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IDENTIFICATION OF TECHNOLOGY TREND ON INDONESIAN PATENT DOCUMENTS AND RESEARCH REPORTS ON CHEMISTRY AND METALLURGY FIELDS

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Abstract. The aims of this study are: to identify technology trends by identifying core topics, prominence topics, and emerging topics; and to assess the overlap between research and development and patents on chemistry and metallurgy fields in Indonesia during 1993-1997. The technology trends are determined by measuring subject and keyword development on those fields. Co-words analysis is employed to measure the technology categories. The objects of this study are granted patents section C according to International Patent Classification (IPC) and research report documents which was collected from CD ROM of research reports on chemistry and metallurgy fields published by PDII-LIPI. Subjects analysis of patent document are measured based on the number of subclass in chemistry and metallurgy fields using IPC code of patent documents. Subjects analysis of research reports are measured based on the number of subclass in chemistry and metallurgy section using DDC21 system of research report documents. Co-words analysis is measured based on the co-occurrence frequencies of the keywords appeared in the research documents. The results showed that overlapping subject and keyword of patent documents and research report documents on chemistry and metallurgy fields in Indonesia during five years (1993 to 1997) was on the organic chemistry, especially on dyes and extraction. Another important subject in patent documents was human necessity, especially on pesticides, drugs, and detergents. The largest subject on research activities period was on food technology, especially on coconut oils, palm oils, and storage. Technology categories on research report documents show that there were no core topics of research activities in Indonesia during five years (1993 to 1997). The prominence topics were only on 1993 and 1996 namely fermentation process, storage processes, and drying apparatus. There were core topics, prominence topics and emerging topics on patent documents.

Introduction

The development of science and technology driven by industries is an important issue for local industries in order to be competitive in the world trade arena. In order to be successful in this respect, the development of domestic innovations, their commercialization and their protections need special attention. Currently, the number of innovations achieved by Indonesian researchers is still relatively low. This is reflected by the low number of patent applications submitted to the Indonesian Patent Office that is only 1760 (3,56%) from total applications per September 2005, and the number of granted patent is only 172 patents or nearly 1% from total granted patents, according to statistics of Directorate General of Intellectual Property Rights, Republic of Indonesia. The rest is still dominated by foreign applications.

Having looked into the above conditions, it is seemed that there must be something wrong with the current research management system in Indonesia. Research duplications and re-inventing the wheels of research activities are often found. Research without clear direction will be wasting time and budget, and performance of Indonesian researchers in producing product-oriented research and patentable research. Therefore, to direct the Indonesian researchers research into the right tracks, it is important to evaluate technology trend and development.

Bibliometrics is an appropriate method to study the development of chemistry and metallurgy field from quantitative perspective. It is a quantitative method to measure the growth of science based on scientific publication published in a period of time. Co-word analysis is an important subset of bibliometrics. It analyzes the co-occurrences of keywords in research documents on a subject. In information sciences area, keywords of a document are important subject. They are not only for recognizing a

document in literature retrieval but also carry and represent concept and idea that contained in a document. Co-word analysis provides an immediate picture of the actual content of research topics dealt with in the literature (Ding, Y; Chowdhury, GG; Foo, 2000).

Many researchers from any disciplines used bibliometrics method for some purposes such as to measure the growth of disciplines, to investigate researcher and institution performance and to evaluate the synergism between research and program. The method has applied on any research fields such as information sciences, anthropology, chemistry and so on. (Ding, Y. et.al., 2000; Butler et.al., 1997; Lacasa et.al., 2003).

The content of patent document is a new solution to a technical problem. Patents cover virtually every field of technology, so it is useful for the analysis of technologies diffusion, except software, which is generally protected by copyright and can be patented only when it is integrated in a technical process of product (Meyer, 2004). According to Ramani and deLooze (2001) Patent statistics remain a unique resource for the analysis of the process of technical change. Nothing else even comes close in the quantity of available data, accessibility and the potential industrial, organizational, and technological potential. Therefore, to evaluate technology trend in Indonesia can be done by using patent documents.

In Indonesia, analysis of patent documents rarely utilize in order to support research policy makers to decide which scientific research fields should be supported by their expected impact on industrial research development. Whereas, the result of patent analysis can be used for evaluation the history of technology (Meyer, 2004), the profile of technology trend (Batthacharya and Khan, 2001; 2002), avoiding research duplications and re-inventing the wheels of research activities, and measure competitive position of firms or countries in technology field (Ramani and deLooze, 2001; 2002).

Technology trend is the general movement or prevailing tendency of a given technology (chemindustry.intota.com). Technology trend describes the changes of technology field, categorize of technology on core topics, prominence topics, and emerging topics during several years. Measurement of technology trend and technology changes can be done by using activity level of countries, subject development, and co-word analysis of patent and research report documents. This paper describes analysis of technology trend in chemistry and metallurgy field. The aims of this study are: to identify technology trend by identifying core topics, prominence topics, and emerging topics; and to assess the overlap between research and development and patent on chemistry and metallurgy fields in Indonesia during 1993 – 1997.

Based on the survey of Center for Data Analysis of Science and Technology-Indonesian Institute of Sciences/ Papiptek-LIPI (2002), the greatest patents registered at the Directorate General of Intellectual Property Rights of the Republic of Indonesia (26% of total patents) is chemistry and metallurgy field/ section C according to International Patent Classification (IPC) system. The diversity of chemical sector, it touches a broad range of products from dyestuffs, fertilizers, fibers, to pharmaceuticals (Lacasa; Grupp; and Schmoch, 2003) make chemistry and metallurgy field became an interesting sector to trace the technology trend over time.

Related to the purpose of this study, identification of technology trend (core topics, prominence topics, and emerging topics) is measured by using co-word analysis. Co word analysis is based on identifying a pair of keywords that occur together in a large number of documents (Batthacharya and Khan, 2001; 2003).

Methodology

In information and documentation area, keyword of a document is important thing. Keyword is a significant term found in a document, in its title or in abstract,. Keywords are the basis of natural language indexing systems (Buchanan, 1976). The analytical framework of co-word analysis is used in this study for determining technology categories. Keywords from patents and research report documents are selected by filtering the punctuation marks and other connecting words in the titles and abstracts. The next step is creating a matrix based on the co-occurrence frequency. Co-word analysis is based on identifying a pair of keywords that occur together in a large of documents. The value of the cell of two words is decided by the times these two words both appear in the same document. The higher co-occurrence frequency of the two words means the closer relationship between them. Level of topics/subtopics assigned based on percentage of total output (Batthacharya and Khan, 2001; 2002). Three level are defined. A minimum of 5% of total output (total patents or total documents in chemistry and metallurgy field) is chosen for core topics; more than 3% to 5% for prominence level; and more than 1% to 3% for emerging level.

In this study, the co-word analysis frameworks was applied on words extracted from titles and abstracts. Title words can indicate concepts, being a part of a broader entity signifying: preparation, techniques, equipment, etc. Further construct, sub-topics/topics were created from the word combinations.

Data collection

This study used Indonesian patent documents section C according to International Patent Classification (IPC) system and research reports on chemistry and metallurgy field with classification number 540 to 549 snd 660 to 669 according to Dewey Decimal Classification (DDC) system.

Population coverage covered the granted patents and CD ROM of research report published by Center for Scientific Documentation and Information (PDII-LIPI). The population data were collected from 1993 to 1997. Choice of this periods because the first Indonesian Patent Law was promulgated in 1989, and there are only two granted patents in 1993, one of them is section C according to IPC system.

The numbers of documents in this area were found 941, consist of 489 patent documents and 452 research reports.

Results and Discussion

The development of subject

Patent documents

In the period of five years (1993-1997) there were 489 patent documents on chemistry and metallurgy that covered 670 subjects. The largest subject on patent documents was organic chemistry (170 patents or 25.37%),, related with health and diseases (A61) were 92 patents (13.73%), and also physics and chemistry processes or general equipments (B01) were 28 patents (4.18%).

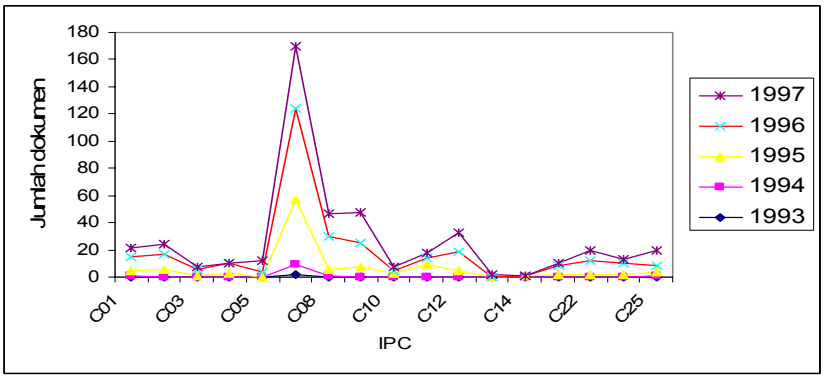

Figure 1. The development of chemistry and metallurgy fields on patent documents

Figure 1 shows the development of chemistry and metallurgy on Indonesian patent documents from 1993 to 1997 was organic chemistry (C07) followed by organic macromolecular compounds: their preparation or chemical working-up; compositions based thereon (C08), and dyes; paints; polishes; natural resins; adhesives; miscellaneous compositions; miscellaneous applications of materials (C09). The largest topics were general methods of organic chemistry and apparatus therefore; acyclic or carbocyclic compounds; heterocyclic compounds; acyclic, carbocyclic, or heterocyclic compounds containing elements other than carbon, hydrogen, halogen, oxygen, nitrogen, sulfur, selenium, or tellurium; sugars, derivatives thereof, nucleosides, nucleotides, nucleic acids; peptides; polysaccharides, derivatives thereof; treatment or chemical modification of rubbers; macromolecular compounds obtained by reactions only involving carbon-to-carbon unsaturated bonds; macromolecular compounds obtained otherwise than by reactions only involving carbon-to-carbon unsaturated bonds; use of inorganic or non-macromolecular organic substances as compounding ingredients; composition of macromolecular compounds; organic dyes or closely-related compounds for producing dyes, mordants, lakes; treatment of inorganic materials, other than fibrous filters, to enhance their pigmenting or filling properties, preparation of carbon black; coating compositions e.g. paints, varnishes, lacquers, filling pastes,

chemical paint or ink removers, inks, correcting fluids; polishing compositions other than french polish; adhesives, adhesive processes in general, use of materials as adhesives.

Other subjects related with chemistry and metallurgy fields was medical or veterinary science, hygiene e.g. the topics of diagnosis, surgery, and identification, preparations for medical, dental, or toilet purposes; chemical aspects of, or use of materials for deodorisation of air, for disinfection or sterilisation, or for bandages, dressings, absorbent pads or surgical articles; methods or apparatus for sterilising materials or objects in general; disinfection, sterilisation, or deodorisation of air; chemical aspects of bandages, dressings, absorbent pads, or surgical articles; materials for bandages, dressings, absorbent pads, or surgical articles.

Research reports

There were 452 research report documents from research institutions from 1993 to 1997 with 452 subjects according to Dewey Decimal Classification (DDC) system. The result shows that the development of chemistry and metallurgy fields were on the subject of food technology (218 documents or 48.23%) followed by organic chemistry (46 documents or 10.18%).

Based on this analysis, organic chemistry was the interesting subject on the patent documents and research reports during five years (1993 to 1997). So, that is the important subject on the development of chemistry and metallurgy fields in Indonesia. Organic chemistry covers a broad range of industrial products from dyestuffs, fertilizers, fibers, to pharmaceuticals (Lacasa; Grupp; and Schmoch, 2003).

Technology category

Frequency of words appearing in the documents allows us to determine intensities of information in each subject area or technical specialty. These intensities used as indicators of importance of respective areas (Pelc, 1996). From 1993 to 1997 there were 1584 keywords from 489 patent documents and 1415 keywords from 452 research report documents. From 1994 to 1997, keywords of pesticide and extraction always appear every year. It means that almost every year there were product of pesticide and extraction process success to be patented. In development of chemistry and metallurgy fields in 1993 to 1997, research institutions in Indonesia doing research on coconut oils and palm oils in the subject of food technology. There were also doing research on dyes and extraction process in the subject of organic chemistry. Overlapping subject and keyword on patent documents and research report documents shows on figure 2.

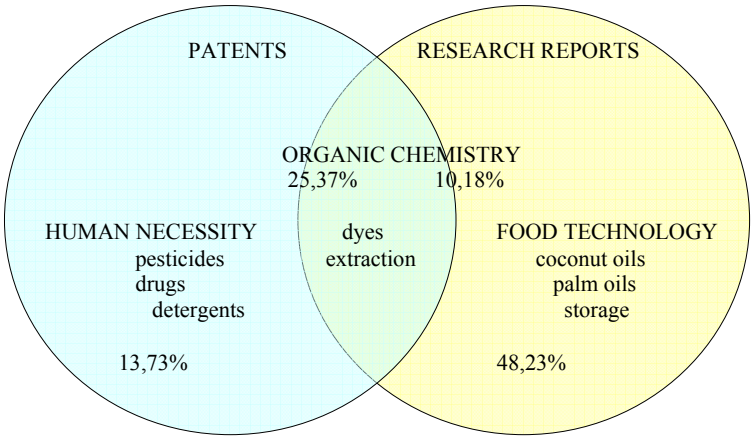

Figure 2. Overlapping subject and keyword

Figure 2 shows that from 1993 to 1997, dyes and extraction were the important product and process on patents and research activities in Indonesia. The development of chemistry and metallurgy field was on the organic chemistry, especially on dyes and extraction. Another important subject in patent documents was human necessity, especially on pesticides, drugs, and detergents. Therefore, the largest

subject on research activities on the same area and period was on food technology, especially on coconut oils, palm oils, and storage.

This study used co-word analysis in order to have detailed result and categorize technology in core topics, prominence topics, and emerging topics based on Batthacharya method. Development of technology categories during five years (1993 to 1997) is shown in Table 1.

Table 1. Development of technologies categories since five years (1993 to 1997)

Technology categories	Year			
	1994	1995	1996	1997
Core topics	composition-drugs preparation-drugs process-composition	anti-inflammatory agents-analgesics	composition-preparation methode-preparation process-preparation	process-preparation preparation-drugs
Prominence topics	insecticides-pesticides insecticides-nitromethylene Imidazole acid-drugs Imidazole acid - composition Imidazole acid-preparation	drugs-analgesics drugs – antiinflammatory agents drugs-antimicrobes equipment-extraction process-vegetable oils extraction-vegetable oils composition-antimicrobes	equipment-methode composition-drugs process-composition waste-treatment preparation-dyes	process-drugs composition-preparation methode-preparation
Emerging topics		detergents-bleaching agents extraction-silver enzymes-drugs composition-pesticides	composition-detergents composition-pesticides process-dyes preparation-drugs	composition-drugs preparation-dyes coating methods process-catalists
		dyes-pesticides process-detergents textiles-dyes synthetic dyes	preparation-detergents preparation-pesticides extraction-precious metals drugs-antimicrobes	pesticides-insecticides preparation-pesticides bleaching agents-textiles

Based on co-word analysis, from 1994 to 1997 the largest patents on chemistry and metallurgy field was pharmaceutical products, such as drugs. Patent assignee interest to patenting their invention because they want to take protection for their products. It was shown that technology on pharmaceutical industries in Indonesia was dominated by foreign countries. However, Indonesia is a rich country with their traditional knowledge and medicinal plants for producing natural drugs. One of Indonesian chemist who have patent rights for their products from USPTO is Dr. S.S. Sardjiman and Prof. Dr. M. Samhoedi Reksodiprodjo from Faculty of Pharmacy, Gadjah Mada University. They synthesize ten molecules from curcuma for anti-inflammatory agents.

Technology categories on research report documents, shows that there were no core topics of research activities in Indonesia during five years (1993 to 1997). The prominence topics only in 1993 and 1996 were fermentation process, storage processes, and drying apparatus. The emerging topics in 1993 were equipment prototypes, microorganisms for coconut oils preparation, product preservation for stor-

age, and flour preparation. The emerging topics in 1995 were preparation of crackers, extraction of coconut oils, and drying apparatus.

Conclusion

Based on the above discussion, we can conclude that:

1. Development of chemistry and metallurgy field in Indonesia during five years (1993 to 1997) was on the organic chemistry, especially on dyes and extraction. Other important subject in patent documents was human necessity, especially on pesticides, drugs, and detergents. The largest subject on research activities on the same area and period was on food technology, especially on coconut oils, palm oils, and storage
2. Technology categories using co-word analysis on patent documents shows that core topics on the document collection 1994 to 1997 were drugs composition, drugs preparation, and drugs processes for antiinflammation and anti-inflammatory agents. Prominence topics were preparation and composition of alkena imidazolel acid as raw materials for drugs to overcome several diseases like glaucoma, hipertension, and heart disease; the using of nitromethylenes for insecticides; processes and equipments for preparation of vegetable oils, composition of 2-oksindol-1-carboxamide for antiinflammation and anti-inflammatory agents; preparation of dyes; waste treatment. The emerging topics were preparation and composition of detergents, pesticides, herbicides, and drugs for HIV, cancer, antimicrobes; textile dyes.
3. Technology categories on research report documents, shows that there were no core topics of research activities in Indonesia during five years from 1993 to 1997. The prominence topics in 1993 and 1996 were fermentation process, storage processes, and drying apparatus. The emerging topics in 1993 were equipment prototypes, microorganisms for coconut oils preparation, product preservation for storage, and flour preparation. The emerging topics in 1995 were preparation of crackers, extraction of coconut oils, and drying apparatus.
4. This study is also confirmed that the direction of research and development in Indonesia is not conforming to the trends of technology.

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