

Technology Position Benchmarking Using Public Data

Nguyen-Truong LE^{a*} & Nguyen-Thinh LE^b

^a*Fraunhofer Institute for Industrial Engineering IAO, Germany*

^b*Humboldt Universität zu Berlin, Germany*

*truong.le@iao.fraunhofer.de

1. Introduction

The term “Industry 4.0” refers to the fourth industrial revolution and has been suggested at the Hannover fair in 2011 (VDI, 2011). According to Hermann et al. (2015), Industry 4.0 is a collective term of technologies and concepts of value chain organization. Similar concepts of Industry 4.0 are e.g. industrial internet, cyber-physical systems, smart manufacturing. Until now, there is still no consent about the scope of technologies within Industry 4.0. Chinese government is fostering industry and research organizations to increase number of patent filing to reach two million annual filings in 2015 (EUCCC, 2012). As more patents are being filed by Chinese inventors and companies, the information about Chinese research and development activities is becoming now abundant. According to Fraunhofer Institute IAO (Fraunhofer, 2015), China is at the moment the pioneer in patenting Industry 4.0 technologies. In this paper, we investigate the research question: How can the technology position of Chinese companies in the context of international competition be determined? In the next section, we present the methodological approach to investigate this research question. In the third section, we show and analyze the results of the study that focuses on the market of industrial automation. In the last section, we discuss our methodology and propose a data mining approach as future work.

2. Methodology and Results

In order to investigate the research question specified in the previous section, we pursue a bibliometric analysis approach (De Bellis, 2009) including thesaurus creation and measuring term frequency. First, we created a thesaurus for the topic “Industry 4.0”. For this purpose, we conducted expert interviews to structure the technologies behind Industry 4.0. We divided technologies into four classes: data generation (e.g., smart sensors), data transmission (e.g., data transmission protocols), data storage and processing (e.g., Big data), and smart applications (e.g., 3D printing). In the next step, the technology position of each company can be analyzed using publicly available data. In order to comprehensively analyze technology position of companies, we propose to employ the theoretical framework of the innovation process (Cooper, 2011). Based on this theoretical concept, adequate data sources for bibliometric analysis were identified. For the first phase (idea and concept generation), patent information (patbase) can serve to identify ideas and concepts about a new technology. Patent information has several advantages: low cost, well structured, easily accessible, highly actual, titles and abstracts are available in English. For the second phase (research and development), possible data for this phase include scientific publications (scopus, cnki). Scientific publications may also give us major information about the current trend of technology development. Information about the third phase (production and product introduction) is sufficiently available on press releases or social media (facebook, renren, twitter, weibo, youtube, google news, baidu news).

In order to investigate the specified research question, we chose two companies from China and two western companies: ZTE (China), Haier (China), Festo (Germany) and GE (USA)¹. Based on this analysis framework introduced in the previous section, we collected data the last five years (01.01.2010 until 30.04.2015) from the four companies and compiled it. In each data source (e.g., patbase) the

¹ <http://www.zte.com.cn>, <http://www.haier.com/uk>, http://www.festo.com/cms/en_corp/index.htm, <http://www.ge.com>

number of documents containing relevant keywords of industry 4.0 as well as the relative frequency have been determined for each company. When calculating the relative frequency the company with the highest number of documents published is taken as reference. After applying this analysis procedure to every data source, the technology position of competing companies can be determined (Table 1).

Table 1: Competition position of each investigated company

| Companies | | ZTE | Haier | Festo | GE |
|--|-----------------|-------------|-------------|-------------|-------------|
| Benchmark criteria | | | | | |
| I.1. Relative frequency of patent families | | 0.42 | 0.13 | 0.25 | 1.00 |
| II.1 Relative frequency of publications in Scopus | | 0.16 | 0.07 | 0.14 | 1.00 |
| II.2 Relative frequency of publications in Chinese literature database CNKI | | 0.21 | 1.00 | 0.03 | 0.34 |
| III.1. Relative number of followers on social media platforms | Facebook | 0.17 | 0.00 | 0.01 | 1.00 |
| | RenRen | 0.02 | 1.00 | 0.00 | 0.03 |
| III.2. Relative frequency of articles on social media platforms | Twitter | 0.72 | 0.71 | 0.71 | 1.00 |
| | Weibo | 0.50 | 1.00 | 0.03 | 0.44 |
| | Google+ | 0.51 | 0.35 | 0.30 | 1.00 |
| III.3. Relative frequency of press releases | Google News | 0.07 | 0.03 | 0.01 | 1.00 |
| | Baidu News | 0.17 | 1.00 | 0.00 | 0.17 |
| III.4. Relative frequency of videos on video platforms | Youtube English | 0.35 | 0.10 | 0.17 | 1.00 |
| | Youtube Chinese | 0.46 | 1.00 | 0.19 | 0.45 |
| IV. Relative technology position with regard to Idea and concept generation | | 0.42 | 0.13 | 0.25 | 1.00 |
| V. Relative technology position with regard to Research and Development | | 0.18 | 0.53 | 0.08 | 0.67 |
| VI. Relative technology position with regard to Production and Market introduction | | 0.33 | 0.58 | 0.16 | 0.68 |
| VII. Total relative technology position | | 0.31 | 0.41 | 0.16 | 0.78 |

3. Discussion

In this paper, we have proposed to apply a bibliometric analysis approach to determine the technology position of companies in the context of industry 4.0, and thus the international competition of companies can be compared. One of the limitations of this approach is the process of calculating the relative frequency of “Industry 4.0” related terms in each source of public data. This process may be more efficient if data mining is deployed. By using data mining methods, e.g. patent data can be combined with other information sources e.g. Chinese scientific publications, social media, press releases, etc. competitive analysis can be made. One of the challenges here is to combine data from different large-size sources of data.

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