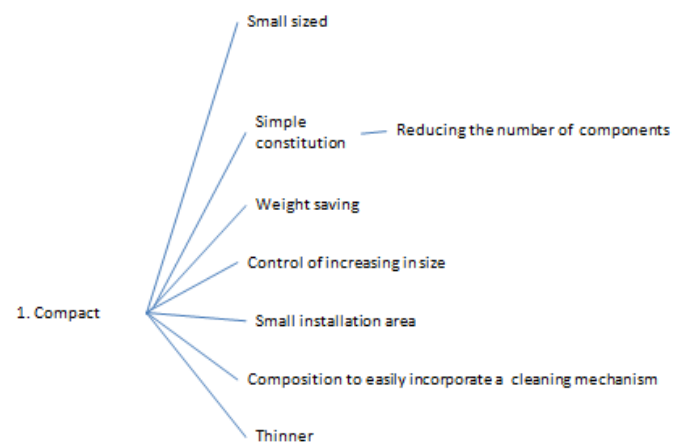


Fig. 6. Adding detailed information to system diagram of patent applications on specific purposes (Filter cleaning)

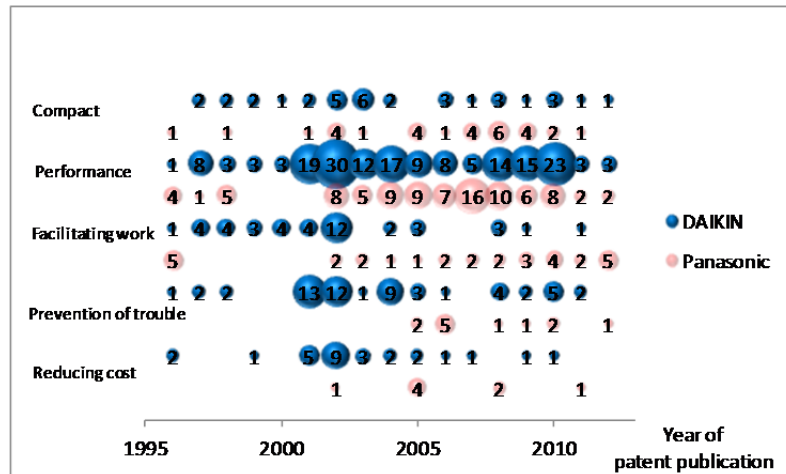


Fig. 7. The changes in the number of patent applications on specific purposes of each company pertaining to humidification function

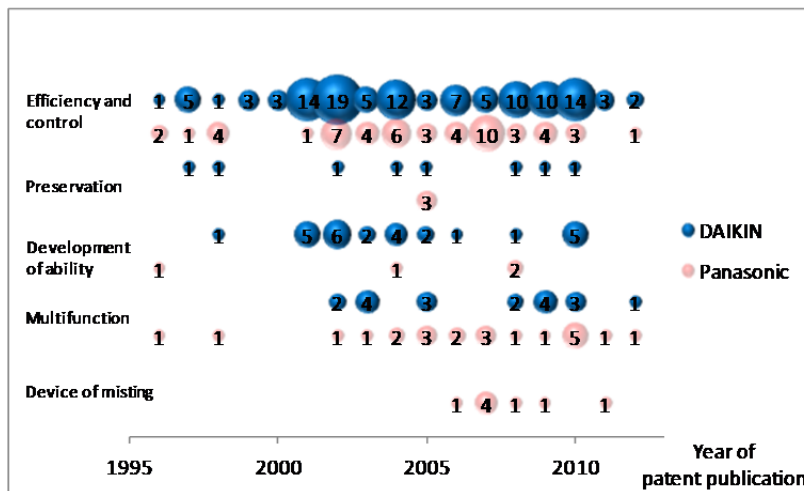


Fig. 8. The changes in the number of patent applications on specific purposes of each company pertaining to humidification performance

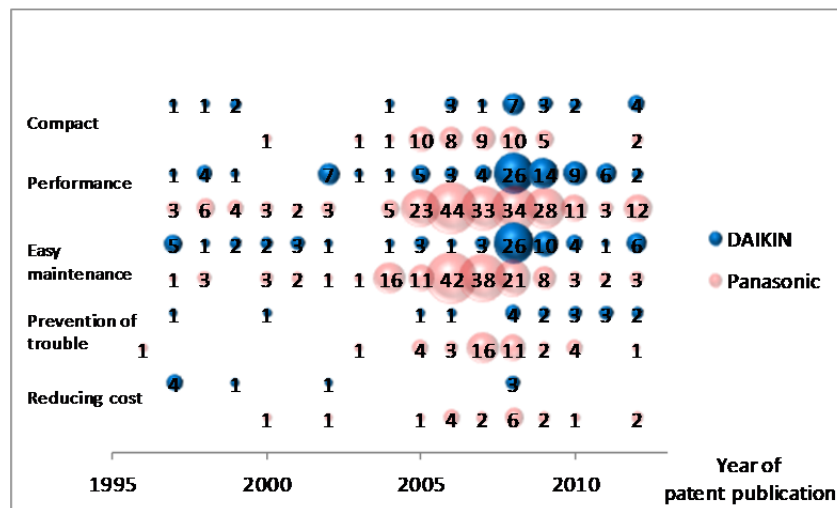


Fig. 9. The changes in the number of patent applications on specific purposes of each company pertaining to filter cleaning function

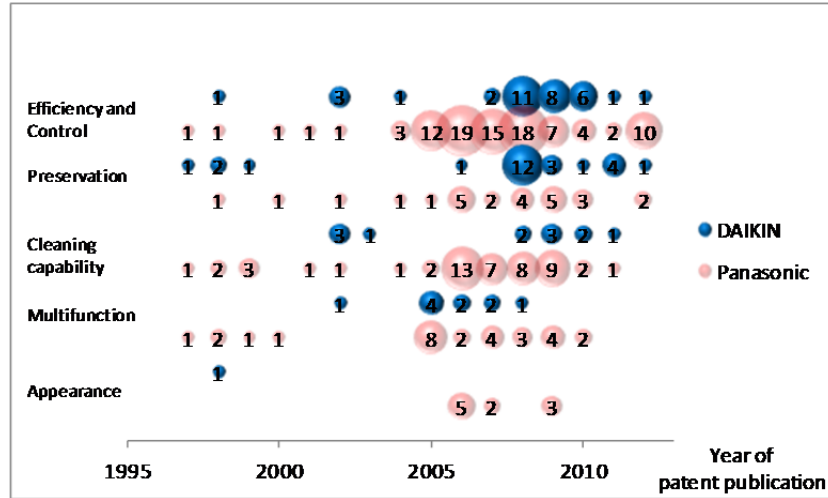


Fig. 10. The changes in the number of patent applications on specific purposes of each company pertaining to filter cleaning performance

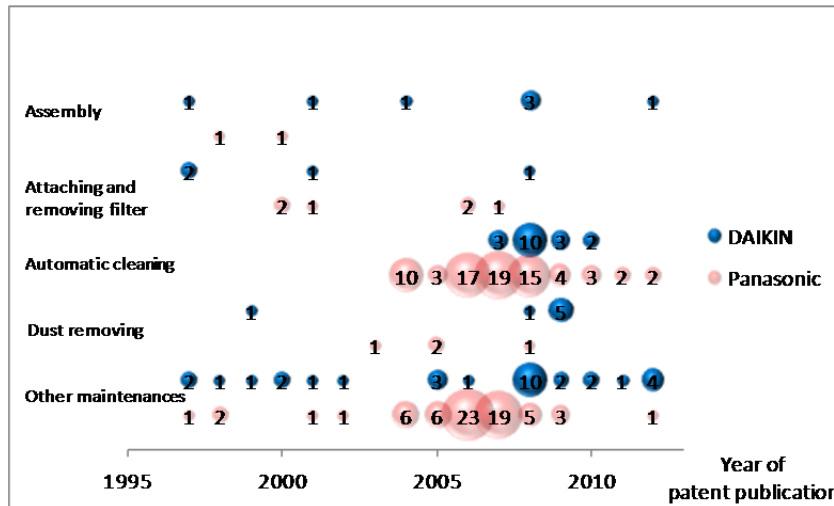


Fig. 11. The changes in the number of patent applications on specific purposes of each company pertaining to easy maintenance of filter cleaning

TABLE 3 TECHNICAL ADVANTAGES OF EACH COMPANY

Function	DAIKIN	Panasonic
	• Prevention of trouble	• Multifunction
	• Reducing cost	• Device of misting
Humidification	• Efficiency and control	
	• Development of ability	
	• Assembly	• Compact
	• Dust removing (dust box)	• Prevention of trouble
		• Reducing cost
		• Efficiency and control
Filter cleaning		• Cleaning capability
		• Multifunction
		• Appearance
		• Automatic cleaning
		• Other maintenances

has technical advantages of almost all the filter cleaning function and some humidified functions, particularly atomization device what we call “nanoe”.

B. *Relation between the number of patent applications of each company and consumer needs*

Fig. 12 shows results of the number of patent applications on specific purposes and the score of consumer needs. From

this figure, we can evaluate how the company applies for responding consumer needs. Also, we understand that each company tried development of different specific technology even within the same function. As you can see the divergence between the number of patent applications of each company and the score of consumer needs, each company has different divergence of relation between the patent portfolio and the consumer needs portfolio. This figure teaches us the importance of matching between the patent portfolio and the consumer needs portfolio. It shall be noted, however, there are some new technologies or function is not to have said nothing, because while new technology is not yet known by the consumer. Therefore, it can be inferred that device of misting technology is the lowest position of consumer needs score, because that people don't recognize this technology may be above mentioned reason.

Table 4 shows the results of correlation analysis between the number of patent applications and consumer needs. As you can see this table, DIKIN has the correlations between the number of patent application and consumer needs related to humidification function. On the other hand, Panasonic has the correlations between the number of patent application and consumer needs related to filter cleaning function and both functions.

As the result of this questionnaire survey, we can confirm some results have the correlations between the number of patent application of each company and the score of consumer needs.

C. Hypotheses

Finally, we put forward 4 hypotheses by considering the results of this research.

3 hypotheses are extracted by the process of comparing with technological trend of each company by analyzing patent information.

Hypothesis 1: In the business field of air conditioner, a specialized manufacturer of air conditioners applies for a lot of patents related to the basic function. On the other hand, manufacturer of having broad electronic business development applies for a lot of patents related to the multifunction.

Hypothesis 2: Each company is affected by the other's technical development shown in the patent applications, and performs competitive technical development and applies for patents.

Hypothesis 3: Air conditioner is a typical product of "market-pull". In the business field of air conditioner, the companies launch new products at the same time of patent applications. Then, they continue technical development responding to consumer needs.

The additional hypothesis is extracted by considering the problem from aspects of consumer needs.

Hypothesis 4: When market leader performs a particular technology development and applies for patents related to particular domain of the leader's, market leader has the correlations between the number of patent applications and consumer needs. On the other hand, when challenger performs a particular technology development and applies for patents related to particular domain of the leader's, challenger has less correlation between the number of patent applications and consumer needs.

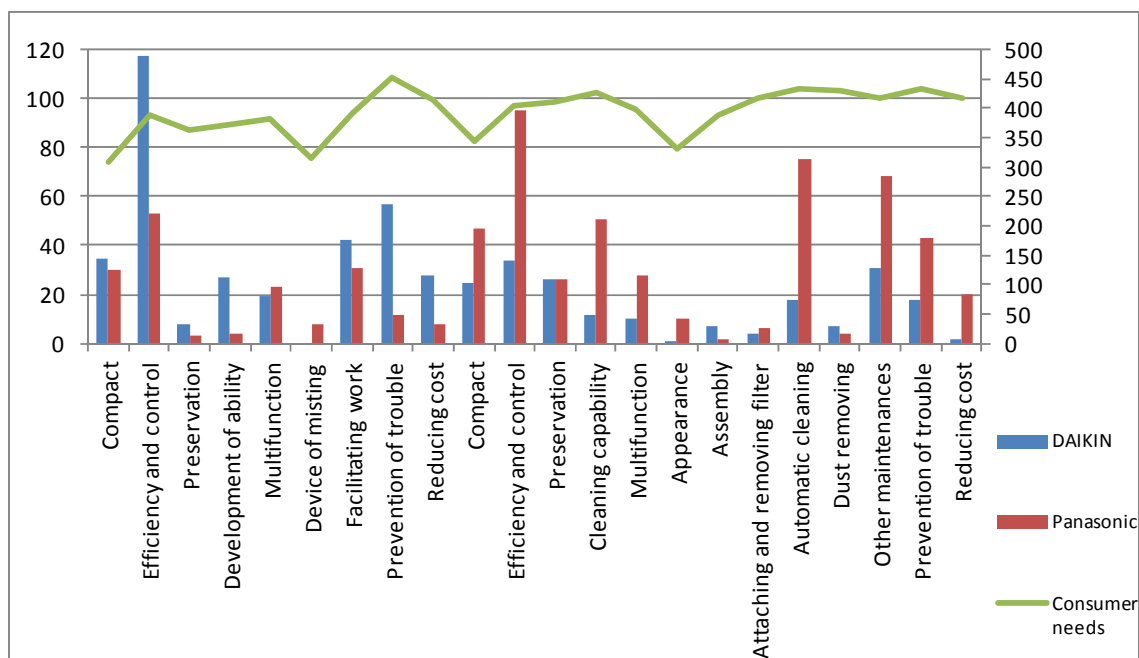


Fig. 12. Results of the number of patent applications on specific purposes and the score of consumer needs

TABLE 4 RESULTS OF CORRELATION ANALYSIS BETWEEN
THE NUMBER OF PATENT APPLICATIONS AND THE SCORE OF CONSUMER NEEDS

Function	DAIKIN	Panasonic
①Humidification	r 0.400	r -0.020
	p 0.286	p 0.959
②Filter cleaning	r 0.116	r 0.217
	p 0.707	p 0.477
③Humidification and Filter cleaning	r 0.108	r 0.226
	p 0.634	p 0.311

IV. CONCLUSION

This research focuses on patent applications filled in Japan, in the business field of air conditioner for home use. In spite of the saturated Japanese market, only two companies, DAIKIN which is a specialized manufacturer of air conditioners, and Panasonic which is manufacturer of having broad electronic business development, have been increasing domestic market share of air conditioner for home use in recent years.

In this study, we visualized technical purposes as a system diagram. We made a comparative evaluation on the difference of technical strength of these two companies. Moreover, we evaluated the correlations between the number of patent applications of each company and the score of consumer needs collected by questionnaire survey. We surveyed how each company applies for patent applications for consumer needs by monitoring and tried to propose a new concept for evaluation patent portfolio.

As the result of this survey, DAIKIN has technical advantages of almost all the humidification function and some specific filter cleaning functions, especially dust box. On the other hand, Panasonic Corporation has technical advantages of almost all the filter cleaning function and some humidification functions, particularly atomization device what we call “*nanoe*”. And we extract three hypotheses from the process of comparing with technological trend of each company by analyzing patent information.

As the result of questionnaire survey, some results have the correlations between the number of patent applications of each company and consumer needs. This research teaches us the importance of matching between the patent portfolio and the consumer needs portfolio. At the end of this research, we

put forward the additional hypothesis by considering the aspects of consumer needs.

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