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A multiple correspondence analysis model for evaluating technology foresight methods

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ABSTRACT

Technology foresight (TF) studies the appropriate extrapolation methodologies for predicting the most likely technology development scenarios in the future. Although there is a vast literature dealing with the classification and development of technology foresight methods (TFMs), the problem of selecting those that best reflect the characteristics of an organization is challenging and remains mostly overlooked. We propose a TFM evaluation procedure that allows decision makers and managers to successfully address this problem. The proposed procedure identifies the most relevant TFMs and organizational criteria and uses them in a multiple correspondence analysis (MCA) model to select the most suitable method(s) for implementation. The proposed MCA model combines the doubling data technique with a row principal scoring procedure to allow for the reduction of dimensionality and, consequently, the graphical analysis of the patterns of relationships among TFMs and evaluation criteria. We present a case study in a knowledge-based organization to demonstrate the applicability and efficacy of the proposed evaluation procedure. The results show that the proposed model can be properly adapted to allow for a wide range of applications involving business organizations and government agencies.

1. Introduction

Technology foresight (TF) is an important phase of a firm's development process of open innovation initiatives and it involves identifying technologies which are critical to the future success of the firm (Battistella, 2014; Rohrbeck and Gemünden, 2011; Tseng et al., 2009). The strategic management literature in general recommends managers to abandon maturing technologies and embrace new ones to stay competitive (Christensen, 2013). As a result, an increasing number of business organizations and government agencies have started using different technology foresight methods (TFMs) as research and development tools (Daim et al., 2006). One of the fundamental responsibilities of research and development managers is to decide between optimizing current technologies and planning new ones (İNtepe et al., 2013). Despite the large number of studies on TFMs and their classification, the complex and challenging problem of assessing the TFMs in order to select those that best reflect the characteristics of an organization remains mostly overlooked in the literature.

Only recently, there has been an increase in the number of studies on assessing TFMs. These studies in general agree on three main points: (1) any attempt to systematically evaluate foresight programs cannot ignore the complex interactive nature of foresight (Miles, 2012); (2) foresight cannot be fully evaluated independently from its context which makes impossible to find a “one-size-fits-all” evaluation method (Georghiou and Keenan, 2006); (3) new integrated approaches are necessary to combine the sophisticated solutions of the technology side with the real needs of the customers, that is, it is necessary to focus on both the market “pull” and technology “push” approach (Vishnevskiy et al., 2016).

Magruk (2011) developed a new approach for classifying TFMs based on their applicability. However, this approach cannot recommend the most suitable TFM for a particular technology development problem. İNtepe et al. (2013) used a multi-criteria interval-valued intuitionist fuzzy group decision making approach to select a TFM, but

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Table 1
Technology foresight methods in the literature (characteristics and citations).

TFM	Exploratory	Normative	Expert based	Evidence based	Assumption based	Quantitative	Semi-quantitative	Qualitative	Citation
Environmental scanning	×	✓	✓	×	×	×	✓	×	Coates et al. (2001), Eto (2003), Firat et al. (2008), Lee and Sohn (2014), Meijering et al. (2013), Miles and Popper (2008), Nosella et al. (2008)
Expert panel	✓	×	✓	×	×	×	×	✓	Bengisu and Nekhili (2006), Chen et al. (2012), Coates et al. (2001), Daim et al. (2006), Kent and Saffer (2014), Miles and Popper (2008)
Brainstorming	✓	✓	×	✓	✓	×	✓	×	Chen et al. (2012), Dubarić et al. (2011), Garimella et al. (2013), Tseng et al. (2009), Daim et al. (2006)
Morphological analysis	✓	✓	✓	✓	×	×	✓	×	Chen et al. (2012), Dubarić et al. (2011), Garimella et al. (2013), Tseng et al. (2009), Daim et al. (2006), Cosmi et al. (2011)
Questionnaires/surveys	✓	✓	✓	✓	×	×	✓	×	Firat et al. (2008), Magruk (2011), Meijering et al. (2013), Garimella et al. (2013), Tseng et al. (2009)
Relevance trees	✓	✓	✓	✓	✓	×	×	✓	Coates et al. (2001), Firat et al. (2008), Lee and Sohn (2014), Magruk (2011), Meredith et al. (1995)
Scenarios	✓	×	×	×	✓	×	✓	×	Coates et al. (2001), Eto (2003), Firat et al. (2008), Magruk (2011), Meijering et al. (2013), Mahmud (2011)
SWOT	✓	×	✓	×	×	×	×	✓	Meijering et al. (2013), Meredith et al. (1995), Miles and Popper (2008)
Delphi	✓	✓	✓	×	×	×	✓	×	Coates et al. (2001), Firat et al. (2008), Magruk (2011), Meredith et al. (1995), Miles and Popper (2008)
Key technologies	×	✓	✓	×	×	×	✓	×	Grossman (2008), Miles and Popper (2008)
Trend impact analysis	✓	✓	✓	✓	×	✓	×	×	Miles et al. (2013), Miles and Popper (2008)
Technology roadmapping	✓	✓	✓	×	✓	×	✓	×	Meijering et al. (2013), Meredith et al. (1995), Miles and Popper (2008)
Modeling & simulation	✓	×	✓	×	×	✓	×	×	Magruk (2011), Meijering et al. (2013), Garimella et al. (2013), Tseng et al. (2009), Miles and Popper (2008)
Trend extrapolation	✓	×	×	✓	×	✓	×	×	Magruk (2011), Meijering et al. (2013), Garimella et al. (2013), Tseng et al. (2009)
Literature review	×	✓	×	✓	×	×	×	✓	Firat et al. (2008), Lee and Sohn (2014), Meijering et al. (2013), Meredith et al. (1995), Miles and Popper (2008)
Back casting	×	✓	×	×	✓	×	×	✓	Firat et al. (2008), Lee and Sohn (2014), Meijering et al. (2013), Meredith et al. (1995)
Cross-impact analysis	✓	×	✓	✓	×	×	✓	×	Daim et al. (2006), Kent and Saffer (2014), Schubert (2015), Garimella et al. (2013), Miles and Popper (2008)
Futures workshops	✓	✓	✓	×	✓	✓	×	×	Magruk (2011), Meijering et al. (2013), Garimella et al. (2013), Tseng et al. (2009)
Stakeholder mapping	×	✓	×	×	✓	×	✓	×	Grossman (2008)
Patent analysis	✓	×	×	✓	×	×	✓	×	Chen et al. (2012), Dubarić et al. (2011), Tseng et al. (2009), Daim et al. (2006), Miles and Popper (2008), Lee and Sohn (2014)
Multiscale analysis	×	✓	✓	×	×	✓	×	×	Miles et al. (2013), Miles and Popper (2008)
Text mining	✓	×	✓	×	×	×	✓	×	Grossman (2008)
System dynamic	✓	×	✓	×	×	✓	×	×	Grossman (2008)
Futures wheel	✓	✓	✓	×	✓	×	×	✓	Lee and Sohn (2014), Meijering et al. (2013), Meredith et al. (1995), Miles and Popper (2008)