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Technology maturity assessment based on blog analysis

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ABSTRACT

R&D managers make strategic decisions regarding technologies that are crucial for the long term success of their companies. Standardized technology intelligence reports on the basis of informetric approaches are an outstanding means of providing them with a sound information basis; one important yet scientifically less considered aspect of informetrics is technology maturity. The portrayal of a technology in text media changes with its maturity; this change can be measured. Our paper focuses on blog analysis as one part of informetrics. It represents a proof of concept for an approach based on changes induced by technology maturity in blog texts. We operationalize the technology life cycle model by Sommerlatte and Deschamps (1986) and measure the utilization of terms specifically used in the context of *pacing technologies* and *basic technologies*, both concepts stemming from the selected technology life cycle model. We test this approach on six technologies and make use of fuzzy logic to assess a technology's maturity. We triangulate the results from blog based analysis with results from an expert survey. Our method provides a quick orientation regarding technologies; it helps compare their maturity, monitor development speed as well as maturity state changes, and even identify re-emerging basic technologies. So far, R&D managers have rated the resulting information as a valuable and intuitive supplement to information sources available.

1. Idea of standardized short technology maturity reports

R&D managers are required to make strategic decisions regarding technologies that are crucial for the long term success of their companies (Burgelman et al., 2004). They have to decide whether to hold, invest or disinvest in a technology, be it inhouse or external (see Enkel et al. (2009) for the actual discussion about opening up the innovation process), and they have to decide which technologies are to be bundled in products, bearing in mind the different probable states of respective life cycles (McCarthy, 2003). For this purpose they have to consider all kinds of information concerning trends, industry, competitors, partners/suppliers, customers, and experts. And they have to act quickly when changes occur.

Standardized short technology intelligence reports in general are an outstanding means of giving R&D managers a sound information basis and thus support the aforementioned decisions. They are of value especially under three preconditions: (i) the reports must provide a comprehensive picture of a technology, (ii) they must be generated by means of information technology in order to keep costs at an acceptable level (Porter, 2005; Veugelers et al., 2010), and (iii) they must be specific in terms of being linkable to the particular strategic resources of a company. Ideally, the reports take into account all openly available data to generate a holistic picture of the technology in focus.

Standardized short technology intelligence reports may comprise several subreports, in particular competitors, application fields, and complementary technology reports (see Geschka and Hahnenwald (2013) for the concept of a technology

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complex covering several relevant aspects of technological analysis). In this paper we focus on a standardized short technology maturity report, as a technology's maturity is crucial for strategic decisions.

While informetrics on patents and scientific literature represent a well-known research front for maturity assessment and related tasks (Martino, 2003; Porter and Cunningham, 2006; Järvenpää and Mäkinen, 2009; Walde, 2010), web content based indicators for technology maturity assessment have not yet been discussed but may be a beneficial supplement or even a complete replacement of traditional patent and scientific literature based approaches (see Cachia et al. (2007) for foresight-related use of web content). Compared with those traditional approaches, they may be able to provide information based on perspectives that could not be covered before with a higher acceptance rate, quicker, and more precisely (we will comment on the benefits of blogs later on). What is still missing is, above all, a method that makes use of the valuable information contained in blog texts. In this paper, we present such a method focusing on an important aspect of technology intelligence, namely the assessment of a technology's maturity.

This paper is organized as follows. In Section 2 we introduce a definition of technology and link it to the technology life cycle model by Sommerlatte and Deschamps (1986). In Section 3 we present the idea that blogs contain valuable information along the lines of experts' perceptions of technology maturity. In Section 4 we introduce a precise informetric method for analyzing technology maturity based on blog content. In detail, we develop an approach, assuming that different states of a technology life cycle lead to different wording in those blog texts, the wording reflecting the experts' perception of the technology's maturity. For this purpose, we operationalize the selected technology lifecycle model. We define terms that are specifically used in the context of either pacing or basic technologies, both concepts stemming from the selected technology life cycle model. We test this approach on six selected technologies, namely modular homes, induction cooking, CO_2-sequestration, wireless energy transmission, nanobots, and quantum computers. We apply a fuzzy logic approach to generate an assessment of the state of technological maturity. In order to triangulate the results from blog based analysis with human experience in the field of technology maturity, we develop an expert based approach in Section 5 and compare both results in Section 6. We conclude in Section 7 that our method is not only valuable for R&D managers but also provokes theoretical aspects, for instance as concerns re-emerging mature technologies.

2. Technologies and related life cycle models

At the core of R&D management decisions about technologies have to be made. In this context, technologies can be defined very generally as knowledge concerning objective and resource relations which can be used for solving applicatory problems (Basalla, 1998). Scientific fields that may contribute to this are natural sciences (e.g. physics, biology), theoretical sciences (esp. mathematics), engineering sciences (e.g. mechanical engineering), and social sciences. In general, technologies are linked to a certain objective they are meant to fulfill. It is quite common to differentiate between *product* (or component) *technology* and *process technology* (Abernathy and Utterback, 1975; Teece, 1986; Dror, 1989). In an automotive environment for instance, brake technology represents a product technology whereas welding technology represents a process technology. Moreover, technologies can be linked to *fields of application* or to *scientific effects*. For example, traffic technology is related to an entire field of application rather than a specific product or process, and nanotechnology is linked to a scientific effect that might enable new product or process technologies.

One major aspect of a technology is its maturity, which is a composition of other important parameters such as its factual vs. theoretical capability, usability, or diffusion among potential users. This maturity can be represented as the technology's position within a technology life cycle. Technology life cycle models presume patterns over time of certain technology parameters (Höft, 1992). Various technology life cycle models have been proposed so far, differing in detail (Sommerlatte and Deschamps, 1986; Ford and Ryan, 1981; Ansoff, 1984; Linden and Fenn, 2003) and bearing relationships to other (product or industry) life cycle models, see Routley et al. (2013) for a recent in-depth analysis. Most of these models consist of three to six maturity states and describe the maturing process of a technology from the discovery of the underlying scientific principles to its introduction to the market and beyond. In this paper we use the model devised by Sommerlatte and Deschamps (1986) with its three clearly-defined states of pacing, key, and basic technologies.

In practical application, however, all presently available technology life cycle models bear a number of shortcomings, a vital one being the lack of methods to operationalize the model parameters (Tiefel, 2008). In order to overcome these shortcomings, we operationalize the life cycle of real world technologies later on by way of the corresponding life cycle of text data, as suggested by Veugelers et al. (2010), Martino (2003), Porter and Cunningham (2006) and Järvenpää and Mäkinen (2009).

3. Blogs as an information source for assessing technology maturity

As pointed out in Section 1, there is a need to automatically generate reports on a technology's maturity. There are various information sources suitable for this kind of report: specialized audience media, such as patents and scientific literature, or public media like the press, and even participatory web content. Each of these sources is able to provide a particular kind of information, as they represent different groups of authors and readers (see for instance the semantic analysis of patents by Walter et al. (2003)). Especially patents and scientific literature are frequently analyzed for technology management and foresight purposes (e.g. Daim et al., 2006), in some cases even supported by text mining methods as applied by Martin and Daim (2007) and Wu et al. (2011).

The focus of this work shall be set on blogs, for the following four reasons:

(i) Research on web content is scarce (Hoewner, 2011), although sorely needed, which can be gathered from the results of a survey conducted among 25 R&D managers of an automotive company in June 2010. In an internal questionnaire they were asked to rate the statement "It is of great importance for my work as R&D manager to consider the visibility of a technology and the awareness

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