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Fuzzy front end of systemic innovations: A conceptual framework based on a systematic literature review

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ABSTRACT

This study aims to analyze the fuzzy front end stage (FFE) of systemic innovations, which are characterised by interdependence with other innovations and actors of the business ecosystem. The methodological approach selected is a systematic literature review based on bibliometric, social network analysis and content analysis. The analysis of the literature reveals that systemic innovations are addressed in a limited manner in specialised articles on FFE. The main frameworks on FFE were analysed in-depth and a conceptual framework for the fuzzy front-end stage of systemic innovations was proposed, encompassing the following elements: (i) ecosystem mapping and identification of the organisation positioning within the ecosystem during the analysis of the influence factors; (ii) use of mechanisms of coordination, collaboration, self-regulation and adaptation as innovation drivers; (iii) conception of new business models, value networks or strategic positioning as a result of the definition of concepts; and (iv) strategic planning or corporate venture capital as stages subsequent to the FFE, instead of the formal process of new product development.

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1. Introduction

Systemic innovation (SI) corresponds to the type of innovation that only generates value if accompanied by complementary innovations. It opposes autonomous innovation, which can be developed independently of other innovations (Chesbrough and Teece, 2002). For Taylor and Levitt (Taylor and Levitt, 2004), systemic innovation changes business processes and requires companies to change their practices. Moreover, it requires significant adjustments of the other parts of the business system involved (Maula et al., 2005).

On the one hand, there is an increasing importance of understanding the innovation dynamics in complex systems to ensure the competitive advantage of companies (Iansiti and Levien, 2004). As the SI processes expand beyond the company boundaries, they generally involve the coordination of different parts of the value network. According to Taylor and Levitt (2004), SI typically increases general long-term productivity but can create switching or initiation costs for some participants and reduce or eliminate the role of others, making SI initiation and diffusion more complex.

On the other hand, the fuzzy front end (FFE) appears as the stage that requires the most investigation while having the greatest potential to increase the success probability of the innovation process (Khurana

and Rosenthal, 1997; Koen et al., 2001; Kim and Wilemon, 2002). FFE is defined as the initial stage, and generally chaotic, that starts by identifying opportunities and by generating ideas, and finishes by approving new concepts for a more structured phase of the innovation process (Koen et al., 2001; Smith and Reinertsen, 1992). This stage is usually part of a Stage Gate® (Cooper, 1990) type model, which is performed by new product development teams.

Thus, the FFE concept arises in a context of new product development within a single organisation. Just a few studies expand beyond the organisation boundaries, addressing only a single additional actor in the business ecosystem, such as the supplier (Wagner, 2012) and the users/customers (Magnusson, 2009; Dahl and Moreau, 2002). Studies of collaboration between functions (cross-functional collaboration) appear to be limited to areas within the same organisation (Moenaert et al., 1995; Brettel et al., 2011).

Wagner (2012), Brettel et al. (2011), Brentani and Reid (2012), Fixson et al. (2012), Verworn et al. (2008), and Rice et al. (2001) show that there is a lack of FFE studies that take into account more variables and external stakeholders to the organisation (environmental factors) to understand this initial stage of the innovation process.

Analysing the SI literature, several authors (Adner and Kapoor, 2010; Afuah, 2000; Jacobides et al., 2006; Prieto, 2013) indicate the need to coordinate the actors of the value chain or business ecosystem that are external to the organisation frontiers for SI, considering the type of connection (e.g., vertical integration, contract, partnerships, and alliances), the choice of the governance structure, the degree of trust/uncertainty among the actors and the mechanisms of knowledge transfer

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among firms. As aforementioned, the relation between FFE activities and issues associated with external actors has not yet been sufficiently explored.

Another issue related to the FFE stage in SI is the need to conceive new business models or new ecosystem architectures, because the value, in this case, is generated and distributed by complex interrelationships among the various actors (Adner and Kapoor, 2010; Jacobides et al., 2006; Moore, 1993). Because the FFE literature focuses on generating concepts for new products instead of new businesses, one question is whether there are theories that support the conception of new business models as one of the activities for the FFE stage of a SI.

This paper aims to prepare the ground to identify the theoretical contours of this emerging field, building on the insight into the potential research gap between FFE and SI. The following research question was defined: how should the FFE of systemic innovations be?

An extensive body of knowledge on FFE and SI is available; however very little work has been reported with respect to the FFE stage of a SI. In the background of FFE and on SI, we find the stepping-stones to link both fields. For this, a systematic literature review (SLR) approach was selected combining bibliometric, network and content analysis. The first phase was the bibliometric approach to identify the most relevant literature on both – FFE and on SI, going through the network analysis for the key points at which these two fields intersect. Keyword network analysis was performed with the software Sitkis, Ucinet, and Netdraw, based on the keywords used by the studies surveyed. This approach was selected in order to rapidly grasp an overview of the relationships between constructs for conceptual modelling, based on the current literature. The second phase, content analysis, was performed by identifying the core FFE models in the literature, which were used as a code tree for the content analysis. In addition, in the SI scholar literature, the key aspects related to the FFE stage were identified and coded. From this background, in the third phase synthesis, we position the conceptual model on FFE and SI, in which the insights from the current literature were reorganised in a new format while pointing out possible new directions.

This paper is structured into five sections. Section 2 presents the summary of the literature review in context for FFE of SI. Section 3 presents the methodological approach and research methods. Section 4 presents the results. Section 5 presents a discussion of the findings and the conceptual framework proposed, and Section 6 presents the conclusions and contributions of the research.

2. A context for FFE of SI

First, let us clarify the definition of FFE and SI adopted in the research. Then, let us turn to the relevance of the research question of how to pursue SI at the FFE stage.

The FFE stage has three characteristics shared by all the authors in the sample studied:

- It is the first stage of innovation development;
- It precedes the formal and structured innovation development;
- The termination of the phase is characterized by a formal approval or rejection of the project for the next stage.

The definition of systemic innovation is far more incipient compared to FFE and deserves further discussion along with the content analysis performed herein. In short, Teece, as the main early author on the subject highlighted three aspects:

- Innovation that requires complementary innovations to generate value;
- Innovation that requires significant changes in other sub-systems;
- Innovation in which coordination and cooperation are necessary.

SI has attracted increasing attention due to recent successful business cases and also due to pressing demands for great infrastructure transitions to achieve a more sustainable economy (Boons et al., 2013; Boons and Lüdeke-Freund, 2013). A typical successful business case of SI is Apple's iPhone and its ecosystem. The way in which Apple delivered a whole pack of innovations surrounding iPod and iPhone is an inspiring case, involving the iTunes, in a partnership with major record labels for online legal music distribution, and App Store as a new way of crowd developing and distributing useful applications for consumers, revolutionised the mobile communication industry. In terms of major transitions towards a sustainable economy, one example is the Smart Grid, which requires orchestrated moves from utility companies, technology suppliers, telecom operators, regulators and changes in consumer habits to fully generate its expected value to society.

However, different stages of SI require different ways of innovation. In addition, a substantial share of the literature on FFE tends to focus on individual product innovations and/or R&D project. This is the stage at which regulation, social acceptance, and technology are still malleable, open-ended and uncertain (Boon et al., 2011); therefore, the great challenge of managing cumulative risks between several parties must be addressed (Adner, 2006). The hope to shed light on these issues was the research team's motivation for this paper.

3. Research methods

Fuzzy front end (FFE) and systemic innovation (SI) have been addressed by various studies, but the intersection between these two fields is still scarce. To bridge both fields, a systematic literature review (SLR) approach was selected to explore the body of knowledge available.

A multi-method combination for SLR is applied, mixing bibliometric, keyword network analysis and content analysis. These methods are complementary (Carvalho et al., 2013), and used in order to get the most from the current literature before a more costly field research. Whereas bibliometrics and network analysis aid in understanding the publication patterns in the main databases, content analysis focuses on the surveyed articles and help to develop the conceptual framework.

The first phase was the bibliometric approach to identify the most relevant contributions of both – FFE and SI, by surveying the existing literature on key scientific databases. Keyword network analysis was performed, going through the network analysis for the key points at which these two fields intersect. This approach was selected in order to rapidly have an overview of relationships between constructs for conceptual modelling, based on the current literature. The second phase, the content analysis, was performed by identifying the core concepts for FFE and SI. From this background, in the third phase synthesis, we position the conceptual model on FFE and SI.

3.1. Articles sample and bibliometrics

To obtain the first sample, articles published in indexed journals, having their impact factor calculated by the JCR (Journal Citation Report) from the ISI Web of Knowledge (Web of Science) database were selected. This database was chosen because it includes articles from other databases, such as Scopus, ProQuest, and Wiley. Moreover, this database provides metadata crucial for the bibliometric analysis, including summaries, references, the number of citations, the list of authors and keywords. All the articles recorded in the database until September 2013 were considered in the initial search.

The search words used in step 1 were ["fuzzy front end" or "fuzzy-front end" or "fuzzy-front-end"], leading to 105 articles, from which 3 were excluded as they only dealt with the "fuzzy logic" method. To select the most relevant articles, the impact factor of each article (I) was calculated based on the number of citations (C) and the impact factor of the journal in which it was published, obtained by the Journal Citation

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