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International Conference on Information Resources Management (CONF-IRM)

5-2015

Considering Corporate Strategies with Self-Organizing Patent Maps and Decision Making with AHP

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Abstract

Previously, we proposed an approach for corporate decision making with self-organizing patent maps labeled by technical terms and AHP. First, we extracted keywords by text mining to transform patent documents into feature vectors of the companies. Second, we inputted the feature matrix of technical terms and company names into self-organizing maps to create patent maps labeled by the technical terms. Then, we considered several corporate strategies utilizing the patent maps and made a decision with AHP. We applied our approach to two patent areas (information home appliance and 3D image) to show examples of corporate decision making. However, it was unclear how to derive corporate strategies in our previous work. In this paper, we propose an approach for considering corporate strategies with self-organizing patent maps labeled by technical terms. Then, we applied our approach to two other patent areas (mobile phone and organic electro-luminescence display) to show examples of considering corporate strategies and decision making with AHP.

Keywords

Business Intelligence, Decision Making, Corporate Strategy, Patent Maps, Self-Organizing Maps, Text Mining, AHP.

1. Introduction

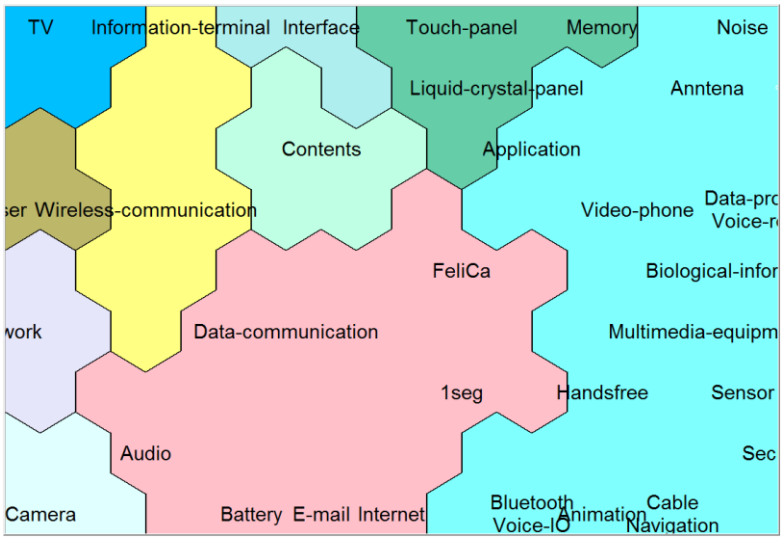
When a company starts research and development or licensing for entering into a new business in a certain technology field, the company needs to recognize the overall scope of that and other related technology fields, including pertinent patents. A patent map is the visualized expression of total patent analysis results for understanding complex patent information easily and effectively. The patent map is produced by gathering, processing, and analyzing pertinent patent information of the targeted technology field. Creating and updating such a map requires substantial human effort. Because automatic tools for assisting patent analysis are in demand, patent documents are typically analyzed by *text mining*, which is a technique for finding hidden and useful patterns in a text database (e.g., (Yoon et al. 2002), (Jun, 2011)). In addition, numerous works show that *self-organizing maps* (SOMs) (Kohonen, 1995) are effective in classifying a collection of text documents and building two-dimensional maps.

Previously, we proposed an approach for decision making of corporate strategy that uses self-organizing patent maps labeled by technical terms and the *analytic hierarchy process* (AHP) (Saaty, 1980) (Kohara et al. 2012). First, we extracted keywords by text mining to transform patent documents into feature vectors of the companies. Second, we inputted the feature matrix of technical terms and company names into SOMs to create patent maps labeled by the technical terms. Then, we considered several corporate strategies utilizing the patent maps and made a decision with AHP. We applied our approach to two patent areas (information home appliance and 3D image) to show examples of corporate decision making. However, it was unclear how to derive corporate strategies in our previous work. In this paper, we propose an approach for considering corporate strategies with self-organizing patent maps labeled by technical terms. Then, we applied our approach to two other patent areas (mobile phone and organic electro-luminescence display) to show examples of considering corporate strategies and decision making with AHP.

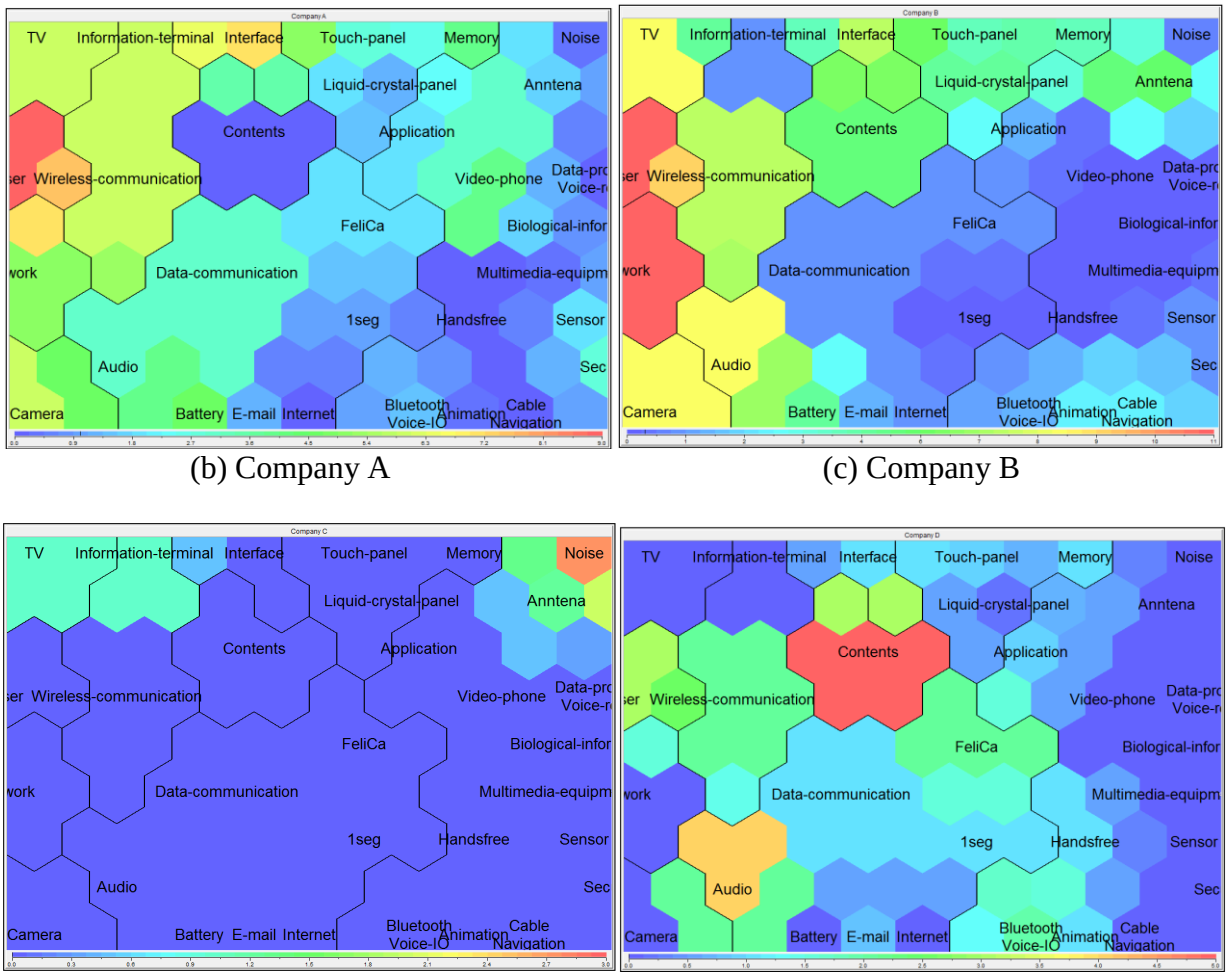
2. Patents on mobile phone

2.1 Creating self-organizing patent maps on mobile phone

We collected 768 patent documents (in Japanese) containing a summary of the problem and the solution from the IPDL (Industrial Property Digital Library provided by Japan's National Center for Industrial Property Information and Training) using the keyword "mobile phone." The number of applicants was 331 from the time period 2009 to 2010. We extract technical terms by word frequency analysis. We extract nouns whose frequency is five or more and whose number of letters is three or more. We ignore words which are vague, such as "computer," "data," or "system." We also extract technical terms by dependence relation analysis. Here, we extract nouns according to four cues of Japanese words: *hon-hatumei* (this invention), *teikyou* (offer), *kadai* (problem) and *mokuteki* (purpose) (Sakai et al. 2009). We extracted 48 words by using the word frequency and dependence relation analysis. We considered similar words as one word to reduce the number of words because a large number of words cannot be used to cluster patents using SOM.



(a) Clusters of technical terms for mobile phone



(b) Company A (c) Company B

(d) Company C (e) Company D

Figure 1: Self-organizing patent maps labeled by technical terms for mobile phone

Figure 1 (a) shows clusters of technical terms for "mobile phone." Figures 1 (b), (c), (d) and (e) show patent maps of Companies A, B, C and D, respectively, in which a color scale shows the number of terms. The color similarity of Companies A and B in Figures 1 (b) and (c) indicate the companies are highly competitive. They are leading companies in this field. The orange, yellow and green nodes for technical terms "Wireless-communication," "Interface," and "Camera" in Companies A and Company B indicate the frequency of occurrence of these terms is comparatively high. Dark blue means that corresponding terms are not present. In Figure 1 (d), the orange node corresponding to the technical term "Noise" means that the frequency of occurrence of "Noise" in the patents applied for by Company C is high. In Figure 1 (e), the red node corresponding to the technical term "Contents" means that the frequency of occurrence of "Contents" in the patents applied for by Company D is high.

2.2 Considering corporate strategies with self-organizing patent maps

Here, we propose a way of considering corporate strategies with self-organizing patent maps labeled by technical terms.

Step 1: Decide the target company for whom corporate strategies are considered.
Here, we decided Company A who is a leading company in the field of mobile phone.
Step 2: Decide the company who is competitive with the company decided in Step 1.
Here, we decided Company B who is another leading company.
Step 3: Find technical terms which appear in the patent map of Company A and don't appear in the patent map of Company B, by observing self-organizing patent maps labeled by technical terms. Consider a corporate strategy in which Company A will promote product development using the technology as a selling point.
Step 4: Find technical terms which appear in the patent map of Company B and don't appear in the patent map of Company A, by observing self-organizing patent maps labeled by technical terms. Consider a corporate strategy in which Company A will promote research and development (R&D) on the technology, or find other company X which has the technology and promote product development by working together with Company X.
Step 5: Find technical terms which don't appear in the patent map of Companies A and B, by observing self-organizing patent maps. Consider a corporate strategy in which Company A will promote R&D on the technology, or find other company Y which has the technology and promote product development by working together with Company Y.

According to the above steps, we considered the following corporate strategy with which Company A will overcome Company B.
Strategy A1: Company A makes plans for business expansion using video phone technology (the green node in the center right part of Figure 1 (b)), patents for which Company B has not yet applied.
Strategy A2: Company A makes plans for business expansion using 1seg technology (the light blue node in the upper right part of Figure 1 (b)), patents for which Company B has not yet applied.
Strategy A3: As noise reduction technology doesn't appear in both patent maps of Companies A and B, Company A enters into licensing agreements with Company C who has already applied for a noise reduction patent.
Strategy A4: As bluetooth technology doesn't appear in both patent maps of Companies A and B, Company A enters into licensing agreements with Company D who has already applied for a bluetooth patent.

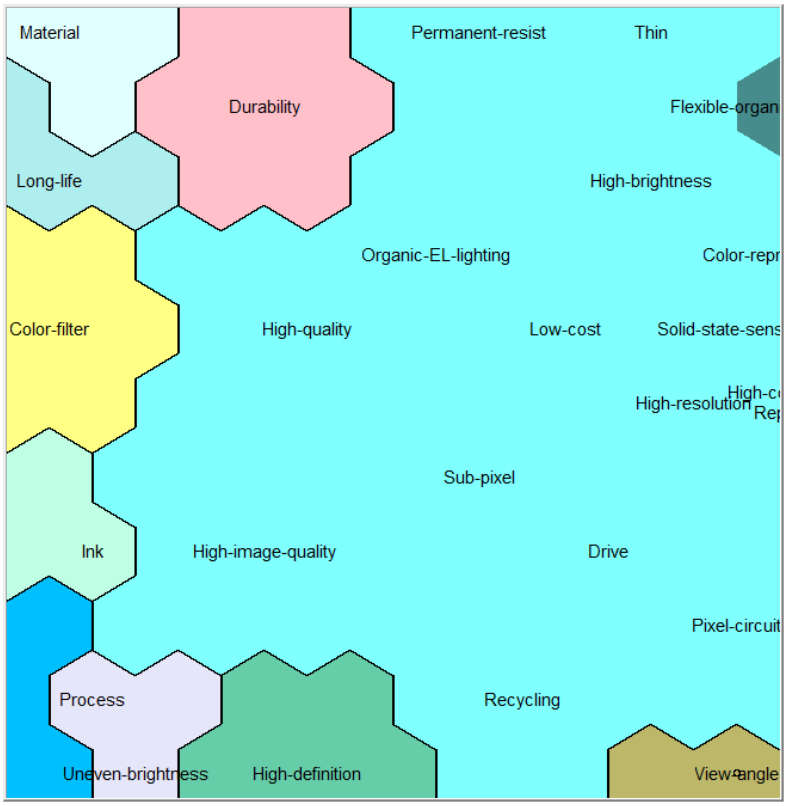
3. Patents on organic electro-luminescence display

3.1 Creating self-organizing patent maps on organic EL display

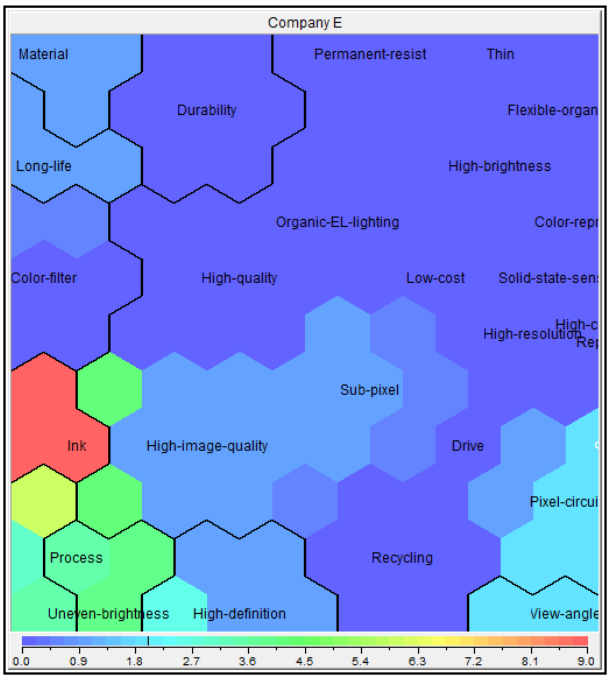
We collected 647 patent documents from IPDL using the word "organic electro-luminescence display." The number of applicants was 66 for the time period 2010 to 2011. Using the word frequency and dependence relation analysis, we extracted 25 words.

Figure 2 (a) shows clusters of technical terms for "organic EL display." Figures 2 (b), (c), (d) and (e) show patent maps of Companies E, F, G and H, respectively. In Figures 2 (b) and (c), the similar colors of the patent maps of Companies E and F indicate they are highly competitive. They are leading companies in this field. The red node for "Ink" indicates the high frequency of occurrence of this term in the patents applied for by Companies E and F. The green node for the technical terms "Process" and the light blue node for "Long-life" in Companies E and F indicate their comparatively high frequency of occurrence. In Figure 2 (d), the green and light blue nodes

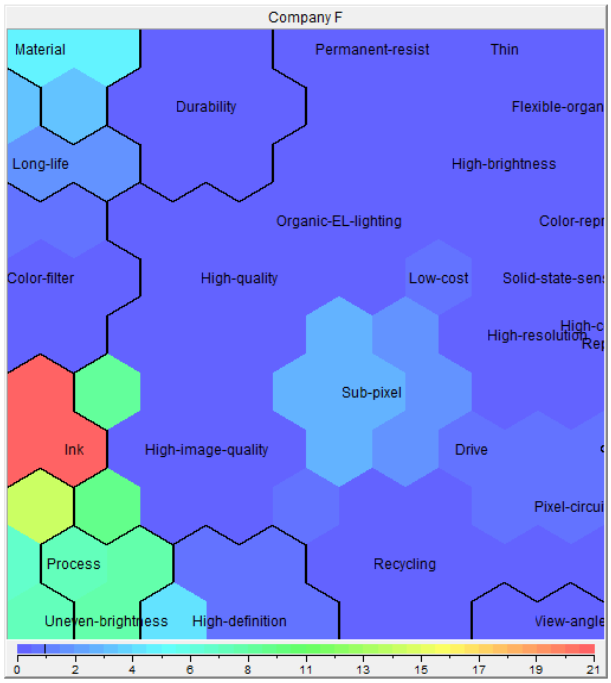
corresponding to the technical terms “Material” and “Durability” mean that the frequency of occurrence of “Material” and “Durability” in the patents applied for by Company G is high. In Figure 2 (e), the green and light blue nodes corresponding to the technical terms “High-definition,” “High-brightness” and “High-image-quality” in Company H indicate a comparatively high frequency of occurrence of these terms



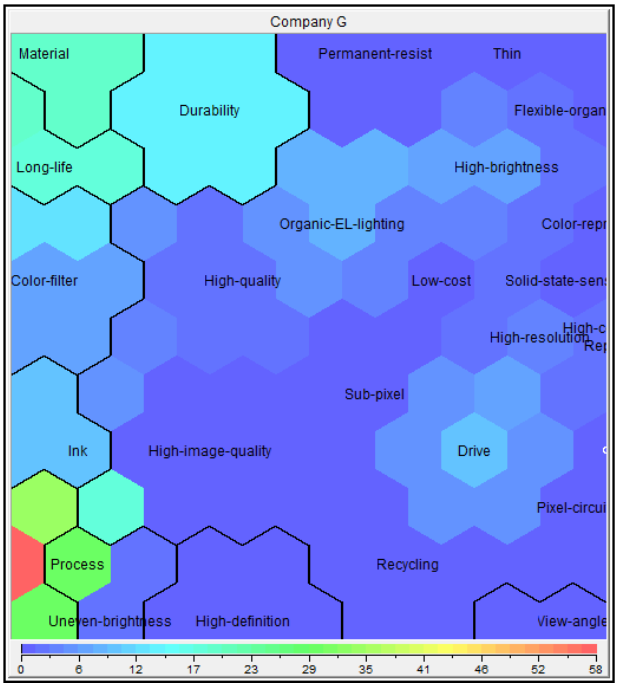
(a) Clusters of technical terms for organic EL display



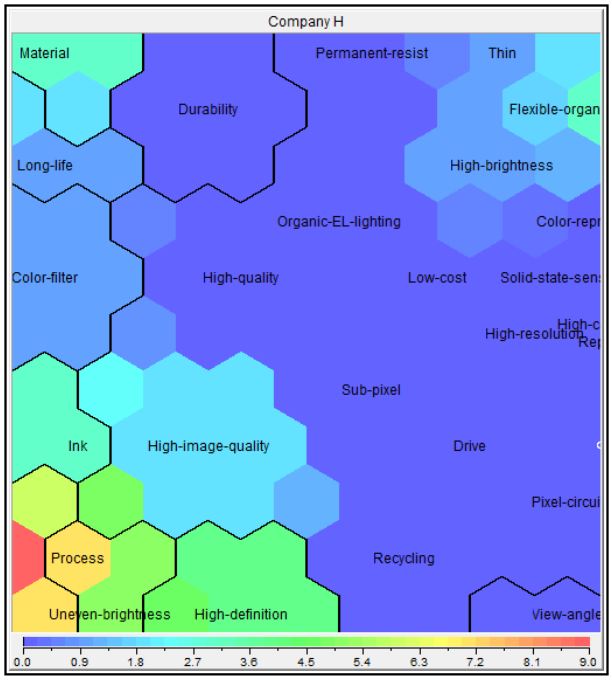
(b) Company E



(c) Company F



(d) Company G



(e) Company H

Figure 2: Self-organizing patent maps labeled by technical terms for organic EL display

3.2 Considering corporate strategies with self-organizing patent maps

According to the steps described in Sec. 2.2, we considered the following corporate strategy with which Company E will overcome Company F.

Strategy E1: Company E makes plans for business expansion using view angle technology (the green node in the lower right part of Figure 2 (b)), patents for which Company F has not yet applied.
Strategy E2: Company E makes plans for business expansion using high image quality technology (the light blue node in the lower left part of Figure 2 (b)), patents for which Company F has not yet applied.
Strategy E3: As drive technology doesn't appear in the patent map of Company E, Company E enters into licensing agreements with Company G who has already applied for a drive patent.
Strategy E4: As high brightness technology doesn't appear in both patent maps of Companies E and F, Company E promotes product development by working together with Company H who has already applied for a high brightness patent.

4. Corporate decision making with AHP

4.1 Corporate decision making on mobile phone

AHP has been widely used for economic, political, social and corporate decision making (e.g., (Saaty & Vargas 1994), (Saaty, 2001)). Figure 3 shows an example of the relative measurement AHP model created for the task of corporate decision making on mobile phone by Company A. Here, we used the following four criteria: required time, income, human resources, and R&D funds.

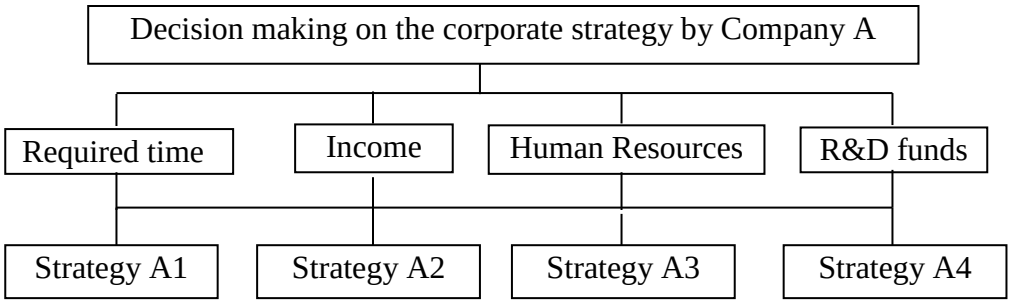


Figure 3: AHP model for corporate decision making by Company A

We assumed the pairwise comparison matrix for Company A. The pairwise comparison matrix for the four criteria is shown in Table 1. Intensity of importance is 1 for equal importance, 3 for moderate importance, 5 for essential or strong importance, 7 for demonstrated importance and 9 for extreme importance. Intermediate values between the two adjacent judgements are used when compromise id needed. Here, we assumed that required time is most important in mobile phones, income is second most important, and human resources is third most important. In Table 1, required time is moderate important to income, strongly important to human resources, and demonstrated important to R&D funds. As a result, required time is most important and its weight is 0.565.

Table 1: Pairwise comparisons of four criteria

	Required time	Income	Human resources	R&D funds	Weight
Required time	1	3	5	7	0.565
Income	1/3	1	3	5	0.262
Human resources	1/5	1/3	1	3	0.117
R&D funds	1/7	1/5	1/3	1	0.055

Consistency index = 0.039

Consistency index shows whether the pairwise comparison is appropriate or not. When the index is lower than 0.1, the pairwise comparison is appropriate. When the index is over 0.1, the comparison is not appropriate and should be corrected. In this case, consistency index was 0.039 and the pairwise comparison was appropriate.

The pairwise comparisons of four alternatives with respect to required time are shown in Table 2. The weights of Strategies A1 and A2 were highest. Because Company A makes plans for business expansion using his own technology in Strategies A1 and A2, we assumed that the required time of Strategies A1 and A2 is shortest.

Table 2: Pairwise comparisons of alternatives with respect to required time

	Strategy A1	Strategy A2	Strategy A3	Strategy A4	Weight
Strategy A1	1	1	3	3	0.375
Strategy A2	1	1	3	3	0.375
Strategy A3	1/3	1/3	1	1	0.125
Strategy A4	1/3	1/3	1	1	0.125

Consistency index = 0

The pairwise comparisons of four alternatives with respect to income are shown in Table 3. The weight of Strategy A2 was highest and the weight of Strategy A1 was lowest. Because we assumed that the income resulting from 1seg technology of Strategy A2 is highest and the income resulting from video phone technology of Strategy A1 is lowest in Japan.

Table 3: Pairwise comparisons of alternatives with respect to income

	Strategy A1	Strategy A2	Strategy A3	Strategy A4	Weight
Strategy A1	1	1/4	1/3	1/3	0.089
Strategy A2	4	1	2	2	0.434
Strategy A3	3	1/2	1	1	0.239
Strategy A4	3	1/2	1	1	0.239

Consistency index = 0.070

The pairwise comparisons of four alternatives with respect to human resources are shown in Table 4. The weights of Strategies A1 (video phone) and A2 (1seg) were highest, because Company A already has human resources concerning with video phone and 1seg technology.

Table 4: Pairwise comparisons of alternatives with respect to human resources

	Strategy A1	Strategy A2	Strategy A3	Strategy A4	Weight
Strategy A1	1	1	5	5	0.417
Strategy A2	1	1	5	5	0.417
Strategy A3	1/5	1/5	1	1	0.083
Strategy A4	1/5	1/5	1	1	0.083

Consistency index = 0

The pairwise comparisons of four alternatives with respect to R&D funds are shown in Table 5. The weights of Strategies A1 (video phone) and A2 (1seg) were highest, because Company A already has video phone and 1seg technology.

Table 5: Pairwise comparisons of alternatives with respect to R&D funds

	Strategy A1	Strategy A2	Strategy A3	Strategy A4	Weight
Strategy A1	1	1	3	3	0.375
Strategy A2	1	1	3	3	0.375
Strategy A3	1/3	1/3	1	1	0.125
Strategy A4	1/3	1/3	1	1	0.125

Consistency index = 0

Table 6 shows final results of AHP. Strategy A2 was the best. Because we assumed that short required time is most important and high income is second most important. The required time of Strategy A2 is shortest and the income of Strategy A2 is highest. Strategy A2 is selected as the final choice.

Table 6: Final results of AHP for the task of corporate decision making on "mobile phone" by Company A

Criteria	Required time	Income	Human resources	R&D funds	Result
Weight of criteria	0.565	0.262	0.117	0.055	
Strategy A1	0.375	0.089	0.417	0.375	0.305
Strategy A2	0.375	0.434	0.417	0.375	0.395
Strategy A3	0.125	0.239	0.083	0.125	0.15
Strategy A4	0.125	0.239	0.083	0.125	0.15

4.2 Corporate decision making on organic EL display

Figure 4 shows an example of the relative measurement AHP model created for the task of corporate decision making on organic EL display by Company E. Here, we also used the following four criteria: required time, income, human resources, and R&D funds.

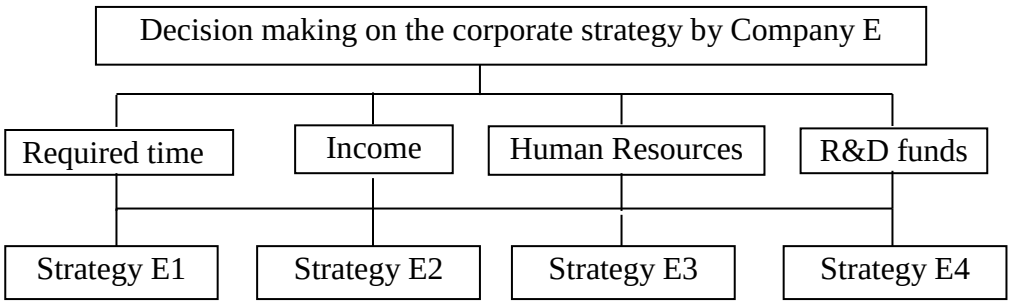


Figure 4: AHP model for corporate decision making by Company E

We assumed the pairwise comparison matrix for Company E. The pairwise comparison matrix for the four criteria is shown in Table 7. Here, we also assumed that required time is most important in organic EL displays, income is second most important, and human resources is third most important.

Table 7: Pairwise comparisons of four criteria

	Required time	Income	Human resources	R&D funds	Weight
Required time	1	3	5	7	0.565
Income	1/3	1	3	5	0.262
Human resources	1/5	1/3	1	3	0.117
R&D funds	1/7	1/5	1/3	1	0.055

Consistency index = 0.039

The pairwise comparisons of four alternatives with respect to required time are shown in Table 8. The weights of Strategies E1 and E2 were highest and the weight of Strategy E4 was third highest. Because Company E makes plans for business expansion using his own technology in Strategies E1 and E2, we assumed that the required time of Strategies E1 and E2 is shortest. As Company E promotes product development by working together with Company H who has his own technology in Strategy E4, we assumed that the required time of Strategy E4 is third shortest.

Table 8: Pairwise comparisons of alternatives with respect to required time

	Strategy E1	Strategy E2	Strategy E3	Strategy E4	Weight
Strategy E1	1	1	3	2	0.351
Strategy E2	1	1	3	2	0.351
Strategy E3	1/3	1/3	1	1/2	0.109
Strategy E4	1/2	1/2	2	1	0.189

Consistency index = 0.003

The pairwise comparisons of four alternatives with respect to income are shown in Table 9. The weight of Strategy E2 was highest and the weight of Strategy E1 was second highest. Because

we assumed that the income resulting from high image quality technology of Strategy E2 is highest and the income resulting from view angle technology of Strategy E1 is second highest.

Table 9: Pairwise comparisons of alternatives with respect to income

	Strategy E1	Strategy E2	Strategy E3	Strategy E4	Weight
Strategy E1	1	1/2	3	3	0.297
Strategy E2	2	1	4	4	0.485
Strategy E3	1/3	1/4	1	1	0.109
Strategy E4	1/3	1/4	1	1	0.109

Consistency index = 0.007

The pairwise comparisons of four alternatives with respect to human resources are shown in Table 10. The weights of Strategies E1 (view angle) and E2 (high image quality) were highest, because Company E already has human resources concerning with view angle and high image quality technology.

Table 10: Pairwise comparisons of alternatives with respect to human resources

	Strategy E1	Strategy E2	Strategy E3	Strategy E4	Weight
Strategy E1	1	1	5	3	0.390
Strategy E2	1	1	5	3	0.390
Strategy E3	1/5	1/5	1	1/3	0.068
Strategy E4	1/3	1/3	3	1	0.152

Consistency index = 0.014

The pairwise comparisons of four alternatives with respect to R&D funds are shown in Table 11. The weights of Strategies E1 (view angle) and E2 (high image quality) were highest, because Company E already has view angle and high image quality technology.

Table 11: Pairwise comparisons of alternatives with respect to R&D funds

	Strategy E1	Strategy E2	Strategy E3	Strategy E4	Weight
Strategy E1	1	1	3	2	0.351
Strategy E2	1	1	3	2	0.351
Strategy E3	1/3	1/3	1	1/2	0.109
Strategy E4	1/2	1/2	2	1	0.189

Consistency index = 0.003

Table 12 shows final results of AHP. Strategy E2 was the best. Because we assumed that short required time is most important and high income is second most important. The required time of Strategy E2 is shortest and the income of Strategy E2 is highest. Strategy E2 is selected as the final choice.

Table 12: Final results of AHP for the task of corporate decision making on "organic electro-luminescence display" by Company E

Criteria	Required time	Income	Human resources	R&D funds	Result
Weight of criteria	0.565	0.262	0.117	0.055	
Strategy E1	0.351	0.297	0.390	0.351	0.341
Strategy E2	0.351	0.485	0.390	0.351	0.390
Strategy E3	0.109	0.109	0.068	0.109	0.104
Strategy E4	0.189	0.109	0.152	0.189	0.164

5. Conclusion

We proposed an approach for considering corporate strategies with self-organizing patent maps labeled by technical terms. Then, we applied our approach to two patent areas (mobile phone and organic electro-luminescence display) to show examples of considering corporate strategies and decision making with AHP.

References

Jun, S. (2011) "Technology marketing using PCA, SOM, and STP strategy modeling", *IJCSI International Journal of Computer Science Issues*, (8)1, pp.87-92

Kohara, K., T. Kato and H. Kouno (2012) "Corporate decision making with self-organizing patent maps labelled by technical terms and AHP," *Proc. of CONF-IRM 2012*, Paper 21

Kohonen, T. (1995) *Self-Organizing Maps*, New York: Springer

Saaty, T. (1980) *The Analytic Hierarchy Process*, New York: McGraw-Hill

Saaty, T. and L. G. Vargas (1994) *Decision Making in Economic, Political, Social and Technological Environments with the Analytic Hierarchy Process*, Pittsburgh: RWS Publications

Saaty, T. (2001) *Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World*, Pittsburgh: RWS Publications

Sakai, H., H. Nonaka and S. Masuyama (2009) "Extraction of information on the purpose and the technical effect from a patent document", *The 23rd Annual Conference of the Japanese Society for Artificial Intelligence*. (in Japanese)

Yoon, B., C. Yoon and Y. Park (2002) "On the development and application of a self-organizing feature map-based patent map", *R&D Management*, (32)4, pp.291-300