Environmental Consciousness in Japan on Materials and Products
- Analysis of Eco-MCPS, a Web-database for Ecomaterials

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【abstract】

Eco-MCPS database is a web-based database system that contains data of environment-conscious materials, components, products, and services. The text data compiled in the Eco-MCPS and the access log data of Eco-MCPS were subjected to data mining. Word-frequency analysis and dependency parsing analysis were applied to the data to obtain the frequently used terms and their situations of use. By analyzing the access log, the interest of the visitors accessed to the web-site can be understood. The results showed that eco-products' environmental performances are realized by the use of environment-friendly components or materials. The page views, which represent the visitors' interest, were related with the frequently used term in the comments of Eco-MCPS to show the social consciousness on environment-friendly products. By further analyzing the access log, it was found that the word search rank followed the Zipf's Law.

【key words】

eco-material, eco-product, web database, data-mining, text-mining

1. INTRODUCTION

"Eco-M･C･P･S" database (simply Eco-MCPS) is a web-based database system developed by the database subcommittee of Ecomaterial Forum in 2006 [1], which includes fact data provided by

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the manufacturers and environmental category descriptions on environment-friendly (environmentally conscious) items that can be categorized in one of the groups of materials (M), components (C), products (P), and services (S). Data in Eco-MCPS were collected by the inquiry survey to companies. Each data can be found by “Keyword Search” and in three different type of categories: product categories, key categories, and environmental categories (Figure 1). Each category has a page which includes a list of product items. Most items appear in multiple categories (even in the same kind of categories). Thus, users can search each item from a variety of performances. Eco-MCPS is not only a simple compilation of facts, but also an interactive site which changes according to the access made by the Web site visitors. For example, there are rankings of users’ action on the top page as shown in Figure 1. From the top page, a visitor can see the latest trend in the environmental interest items and keywords.

Eco-MCPS database has been revised several times and the latest version is Ver. 5, with intensified security level and newly added functions such as showing the searched item ranking and the searched word ranking. The data in the database are renewed every year by sending enquiry sheets to the companies. The database currently contains ca. 900 data sheets; products account for 57% of the entire items, while materials, components, and others each account for 20%, 15%, and 8%, respectively.

It has been reported [2] that the general interest to the environmental issues can be effectively studied by analyzing the access log of Eco-MCPS using a data mining technique. Since environmental problems not only are a matter of technology but are also related to human behavior or consciousness, it is

Figure 1(a) The top page　**Figure 1(b)** A list page　**Figure 1(c)** A product page

extremely important to involve such methodologies of social science in analyzing the general trends of eco-materials. By applying text mining [3] to the text data compiled in Eco-MCPS as product "profile (short sentence describing the product)" and "comments (longer description on the product)", it was found that the manufacturers and assembling companies use the term "environment-friendly" to stress their product superiority in energy saving or resource saving [4].

The present study aims to analyze the social consciousness on environment-friendly products by data-mining the access log, in contrast to the results obtained by text-mining of the facts stored as data in the Eco-MCPS. Word-frequency analysis and dependency parsing analysis were applied to the data to obtain the frequently used terms and their situations of use.

2. METHOD

2.1. Details and Functions of Eco-MCPS Web database

The database is freely accessible through the internet at URL http://eco-mcpsdb.sntt.or.jp/index.php. Referring to Fig.1, the products can be accessed either from the Product categories, the Key categories, or the Environmental categories (from the viewpoint of A: environmental impact reduction, B: the environmental performance required for resolving the problems, or from C: the life cycle stages of interest). The environmental impacts considered were: (A-1) climate change, (A-2) air pollution, (A-3) hazardous substances, (A-4) wastes, and (A-5) resource consumption. The environmental performance was categorized by (B-1) easy-to-recycle, (B-2) longer life, (B-3) resource saving, (B-4) higher performance, (B-5) energy saving, (B-6) environment cleaning, (B-7) use of recycled materials. Concerning the life cycle of the product, six stages as follows were set: (C-1) extraction, (C-2) material and parts preparation, (C-3) product design, (C-4) production, (C-5) product use/maintenance/repair, and (C-6) waste.

In the Key categories, some products are related to others by linking through "keys"; for instance, if cell phone is categorized as OA/IT equipment, and if the eco-material used for the casing is a bio-polymer usable for other components such as computers, this product is linked to "housing".

Figure 1(c) shows the product page of the Eco-MCPS. Each product item has two Japanese text data: the profile and the comment. The profile text is a short phrase to explain the item's feature. The comment text is a detailed explanation of the item.

2.2. Analysis of item feature

Text mining [3] was applied to the text data; more specifically, the text data compiled in the database as the "profile" and "comment" of each data sheet, were imported in Text Mining Studio (NTT Data Mathematical Systems, Inc.), which is a package program for text-mining, and were subjected to word-frequency analysis. In the analysis, the original text data were re-written depending on the parse by leaving spaces among the words, and the words were subjected to dependency parsing. In this manner, frequently

used words were searched and checked to see at which situation they were used.

2.3. Access log

The Eco-MCPS system logs every user access under anonymity. The logged data are following: (1) log id, (2) user id, (3) view page, (4) date, (5) IP, (6) domain.

The access log data provides the information how many times a particular page was viewed in a certain period of time. That is, by keeping record of the page views, the so-called access ranking can be obtained.

The total access log for one year was taken for analysis to compare the yearly change in the social interest for the environmentally conscious products.

3. RESULTS AND DISSCUTION

The following three results were obtained by applying mining analyses to Eco-MCPS.

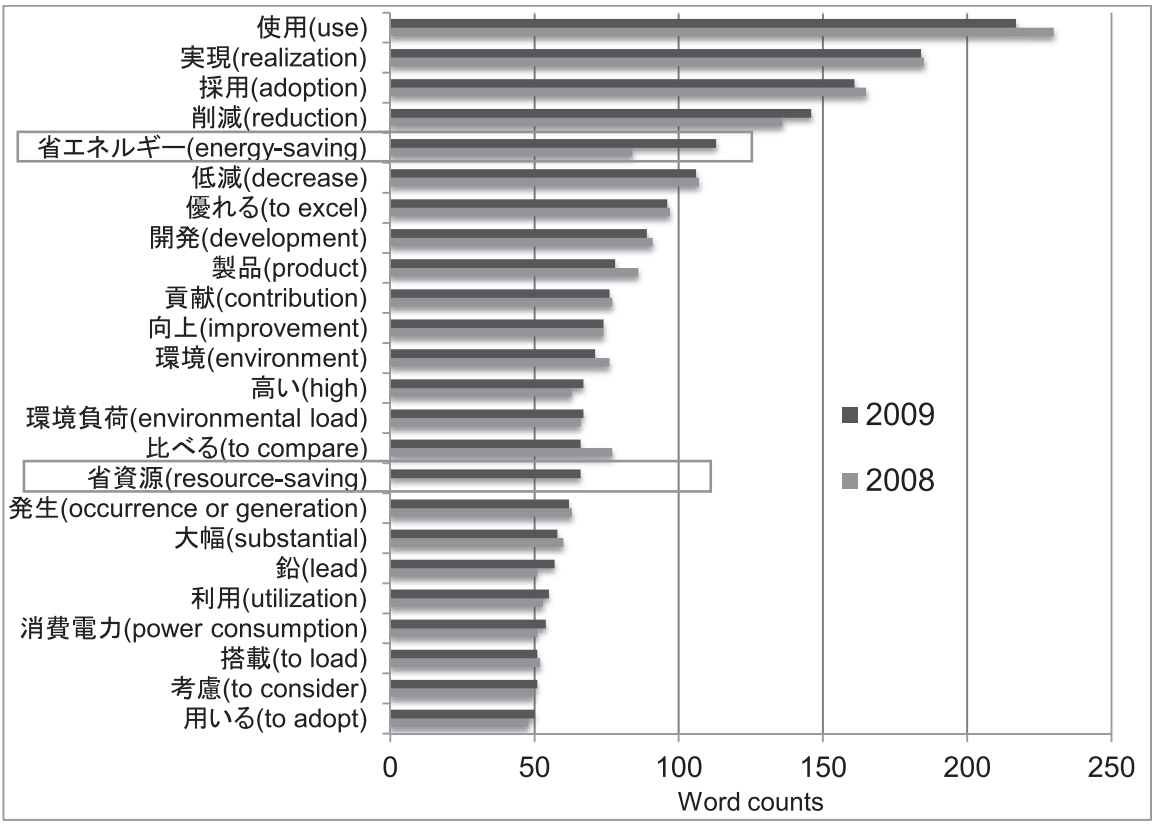

Figure 2 Word frequency analysis results for 2008 and 2009.

3.1. Frequency analysis of words in the data sheet

Text mining was applied to the data contained in Eco-MCPS from October 2007 to September 2008, and to the data between October 2008 and September 2009. Figure 2 shows the results of word frequency analysis for two years. The datasheets contain "use" most frequently in the profiles describing the products, and also "realization" to describe how the products realize the concept of environmental advantages. The greatest differences between the 2008 datasheets and those of 2009 appear in "energy-saving" and "resource-saving". This can be attributed to the Program to promote the spread of Green home appliances by utilizing Eco-Points, launched jointly by the Ministry of the Environment (MOE), the Ministry of Economy, Trade and Industry (METI), and the Ministry of Internal Affairs and Communications (MIC). The impact of this program can be easily understood from these results since the program promotes use of energy-saving and resource-saving home appliances. It can be understood that the manufacturers made great efforts to realize such products. In other words, it can be said that Eco-MCPS database reflect the manufacturers' intension [4].

3.2. Word frequency vs page views

Figure 3 shows the page views (PVs) between October 2008 and September 2009 taken in the ordinate,

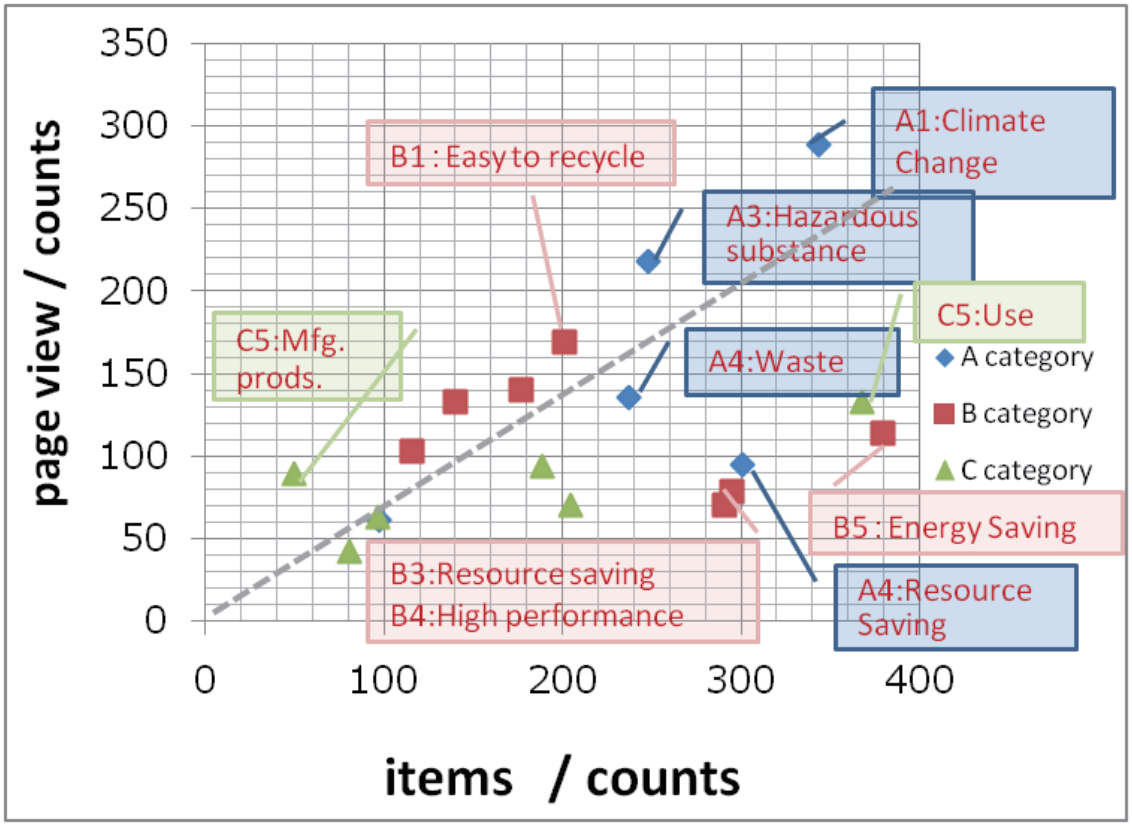

Figure 3 Item categories in Eco-MCPS vs page views (October 2008- September 2009)

which represents the visitors' interest in this period, vs the frequently used term in the comments of Eco-MCPS taken in the abscissa. The slope of the dashed line is 2,555/3,789; the total PVs is divided by the total number of categories to obtain the gradient. It is natural that the page views increase with the number of items stored in the database. However, the figure reads that, unexpectedly, resource- and energy- saving products (A4, B3 and B5), as well as higher performance (B4) products are less viewed by the database visitors. This may suggest that there is some discrepancy concerning the environmental interest between the manufacturers and the users; i.e., companies and manufacturers focus on energy and resource-saving products, whereas general interest is more related to global warming (A1) and toxic chemicals (hazardous substance A3).

Similar to Figure 3, Figure 4 shows the PVs vs items for the period October 2010 to September 2011. The PVs for Easy to Recycle (B1) products and products having environmental influence to Wastes (A4) have considerably increased. Products related to the Use of Recycled Material (B7) also have gained some popularity. These can be attributed to the Great East Japan Earthquake which attacked Japan on March 11, 2011.

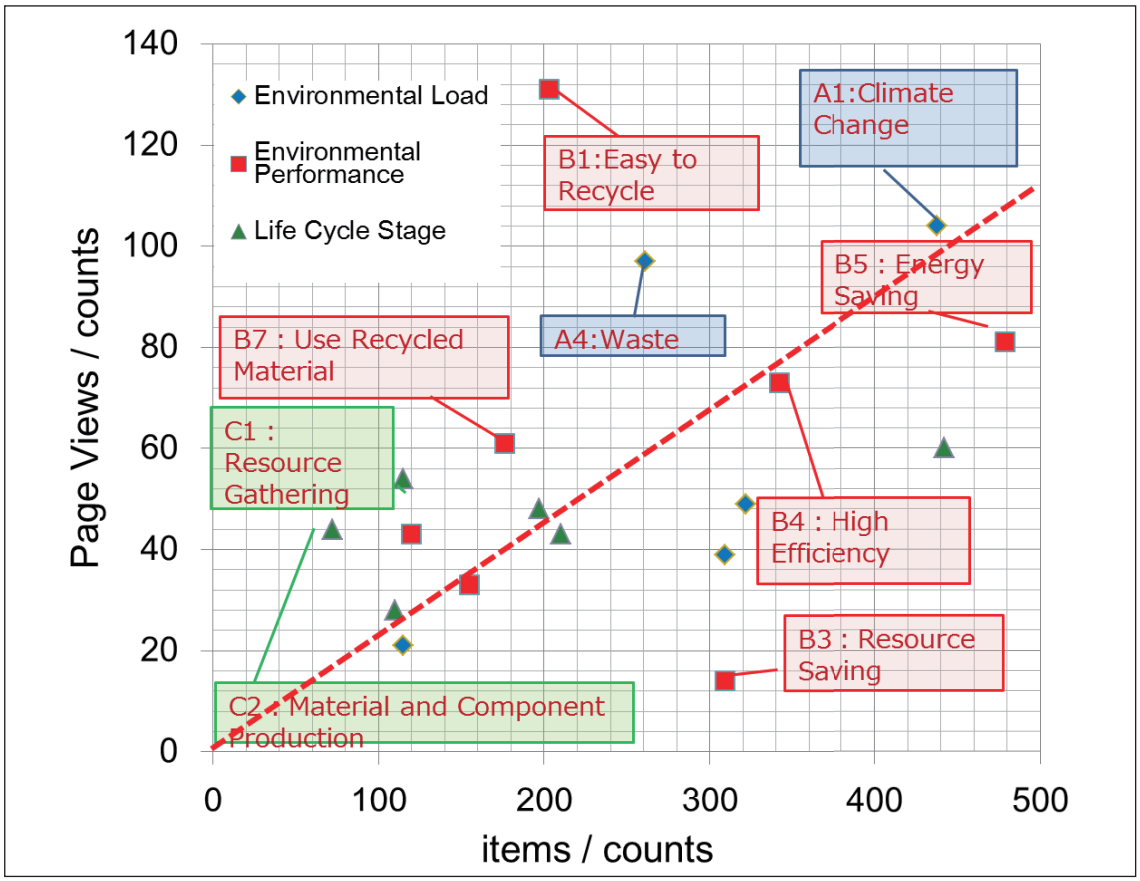

Figure 4　Item categories in Eco-MCPS vs page views (October 2010- September 2011)

The aftermath of the earthquake required recovery of the crippled machines and buildings, and recycling the rubble. Thus, it can be easily understood that the products in A4, B1, and B7 are more accessed than ever. In addition, the PVs for the Energy Saving (B5) and High Performance (B4) also increased, which may be attributed to the well-established promotion of eco-points.

3.3. Zipf's Law and searched words

Analysis of searched words also provides information of public interest. The searched word data was accumulated from January to September, 2008. Zipf's law [5] states that while only a few words are used very often, many or most are used rarely. Generally, the law is a power-law function expressed by:

$$P(n) \propto n^{-1} \quad (1)$$

where frequency of occurrence of some event (P), as a function of the rank (n) when the rank is determined by the above frequency of occurrence. As is shown in Fig.5, the searched words rank and frequency plots nicely fit to this phenomenological function (with the exponent being-0.998≈-1). Although there is no established explanation for this phenomenon, this may suggest stable distribution of searched words. The rank vs word frequency data shown in Fig. 2 (top 7 ranked words and their frequencies are given in Table 1 for reference) also fits a power law function with an exponent of -1.4. Hence, in the profile, the words seem to be unevenly distributed, and this also provides sound base that the Eco-MCPS is widely viewed free of any intention.

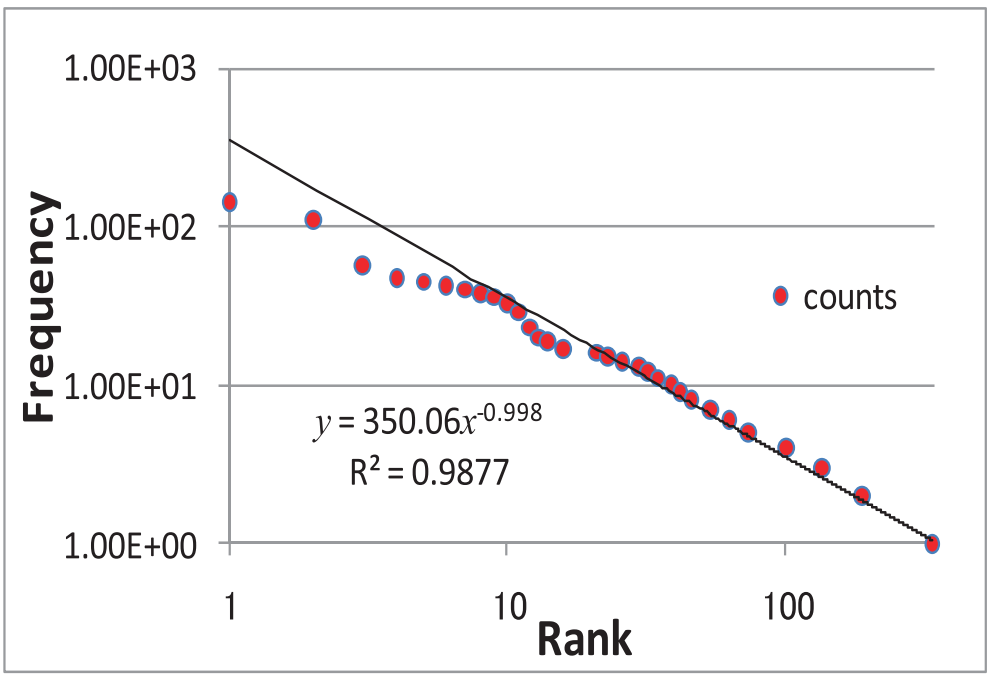

Figure 5 Rank vs. frequency distribution of words searched in Eco-MCPS

Table 1 Top seven searched words (Jan – Sept 2008)

rank	word	counts
1	キヤノン（CANON INC）	144
2	RoHS	110
3	東芝（Toshiba Co.Ltd.）	57
4	電池（batteries）	47
5	ニコン（Nikon）	45
6	携帯（portable）	42
7	ソニー（SONY Corp）	40

4. CONCLUSION

By analyzing text data and access log of Web-based database Eco-MCPS, it is suggested that companies and manufacturers focused on marketing energy and resource-saving products in 2008, whereas general interest were more related to global warming and toxic chemicals (hazardous materials). This clearly illustrates discrepancy in environmental consciousness between the public and the manufacturers. However, following the yearly change in social (public) consciousness and in manufacturers, it have been found that political or national promotion for environmentally friendly products considerably changes the public attitude to environmentally conscious products.

It was also suggested that Eco-MCPS is not only a simple compilation of fact data, but it sensitively reflects the social movement, i.e., with the advancement in materials and technology, as well as the general consciousness in environmental issues.

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References

[1] R. Ozao, M. Iji, T. Furuyama, K. Yamada, C. Yoshida, Y. Nishimoto, Y. Shimura, K. Halada, “Report on Ecomaterials for Sustainable Society and Feasibility Study on the Development of Eco-materials Database”, Report for The Watanabe Memorial Foundation for the Advancement of Technology (2006).

[2] R. Ozao, T. Sawaguchi, H. Ishida, M. Iji, T. Furuyama, Y. Shinohara, K. Yamada, K. Halada: Eco-MCPS: a Newly Developed Web-Based Database for Eco-Materials in Japan, *Materials Transactions*, 48 (2007) pp.3043-49.

[3] R. Feldman and I Dogan: Knowledge Discovery in Textural Datatbases (KDT), Proc. 1st *Int’l Conf. on Knowledge Discovery* (KDD-95) (1995) pp. 112-117.

P. Cabena, P. Hadjinian, R. Stadler, J. Verhees, A. Zanasi, “Discovering Data Mining, from Concept to Implementation”, Prentice Hall, New Jersey (1997)

[4] H. Ishida, R. Ozao, T. Utsumi, Y. Shinohara, K. Halada, Y. Nishimoto: Trends in Eco-materials and Products as Observed through Studies on a Web Database, Eco-MCPS, *Trans. Mater. Res. Soc. Jpn*., 34 (2009), pp.249-252.

[5] G. K. Zipf, “Selected Studies of the Principle of Relative Frequency in Language”, Harvard University Press (1932); T. Musha, “World of Fluctuation”, Kodansha (1980) (in Japanese).