Constructing Design Patent Map and Design Strategy Based on Two Perspective of Classifying Methodology

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Abstract: The design patent is considered less definite than other patent categories such as invention and utility model patent, so it is relatively difficult to create a design patent map for design strategy planning. This research adopts two perspectives of classifying methodology to construct innovative design patent mapping using multivariate analysis such as Multidimensional Scaling (MDS) method and cluster analysis. Thirty-eight chair design patents in Taiwan are selected as analytical cases for patent mapping. The findings reveal that the two design patent maps based on MDS method and cluster analysis both show similar design category. The comparable study also depicts the MDS-based design patent map is better in external environmental monitoring such as design trend analysis, selection of design hot zone, design forecasting, and evaluation the design strategy from major competitors. The cluster-based design patent map is useful to understand the design features of existing patent, especially in the current dominant design and new design focus in the context of aesthetic, functional, creative and experience value.

Key words: Design patent, Patent map, Design strategy, Multidimensional scaling, Cluster analysis

1. Introduction

With design knowledge evolving dynamically and proliferating globally, product and industrial design is becoming a more innovative approach wherein the integration of system knowledge is pivotal in accelerate design-driven innovation and expand markets for the new users. Under this competitive environment, some discussions shed light on the constructing design strategies for new product development and design resource planning. The quantity and quality of design patents have also been widely used for evaluating the organizational design capabilities in practice. However, research which has empirically documented the link between design strategy and design patent analysis is still scant because there is limited research findings yet available regarding the constructing of design patent map.

Conventionally, it is also relatively difficult to create a design patent map for design strategy planning because the design patent is considered less definite than other patent categories such as invention and utility model patent [1, 2]. In practice, a invention patent map was built by evaluating novelty and non-obviousness of each related patents, thereby dividing each patent into different blank space in the same portfolio and constructing a means-function matrix using two dimensions of invention means and improved function, respectively [3, 4, 5]. However, the criteria for classifying design patent is still critically lacking compared with invention patent and there is still a need regarding how to construct a design patent map from a new perspective of classification. This research

addresses two perspectives of mathematical methodology to verify design patents using multivariate analysis. Firstly, the multidimensional scaling (MDS) approach is utilized to divide these patents depending upon their similarity in design shape. Secondly, the cluster analysis is also adopted to classify the same patents based on four evaluated criteria involving aesthetic, functional, creative, and experience value.

The findings reveal that the two design patent maps based on MDS method and cluster analysis both show similar design category. The comparable study also depicts the MDS-based design patent map is better in external environmental monitoring, and the cluster-based design patent map is useful to understand the design features of existing patent analysis. These two patent mapping results both provide a strategic suggestion and innovative patent map for further product and design improvement.

This paper is organized as follows. The conceptual development of patent map is introduced in Sections 2. The utility of patent information and the limitation of design patent drawing are explained in this section. A research method and framework are shown in Section 3, and the empirical results of chair design patent category in Taiwan are presented in Section 4. Next, the comparable discussion of these two classifying perspective is explored in Section 5. Finally, the conclusions are presented in Section 6.

2. Development of Patent Map

The concept and development of patent map is introduced in this section. The topic in this context will be addressed regarding how the patent information can be used for product development planning and why the current development is only focusing on invention patent and product R&D but not discussing the role of design patent and design strategy planning.

2.1 Patent Information for Product Development Management

A number of studies have called for the use of patent information in technological and product development [6, 7, 8]. The utility of patent information to measure R&D and design activities is attributed to some unique characteristics of patents. Firstly, invention or design patents are available for firms, which are not required to publish R&D figures and they can be allocated to each product, design, technological fields or inventors. Thus, the upcoming of patent databases has greatly enhanced the possibilities of systematic data retrieval on a large scale. In addition, patents are an objective measure of R&D and design activities, since a patent will be examined and eventually granted by the patent office certification. They are uniformly classified according to the International Patent Application (IPC) classification category, which eases the useful analysis of specific technological or product aspects [3, 4].

Recently patent information has been utilized in several areas of product development and innovation. First, analyzing patent information provides relevant information about the competitor’s product strategies and helps to assess the competitor’s innovativeness. Some important questions of product development management addressed in this context involving how can the firm’s position be evaluated in comparison with the competition in product fields and how can changes in the competition’s product strategies be identified. Meanwhile, patent information can also be adopted to verify options for the external generation of technological knowledge. Some important questions addressed in this context of technology transfer and acquisition encompassing how can external know-how which is of relevance to the firm be identified and how can the technological position of potential acquisitions and R&D alliance partners be evaluated [4, 9, 10].

Furthermore, patent information is also valuable for storing relevant knowledge as a core element of knowledge management and as a tool for human resource management in product development process. Some important questions of product development include how the relevant knowledge can be made available to recipients in the organization and how can leading inventors in a specific product technological field be found [4, 11]. These literatures reveal the information in patent data can be used for strategic planning purposes, especially in product and design development process.

2.2 Conception of Patent Map

With this stream of patent information exploitation, several studies still indicate that many firms have not yet recognized the benefits of patents as a strategic planning source and therefore seldom utilize the patent information for strategic management [3]. This may be attributed to a lack of understanding regarding the advantages of patent information and more specifically on the unfamiliarity with instruments, which are based on patent data and can be used in strategic R&D planning. This practical gap results in a occurrence of patent mapping design.

The concept of patent map is a graphical model of patent visualisation. It is essentially the visualization of the results of statistical analyses and text mining processes applied to patent documents. Patent mapping allows firms to create a visual representation of information from and about patent documents in a way that is easy to understand. It is a useful tool for assessing large sets of patent data [3, 5, 12, 13]. Using bibliographic data one can identify which technical fields particular applicants are active in, and how their filing patterns and IP portfolios change over time. This practice enables firms to identify the patents in a particular technology space, verify the characteristics of these patents and identify their relationships among them [4, 12, 14].

As a result, these patent statistics and patent mapping can provide invaluable information for corporate decision-makers, investors, innovators, and related influencers such as patent offices, policy-makers [12]. However, as the research question mentioned above, these patent mapping skills were only designed for invention patent, not for design patent and the demand of designers. There is still a huge limitation regarding how to draw a useful design patent map.

2.3 Limitation of Design Patent Map

The above-mentioned advantage of patent map planning for new product development was conventionally designed for invention patent index. However, these strategic planning process and evaluated indices can only be used for invention or utility model patent, and there is still a limitation in design patent field. The design patent is considered less definite than other patent categories such as invention patent, so it is relatively difficult to create a design patent map for design strategy planning. Relatively less research has been discovered in a worldwide search of patent documents or publications that is relevant to design patent map drawing [1, 2].

To be elaborate, a invention patent map was conventionally built by the evaluation of novelty and non-obviousness of each related patents, thereby dividing each patent into different block in the same portfolio and constructing a means-function matrix using two dimensions of invention means and improved function, respectively. Table 1 shows a example of invention patent map in semiconductor field. However, the criteria for classifying design patent is still critically lacking compared with invention and utility model patent, and the same concept of means-function typology cannot be applied in design patent analysis. While a user aims to examine each design patent and classify it with each other similar design patent, he cannot clearly depict where the

invention (design) means are and what the improved function is in this specific design ideas, resulting in the difficulty about allocating these similar design patents in a means-function matrix following the same process of invention patent map. There is still a demand concerning how to construct a design patent map and design strategy from a new perspective of classification.

Table 1. Example of Invention Patent Map

	Function 1 (Reduce cost)	**Function 2** (Dissipating heat)	**Function 3** (Decrease thickness)	**Function 4** (Increase electricity)	**Function 5** (Mass production)	**Function 6** (Easy to disassemble)
Invention means 1 (Heat-dissipating)		**64**	**3**		**34**	**8**
Invention means 2 (Material change)	**67**			**24**		**57**
Invention means 3 (Structural design)			**44**		**76**	
Invention means 4 (Add component)		**12**				**33**
Invention means 5 (Reduce process)	**87**				**27**	

3. Methodology

In order to solving the problem of design patent map, this research adopts two perspectives of mathematical classifying methodology to verify design patents using multivariate analysis including multidimensional scaling (MDS) and cluster analysis.

In this two-step analysis, thirty-eight chair design patents are selected as studying cases. Firstly, the multidimensional scaling (MDS) approach is utilized to divide these patents depending upon their similarity in design shape. Secondly, the cluster analysis is also adopted to classify the same patents based on four evaluated criteria involving aesthetic, functional, creative, and experience value. These classifying data of MDS and cluster analysis are collected by questionnaires to professional designers and graduate students in design school. The questionnaire sample is seventeen persons and the investigation duration covered from January to March in 2013. The following sections will briefly introduce these two multivariate classifying methods.

3.1 Multidimensional Scaling (MDS)

Multidimensional Scaling (MDS) is a set of related statistical techniques used in information visualization and categorizing for exploring similarities or dissimilarities in data. To be elaborate, MDS is a special case of ordination. An MDS algorithm begins with a matrix of pariwise comparisons of target similarities, then assigns a location to each target in *N*-dimensional space, where *N* is specified a priori. For sufficiently small *N*, the resulting locations may be displayed in a graph or 2D visualization techniques such as scatterplots. Then, the basic classification of all targets based on their similarities can be shown in this scatterplot [15, 16, 17].

Currently, the implications of MDS approach include scientific visualisation and data mining in fields such as cognitive science, information science, psychophysics, psychometrics, marketing and ecology. New applications also arise in the scope of autonomous wireless nodes that populate a space or an area. MDS may apply as a real time enhanced approach to monitoring and managing such populations. As a result, this study selects MDS method for data visualization, thereby visually categorizing many similar chair design patents depending upon their similarities and differences [16, 18].

3.2 Cluster Analysis

This research will also employ the cluster analysis to classify the related design patent based upon their homogeneous characteristics. The cluster analysis, also known as segmentation analysis and taxonomy analysis, is a set of techniques for accomplishing the task of partitioning a set of observed objects into relatively homogeneous subsets based upon the inter-object similarities [16, 18, 19]. Sharma [17] also defined cluster analysis as a technique used for combining observations into groups or clusters so that: (1) Each group is homogeneous or compact with respect to certain characteristics. (2) Each group should be different from other groups with respect to the same characteristics; that is observations of one group should be different from the observations of other groups.

The objective of cluster analysis is to group observations into clusters in such a way that each cluster is as homogeneous as possible with respect to the clustering variables. The first step in cluster analysis is to select a measure of similarity. Next, a decision is made on the type of clustering technique to be used. Third, the type of clustering method for the selected technique is selected. Fourth, a decision regarding the number of cluster is made. Finally, the cluster solution is interpreted [17]. To classify the operation of cluster analysis smoothly, a analytical procedure in this study introduced by Everitt et al. [19] is indicated as bellow.

The purpose of cluster analysis in this research is to partition a set of observed objects into relatively homogeneous groups such that each group should be different from the other groups with respect to the same or similar clustering variables. In this portion, the observed objects selected for the cluster analysis are the thirty-eight chair design patent. In addition, the clustering variables used for partitioning is four value evaluated criteria involving aesthetic, functional, creative, and experience value. These similar design patents will be categorized by these four value dimension.

4. Research Results

This section will show two design patent mapping result from different perspective of classifying methodology mentioned above, respectively.

4.1 Design Patent Map by Multidimensional Scaling (MDS)

The questionnaire results by MDS from seventeen design-based experts can be obtained and visualized by SPSS for Windows 10 software to show the relative distance of these thirty-eight chair design patent. Figure 1 shows this visualized design patent map by MDS analysis. Thirty-eight points were distributed in this MDS diagram according to their pairwise comparison of similarity. These points account for each different chair design patent and were given the representative symbol from A, B, … Y, Z, AA, AB, … to AL. The mapping result reveals that there are seven primary design categories in chair product (shown as the circle in Figure 1).

Considering the characteristic of MDS method, the only criteria of classifying these patents is just their shape similarity. There is no other classifying variable used in this MDS analysis.

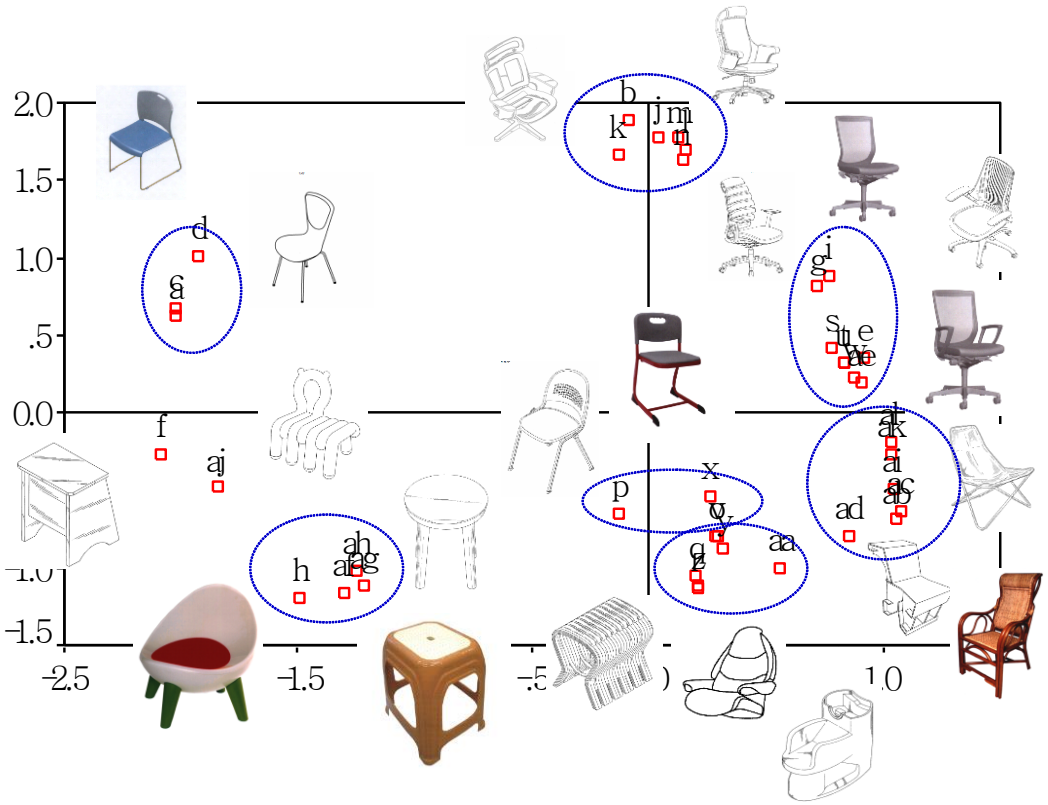


Figure.1 Design Patent Map by MDS Method

4.2 Design Patent Map by Cluster Analysis

The chair design patent map can also be drawn using cluster analysis. The questionnaire of cluster analysis was answered by the same group with seventeen design-based experts. Figure 2 shows the clustering result of these thirty-eight design patents by four value dimension in the form of dendrogram. The result of this clustering dendrogram is obtained by the SPSS for Windows 10 software. Figure 2 also depicts that this study selects the five grouping category for further discussion.

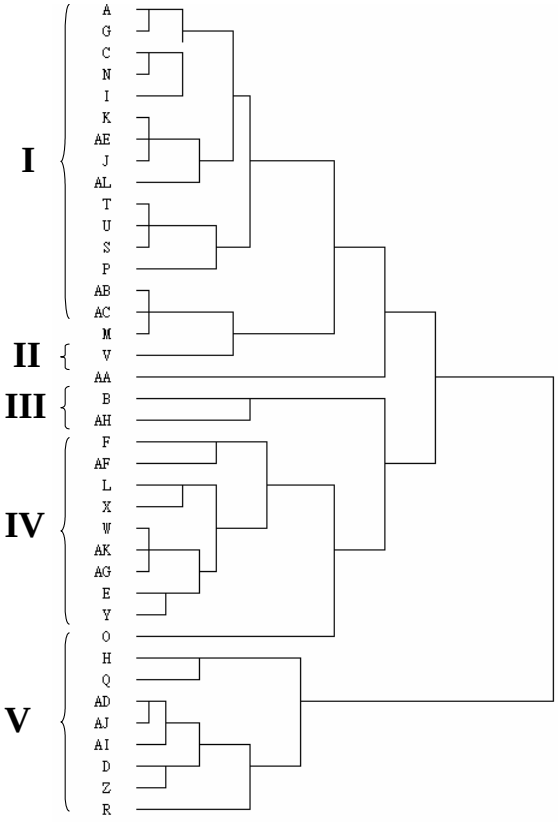


Figure.2 Results from Cluster Analysis

This cluster result can be presented in a form of radar diagram with four dimensions representing the clustering variable of each value, involving aesthetic, functional, creative, and experience value. Figure 3 schematizes this result, showing the different pattern of these five groups in different value combination pattern..

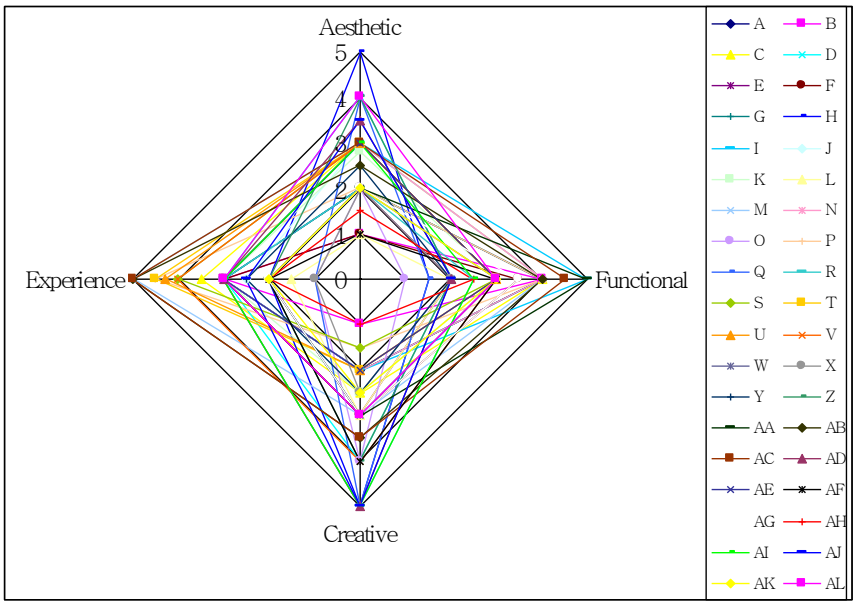
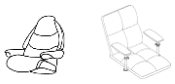
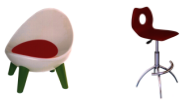


Figure.3 Design Patent Map by Cluster Analysis

These five groups can be named in Table 2 in accordance with their corresponding characteristics of design value. To be elaborate, the first cluster is the Type I design pattern, which focuses on high functional and experience value, encompassing seventeen design patent shown as table. The second cluster is the Type II design pattern, which specializes in high functional value and lower aesthetic / experience value, only has design patent number AA (designed for haircutting implication). The third cluster is the Type III design pattern, which focuses on low aesthetic and creative value, only involving design patent numbers B and AH. They are both more traditional chair design. Additionally, the fourth cluster is the Type IV design pattern, focusing on high creative and low aesthetic value, including ten primary design patents. Finally, the fifth cluster is the Type V design pattern, concentrating on high aesthetic / creative value and lower experience value, encompassing eight design patents. They are all belonged to a more fancy design stream.

Table 2. Category of Design Patent Map by Cluster Analysis

Type	Characteristics	Number of Patent	Typical Case
I	High functional & experience value	A, C, G, I, J, K, M, N, P, S, T, U, V, AB, AC, AE, AL	
II	High functional & low aesthetic / experience value	AA	
III	Low aesthetic / creative value	B, AH	
IV	High creative & low aesthetic value	E, F, L, O, W, X, Y, AF, AG, AK	
V	High aesthetic / creative & low experience value	D, H, Q, R, Z, AD, AI, AJ	

5. Discussions

The research findings reveal that the two design patent maps based on different classifying approaches show similar design category. This classification information is useful for designers and managers in design strategy planning and trend analysis. However, it is not easy to say which methodology and design patent map is more appropriate to further design planning. They should have different implications for theory and practice. This research tries to use Table 3 to discuss the comparable base between the MDS-based and cluster-based design patent maps.

The comparable study shows the MDS-based design patent map is better in external environmental monitoring such as design trend analysis, selection of design hot zone, design forecasting, and evaluation the design strategy from major competitors. This map provides additional information for designers or managers to know the

necessary design-around strategy and new development direction. Contrarily, the cluster-based design patent map is useful to understand the design features of existing patent. Further patent analysis such as patent valuation, current design category, and self-positioning can be obtained by this map, respectively. Five design types from cluster analysis will also indicate the current dominant design and new design focus in the context of value dimension involving aesthetic, functional, creative and experience aspects. These two patent mapping results both provide a strategic suggestion for future product and design improvement.

Table 3. Comparison of Two Perspective of Classifying Methodology

Design planning and strategy		MDS-based design patent map	Cluster-based design patent map
Environmental monitoring	Design trend analysis	**Easy to know the trend distribution and focus**	Limited to selected clustering variables
	Design hot zone	**Easy to know where is hot zone**	Limited to selected clustering variables
	Design forecasting	**Trend can be forecasted by long-term analysis**	**Trend can be observed in different clustering group**
	Major competitor monitoring	**Easy to observe the development context**	Limited to selected clustering variables
Existing patent analysis	Patent valuation	Lack of evaluated criteria	**Value can be verified by clustering variables**
	Dominant design	Only know the design hot zone	**More information about dominant design by clustering variables**
	Self-positioning	**Self-positioning in overall patent track**	**Self-positioning in which patent type**
	New design opportunity	Lack of design criteria for vacant area	**New opportunity can be observed from emergent type**

6. Conclusions

The design patent is considered less definite than other patent categories such as invention and utility model patent, so it is relatively difficult to create a design patent map for design strategy planning. Relatively less research has been explored in a worldwide search of patent documents or publications that is relevant to design patent map drawing. This research adopts two perspectives of classifying methodology to verify chair design patents in Taiwan using multivariate analysis. The findings reveal that the two design patent maps based on MDS method and cluster analysis both show similar design category. The comparable study also depicts the MDS-based design patent map is better in external environmental monitoring such as design trend analysis, selection of design hot zone, design forecasting, and evaluation the design strategy from major competitors. On the other hand, the cluster-based design patent map is useful to understand the design features of existing patent, especially in clarifying the current dominant design and new design focus in the context of aesthetic, functional, creative and

experience value. These two patent mapping results both provide a strategic suggestion and innovative patent map for further product and design improvement.

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