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Research on Evaluation Technique of Patented Invention Using both Technical Value and Economic Value

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Abstract--The number of patent applications is around 400,000 a year in Japan, and its ratio by the Japanese applicant achieves about 84% out of the total number of patent applications. This ratio is extremely high compared with the ratio filed by each nationality in Europe and in the US. The number of applications or/and the number of registrations, etc. have been often used to evaluate the company's strength using patents, comparing with the competitors strength using patents. However said number does not describe the value of patents. In this study, we propose an evaluation technique of patented inventions using from both technical value such as the number of patent citation, ratio of patented inventions to patent applications, and economical value such as the sales of the commercial products etc., which can be called micro approach. This method makes it possible to give substantial evaluation of patented inventions, and gives an evaluation tool for Intellectual Property management which supports the decision making whether the invention shall be filed or not, reducing the useless patents, which will lead to maintain the company's competitiveness using limited resources effectively. In addition, the proposed method evaluating patents value will contribute to strengthen Technology Management.

I. INTRODUCTION

The number of patent applications is around 400,000 a year in Japan, and its ratio by the Japanese applicant achieves about 84% out of the total number of patent applications. This ratio is extremely high compared with the ratio filed by each nationality in Europe and in the US [1, 2, 3, 4]. Recently, the age at the time of which it was enough in recognition that a defensive effect is vaguely expected is ending in Japan as long as it applies for the patent. We should do the decision making whether apply for the patent while strictly evaluating the balance of the use of the patent and the leakage risk of the technical intelligence from the patent. And, it is necessary to change into the patent application trend in Japan now.

When applying for the patent once, the content of the application will be issued as an official patent gazette for every patent application in 18 months after its filing date as a publication of unexamined application in the current patent system. And its own technical intelligence is opened to the public to the world and they will provide it. Despite this, a large amount of patent application has been done by the Japanese applicant in Japan. And about half the number of the total patent application gets to request for patent examination and it is about 25% of the total patent application that the patent applications are finally given to grant patent. So, the majority of the patent application have not been generated the patent right such as the right to require an injunction and the right to demand compensation for damage. This has been

only to have opened the technology that its company has to the public all over the world spending cost and time.

However, in the past, it was a situation in which the approach on intellectual property was often compared by using the patent application number and the patented invention number, etc. with the competitor, and these methods were not the methods of correctly evaluating the value of the patented invention in the enterprise. Then, if we can evaluate the value of every patent application and patented invention properly, we will make decision the patent management whether apply for the patent or not, etc. And the change in the application trend is expected.

Moreover, the evaluation by three viewpoints has been considered up to now for the evaluation of value of the patented invention. The three viewpoints are technical value, legal value and economical value. These values must be high. Legal value must be high because the effectiveness of the patent should be able to be maintained. It is require that quality of the description of description and claims is high. And economical value is sales volume in the market and the contribution rate to the product.

The data base concerning the patent citation after 1980 was a start in United States Patent as for maintenance, and various analyses that used the quotation of United States Patent became active. For instance, Carpenter proves the patent citation counts concerning the technology that wins a famous prize to be more than that of other patents [5]. Albert shows the height of the correlation with the evaluation of the reformation level by the citation count of the patent and the engineer [7]. Moreover, Harhoff shows the importance of an individual patent by using various indices besides the patent citation [8]. For instance, they pointed out that the quality and not only inventor forward citation but also inventor backward citation correlated the patent. In addition, it is assumed that the science linkage is a profitable index of the quality of the patent in the patent in a medicine and a chemical field, and it doesn't become a profitable index in other fields [13]. On the other hand, there is a report that the science linkage is not necessarily the one to show an immediate relation between the science and the technology [14]. The typical index that shows the quality of the patent is assumed the number of patent citation [6, 9-12].

II. THEORETICAL FRAMEWORK

In this study, it proposes the techniques for evaluation the patented invention is using both technical value and economical value of the patented invention which company has possesses in Japan and is using analyses from a micro

approach, and is not using number of the patent application etc. In a current research, there were a lot of statistical consideration by a macro approach and the technique for approaching by the viewpoint of technical value and economical value is a little. It is important to approach from economic point of view. Because enterprise's economical index related to the profit is more important for enterprise. Then, the relation to the patent that has the technology that corresponds to the market data and the product of the number of sales in the market is examined about a certain product.

A. Technical Value

The index that shows technical value of the patented invention is the number of times cited and ratio of number of granted patents to number of patent applications.

B. Economic Value

The index that shows the economic value of the patented invention is the sales volume of products which the patent invention is used and concerned. And the index that shows the economic value of the patented invention is the number of inspection times.

C. Hypothesis

The above discussion leads us to the following hypothesis.

Hypothesis I: The patent that a certain company has the correlation of technical value that depends on the maximum number of times cited with the economic value that depends on the sales volume and the maximum number of times inspection.

III. DATA AND METHODOLOGY

A. Background and summary of the integrated circuits (IC) chip for contactless IC card.

In this study, we take up the IC chip of contactless IC card (contactless smart card, non-contactless IC Card) technologies as the investigation object. Because the contactless IC card technology makes not a mere technological element but the technology a nucleus, composes the part of the society's infrastructure, and promotes the innovation.

A contactless IC card is in any pocket-sized card with embedded IC which can process and store data. The contactless IC card is a card in which the chip communicates with the card reader through an induction technology similar to that of a Radio Frequency Identification (RFID). These cards require only close proximity to an antenna to complete transaction. They are often used when transactions must be processed quickly or hands-free, such as on mass transit systems, where a smart card can be used without even removing it from a wallet. The contactless IC card sales has been kept increasing for less than a decade all over the world. The contactless IC card technology spreads especially as an electronic ticket in the public transportation facility such as railways and buses and is used in each country of the world

now. For examples, there are Octopus card of Hong Kong, OV-Chipkaart of the Netherlands, Oyster card of London, Moscow Metro Transport/Social Card of Moscow, T-money of South Korea, myki of Australia. Especially, the contactless IC card technology in Japan increases as come to being able to shop without it is possible to go through the entrance gate even if the ticket of the train is not bought at the station after electronic ticket "Suica" of East Japan Railway is introduced in 2001, and putting out small change in the shop and the vending machine user's convenience and has increased use. And, this contactless IC card technology has expanded the usage like an electronic ticket, digital cash, and the coming in and going out management, etc. to many topics now. Here, IC card is divided into the contactless IC card and contact IC card by the difference of the interface and communications. The contactless IC card doesn't have the terminal, and exchange the supply of the power supply and the signal by the electromagnetic induction, it is excellent also in respect of security, operability and reliability.

Therefore, the contactless IC card chip spreads in the market today, and the contactless IC chip from which development will be expected in addition in the future is researched.

B. Market Data Analysis

The market trend and the share of market are investigated about the contactless IC chip for the contactless IC card among markets where the contactless IC card technology is used. Contactless IC chip, which is installed on contactless IC card (ISO/IEC14443 Type A and Type B, Felica) and the dual interface card (both contact/noncontact interfaces have in single-chip) is counted. However, Contactless IC chip for the cellular phone equipped with Felica is excluded. It was assumed a Japanese domestic market. The period was assumed 2001-2004, 2005 - 2007 [15, 16, 17]. This study focuses on five companies which are the contactless IC chip for the contactless IC card vendors. The contactless IC chip for the contactless IC card vendors are Sony Corporation (Sony), Infineon Technologies Japan K.K. (Infineon), NXP Semiconductors Japan Ltd (NXP), Toshiba Corporation (Toshiba) and Fujitsu Limited (Fujitsu).

C. Patent Data Analysis

This study used patent analysis to explore about five companies, Sony, Infineon, NXP, Toshiba, Fujitsu. The patent data of this study are obtained from Japanese Patent Office (JPO) database, the Industrial Property Digital Library (IPDL) [18]. The range of the investigation is an official report issued from January, 1983 to January, 2010, such as publication of unexamined applications, published Japanese translations of PCT international publication for patent applications and Patent Gazette. Technological field of patent in this study is discriminated according to File Index (FI) [18]. FI is a classification which is used to organize prior art search file in the JPO. It was constructed under the International Patent Classification (IPC). Because the technology of the

contactless IC card is in IC card technology in IPC (e.g. G06K17/00, G06K19/00, G06K19/07, and B42D15/10), and cannot be accessed directly from the IPC to the technology of the contactless IC card. So, the technology of the contactless IC card can be directly accessed from the FI (e.g. G06K19/00 H, G06K17/00 F). The FI classification (e.g. B42D 15/10 52) that is not able to be accessed directly even if FI is used is used as a key word to retrieve. Contactless, wireless, noncontact are added as a key word to retrieve it.

D. Technical value of the patented invention

Technical value of the patented invention describes the number of granted patent, the ratio of the number of granted patent to the number of patent application by each company in the past years. And Technical value of the patented invention describes patent citation analysis. Patent citations include both forward citation and backward citation.

And patent citation has been often interpreted as a measure of the knowledge diffusion from the patent. Forward citation is defined as the citation received from subsequent patents. The number of forward citation is the number of cited by, meaning the number of citations to the patent from patents which are forward in time from the patent. In contrast to backward citation is defined as the number of reference to prior patents, meaning the number of citations to patents which are backward in time from the patent. The patent citation in this research focuses it on forward citation.

E. Economic value of the patented invention

Economic value of the patented invention describes the number of inspection of files. Inspection of files is able to request from a third party or interested party to the administrative organ such as JPO for inspection of documents or evidence. Fees are required for this request. The patent which is inspected by someone is to attract a lot of attention. More the number of inspection times is, the more increasing attention degree from outside of the patent is.

IV. RESULT

Figure 1 shows the transition of the number of patent application accumulated of each company, five contactless IC card chip companies in the contactless IC card technology in Japan. The application year is taken in a horizontal axis, and the number of patent applications is taken in the spindle. It is order with a lot of numbers of patent application accumulated Toshiba, Sony, Fujitsu, NXP, Infineon, and it is understood that there are a lot of patent application numbers of Japanese firms from Figure 1 among five contactless IC card chip companies. According to Figure 1, Sony began to apply for its first patent in Japan in 1982. Afterward, Toshiba and Fujitsu applied for patents in 1983, and Infineon in 1985, NXP in 1991.

Figure 2 shows the transition of the number patented invention accumulated of each company, five contactless IC card chip companies in the contactless IC card technology in

Japan. The application year is taken in a horizontal axis, and the total of the number of patent inventions is taken in the spindle. It present is Toshiba, Sony, Fujitsu, NXP, Infineon, and it is the same as the orders of the number of patent application accumulated at present in the order with a lot of numbers of granted patent accumulated from Figure 2 among five contactless IC card chip companies. In the comparison of Sony and Toshiba, it is understood that the registration number of Sony exceeded it compared with Toshiba for 1987-199, 2001, 2002.

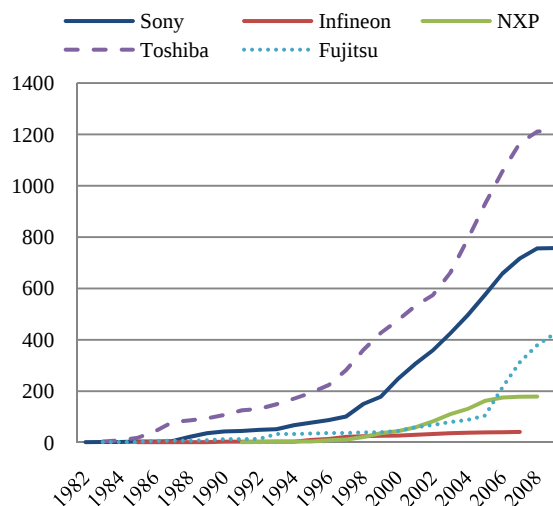


Fig. 1: Number of patent applications accumulated of each company in Japan. (1983.01-2010.01)

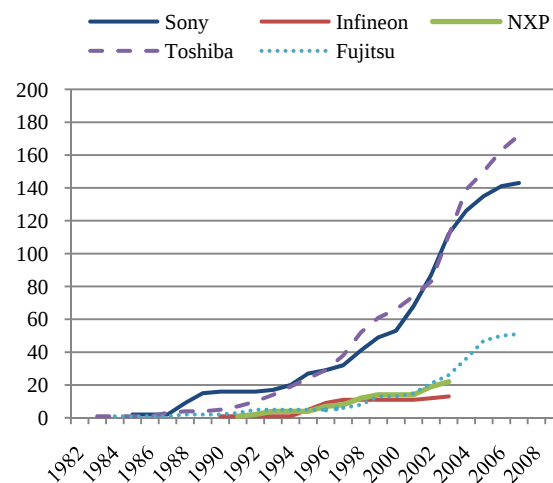


Fig.2: Number of granted patents accumulated of each company in Japan. (1983.01-2010.01)

Figure 3 shows the ratio of number of granted patent accumulated to number of patent application accumulated of each company in Japan. The application year is taken in a horizontal axis, and the patent registration rate is taken in the spindle. When the transitions of the ratio of number of

granted patent accumulated to number of patent application is compared from Figure 3 among five contactless IC card chip companies, it is understood that the ratio of the foreign firm of Infineon and NXP is high. On the other hand, it is understood that the ratio of Toshiba changes in a low level. The results are summarized in Table 5.

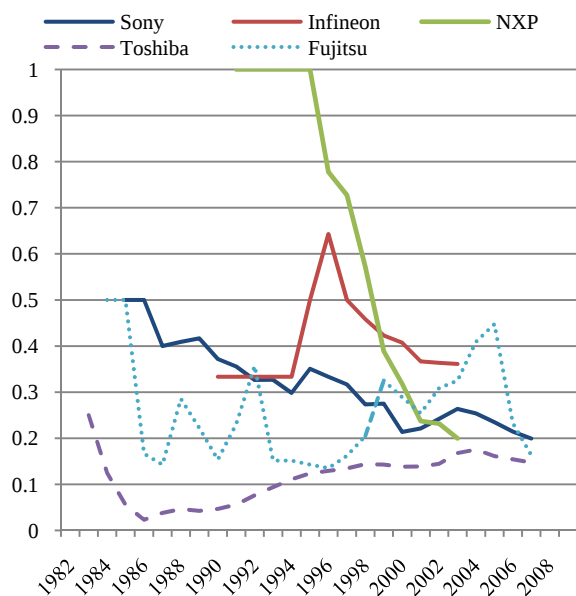


Fig.3: The ratio of number of granted patents accumulated to number of patent applications accumulated of each company in Japan. (1983.01-2010.01)

Figures 4-8 indicate the number of citation times of each company, five contactless IC card chip companies. The number of citation times in a horizontal axis is taken, and the number of patented invention is taken in the spindle. The results are summarized in Table 5.

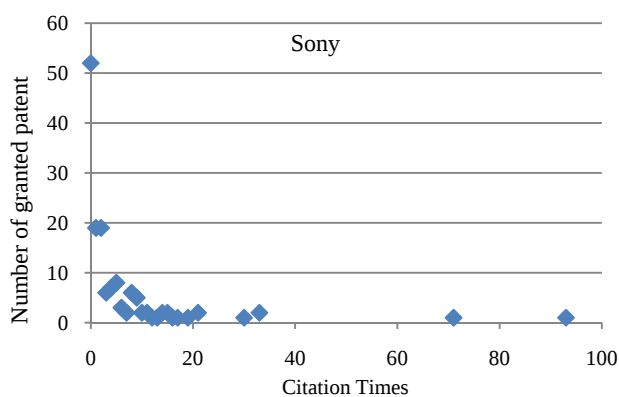


Fig.4: The number of citation times in Japan (1983.01-2010.01)

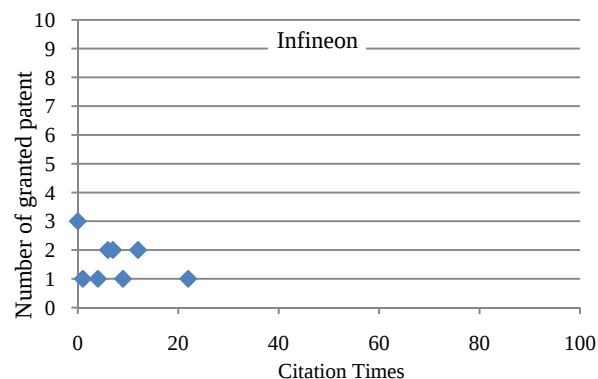


Fig.5: The number of citation times in Japan (1983.01-2010.01)

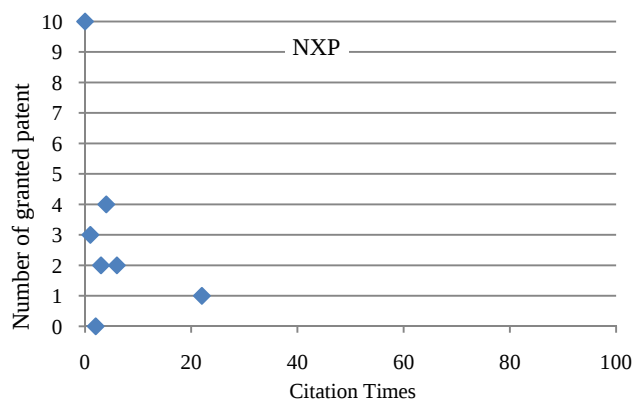


Fig.6: The number of citation times in Japan (1983.01-2010.01)

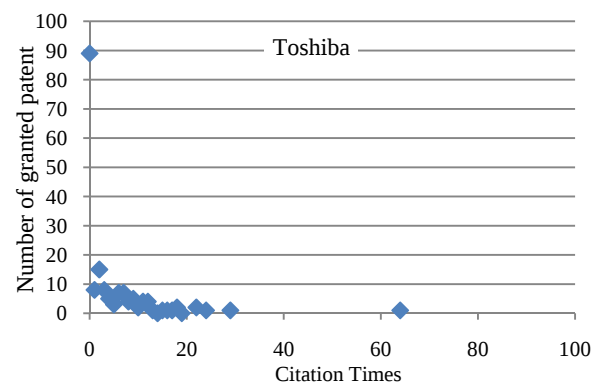


Fig.7: The number of citation times in Japan (1983.01-2010.01)

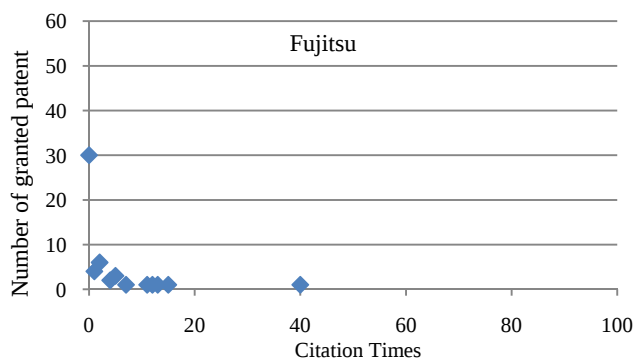


Fig.8: The number of citation times in Japan (1983.01-2010.01)

Figures 9-13 indicate the number of inspection times of each company, five contactless IC card chip companies. The number of inspection times in a horizontal axis is taken, and the number of patented invention is taken in the spindle. The results are summarized in Table 5. Figures 9-13 show the transition of the sales number total of five contactless IC card chip enterprise companies in the contactless IC card technology.

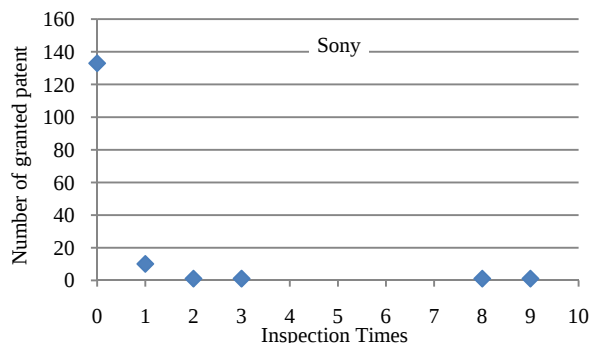


Fig.9: The number of inspection times in Japan (1983.01-2010.01)

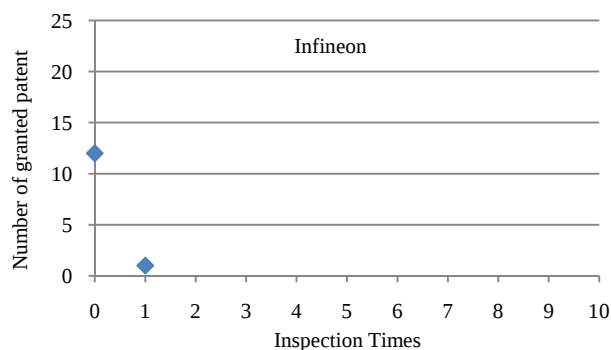


Fig.10: The number of inspection times in Japan(1983.01-2010.01)

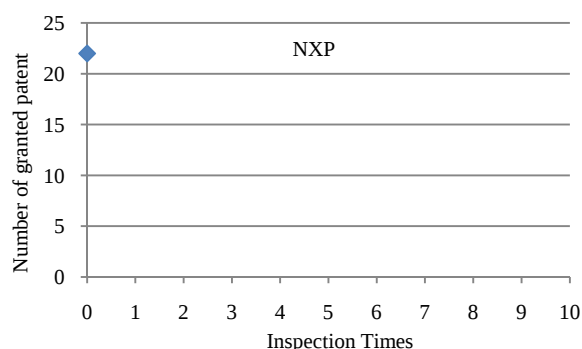


Fig.11: The number of inspection times in Japan(1983.01-2010.01)

Figure 14 indicates Sales Volume of Contactless IC Chip of each company in Japan for 2005-2007. Figure 14 shows market in number of Contactless IC Chip by single year and cumulative sales for 2005-2007. Contactless IC chip, which is installed on contactless IC card (ISO/IEC14443 Type A and Type B, Felica) and the dual interface card (both

contact/noncontact interfaces have in single-chip) is counted. Contactless IC chip for the cellular phone is excluded [15, 16, 17]. Figure 14 is a results value of the sales volume in 2005-2007 as actual achievement. The results are summarized in Table 1, 2.

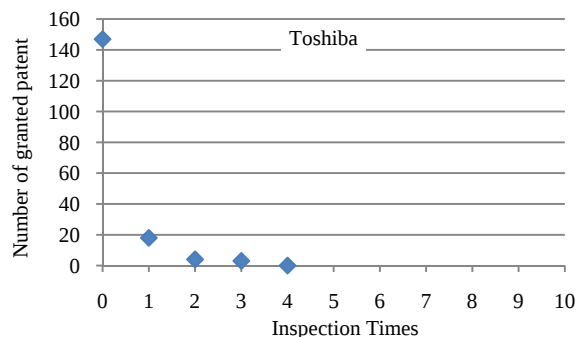


Fig.12: The number of inspection times in Japan(1983.01-2010.01)

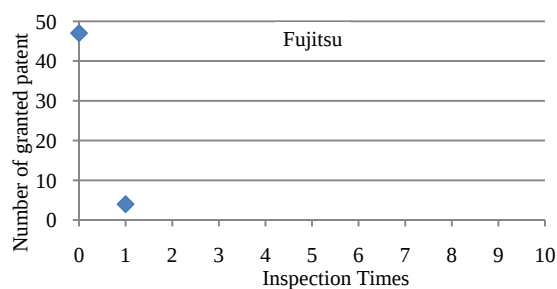


Fig.13: The number of inspection times in Japan(1983.01-2010.01)

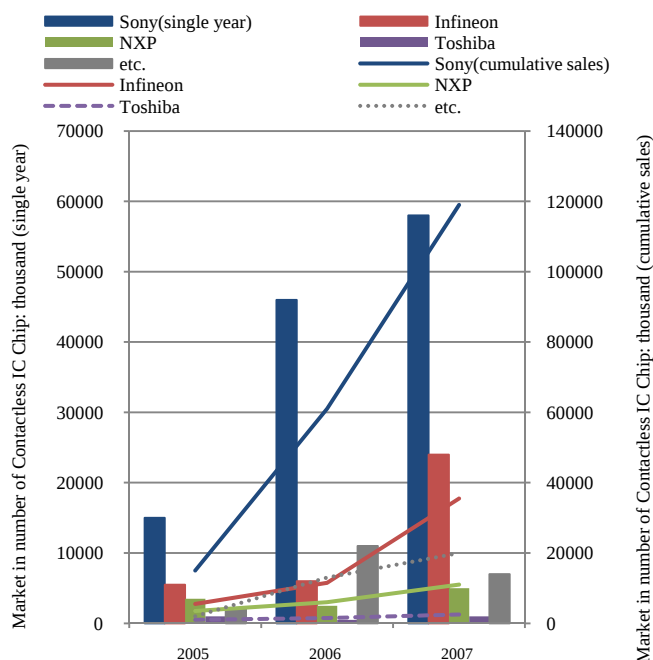


Fig.14: Sales Volume of Contactless IC Chip of each company in Japan

		2005	2006	2007	2008	2009
Market in number of Contactless IC Chip: thousand	Sony	15000	46000	58000		
	Infineon	5500	6000	24000		
	NXP	3500	2500	5000		
	Toshiba	1000	500	1000		
	etc.	2000	11000	7000		
	Total Market	27000	66000	95000	100000	
Total Sales Turnover: mio US\$		27	60	80	85	85

		2005	2006	2007
Market share of Contactless IC Chip: %	Sony	55.6	69.7	61.1
	Infineon	20.4	9.1	25.3
	NXP	13.0	3.8	5.3
	Toshiba	3.7	0.8	1.1
	etc.	7.3	16.6	7.2
	Total Market	100.0	100.0	100.0

Figure 15 indicates Sales Volume of Contactless IC Chip of each company in Japan for 2001-2004. Figure 15 shows market in number of Contactless IC Chip by single year and cumulative sales for 2001-2004. Contactless IC chip, which is installed on contactless IC card (ISO/IEC14443 Type A and Type B, Felica) and the dual interface card (both contact/noncontact interfaces have in single-chip) is counted. Contactless IC chip for the cellular phone is excluded [15, 16]. Figure 15 is a results value of the sales volume in 2001-2003 as actual achievement. However, the predicted value is used about the sales volume in 2004. The results are summarized in Table 3, 4. Sony has been recording the maximum sales volume in the contactless IC chip market in Japan from 2001 to 2007 compared with the other companies.

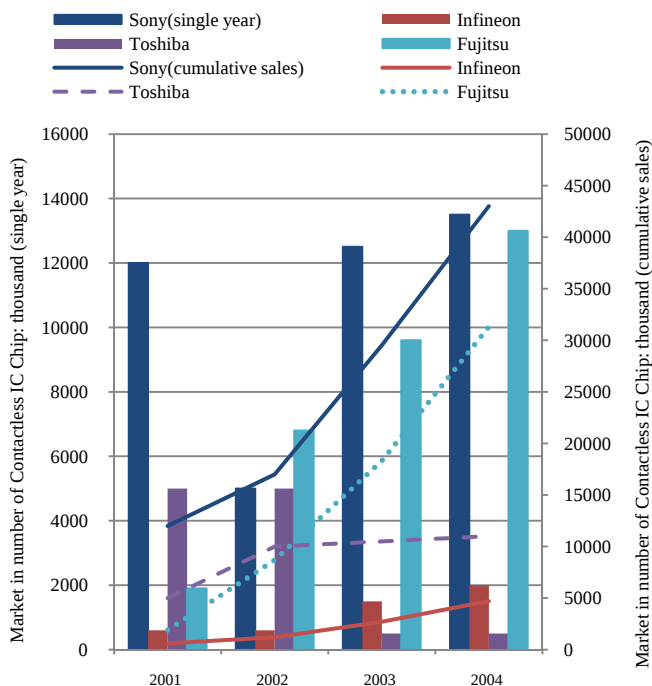


Fig.15: Sales Volume of Contactless IC Chip of each company in Japan

		2001	2002	2003	2004
Market in number of Contactless IC Chip: thousand	Sony	12000	5000	12500	13500
	Infineon	600	600	1500	2000
	Toshiba	5000	5000	500	500
	Fujitsu	1900	6800	9600	13000
	Total of 4 companies	19500	17400	24100	29000

		2001	2002	2003	2004
Market share of Contactless IC Chip: %	Sony	61.5	28.7	51.9	46.6
	Infineon	3.1	3.4	6.2	6.9
	Toshiba	25.6	28.7	2.1	1.7
	Fujitsu	9.7	39.1	39.8	44.8
	Total of 4 companies	100.0	100.0	100.0	100.0

Sony has a patented invention which is maximum number of times cited and a patented invention which is maximum number of times inspection required in the contactless IC chip of contactless IC card technologies. The results are shown in Table 5.

When the hypothesis is verified, it is suggested that our Hypothesis I be supported by showing results in Table 1, 3, 5. In the case with Sony, it can be said at least that there is a correlation of technical value that depends on the maximum number of times cited with the economic value that depends on the sales volume and the maximum number of times inspection.

		Sony	Infineon	NXP	Toshiba	Fujitsu
Number of patent applications	Number of patent applications	757	41	179	1218	427
	Number of granted patents	143	13	25	172	51
	Ratio of granted patents to patent applications	0.19	0.32	0.14	0.14	0.12
Number of times cited	Number of granted patent cited	95	10	22	83	21
	Number of citation times accumulated	747	84	59	635	137
	Maximum number of times cited	93	22	22	64	40
	Average of times cited	5.1	6.5	5.1	3.7	5.3
Number of times inspection required	Number of granted patents inspected	14	1	0	25	4
	Number of inspection times accumulated	32	1	0	35	4
	Maximum number of times inspection required	9	1	0	3	1

V. CONCLUSIONS AND IMPLICATIONS

In this study it is suggested that some relations exist in technical value that depends on the maximum number of times cited and the economic value that depends on the sales volume and the maximum number of times inspection.

It was disclosed that the more important patent has bigger number of forward citation and number of times inspection. The evaluation of an individual patent is needed though evaluation figure of technical value was evaluated as a unit in the future with the patent group that the company has. In addition, it is necessary to consider the influence by the alliance of the license and business tie-up, etc. according to

the business strategy of the enterprise to acquire the number of sales and the market share of the product in this study. Moreover, because the evaluation is difficult, it is necessary to examine the item that shows the relation between the literary property and the entire business like "core technology and business model" and "directionality of the research and development segment and the business strategy", etc. about technical value and economic value in these evaluations. This method makes it possible to give substantial evaluation of patented inventions, and gives an evaluation tool for Intellectual Property management which supports the decision making whether the invention shall be filed or not, reducing the useless patents, which will lead to maintain the company's competitiveness using limited resources effectively. In addition, the proposed method evaluating patents value will contribute to strengthen Technology Management. This paper is a work in-progress. We intend to continue our research to better understand the evaluation technical value and economic value.

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