Patterns of the Incremental and Radical Innovation of Design-Driven Enterprises in Singapore

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Abstract:

This paper explores the patterns of design characteristics, design knowledge and design impacts both in incremental and radical innovation based on Singapore design-driven enterprises through case studies approach. Six cases were undertaken. The qualitative case description leads to the development of a visual-designed pattern for the ease of understanding design issues within the two innovation models.

The research concludes that design has important but different impacts on incremental and radical innovation. Four levels of design knowledge for training design students should be conducted in a holistic manner to gain broad and integrative knowledge and skills during their academic education essential for their future design work.

Key words: Design Management and Strategy; Design Issue; Design Education

1. Introduction

There is an increasing consensus that design and innovation is essential to sustain competitive advantage and ensure long-term success through bringing new products to users quickly and efficiently [8, 11, 20]. Managing design innovation is not an easy task. Companies are compelled by intensive competition pressure to develop incremental innovative products to meet current user needs and explore radical innovative products for a new market [2]. The nomenclatures associated with incremental and radical innovation were proposed as early as in 1960's [18]. Past studies focused mainly on incremental innovation or radical innovation alone in the aspects of product development process, marketing and organizational structure and more [1, 15, 19]. It is unclear whether there is any association between the patterns of incremental and radical innovation and whether these two innovation models can be operated in the same way.

Design as an innovation tool was emphasized by scholars and practitioners that it relates not only to aesthetics, but also to other aspects such as human factor, ease of manufacture and product performance. For example, Philip and Alexander [16] described design as a potent strategic innovation tool to enhance products, environment, communications, and corporate identity. Bruce and Bessant [3] indicated design is a facet of both incremental and radical innovation. In addition, innovation alliance and collaboration as a strategic police in product development were widely adopted recently. Chesbrough et al. [5] defined it as "open innovation" and

suggested firms could and should use internal ideas as well as external ideas. Many other scholars also agreed that alliances, outsource and partnerships with other companies, institutions and universities are the essential sources in the innovation process [7, 9, 17]. It is essential to determine three important but unclear issues: innovation process and its outcome, design involvement & impacts and collaboration in the incremental and radical innovation, for in-depth understanding on how to manage these two innovation models effectively and successfully, which will be a good contribution for today's product innovation theory framework.

2. Research methodology

2.1 Research Process

This research focuses on a comparative study of the incremental and radical innovation in order to gain an understanding of patterns between both innovation models adopted by the Singapore design-driven companies. The research is not only to evaluate the existing theories in practice but also to explore and investigate the contemporary phenomenon of design and innovation in practices, in order to inform such theories. Thus, using case study method would be the most appropriate research method to gather contextual understanding about design and innovation patterns. An overview of research process is shown in Figure 1.
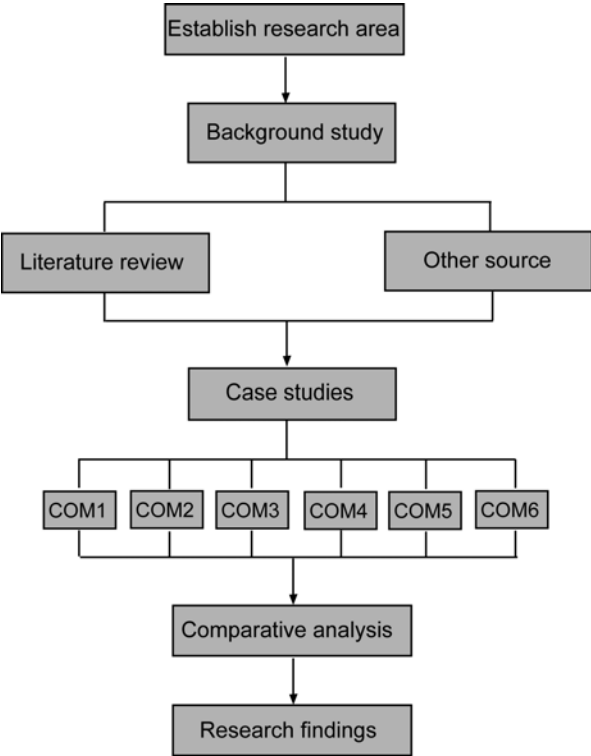

Figure.1 Research process of this study

2.2 Selection of cases

This study aims to get the representative information of product design and innovation patterns through investigating appropriate design-driven companies within Singapore. Based on Langrish's [14] case study selection, the "representative" "the one next door" and "the best practice" approaches were adopted to this study. The principles about selection of companies are:

- The representative: Firms that have good performance in product design and innovation in Singapore.

- The one next door: Firms where investigators have easy access to the design managers or NPD managers for interview.
- The best practice: the competition winner or award winning companies.

Considering the principles mentioned above, this study focuses on the electronic manufacturing industry such as consumer electronics, telecommunication, domestic appliances, health and lifestyle, which requires excellent design and innovation performance. Six firms were selected for case studies with the agreement of participation.

3. Analysis and Discussion of the Research Findings

3.1 Innovation impact in business performance

Table 1 presents six companies' views about the objectives of incremental and radical innovation related to their business performance.

Table 1 Comparison about the objectives of incremental and radical innovation in six cases

	Incremental innovation	Radical innovation
COM1	Good sale High profit	Create new market industry Boost company image and brand value To gain new revenue
COM2	Reduce the cost of production Roll out faster to get market share	Become market leader Explore new market potential Maintain the top brand image
COM3	Quick turn around Gain margin	Explore new direction for the product house Build the brand image Make money, but not necessary
COM4	Maintain the profit Keep the market share	Position Brand image Explore new potential market Push the frontiers
COM5	Follow up customer requests Gain the market share safe revenue	On-going research and exploration to push boundaries for better innovation Show the company is forward-thinking
COM6	Keep the product's competitiveness Obtain revenue	Explore potential market Gain incomings Sets up positive brand image

As indicated in the Table 1, incremental and radical innovations have different but complementary impacts on business performance as follows:

Incremental innovation: is the main force to maintain the profit and maintain the market share. All the six companies indicated that incremental innovation is to provide better sale and obtain more revenue. The improvement and upgrading of product are based on customer's requests or even to reduce costs to keep the product's competency. High intensive competitions impel them to focus on incremental innovation to survive. Thus, the successful implementation of incremental innovation will be one of the key factors contributing to the success of the company.

Radical innovation: has three impacts to business as follows:
1. Push boundaries to create new potential market and detect market reactions: All the six companies agreed that radical innovation can create new market directions. It is a powerful tool to make the company become

market leader, as companies can push the current product boundaries into new areas for new business growth. Radical innovation meets this demand through the exploration of potential customer needs or identification of potential market. However, due to high cost and high market uncertainty, most radical innovations were not "top sale", some even fail, which indicated the development of radical innovation is a risk task. That is why the number of radical innovation is far fewer than that of incremental innovation in most companies. Most of the time, radical innovation plays the pilot role to detect market expectations. After the launch, feedback from market (customers or users) can provide more appropriate directions for forthcoming next generation products, to gain a better market position. These approaches have been widely adopted in the strategy of car industry which produces concept car in the exhibition to show and test market reactions and feedbacks. [13]

2. Boost company image and add brand value: All the respondents indicated radical innovation can have significant impact on the brand value and company image. In general, radical innovation can positively deliver the message that the company is forward thinking when the customers see the innovations in the advertisement or try them on the market, etc. Radical innovations can also attract more investments from stakeholders or other sources. Even though the sale of radical innovation may not be a success, the brand value is still strengthened due to the positive and forward thinking image portrayed by the company. Thus, most well-known brand companies launched a few radical products every year to keep customers interested and demonstrate the latest excellent research achievements to the public and competitors.

3. To gain revenue: Almost half of the respondents indicated that gaining revenue is also one of the main objectives of radical innovation. As the newly launched radical innovative product may attract more customers to buy the product, generally, the price of radical products is much higher than incremental products. However, as most respondents indicated, the revenue gained by radical innovation is limited. The potential is the creation of new market for better incomings.

3.2 Product design characteristics

Figure 2 and Figure 3 demonstrate that the characteristics of incremental and radical innovation in each company vary due to the different market requirement and business strategy, etc.
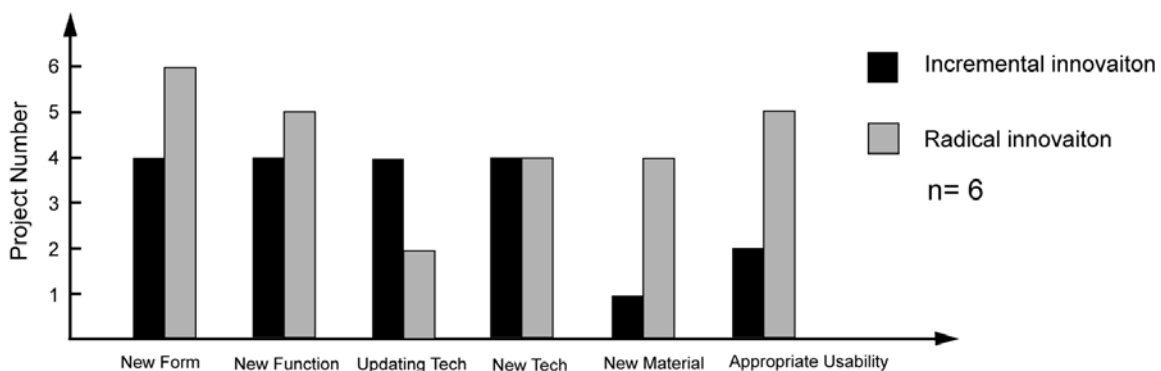

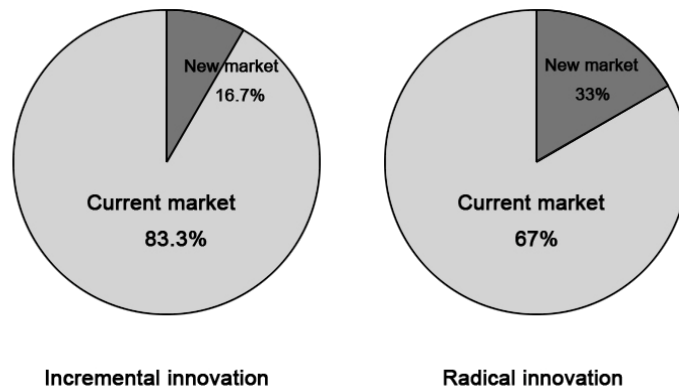Figure 2 Comparison of product characteristics between incremental and radical innovation

Figure 3 Market information of incremental and radical products

From Figure 2 and Figure 3, it can be found that differences in the product characteristics existed in incremental and radical innovation as follows:

- Incremental innovation: redesign and upgrading technology -oriented

  Incremental innovation needs to consider cost, development schedule and market risk. As discussed previously, these products mainly focus on redesigning the product form and applying the upgraded technologies to improve their functions. In some cases, incremental innovation also involves new technologies or new materials; however, there is a big difference in the purpose of adopting new technologies between incremental and radical innovation. In incremental innovation, new technologies and materials were used to assist improvement of existing product system, while radical innovation adopts new technologies or new materials as the innovation drive to develop extremely new products.

- Radical innovation: design & creativity and new technology -oriented

  Comparing to incremental innovation, radical innovation is far beyond the current products.   As discussed above, there are two kinds of orientation in the radical innovation. One is new application of current technologies or materials to innovation. This type of radical innovation is design and creativity orientation, which requires the development team with open-minded thinking to identify potential opportunities. The other is new technology orientation. This type of radical innovations involves the application of new developed technologies. The role of design is only to support the transformation of technologies into a real product.

3.3 Product innovation process

The case studies indicate innovation process and activities in each company consist of five main phases: research & assessment, concept generation, evaluation, production and launch, which is called "five steps" process in this article (See Figure 4). The "five-step" process is similar to that of new product development process suggested by Crawford [6] but with an integration research process as a start point of innovation.
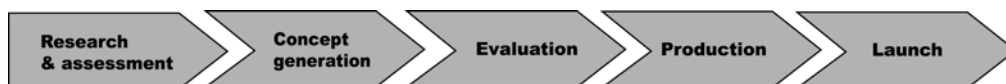

Figure 4 "Five steps" innovation process based on six case studies

However, According to the research finding, innovation activities in each phase vary from one company to another, which depend on company's execution preference and project situation. For most companies, radical innovation shares the same process with incremental innovation, but the contents of activities and emphasis are different; the sequence of sub-steps in radical innovation is fuzzy, especially in the initial phase.

3.4 Levels of design knowledge in the product innovation

Table 2 and Table 3 demonstrates, within both incremental and radical innovation, design plays an important role and has various impacts on all the phases. Various design activities required a lot of knowledge to execute design tasks, which can be categorised into four levels: basic operations & skills, tacit knowledge, design strategic knowledge and visionary capabilities. Based on Hytőnen et al's [10] model, a new level of capability has been added, i.e. visionary capability.

Table 2 Six companies' design impacts in incremental and radical innovation

	Design impact in incremental innovation	Design impact in radical innovation
COM1	Concept generation Styling Usability UI Design coordinating	Concept generation Styling Coordination
COM2	Product styling design Prototype User research Project presentation Coordination with other people	Product styling design Prototype More in-depth user research Presentation High involvement of coordination
COM3	Research Usability UI User experience Packaging	Research Usability Design execution
COM4	Concept generation Visualization Design execution	Concept generation Visualization Design execution
COM5	Plan the product portfolio of the company Identify potential areas in the research stage	Explore the potential customer needs
COM6	Research about the form establishment PI (product identity) design Prototype Gate keeper in the production phase	Research about the form establishment PI (product identity) design Prototype Gate keeper in the production phase

Basic operations & skills: these are the basic requirements for design execution. The main operations and skills identified in the case studies are product styling, aesthetics, prototyping, sketching, usability and user research; sometimes UI (user interface) and packaging also need designers to accomplish. Besides, a lot of other design related knowledge, such as modelling technologies, material finishing, mechanical design, supply chain, business and market knowledge is required to be understood by designers.

Tacit knowledge: this study also discovered tacit knowledge related to personal features such as coordination capabilities, design presentation skills and negotiation abilities is important in the innovation process. Many subjects mentioned that coordination is an essential design impact. Design or innovation requires this tacit knowledge for better and smoother execution.

Design strategic knowledge: many responses indicated that design strategy, product position and branding are very essential in the product innovation. These design strategic knowledge focuses much more on product portfolios and branded house [12]. It belongs to the strategic management level. This research finding illustrates that design is recognized in some companies to optimize the product position and brand image. For instance, COM3 used design strategy to set up the right product position. COM6 adopted design language to build up the product identity to deliver consistent brand image to public. As a strategic role, designers are required to have high level of knowledge in business, marketing, finance and design management. In this way, designers can have a shared language with business managers for better understanding of product strategy, which is helpful for design execution.

Visionary capabilities: most interviewees indicated designers should be creative, forward thinking and predict what is the new user scenario for the new design, which is coined as visionary capabilities. Visionary capability is beyond the product style design, which focuses more on finding new solutions, new user experiences or approaches for future products. It considers what the products are supposed to be without being restricted by the current product systems. All the companies indicated designers should have such creative abilities to explore the potential customer needs and develop revolutionary new product for the future. Therefore, design plays a very important role in product innovation, especially for radical innovation. It requires designers with a systematic knowledge for visionary capability: high ability of observation, in-depth insight of product usage scenario, broad research ability, and creative-thinking genius.

Table 3 Design knowledge requirements in incremental and radical innovation within six companies

	Design requirement in incremental innovation	Design requirement in radical innovation
COM1	Basic knowledge such as: Modelling technologies Material finishing, Mechanical structure	Creativity Coordination to support the whole process High ability of observation In-depth insight of product usability Research ability
COM2	High ability of aesthetic design Ability to solve occurred usability problems	Exploring and determining the potential use problems or requirements Creativity and looking forward thinking
COM3	Ability of detail design	Product position Design strategy
COM4	Design skills Business and marketing knowledge	High ability of Coordination
COM5	Styling and aesthetics High abilities to solve customer requirements	High abilities to foresee the futures of products
COM6	Consistency of design language	Usage scenario and product creativity

As discussed above, Figure 5 presents these four levels of design knowledge for better understanding.

For incremental innovation, design plays more on product form and function, and covers activities such as concept generation, product aesthetic, usability, prototyping, presentation, coordination, product portfolio and strategy planning, which implies incremental innovation requires design knowledge in 1) basic operation & skills, 2) tacit knowledge and 3) design strategic knowledge. For radical innovation, design covers activities such as creativities, basic research, product styling, usability, prototype, presentation and coordination, which

suggested that design in radical innovation focuses on 1) basic operation & skills, 2) tacit knowledge and 3) visionary capabilities. Figure 6 presents the design knowledge allocation in incremental and radical innovation which indicates that basic operation & skills and tacit knowledge are required by both incremental and radical innovation. However, visionary capability is the most important for radical innovation, while basic design knowledge and skills are the essence for incremental innovation.
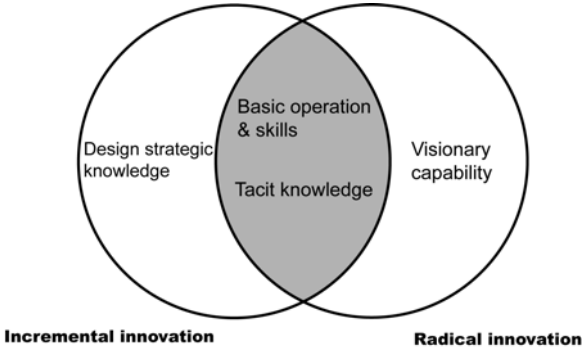

Figure 5 Classification of design knowledge

Figure 6 Allocation of design knowledge in incremental and radical innovation

5. Conclusions

The research findings demonstrated that:

- Incremental and radical innovations have different objectives in business strategic directions. Incremental innovation is for profit and revenue while radical innovation is to explore new market potential and boost brand image.

- Products resulting from incremental and radical innovation possess different design characteristics. Incremental innovation involves redesign and upgrading that is always technology-oriented, while radical innovation could either be design & creativity-oriented or new technology –oriented.

- Most of the companies share a similar process with incremental and radical innovation, but the contents and emphasis are different. Radical innovation focuses on research phase (fuzzy front end) with a more iterative and concurrent process than that of incremental innovation.
- Designers are required to possess four levels of knowledge: basic operations & skills, tacit knowledge, design strategic knowledge, and visionary capabilities. Incremental innovation and radical innovation requires different design knowledge, which indicates incremental innovation more emphasizes on basic operation & skills, while radical innovation more focuses on visionary capabilities.

The research finding suggests several tentative guidelines for design and innovation. First, though radical innovation incurs high cost and is risky to explore, companies, especially for those seeking to set up brand image, cannot ignore but instead, should recognize its key effects on creation of new market and enhancement of brand image, which cannot be achieved by incremental innovation. Second, design is essential to play in accelerating the innovation pace through leading and supporting the whole process from business strategy decision to manufacturing and launch. Companies should utilize the design for better innovation. Third, innovation requiring four levels of design knowledge evokes the appropriate design recruitment and training. This research finding suggests that design education should review the design training to move away from traditional view of design as aesthetics & styling towards a new perception of design in systematic curriculum including creativity, strategy and management. Designers should be trained in a holistic approach and broader based design programs which cover a multi-disciplinary approach, such as the involvement of business management, marketing, engineering etc.

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