



STUDY ON TIME EMERGENCE OF DOMINANT DESIGN OF INKJET PRINTER AND NC MACHINE BY USING F-TERM IN JAPANESE PATENT

Estudo sobre o surgimento no tempo de projeto dominante de impressora a jato de tinta e máquina NC usando termo F na patente japonesa

Yoshie Ishii¹, Oke Oktavianty², Nguyen Huu Phuc³, Ken Kaminishi³, Shigeyuki Haruyama³

¹ Graduate School of Science and Technology for Innovation, Yamaguchi University, Japan, 7550097

² Universitas Brawijaya, Indonesia

³ Graduate School of Innovation and Technology Management, Yamaguchi University, Japan, 7550097

(E-mail: i001wc@yamaguchi-u.ac.jp, okemn7@ub.ac.id, phuc@yamaguchi-u.ac.jp, kaminisi@yamaguchi-u.ac.jp, haruyama@yamaguchi-u.ac.jp)

Abstract: This research is aimed at identifying the trend of technology and time emergence of the dominant design of inkjet printer and NC machine by using F-term in Japanese Patent. F-term was employed instead of International Patent Classification (IPC) because of the multi view point of the theme and it provides the certain technical area. The firm's product entering time to the market was evaluated to the S curve of the product lifecycle and technology life cycle was also investigated.

Key words: Dominant design; Product life cycle; Japanese patent; F-term

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ESTUDO SOBRE O SURGIMENTO NO TEMPO DE PROJETO DOMINANTE DE IMPRESSORA A JATO DE TINTA E MÁQUINA NC USANDO TERMO F NA PATENTE JAPONESA

Study on time emergence of dominant design of inkjet printer and nc machine by using f-term in japanese patent

Yoshie Ishii¹, Oke Oktavianty², Nguyen Huu Phuc³, Ken Kaminishi³, Shigeyuki Haruyama³

⁴ Graduate School of Science and Technology for Innovation, Yamaguchi University, Japan, 7550097

⁵ Universitas Brawijaya, Indonesia

⁶ Graduate School of Innovation and Technology Management, Yamaguchi University, Japan, 7550097

(E-mail: i001wc@yamaguchi-u.ac.jp, okemn7@ub.ac.id, phuc@yamaguchi-u.ac.jp, kaminisi@yamaguchi-u.ac.jp, haruyama@yamaguchi-u.ac.jp)

RESUMO: Esta pesquisa tem como objetivo identificar a tendência da tecnologia e o surgimento de tempo do design dominante da impressora a jato de tinta e da máquina NC usando o termo F na patente japonesa. O termo F foi empregado em vez da Classificação Internacional de Patentes (IPC) por causa do ponto de vista múltiplo do tema e fornece uma certa área técnica. O tempo de entrada do produto no mercado foi avaliado pela curva S do ciclo de vida do produto e o ciclo de vida da tecnologia também foi investigado.

Palavras-chave: Design dominante; Ciclo de vida do produto; Patente japonesa; Termo F

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1 Introduction

In global competitiveness, it is important to make a long-term strategic decision in research and technology development. The potential direction of technology development and innovation can be determined by forecasting the trend of technology (A. K. Firat, et.al., 2008) (S. Jun, 2011) (D. Kang, et.al., 2013). However, forecasting technology is difficult because most of the forecasting method was using the expert subjective experience (S. Jun and S. Joo Lee, 2012). In addition, most of the previous study was only depicted the simply current condition, not describing the future trend of technology (J. Kim, et.al., 2012). Some related studies of technology trend analysis and forecasting application to predict the future technology development were conducted.

The comparative study between decision tree and statistical feature analysis and Gartner's forecasting model was done for technology trend analysis and forecasting application (J. Kim, et.al., 2012). The analysis on this study was using three sub models namely Technology Life Cycle Discovery (TLCD model, Technology Maturity Forecasting (TMF) model, and Emerging Technology Discovery (ETD) model. TLCD model was made by the analysis of papers and patents.

The identification of future trends was done by a mixed methodology using journal content analysis, focus group and trend reports on the academic libraries. The most popular topic was concluded with the highest number of downloaded article (R. Gwyer, 2015). There is no previous study stated the correlation between the number of downloads article and the popular topics that would indicate the trend.

The trend of innovation of Small Medium Enterprise's companies was conducted by using American standard industry classification (SIC) data (Z. J. Acs and D. B. Audretsch, 1988). Although the evaluation method of this research is an effective means for evaluating the trend of the American manufacturing industry, it may not viable to be applied to the evaluation of the Japanese manufacturing industry.

Previous studies have employed the patent document to predict the future state of technology (S. Jun and S. Joo Lee, 2012)(Jun, S. et. al., 2012) (Shrivastava, S., et. al., 2015) (Jun, S. and Park, S.S., 2013) (Kim, G. and Bae. J, 2017) (P. L Chan, et.al., 2010). The study of technology forecasting employed the International Patent Classification Code. The IPC code was used in Path analysis. The patent documents that concerning nanotechnology as the target technology was analyzed for verifying the analysis result (S. Jun and S. Joo Lee, 2012). The other study was also employed IPC code to search the direction and trend of technology over patent period (Shrivastava, S., et. al., 2015) (Jun, S. and Park, S.S., 2013). In International Patent Classification, there is the limitation of subdivision of IPC (FI) and inadequate segmentation. There are too many documents that are included in one symbol. This is also a single view point that from IPC only. The F-term indexing system is based on multiple viewpoints differing from those in IPC.

In this study, we propose the patent information analysis method using the F-term as Japanese patent classification code. The patent information analysis was used to predict the technology trend particularly on inkjet printing technology (IJ) and microfabrication equipment (MC) as the target technology in the case study company. The F-term is the more detailed information related to the patent information that derived from the IPC. This is a unique and more specific classification. By using the F- term in Japanese patent, we able to find the more specific technology that related to the target technology in this study. By understanding the trend of technology, the product innovation process will be on the right path. It is important to integrate the product innovation process to the product life cycle management (A. Staisch et.al, 2012).

It is important to discern technology trends and the timing of the new technology for emerging the product to the market. In response to the issue of how to view the market and technology trends, we used the concept of technology and market change that was shown in "Dominant Design Theory" of James M. Utterback (Utterback) (J. Utterback, 1998) (J. Utterback,et.al., 2006). Utterbacks' model for innovation defined three phases of innovation in the marketplace for product namely the Fluid, Transitional and Specific phases. Some studies work on recognizing the dominant design (Bakker, S. et.al., 2010) (P. Anderson and M. L. Tushman, 1990) (R. Roy,

2016) (M. Hekkert and R. van den Hoed, 2004) (H. Sievers, 2015) (F. Suarez, 2015) (S. Wilson, 2007) (A. Brem et.al., 2016).

Nobeoka (Nobeoka Kentaro, 2006) states that the problem of Japan's manufacturing is the manufactures in Japan only suffers in "making things" as well, but it is not linking to the customer's satisfaction or profits. It makes creating the "value creation" is not possible. For linking to the —value creation", there are two important points, namely the technology uniqueness / differentiation and a high customer value.

Therefore, we must recognize the dominant design of our product in a pre-market phase of development. To be dominant in the market share, we must understand our dominant design. When a dominant design is defined, we are mostly out of the product innovation phase. The phase take place when all players start to optimize their processes, improving the quality and reducing the cost of their products. Therefore, in this research, we devised a method to evaluate the change of product and process innovation by patent analysis and investigate the dominant design of target technology.

2 Research Methodology

As a case study research, we conducted the study in a manufacturing company in Japan. As a target technology of company, we selected two products namely small NC microfabrication equipment (MC) and inkjet printer device (IJ). The research methodology is shown in Figure 1. Related to the company's target technology, the previous studies, and Japanese patents documents were reviewed. The trend of technology was obtained from the F-term as a specific term in Japanese patent. the S-shaped curve of technology is evaluated by diminishing down FI (File Index) to the Japanese patent application and obtaining the number of technology applications. The Japanese patent was reviewed over period 1998 – 2016. The overview of F-terms in the Japanese patent classification and its correlation to the International Patent Classification (IPC) is shown in Figure 2. In the F-term indexing system of Japan patent classification, the entire technical area is divided into small areas called —themel and patent documents are analyzed in each —themel. Each —themel has —F-termsl, which are search keys. After obtaining the theme from the F-term of.

In this research, "technology trend" refers to the next market and technology evaluation factor.

- 1."S curve of technology" representing market growth and product life cycle
- 2."Product innovation" and "process innovation" representing the status of innovation
- 3."Dominant design" (period of emergence, technical elements) representing the transition period of "process innovation" from "product innovation"

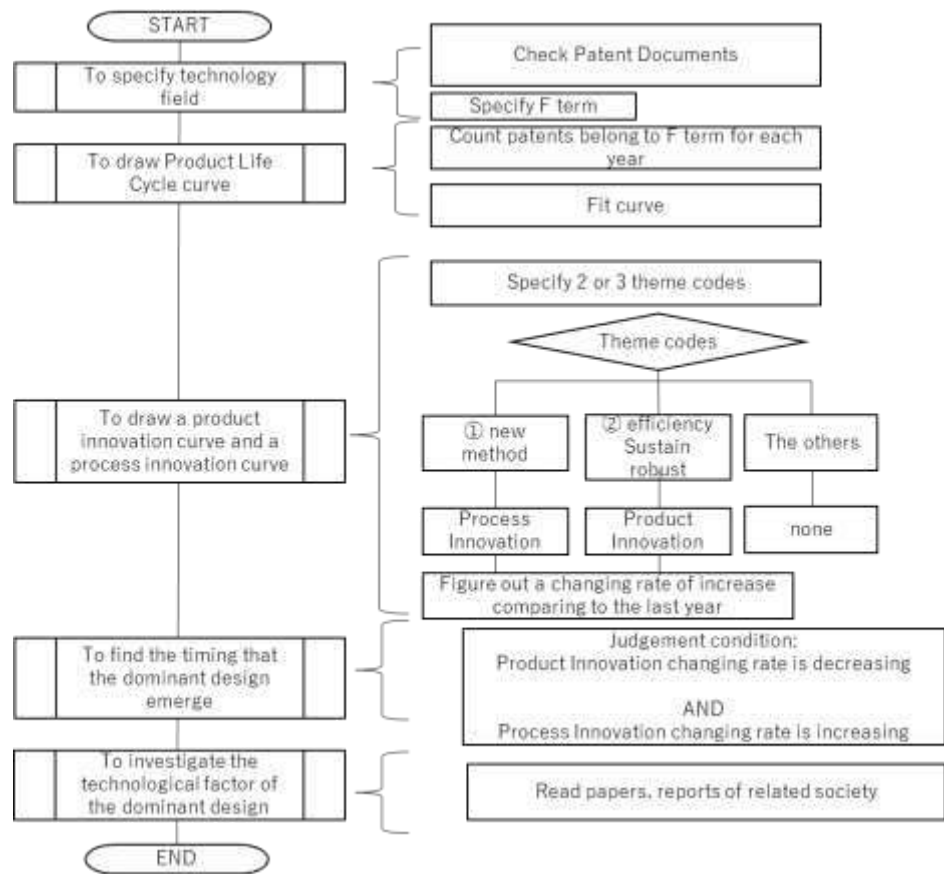


Figure 1 Research Methodology

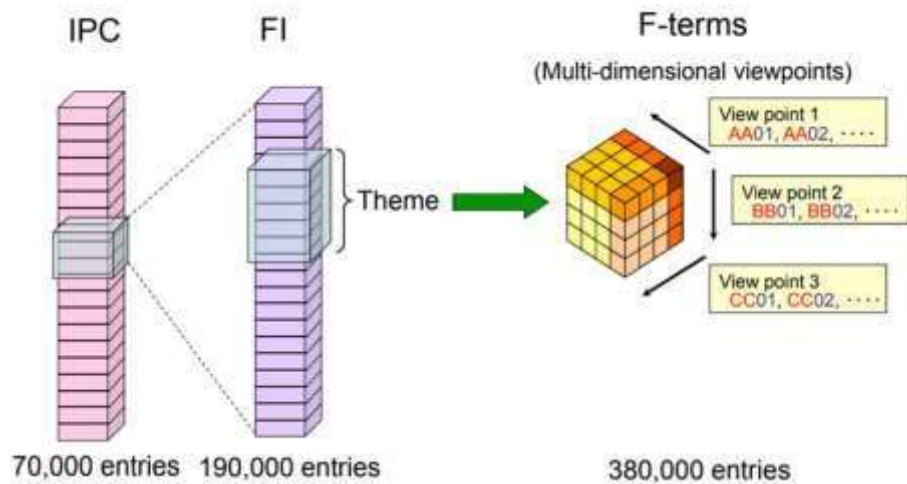


Figure 2 Overview of IPC, FI and F term

3 The Emergence Time of Dominant Design of IJ and NC Machine Technology

As described in Figure 2 (Japan Patent Office, 2013), the theme code was obtained from the F-term in the Japanese patent classification. This code is the unique and specific code according to the specific field in Japan's technology. The theme codes that employed in determining the dominant design of IJ technology from the Japanese patent application were 2C 056, 2 C 057. Subsequently, the S-curve of technology was obtained and shown in Figure 3. The figure shows that the S-shaped curve of technology has reached the peak phase around 2006, and after 2017 it is at the "declining period". The innovation of product and process were investigated by using the number of cases from F-term in Japanese Patents. Both product and process innovation are fluctuating and recognized as the dominant design at around 1990 until 2003. The dominant design of IJ then obtained from academic journals over period 1990 – 2003, namely "on-demand printer" and "line printer".

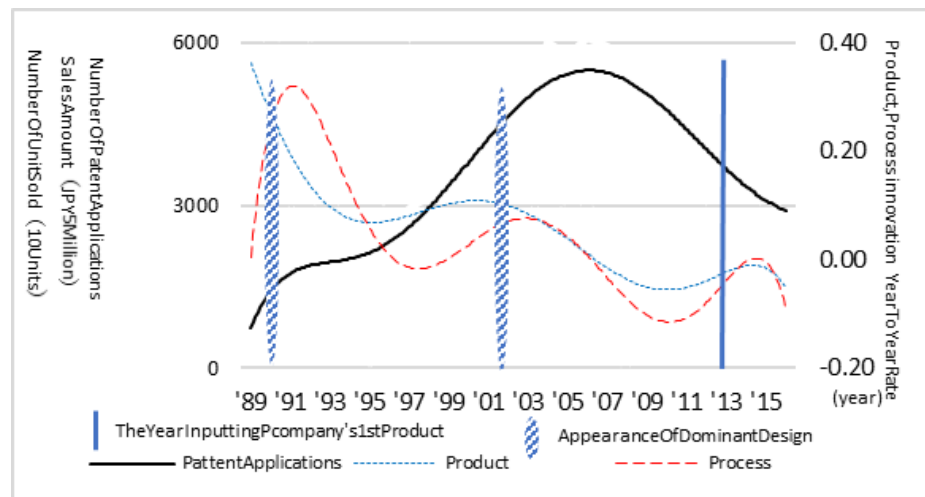


Figure 3 S-curve and Innovation of IJ Technology

It depicted in Figure 3 that the company as the object of this research entered to introduce its product to the market in around 2013. The period of entering the market indicated in the specific phase as in Utterback Innovation model. Therefore, the company must make a new breakthrough in innovation and using it to move from the end of the innovation cycle to the beginning of a new one with the next innovation of product. The company must create a wave of radical innovation to sweeps across existing technologies and make it become obsolete. As the current result, this company’s IJ business has not reached to making big benefit for 6 years.

The "S-curve of technology" and the innovation of the NC machine technology is shown in Figure 4. The theme code used is 3C001 (machine tool). As shown in Fig. 4, the S curve of technology reached its peak around 1994 and declining in 2017. It is judged as 'declining period'. The innovation of product and process increased until 2009 and currently declining. From the viewpoint of technology development, the NC machine field is not as active as the IJ device. The dominant design emerged around 1993 - 2004. The company entered the market before the period of dominant design ended. After the dominant design period, the innovation of process increasing significantly. The company entered the market prior to the rapid increase in technology development pursuing Quality, Cost, and Delivery (QCD), in a situation where various technical elements are easily accessible to small and medium-sized enterprises.

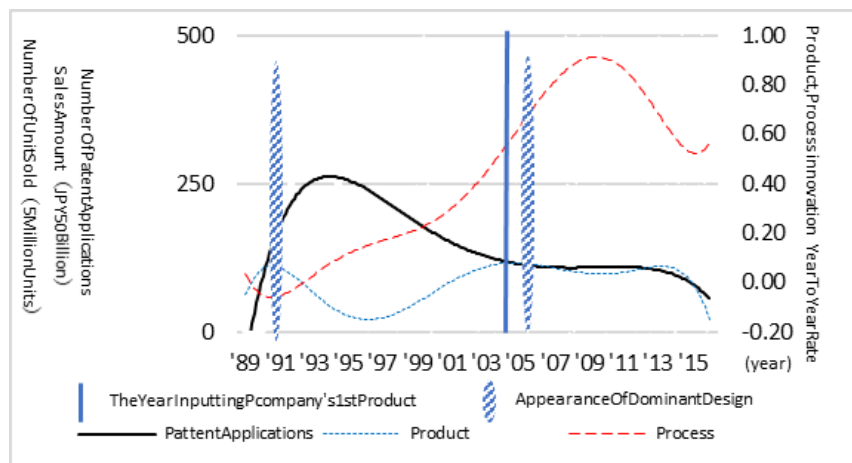


Figure 4 S-curve and Innovation of NC Machine Technology

The market segments are clear and therefore the company able to concentrate on serving specific customers. It can be stated that they introduced their product at the correct time and can be successfully grasped the customers who need special orders. As the result, the company has obtained the niche market concerning R&D laboratory of the enterprises and universities with steady benefit for 16 years. Furthermore, product

innovation is in the specific phase, waiting for the new radical development on the product for jumping to the new cycle of innovation.

4 Conclusion

The objective of this research is to identify trends of technology and examine the product's introduction time to the market. The trend of technology was evaluated by using the theme code of F-term in Japanese Patent Classification. The emergence time of dominant design of Inkjet printer (IJ) and NC machine was investigated. From the S curve and innovation lifecycle, it was determined the period of emergence time of dominant design for inkjet printer technology over period 1990 until 2003. The introduction time of inkjet printer to the market was behind the dominant design period. The introduction time of NC machine to the market was in the vicinity period of dominant design around 1993 until 2004. The company entered the NC machine's market prior to the rapid increase in technology development pursuing Quality, Cost, and Delivery (QCD). It becomes viable for the firm to successfully grasp and concentrate on the customers who need special orders.

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