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# Technology assessment in patent search engine: An effort for reading invention opportunities and product innovation

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## Abstract

Examining the technology opportunities of the patent search engine through technology assessment can help the companies determine the appropriate direction of further technology development to open-up business opportunities in the future. This paper aims to conduct a technology assessment on patent search engine technology to understand the trends of patent search engine development. This study used a qualitative research methodology with descriptive analysis according to literature studies and patent analysis. Innography software was used to derive the patent data. The results showed the technology development trend, key players involved, and the competitors related to patent search engine technology. The analysis has been conducted on IPRs data of 38 registered in patent search engine fields to identify several aspects, such as inventor, organisation, IP class, filling year, patent strength and factor, portfolio strength, and GEM finder. The patent database becomes an asset to define many technical processes from research and development. Conducting patent analysis in patent search engines is essential to capture opportunities for invention and innovation in related field technology.

**Keywords**: innography; patent analysis; patent search engine; technology assessment.

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## INTRODUCTION

Companies should inevitably keep up with the competition by producing innovative technologies or products to sustain their growth since customer or market needs are highly dynamic and quickly change. Thus, if they cannot keep up with it, they will be left behind or even abandoned by the customers. Companies should manage their business strategy and take strategic steps to ensure the core business product to answer the customer needs. Therefore, it requires an excellent R&D strategy to bring out breakthrough technologies. However, R&D strategy might be complex for companies, especially with several possible obstacles, such as high R&D investment. So that the ability to identify technology opportunities is crucial for companies in prioritising R&D investment and promoting successful R&D activities (Yoon et al., 2015; Zhu & Porter, 2002).

Technological opportunity is defined as potential prospects of technological advancement either in general or within a specific field (Olsson, 2005; Yoon et al., 2014). Examining the technology opportunities can help the companies determine the appropriate direction of further technology development to open-up business opportunities in the future. The exploration of technology opportunities is usually referred to as technology opportunity discovery or technology assessment. The patent has become an influential resource for technology assessment and the accessible vast amount of patent documents and available tools for computer-aided text mining (Livotov, 2015). The utilisation of patent documents provides the opportunity to understand the growing trend of technology, the players within the technology field, and the competitors mastering the specific technologies (Hendrix, 2019).

Based on Qiu & Yang (2018), the patent system is one of the most important regulations that provide legislative protections for invention and innovation. The patent assignee would possess exclusive rights, such as making, using, offering, selling, or importing the invention for a certain period of protection if their patent is granted. Meanwhile, the assignee is obligated to disclose their innovation information sufficiently clear and complete to allow possible duplication of the invention. The technical disclosure requirement sheds light on innovative activities. Therefore, patents are regarded as an essential knowledge production output and have been harnessed by economists, industrialists, and policymakers for many purposes.

The patent documents contain several details of the invention which cannot be obtained from other sources, including the prior art, the problem to be solved, the method used to solve the problem, and the results obtained from the invention. This information can be used to understand the existing technology to start new industries. There are three reasons the patent becomes an important source for technology assessment: (1) it provides a compelling incentive for innovative activities; (2) it reflects the dynamic of technological change; (3) it provides an important way for inventors to obtain economic returns from technological innovations. The analysis of patent information has long been regarded as an important way of investigating various aspects of technological changes and

understanding trends in the innovative activities of a particular technology (Qiu & Yang, 2018).

The current number of technology patents can be accessed through the patent information system, which has been expanded with information technology. However, searching for patent information through a web-based information system still has limitations, including: (1) it cannot display full-text documents; (2) it provides a relatively general analysis feature; (3) it cannot display detailed technological trends. On the other hand, tracking patent documents needs to be faster, more complete, and more capable of displaying the analysis results objectively. Patent search engines can answer these needs and have a big chance of being exploited by the market. The innovation race in patent search engine technology is very competitive. This is because the key to winning the competition in research, innovation and the market is how to create new technologies and inventive steps. The two main requirements can only be obtained in full by searching for patent information. Patent information search relies on patent search engine technology. Therefore, the development of patent search engine technology has proliferated. Therefore, analysing technology in patent search engines is essential to capture opportunities for invention and innovation in patent search engine technology, where this technology is one of the most massive technologies developed in the world (WIPO, 2015).

This research aims to conduct a technology assessment on patent search engine technology to understand the trends of patent search engine development. Patent analysis helps them understand the implications of alternative technological or societal paths (Rohrbeck & Schwarz, 2013). Several previous studies have indeed carried out technology assessments based on patent analysis. These studies commonly aim to analyse the development of particular technology, such as magnetic resonance imaging technology (Ding et al., 2017), carbon capture and storage technology (Qiu & Yang, 2018), artificial intelligence (Yang & Yu, 2019), high-speed rail technology (Liu & Yang, 2019), graphene biomedical technology (Yang et al., 2019), and food canning technology (Hendrix, 2020). However, no previous research on patent analysis focuses on analysing the technological development of patent search engines. Therefore, this paper attempts to fill this gap by exploring the patent data information related to patent search engine technology (Rohrbeck & Schwarz, 2013).

This paper provides information within the patent search engine field that can be used as a consideration and a basis for companies to determine the right direction for further technological development and to open business opportunities in the future or to create an innovation that can answer the dynamism of consumer needs. This further supports the companies in sustaining their competitiveness and advancing their business.

**Technology assessment through patent analysis**

Technology diffusion becomes a requirement for continuous innovation to enhance economic competitiveness. That should require the design of new patterns of production and consumption, the value of technological change, adapting from existing products, and productivity applicable to their local contexts in the innovation area (Haščič et al., 2015).

The company must continue to improve its strategy to produce innovative breakthroughs to generate new business or expand the market to win the competition. Therefore, assessing promising technology is an essential factor for any successful business. Technology assessment possibly increases technology competitiveness as it minimises the trial-and-error process in R&D and reduces the possibility of duplication of research since it scrutinises global research trends (Yoon et al., 2014).

Several previous studies have proposed various methods of identifying technological opportunities. Earlier studies primarily rely on expert judgment and entrepreneurial recognition, such as the Delphi and scenario approach (Kim & Bae, 2017; Baron & Ensley, 2006; Lee et al., 2017; Salo & Cuhls, 2003). The Delphi approach is an iterative process to generate consensus among several technology experts in predicting future promising technology. Prior studies have demonstrated expert judgement approach is relatively useful, especially during the absence of past data or when mathematical modelling is impossible (Kim & Bae, 2017). However, it is also subject to limitations, including subjective bias and bounded knowledge due to the human-centred analysis (Lee et al., 2020; Lee et al., 2017). Furthermore, finding the appropriate experts that willingly join is also challenging (Kent & Saffer, 2014).

The recent developments in data analytics give new light to technology assessment and complement expert-based analysis (Lee et al., 2020). Accordingly, patent analysis emerges as one of the primary approaches to technology assessment because the patent data serves a thorough information on various characteristics of technological development across fields and there has been a large amount of patent data accumulated over a long period that will enrich the analysis (Ernst, 1997). The obtained data can be used in the early stage of the innovation process to formulate innovation goals and desired new product features (Livotov, 2015). Implementing patent analysis is beneficial to supporting the new product development process, especially during ideation and preliminary investigation, as it provides information on idea generation of the most recent developments, not only within that specific field but also for the potential acquisition of external technologies as substitutes for developing new ones (Großmann et al., 2016).

A patent is a novelty indicator of an invention and innovation that exhibits the specificity and difference of a scientific outcome, generating business impact. Patent as a part of the intellectual property right scheme commonly becomes a significant output of research and development activities. Patent data is considered

a valuable source of standardised information for technological knowledge (Sharma & Tripathi, 2013). A new perspective on exploiting patent databases becomes an approach to new technology development idea sources. On the other hand, patent portfolio analysis is closely related to industrial users, such as monitoring the technological advances on the related business line, identifying the competitors' inventions, and law cases on the related patent (Brockhoff, 1992). The goals above make developing a patent search engine necessary to discover the latest technology, identify the major technology areas, and explore the distribution of patents over time (Livotov, 2015).

Patent analysis is differentiated into two methods based on patent document characteristics: analysis of structured part (e.g., patent co-classification analysis, patent citation analysis and analysis of non-structured part (e.g., keyword analysis, patent network analysis) (Feng et al., 2020). Yoon et al. (2014) and Zhu & Porter (2002) proposed the technology assessment steps, which can also be a reference for general patent analysis steps, i.e. (1) searching and retrieving data from large databases; (2) profiling the search results; (3) extracting latent relationships; (4) representing relationships graphically; (5) interpreting the prospects for successful technological development and marketability.

Several prior studies on patent analysis have researched technological opportunity discovery or forecasting. Lee et al. (2009) proposed several patent analyses schemes for technology-driven road mapping, including monitoring, collaboration, diversification, and benchmarking, using various techniques, such as text-mining, network analysis, citation analysis, and index analysis. It results in meaningful implications in the *actor-similarity map, actor-relations map, technology-industry map, and technology-affinity map*. Livotov (2015) scrutinized the patent data to explore the customer benefits and identify customer needs to lower the product development cost. Ouyang & Weng (2011) proposed a new approach called the New Comprehensive Patent Analysis model (NCPA), which combines the patent family with patent citation analysis in a new product design process: (1) integrating the perspective of management-based and technology-based design for patent searching; (2) building a patent family based on basic industry patents; (3) filtering the patent family to obtain key patents, (4) utilising patent citations to gain necessary technology information in product development design; (5) combining TRIZ theory to construct patent technology performance maps, and to discover product niches. Feng et al. (2020) proposed a hybrid approach based on morphological analysis (MA) and unified structured inventive thinking (USIT) for technology opportunity discovery (TOD) through patent analysis using text mining and Word2Vec clustering analysis to explore the intrinsic links of innovation elements. Trappey et al. (2012) conducted patent quality analysis for technology road mapping.

In accordance with patent analysis, Hendrix (2020) puts forward several important terms in understanding the obtained patent information. Organisation

also called assignee, refers to an organisation or individual holding the legal right to patent ownership. Patent filing defines a procedure in which is the applicant should fill in the specification of knowledge and provides complete information about the invention. Patent strength score reflects the value of a patent, which refers to the innovative breakthrough of new technology development. The score is calculated based on various indicators, including the grant status, citation frequency, patent age, breadth, and examiner comments or office actions. The higher the score, the stronger and more valuable a patent is. Patent strength, also called patent valuation algorithms, estimates the strength score of a patent based on a variety of indicators, including the number of patent claims, the types and number of patent citations, the number of different international patent classifications, the location of the patent assignee, other indicators, or any combination thereof (Burhan et al., 2017).

Furthermore, patent claims explain the invention limitation coverage protection scope. In exploring patent information, the interpretation of patent claims becomes the essential factor since it has a substantive role in determining the essence of technology protection similarities, and differences with other technologies. The information derived from a patent document and optionally other information related to a patent document can be used to calculate the strength score of each patent. It presents an insight into a patent value and becomes an important tool for ranking the patents (Lemley, 2005).

Patent cites refer to the amount of patent document citation by an applicant, third party, or a patent office examiner (Hall et al., 2005). Patent industry refers to patents that have been applied in industries whose implementation is regulated in binding laws and regulations in civil law, and the patent holder has the right to sue the party who violates it (Risch, 2015). Patent litigation is the legal action when someone who holds the patent right of a particular invention enforces their right against another party for manufacturing or selling the invention without permission (Yang et al., 2018). Patent forward cites imply that the applicant and the patent examiner must find and cite documents to anticipate if there is a claim of an invention or like the invention and limit the scope of the patent protection. They were generally intended to reveal the state of the art of technology. Patent life is defined as the maximum period of patent ownership, starting from the application date or the date of the patent granted. It means that it has a low impact from the protection period on filing until granted (Hendrix, 2020).

**Patent searching**

WIPO (2015) defines IPC as a "hierarchical system of independent language symbols for the classification of patents and utility models according to the different areas of technology to which they pertain." According to the hierarchical symbol used in the technology process, IP class mapping shows the distribution of

technology development in a specific field. The interpretation from the IPC is mainly used to identify the future technology with a high captive market.

A patent search is a general term covering different search processes such as technology survey, prior art search, freedom to operate, validity, and patent portfolio search. These search processes differ in terms of the searcher's information need, the corporation, and the output of the search (Kumar et al., 2016). However, these search processes' exact names and definitions vary between those dealing with patents, like information specialists, private patent searchers, patent examiners, and patent lawyers (Lupu & Hanbury, 2013). In other words, by measuring the influence of the patent on the technical development of subsequent patents, forward citations indicate the technical value of patents but not the commercial value (Chang & Fan, 2017). In patent searching, keywords become a crucial element in retrieving patent information of technology registered in the patent database. The correct input on keyword searching would provide more focused and more accurate retrieved data (WIPO, 2015).

## METHODS

This research employed a qualitative approach through literature review and patent analysis for technology assessment in patent search engines. This research method emphasises qualitative methods because the data generated from this research is secondary data processed through the Innography software. Hence, this study focuses on the descriptive analysis to read and translate the data processing results by the software. However, efforts to describe the results of the processed data also require special competence and experience so that the data can be accurately described. Thus, qualitative research is an appropriate and relevant method in this context.

This paper examines on examining R&D tool competitiveness based on technology assessment in patent search engines using patent analysis, which was conducted through data mining techniques. Regarding patent analysis, data mining is usually used as a method or process for extracting hidden patterns from a collection of data and transforming them into patent information (Yanhong & Runhua, 2007). Data mining and information are done with two approaches, namely literature study and patent analysis.

Literature study is browsing information related to the topics and issues from various sources, such as books, journals, articles, or other scholars' papers. The patent search engine results deliver essential information about the technical process to register an international patent. Data gathering in the WIPO database on August 28, 2020, using "patent search engine" as a keyword, delivered all registered portfolios. Thirty-eight patents were selected from 2000 until 2018. These search results are further elaborated in subsections below according to some aspects such as inventors, organisation, IP class, year of filing the patent, patent strength and radar, portfolio, and GEM finders.

This study conducts the analysis of patent database using Innography software, an online data mining software that relates to the WIPO database. The analysis consists of several steps as follow. (1) Prioritizing semantic keywords are keywords taken from the core protection of a patented technology, usually taken from the most priority starting from the claim or description. The use of keywords from the claim is usually sufficient to represent the overall search results. Accordingly, this study uses 'patent search engine' as the keyword. (2) Searching using semantic keywords will then produce a list of patent titles that have been registered in various patent offices and have been entered into the international patent database. Then, from the list of titles, the results of the disbursement can be matched with the planned research topic to be carried out. (3) The search results will display various patent visualizations with relatively complete database mapping including inventor data, patent classification, filing date, location, etc. (4) Analysis of search result data through interpretation and descriptive reading of data visualization including mapping of technology searches for commercial use, novelty aspects, patent power, infringement analysis, competition analysis, technology analysis, economic value, technology trends, etc. (5) Providing recommendations on the results of analysis and interpretation of search results data such as research strategies, commercialization strategies, strategies for creating novelty from inventions and innovations, as well as other actions that prioritize measurable decisions. The research framework is depicted in Figure 1.

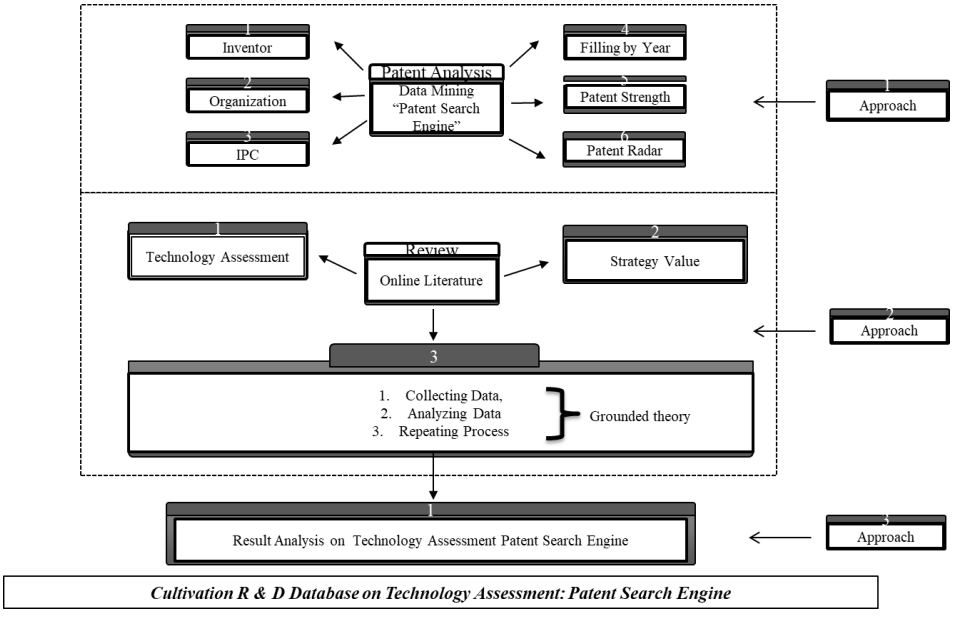



Figure 1. Research Framework

## RESULT AND DISCUSSION

### Inventor on patent search engine (patentee)

An inventor who holds a patent certificate involves in the R&D process and delivers substantial contributions to encourage the development of science and

technology through invention. According to 38 patents that have been identified, 48 inventors were involved. Figure 2 shows the top 20 inventors of 48 total identified inventors.

Accordingly, this research also found two prominent inventors, such as Xiaoyong Zhao, from Security Engineer at Google with ten registered patents (16,4%) and Jason David Resnick, from CPA Global Patent Research Limited with five registered patents (8,2%). Both have significant filed patents, especially in electric digital data processing.


Figure 2. Top 20 Inventors on Database Patent Search Engine
Source: Innography (Processed)

**Organisation (assignee) on patent search engine**

The market map is a robust algorithm employed in Innography that visually describes a competitive landscape. The map consists of a technological (horizontal) axis and a resources (vertical) axis. The former combines three key factors: patents, classifications, and citations. The latter also combines three key factors: total revenue, patent litigation, and the number of locations. The assignee will have a greater ability to capitalise on its patents if it has a higher location on the resources axis, and the assignee would also have a greater competitive strength on patent activities if it has a higher score on the technological axis. Furthermore, the mapping results showed 34 patents from 14 organisations that have been applied for industrial purposes, as depicted in Figure 3.

Organizations that have been applied in patent search engines remain in massive utilisation of the captive market for commercialisation. Two from twenty organisations with significant economic impact and have already gained revenue and litigation: (1) Dalian Junfang Technology Co., Ltd. (with ten applied patents, revenue $0,00, 0 U.S. patent litigation, 100 vision, 5,26 resources, $80,506 estimated cost on top country portfolio, and 60 active applications); (2) Leonard Green & Partners, L.P. (a leading private equity investment firm with five applied patents, $9,600,000,000 revenue, 75 U.S. patent litigation, 76,75 vision, 24,93 resources, $2,9 M estimated cost on top country portfolio, and 290 active applications).

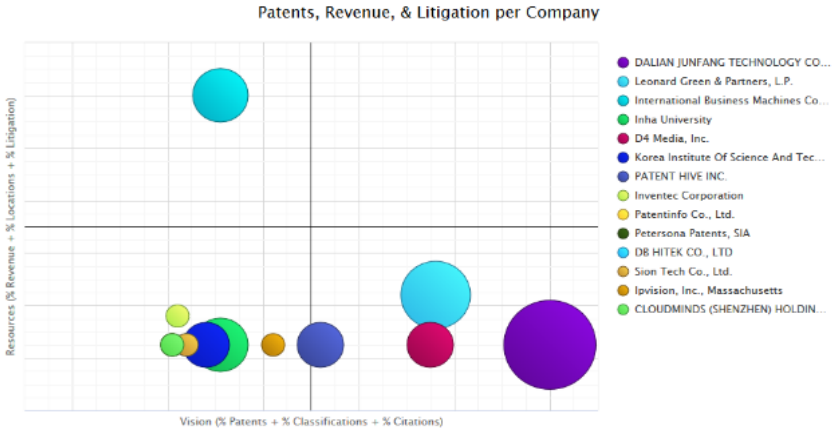



Figure 3. Potential Assignee on Patent Search Engine Distribution
Source: Innography (Processed)

**IP class on patent search engine**

As regards Appendix 1, from 38 patents of patent search engine, 9 IPC groups were identified. Three major groups have the highest number of patents, i.e. (1) G06F 17/00: digital computing or data processing equipment or methods, specially adapted for specific functions with 18 patents (47,4%); (2) G06Q 10/00: administration: management with six patents (15,8%); (3) G06Q 50/00: systems or methods specially adapted for a specific business sector, e.g., utilities or tourism with four patents (10,5%). From these results, G06 (computing, calculating, and counting) was the dominant IPC among others with 36 patents belonging to this class.

**By filling year on patent search engine**

Based on data mining results in patent search engine filing, there were 32 patents from 2000 until 2018, as shown in Appendix 2. Furthermore, filing a patent search engine is distributed among five sources: eleven patents of CN applications, eight patents of US grants, six patents of US applications, four patents of KR grants, and nine patents belonging to other sources. According to WIPO database, these results are based on the top 5 countries that significantly affect patent search engine fields.

**Positioning patent strength (bar) and factor (radar) on patent search engine**

Appendix 3 depicts a patent search engine's top 10 Patent Strength Deciles from 38 identified patents. The red bars indicate the total patents that belong to the fragile level category (patent strength score 0 – 30), with 24 patents belonging to this category. Meanwhile, the brown bars depict the amount of patent that belongs to the intermediate level category (patent strength score 30 – 70), with 11 patents belonging to this category. Furthermore, the blue bars indicate the strong level category (patent strength score 70 – 100), with three patents belonging to this category.

Appendix 4 shows patent strength factors of 38 identified patents: litigation, industries, claim, life, inventor, cites, and forward cites. The detailed interpretation of patent strength factors delivers on-target achievement of maturity patentability in industrial applications. The outline of targeted factors are patent claims, patent cites, patent industry, patent inventors, patent litigation, patent forward cites, and patent life.

Appendix 5 shows the patent claim score is equal to 0.954036, which were resulted from the axis weighting of 16 mean patent claims. The data shows that the patent search engine's patent cites are equal to 0.357126, resulting from the axis weighting of 30 mean patent cites. The result shows that the patent search engine patent has low yearly citation and might be possible to target the acquisition of active patents, which expect information only to enhance R&D output and new products.

The results show that the patent industry score for patent search engines equals 0.423243 from the axis weighting of 3 patents indicates that the patent search engine patent position remains in the low capability of industrial applications. This is indicated that the patent search engine patent inventors' position has low productivity in producing patents each year.

The results show that the average score of the patent search engine patent inventors is 0.941467, which resulted from the axis weighting of 3 patents indicated. In order to determine whether a third party has infringed a patent claim requires two analysis steps. First, the court must interpret the patent claim to determine the scope of the patent claim. Second, the court must assess whether any element of the patent claim, which the court has interpreted, is present in the product or process that violates the claim. According to the data, the average patent search engine litigation is equal to 0 from an axis weighting 0.008. It means that the patent search engine patent has a high impact on protecting patents from infringement or violation of the law.

The results show that the average number of the patent search engine forward cites is 0.801864, which resulted from the axis weighting of 5 mean patent forward cites. Implies that the patent forward cites have a low impact on anticipating claim invention or similar invention from revealing state of the art. Furthermore, the data shows that the average score of patent search engine life is 0.495413, resulting from the axis weighting of 11 patents.

**Portfolio strength on patent search engine**

The result of the patent search engine's patent portfolio is shown in Appendix 5. This portfolio consists primarily of computer and office equipment, communications equipment, electronic components and accessories, and non-classifiable establishments patents. According to 38 identified patents. 4 patents were expired grants, 10 were active grants, 10 were active applications, and 14 were expired applications.

This portfolio identification enables quick comprehension of a patent, especially related to the leading technology areas in this portfolio and the distribution of patents into those categories. Furthermore, the most valuable sector is computer and office equipment, with most patents, are related to search engines, management functions, and user interfaces. From the description above, the portfolio indicates the decrease in patent filings over time, especially in South Korea. Moreover, only a few of these patents are expired. According to those active patents, the average remaining life is 12 years. It is implied that the average remaining effectiveness is lower than the typical product cycle time.

**Portfolio strength on patent search engine**

This result can quickly assess the top list of IP opportunities or threats to portfolios and specific patents. The total portfolio patent strength in Appendix 5 shows how the patent strength of all 38 analysed patent search engine patents are distributed. According to the result, 17 of 38 identified patents and 17 patents had been analysed. Those patents had a low industrial capability in terms of analytical instruments, measuring and controlling devices, NEC, and process control instruments. Industries are at the top level of the patents' Standard Industrial Classification (IPC). Appropriate individual patents are then analysed and consolidated into these industries.

**Discussion**

Based on the market map results, the competitive position of assignees in a particular technological field implies the relative strength of technological innovation (Qiu & Yang, 2018). Identifying the assignee is essential in examining the competitive landscape and the major players in a particular technological field (Liu & Yu, 2016). It means that the organization receives the ownership of legal IP (current assignee) and usually pinpoints that the users have been using technology for business development through implementation in production or concept of development in industries and concerns in the commercialized area under management organization. According to Figure 3, the two highest rank organization are located in the lower right quadrant. It means that they have competitive technological capabilities and would potentially be the leading inventors (Yang & Yu, 2019). These organizations might be the main competitor. Meanwhile, there is International Businesss Machines corporation (IBM) which is located in the upper left quadrant, which have lower technical capabilities in patent search engine but high competitive resources and would be a potetial buyer. Therefore, if a company searching for market potential, this organization might be an option. Several organizations located in the lower left quadrant are usually followers which posses lower technical and resource capability (Liu & Yang, 2019). Furthermore, although the above result of assignees showing that there are two organization that have gained economic benefit from patent search engine innovation, we consider that the

opportunities for development and greater economic gain are still widely open. This is because there is no organization that has been able to achieve the upper right quadrant shown in Figure 3, which also means that there is no organization that really dominates the market in terms of patent search engine technology. The upper right quadrant showing the position of market leader (Qiu & Yang, 2018; Yang & Yu, 2019). It might happen due to each patent search engine has its own characteristics, advantages, and shortcomings (Wang et al., 2020).

The filing patent process was to protect the invention from violation by competitors that have similar activity in technology advancement. Those registered patents will significantly impact development and competitiveness in R & D. A patent gives safety to the patentee for his discovery. The safety has been approved for 20 years. When the patent time limit expires, the production also ends and the patentee no longer holds the right to the discovery (Kumar, 2018). Some of the US and Korea patents on patent search engine are free to be used. It means that the utilization value of expired patents still has opportunities to be developed by a company into new products that are likely to have high commercial value. When the patent is expired, other manufacturers sometimes enter the market with the similar product but they offer relatively lower price. This strategy can be used for the new entrant company which just strated to understand the market interest (Pearce, 2006).

According to the filing year, US can be considered as the first mover. Meanwhile, it took a long time for China to catch up with the US. However, China was able to accelerate its technological capabilities to compete with the US capabilities, since their total number of patents are relatively even. South Korea initially showed faster engagement than China in this field, but its progress has been quite inconsistent and slow, with a few patents being filed in the following years.

Patent search engines are typically used in searching new technology sectors. This kind of effort is useful as a tool to start a search for technology. Patent data are increasingly used for international comparisons and analysis in relatively 'narrow' technology fields, such as many environment-related technologies (Dechezleprêtre et al., 2010; Johnstone et al., 2011). However, achieving comparability across countries and representativeness within a country (statistical robustness) creates additional challenges. Several approaches have been developed to improve cross-country comparability of patent statistics. These are not always suitable for such analyses – either because they require additional data that might not be available in all countries or because they impose restrictions that are less appropriate for analysis of narrow technological fields (Haščič et al., 2015). Thus, searching and analysing patent document databases in patent search engines obtain openly processed patent document data from trend, technical, strategic, geographic, corporate, and legal status.

Patents with a high level of strength reflect the high capability of technological innovation and competitive advantage. Patent strength demonstrates

the position of technology competitiveness and reflects the performance of a company's business strategy. Moreover, it has a significant impact on increasing organisational productivity and market portfolio based on the utilisation of R&D results.

Examining the information on patent strength level is an essential strategic basis for providing a comprehensive overview of the patent value in a related field. Thus, it supports better decision-making for a company in developing and commercialising its technology. Once a company figures out the distribution of patents that belong to a high level of strength, it can explore the strategic fields for technology development and the more involved actors. According to its patent score, technological development of patent search engine is still relatively low. The patent is considered as an influential patent if the patent strength is more than 80 (Qiu & Yang, 2018). Moreover, the number of patents in the weak category is still higher when compared to other categories. Therefore, to achieve higher impact, organisations need more advocacy and learning to align the technology development with the market needs. On the other hand, patent strength factors (radar) represent the gap between actual and targeted value and indicate the average patent rankings compared to other patent claims. This value also shows the expectations and goals of modifying the previous similar product. This section is the essential part of the patent specification since it defines the invention gap against similar patents. The most prioritised and essential patents in a portfolio regarding market requirements are including reviewing an internal list of patents for licensing strength and an external portfolio for purchase, performing annuity reviews for maintenance payments, and assessing competitive threats from a portfolio of patents.

## CONCLUSION

An assessment of the development of technology that is sustainable through the patent information is important to support the enrichment of knowledge to achieve a strategic value in the planning and development of a product. Technology assessment can be conducted in the following manner: first, by linking patent information and innovation systems; second, by creating a roadmap for strengthening in-field implementation; third, by encouraging the users through dissemination activity to encourage the use of patents as the basis for the development of a new product through technology environments and sustain their competitiveness. The trajectories show that related information from the patent analysis can define positioning technology, especially when using the patent search engines as a tool in value strategy in market position. Attention will deliver to the industrialisation sectors, especially the need for process development of their product.

Technology assessment through the utilisation of patent search engines until now is still rarely used as a method for new product ideation. It means that it is still

based on curiosity from personal interest and is rarely used to manage innovative strategies in the company. The patent database is a critical asset that contains detailed technical information from the latest research and development results, especially the need for reverse engineering technology. Detailed technical information from the patent database can be used as the basis for analysis to see technological developments and become an essential consideration for determining a company's steps in making an effective invention and innovation program. Thus, analysing technology in patent search engines is essential to capture discovery and innovation opportunities in patent search engine technology to determine the right and practical business steps for a company.

This descriptive analysis is relatively sensitive to the researcher's viewpoints, further research may consider providing additional data such as gathering questionnaires or interviews with main actors directly involved in the technology field to increase the richness of the data. In addition, expanding the methodology by employing text mining, social network analysis, and patent roadmap might further enrich the analysis.

## REFERENCES

Baron, R. A., & Ensley, M. D. (2006). Opportunity Recognition as the Detection of Meaningful Patterns : Evidence from Comparisons of Novice and Experienced Entrepreneurs. *Informs PubsOnline: Management Science*, 52(9), 1331–1344. https://doi.org/10.1287/mnsc.1060.0538.

Brockhoff, K. K. (1992). Instruments for Patent Data Analyses in Business Firms. *Technovation*, 12(1), 41–59. https://doi.org/10.1016/0166-4972(92)90031-C.

Burhan, M., Singh, A. K., & Jain, S. K. (2017). Patents as Proxy for Measuring Innovations: A Case of Changing Patent Filing Behavior in Indian Public Funded Research Organizations. *Technological Forecasting and Social Change*, 123, 181–190. http://dx.doi.org/10.1016/j.techfore.2016.04.002.

Chang, S. H., & Fan, C. Y. (2017). The Lifespan of Semiconductor Patents by Assignee and Patent Characteristics. *MATEC Web of Conferences*, 119, 1–11. https://doi.org/10.1051/matecconf/201711901026.

Dechezleprêtre, A., Glachant, M., Hascic, I., Johnstone, N., & Ménière, Y. (2010). Invention and Transfer of Climate Change Mitigation Technologies on a Global Scale: A Study Drawing on Patent Data. *SSRN Electronic Journal*, (January), 1–49. https://doi.org/10.2139/ssrn.1414227.

Ding, Q., Luo, R., Tong, Q., He, H., & Zhong, J. (2017). Patents analysis on Magnetic Resonance Imaging and data Processing Technology. *2nd International Conference on Biomedical Image and Signal Processing (ICBISP 2017)*, 1–5. https://doi.org/10.1049/cp.2017.0101.

Ernst, H. (1997). The Use of Patent Data for Technological Forecasting : The Diffusion of CNC-Technology in the Machine Tool Industry. *Small Business*

*Economics*, 9, 361–381. https://doi.org/10.1023/A:1007921808138.

Feng, L., Niu, Y., Liu, Z., Wang, J., & Zhang, K. (2020). Discovering Technology Opportunity by Keyword-based Patent Analysis : A Hybrid Approach of Morphology Analysis and USIT. *Sustainability*, 12(1), 1–35. https://doi.org/10.3390/su12010136.

Großmann, A. M., Filipović, E., & Lazina, L. (2015). The Strategic use of Patents and Standards for New Product Development Knowledge Transfer. *R and D Management*, 46(2), 312–325. https://doi.org/10.1111/radm.12193.

Hall, B. H., Jaffe, A., & Trajtenberg, M. (2005). Market Value and Patent Citations. *RAND Journal of Economics*, 36(1), 16–38.

Haščič, I., Silva, J., & Johnstone, N. (2015). The Use of Patent Statistics for International Comparisons and Analysis of Narrow Technological Fields (No. 2015/05). *OECD Science, Technology and Industry Workin Papers*, 1–42. https://doi.org/10.1787/18151965.

Hendrix, T. (2019). Technology Foresight of Patent Management: an Overview on Big Data for Repository Fields. *Jurnal Bisnis Dan Manajemen*, 20(2), 175–193. https://doi.org/10.24198/jbm.v20i2.327.

Hendrix, T. (2020). Analyzing Patent Information on Canning Technology for Food to Enhance Potential Industrial Development. *FIAT JUSTISIA:Jurnal Ilmu Hukum*, 14(2), 141–158. https://doi.org/10.25041/fiatjustisia.v14no2.1772.

Kent, M. L., & Saffer, A. J. (2014). A Delphi Study of the Future of New Technology Research in Public Relations. *Public Relations Review*, 40(3), 1–9. https://doi.org/10.1016/j.pubrev.2014.02.008.

Kim, G., & Bae, J. (2017). A Novel Approach to Forecast Promising Technology through Patent Analysis. *Technological Forecasting and Social Change*, 117, 228–237. https://doi.org/10.1016/j.techfore.2016.11.023.

Kumar, R., Tripathi, R. C., & Singh, V. (2016). Keyword Based Search and its Limitations in the Patent Document to Secure the Idea from its Infringement. *Physics Procedia*, 78, 439–446. https://doi.org/10.1016/j.procs.2016.02.086.

Lee, C., Jeon, D., Ahn, J. M., & Kwon, O. (2020). Navigating a Product Landscape for Technology Opportunity Analysis: A Word2vec Approach using an Integrated Patent-product Database. *Technovation*, 96. https://doi.org/10.1016/j.technovation.2020.102140.

Lee, J., Kim, C., & Shin, J. (2017). Technology Opportunity Discovery to R&D Planning: Key Technological Performance Analysis. *Technological Forecasting and Social Change*, 119, 53–63. https://doi.org/10.1016/j.techfore.2017.03.011.

Lee, S., Yoon, B., Lee, C., & Park, J. (2009). Business Planning based on

Technological Capabilities: Patent Analysis for Technology-driven Roadmapping. *Technological Forecasting & Social Change*, 76(6), 769–786. https://doi.org/10.1016/j.techfore.2009.01.003.

Lemley, M. A. (2005). The Changing Meaning of Patent Claim Terms. *Michigan Law Review*, 104(1), 101–122.

Liang, Y. & Tan, R. (2007). A Text-Mining-based Patent Analysis in Product Innovative Process. In: León-Rovira, N. (eds) Trends in Computer Aided Innovation. IFIP The International Federation for Information Processing, vol 250. Springer, Boston, MA. https://doi.org/10.1007/978-0-387-75456-7_9.

Liu, X., & Yang, X. (2019). Identifying Technological Innovation Capability of High-Speed Rail Industry Based on Patent Analysis. *Proceedings of 2019 8th International Conference on Industrial Technology and Management, ICITM 2019*, 127–131. https://doi.org/10.1109/ICITM.2019.87 10710.

Liu, X., & Yu, X. (2016). Patent Analysis for Guiding Technology Transfer from EU/EEA to China: The Case of CO2 Compressor in CCUS Cooperation. *Portland International Conference on Management of Engineering and Technology: Technology Management For Social Innovation, Proceedings*, 1659–1671. https://doi.org/10.1109/PICMET.2016.7806765.

Livotov, P. (2015). Using patent information for identification of new product features with high market potential. *Procedia Engineering*, 131, 1157–1164. https://doi.org/10.1016/j.proeng.2015.12.438.

Lupu, M & Hanbury A. (2013), "Patent Retrieval", Foundations and Trends in Information Retrieval: Vol. 7: No. 1, pp 1-97. http://dx.doi.org/10.1561/1500000027Olsson, O. (2005). Technological Opportunity and Growth. *Journal of Economic Growth*, 10, 35-57. https://doi.org/10.1007/s10887-005-1112-4.

Ouyang, K., & Weng, C. S. (2011). A New Comprehensive Patent Analysis Approach for New Product Design in Mechanical Engineering. *Technological Forecasting & Social Change*, 78(7), 1183–1199. https://doi.org/10.1016/j.techfore.2011.02.012.

Pearce, J. A. (2006). How Companies Can Preserve Market Dominance after Patents Expire. *Long Range Planning*, 39(1), 71–87. https://doi.org/10.1016/j.lrp.2005.04.006.

Qiu, H. H., & Yang, J. (2018). An assessment of technological innovation capabilities of carbon capture and storage technology based on patent analysis: A comparative study between China and the United States. *Sustainability*, 10(3), 1–20. https://doi.org/10.3390/su10030877.

Risch, M. (2015). A Generation of Patent Litigation. *San Diego L. Rev.*, 52(1). 68-132.

Rohrbeck, R., & Schwarz, J. O. (2013). The Value Contribution of Strategic Foresight: Insights from an Empirical Study of Large European Companies. *Technological Forecasting and Social Change*, 80(8), 1593–1606. https://doi.org/10.1016/j.techfore.2013.01.004.

Salo, A., & Cuhls, K. (2003). Technology Foresight Past and Future. *Journal of Forecasting*, 22, 79–82. https://doi.org/10.1002/for.846.

Sharma, P., & Tripathi, R. C. (2013). Patent Database: A Methodology of Information Retrieval from PDF. *International Journal of Database Management Systems*, 5(5), 9–16. https://doi./10.5121/ijdms.2013.5502.

Trappey, A. J. C., Trappey, C. V, Wu, C., & Lin, C. (2012). Advanced Engineering Informatics a Patent Quality Analysis for Innovative Technology and Product Development. *Advanced Engineering Informatics*, 26(1), 26–34. https://doi.org/10.1016/j.aei.2011.06.005.

Wang, Y., Gui, H., & Ma, L. (2020). A Survey on Services Provision and Distribution of Official and Commercial Intellectual Property Platforms. *Security and Communication Network*, 2020, 1–14. https://doi.org/10.1155/2020/8833416.

WIPO. (2015). *Patentscope The User's Guide*. World Intellectual Property Organization. Retrieved November 1 2021, from https://www.wipo.int/export/sites/www/patentscope/en/docs/patentscope_user_guide.pdf.

Yang, X., Yu, X., & Liu, X. (2018). Obtaining a Sustainable Competitive Advantage from Patent Information: A Patent Analysis of The Graphene Industry. *Sustainability*, 10(12). http://dx.doi.org/10.3390/su10124800.

Yang, X., Liu, X., & Song, J. (2019). A Study on Technology Competition of Graphene Biomedical Technology Based on Patent Analysis. *Applied Sciences*, 9(13), 1–25. https://doi.org/10.3390/app9132613.

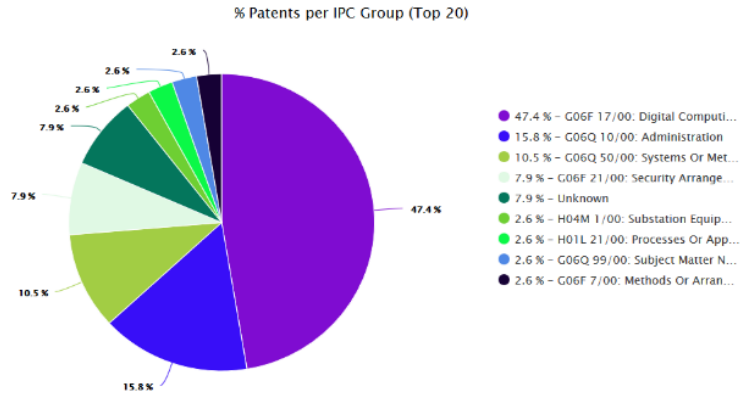
Yang, X., & Yu, X. (2019). Identifying Patent Risks in Technological Competition: A Patent Analysis of Artificial Intelligence Industry. *Proceedings of 2019 8th International Conference on Industrial Technology and Management*, 333–337. https://doi.org/10.1109/ICITM.2019.8710719.

Yoon, B., Park, I., & Coh, B. (2014). Exploring Technological Opportunities by Linking Technology and Products: Application of Morphology Analysis and Text Mining. *Technological Forecasting and Social Change*, 86, 287–303. https://doi.org/10.1016/j.techfore.2013.10.013.

Yoon, J., Park, H., Seo, W., Lee, J. M., Coh, B. Y., & Kim, J. (2015). Technology Opportunity Discovery (TOD) from Existing Technologies and Products: A Function-based TOD Framework. *Technological Forecasting and Social Change*, 100, 153–167. https://doi.org/10.1016/j.techfore.2015.04.012.

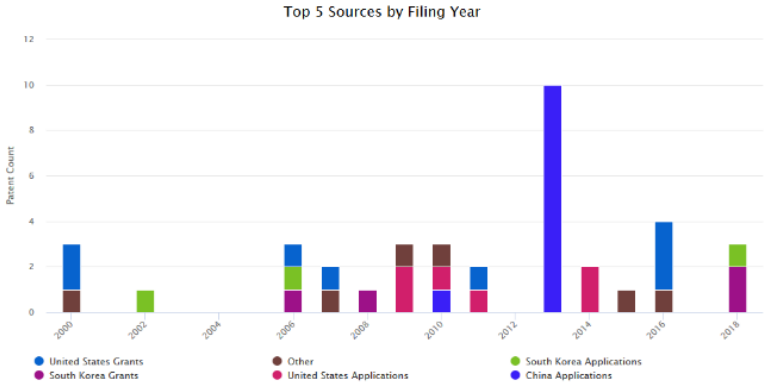
Zhu, D., & Porter, A. L. (2002). Automated Extraction and Visualization of Information for Technological Intelligence and Forecasting. *Technological Forecasting and Social Change*, 69(5), 495–506. https://doi.org/10.1016/S0040-1625(01)00157-3.

Appendix 1. IP Class on Patent Search Engine



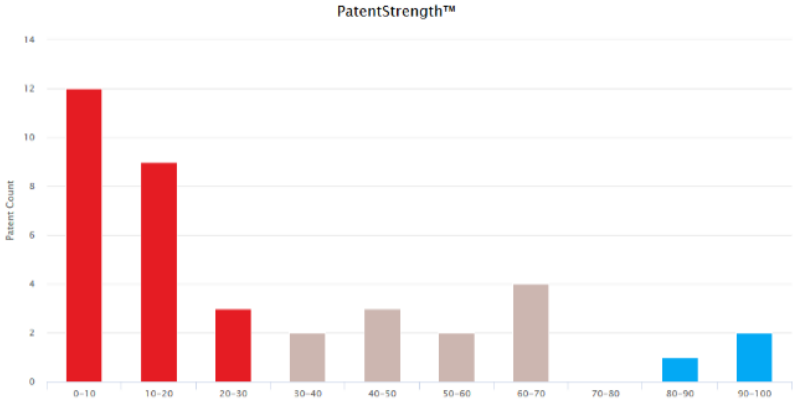

Source: Innography (Processed)

Appendix 2. Patent Filling Distribution in 2000-2018



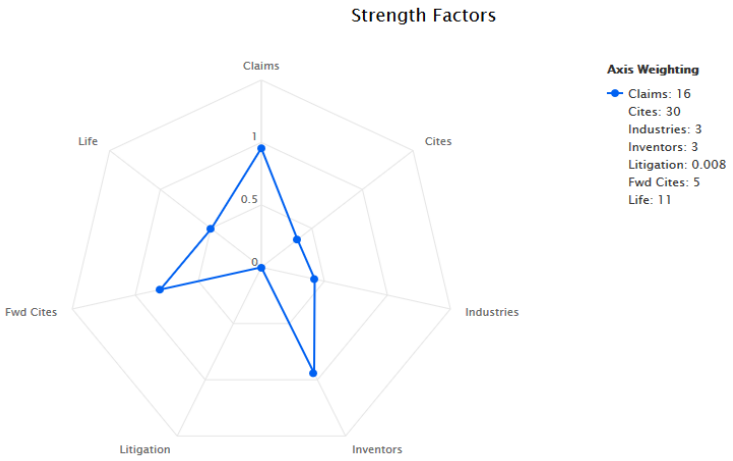

Source: Innography (Processed)

Appendix 3. Patent Search Engine in Position Strength Deciles



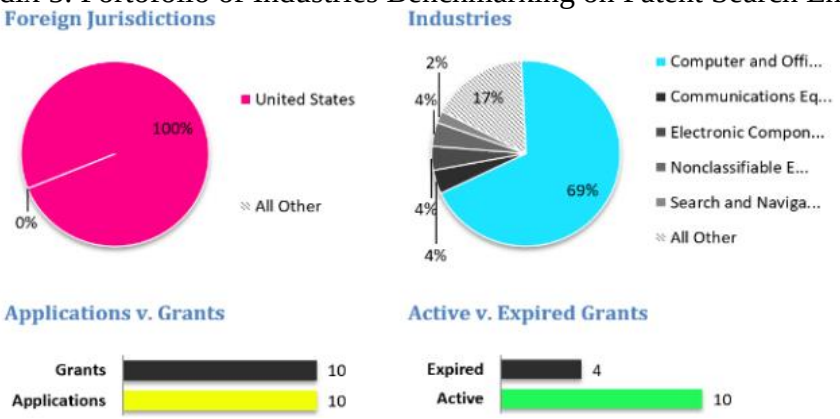

Source: Innography (Processed)

Appendix 4. Patent Search Engine in Position Strength Factors



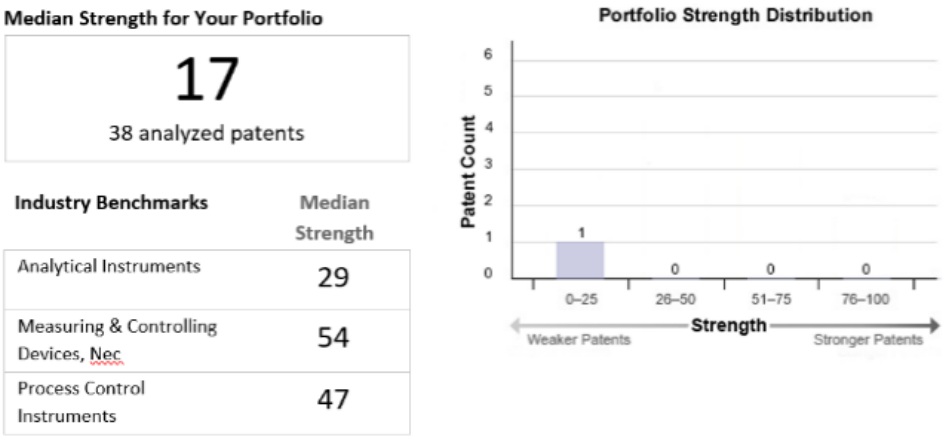

Source: Innography (Processed)

Appendix 5. Portofolio of Industries Benchmarking on Patent Search Enginee




Source: Innography (Processed)

Appendix 6. GEM Finder on Patent Search Engine




Source: Innography (Processed)