



An integrated model of innovation drivers for smaller software firms



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ABSTRACT

High-technology innovation is essential for economic development in industrialized societies. However, innovation practice in smaller software companies has received little attention. We derive software innovation drivers and outputs from a fragmented literature and analyze their empirical relevance using qualitative data from 25 in-depth interviews with software executives in the Silicon Fen. Repeating patterns in the data set revealed through content analysis show that the most important innovation drivers for smaller software firms are external knowledge, leadership and team processes. Specialized innovation tools and techniques are hardly used. We develop a model of software innovation drivers, together with explorative theoretical propositions.

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1. Introduction

Technological innovation has long been associated with entrepreneurship, market power and economic growth, and it has been widely studied by economists, and organizational and management theorists. High-technology industries (including the software industry) are particularly dependent on innovation, providing many high-growth firms. The high-technology sector is important for national economies because of its ability to stimulate jobs and growth through high levels of invention and innovation. The result can be new industries with high profits, competitive edge and good salaries [67]. The US National Science Foundation reports that knowledge and technology industries 'have a much higher incidence of innovation than other industries' and that 'software firms lead... with 69% of companies reporting the introduction of a new product or service'.¹ Thus, the performance of software companies has broad economic consequences: 'the software sector has effects that spill over beyond its specific niche, particularly as a widening array of economic activity, goods,

and services rely to some extent on software-related technologies. Since these technologies promise to command a greater share of economic activity, the size and effectiveness of investment in software-related R&D may determine economic performance and international competitiveness more broadly' [50]. Moreover, the importance of the sector is not confined to large companies; high-technology start-ups drive economic growth and catalyze technical innovation in societies [67]. However, research and development in small high-technology small firms remains risky – success in the development of leading-edge technology is never guaranteed, and it may be both expensive and time consuming. Small- and medium-sized software enterprises (SMSEs) operate under difficult competitive conditions as a result of their size in relation to their competitors [29]. They often operate with constrained resources (especially for investment in new projects), specialist skill shortages and a small customer base over which they have little control. They face entry barriers imposed by larger competitors [68], challenges with internationalization and markets distorted by the availability of free software; therefore, they are often confined to niche markets of their own development. One important response to these difficult conditions is the ability to innovate; innovation facilitates the development of novel value for customers, streamlines internal development processes and opens market spaces that are not yet dominated by larger competitors.

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¹ <http://www.nsf.gov/statistics/seind14/index.cfm/chapter-6/c6s4.htm>.

Innovation involves ‘the generation, development, and adaptation of novel ideas on the part of the firm’ [90], where novelty is accompanied by utility, or value for the firm and its customers. Some researchers link innovation with the creation of new knowledge: ‘innovation, which is a key form of organizational knowledge creation, cannot be explained sufficiently in terms of information processing or problem solving. Innovation can be better understood as a process in which the organization creates and defines problems and then actively develops new knowledge to solve them’ [66]. However, innovation is generally understood as complex and multifaceted: ‘innovation is not a single action but a total process of interrelated sub processes. It is not just the conception of a new idea, nor the invention of a new device, nor the development of a new market. The process is all these things acting in an integrated fashion’ [90].

Innovation in SMSEs requires independent study for two interlinked reasons. The first is that smaller firms may innovate in ways different from large firms. Their innovation advantages tend to be linked to behaviour such as entrepreneurial dynamism, flexibility, efficiency, proximity to the market and motivation, whereas the advantages of larger firms are material such as economies of scale and scope, and financial and technological resources [52]. Innovation may be informal, ad hoc and opportunistic, which is integrated with daily work (in our case, software development) and primarily focused on design. SMSEs have a low degree of job specialization [99] and do not normally have specialist innovation or research and development departments. Their innovation may involve cooperative and open strategies, led by owner-manager-decision makers who are well integrated into the everyday work [86]. It is likely to be financed through bootstrapping [2], as smaller firms have greater difficulty raising capital. The second reason SMSEs are deserving of independent study is that innovation with software may be different from innovation in other sectors, because of the special characteristics of software and its development. Software innovation, according to the Organisation for Economic Co-operation and Development (OECD), can be defined as

- ‘the development of a novel aspect, feature or application of an existing software product or process; or
- introduction of a new software product, service or process or an improvement in the previous generation of the software product or process; and
- entry to an existing market or the creation of a new market.’ [50].

Pikkarainen et al. [70] argue that software innovation differs from other forms of innovation. Software is intangible and highly malleable, has a low market entry threshold and often depends on the input of users and experts. Moreover, the cost of software is focused on its development; the reproduction and distribution costs are negligible. Rose [77] states that that globalization, standardization and industrialization are forcing software development firms in developed countries to become increasingly reliant on their innovation skills. However, software has particular design characteristics, and software companies operate in particular ways, so it cannot be safely assumed that innovation studies from other industries are directly transferrable, especially not to SMSEs.

Researchers have identified and studied many different facets of software innovation. Early contributions focused on creativity and creativity techniques in systems development [20], innovation leadership [60] and creative requirements analysis [56]. A parallel trend in the organization and management sciences focused on open innovation [16] and open-source development [93]. More recently, disruptive innovation has become a focus in the field of information systems (IS) [54]. Overall, however, the literature

reflects the complex and multifaceted nature of the subject: many fragmented contributions from several disciplines, many different related foci, little cross-disciplinary referencing and thus a lack of cumulative knowledge generation in the area. Moreover, there is little consistent focus on SMSEs: much of the literature focuses on larger companies, some contributions do not distinguish on the basis of company size and only a few researchers [15,42,74,76,89,97] explicitly target SMSEs. It is currently hard to distinguish what drives innovation in larger software companies from what drives it in SMSEs. Therefore, we have the following research questions: which organizational levers drive innovation in SMSEs, and how are they related? We primarily consider the work of software developers and their team leaders and managers, the artefacts or products they develop and the processes they use to develop these artefacts. Thus, our analysis spans individuals, teams and organizations.

The starting point for the study is a literature study identifying the drivers of software innovation (irrespective of size). This provides the initial conceptual framework for semi-structured interviews with experienced software developers in the Silicon Fen. The Silicon Fen is a regional innovation cluster in the East of England centred around Cambridge with a high concentration of small- and medium-sized software companies. The name ‘Silicon Fen’ alludes to Silicon Valley in California, as well as to the former wetlands in this area known locally as the Fens. The transcribed interviews were explored through content analysis for structural patterns. Thus, concepts from the literature are filtered and refined into an exploratory descriptive theory of software innovation in SMSEs. These methodological considerations are reported in Section 3, and the results of the analysis are presented in Sections 4 and 5. Section 6 presents the refined concept set as overview and detailed models with a related set of exploratory propositions, and the article ends with a discussion and conclusions.

2. Software innovation: outputs and drivers

2.1. Software innovation outputs

The most common form of software innovation results in the creation of new software functionality used in new *products and services*. Innovation of this form has led to the creation of an extensive array of software systems including enterprise tools, end-user applications, operating systems, communication protocols, mobile software and embedded software [77]. Many forms of software are referred to as services, such as web services or mobile services [45]. A wide range of software-related activities such as installation, customization, help desk, platform management and consulting can also be referred to as services. In addition, hosting or provision of application service includes a combination of software with additional services that permit organizational computing functions to be outsourced to software providers. A modern variant of such an offering is software as a service (SaaS) [50]. *Software process innovation* focuses on the tasks and actions, the shapes and norms as well as the formal and informal procedures that lie behind software development. These are expressed in the methods, tools and techniques that organize the work of a developer, and they describe how software is developed [77]. [15] define this as innovation in the means of envisioning, designing and implementing software. All significant improvements in design techniques, team organization and managerial processes can be classified as process innovations. Product/service innovation and process innovation constitute the two main innovation outputs for this study.

2.2. Management drivers

An important group of software innovation drivers include those taking a leadership role, whether formally as a manager or

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