

Innovation in Software: Concept and Practice

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Abstract - This paper is an attempt to study the closely related concepts of innovation and Research & Development. The objective of the study is to research the extant literature to arrive at a meaningful conceptualisation of innovation and apply it in the context of the software industry. Taking a qualitative research approach and relying on secondary sources, the paper theorises the concept of innovation from the software industry perspective. In this adaptation of the concept of innovation this paper explores the intricacies of innovation in the software sector with suitable examples.

Keywords — Innovation, Research & Development, Software Industry, Technology Integration, Innovation in Software

I. INTRODUCTION

Innovation and knowledge creation have long been recognized as the main fuel for a company's continued growth in high technology industries [1]. In many high technology companies continued innovation and creativity are vital not only for growth but also for their survival. In fact, the nature and pace of innovation achieved by a company often determines the future growth trajectory of a firm. Therefore, it becomes pertinent to study the concept of innovation as practiced in the industry. In this paper while studying the concept of innovation, we try to answer the following questions: What does innovation mean? What is the relation between Research & Development and Innovation? How does innovation happen in the software industry?

II. METHODOLOGY

The Qualitative Research Approach has been adopted for this paper. **Qualitative research** is a method of inquiry in which the researcher makes knowledge claims based on constructivist outlook (i.e., the diverse understandings of personal experiences, meanings constructed socially and historically for evolving a theory or pattern) or advocacy/participatory perspectives (i.e., political, issue-oriented, collaborative, or change oriented [2]. It is concerned with enquirer's subjective assessment of attitudes, behaviours, and opinions and is dependent upon the researcher's insights and impressions [3]. Qualitative research may include strategies of enquiry such as narratives, ethnographies, phenomenology, grounded theory studies, or case studies. The researcher collects open-ended non quantitative data through techniques like focus group discussions, projective techniques, depth interviews, etc with the objective of developing themes from the data [2]; [3]]. In this paper, we have relied on secondary sources for conducting a qualitative analysis. The qualitative analysis is done for conceptualising innovation and mapping it to the patterns of innovation in the software sector.

III. INNOVATION

In this section, we discuss the concept of innovation and its components. By the end of the discussion, we aim to arrive

at a conceptualization of innovation which could be suitable for our study of the software industry.

Before we discuss the concept of innovation, it would be pertinent to briefly discuss the concept of Research & Development (R&D) which is an important component of the process of innovation. R & D can be viewed as an activity that gives rise to new and improved materials, products, processes and systems [4], [5], [6]. It includes dissemination of knowledge through the education system, industrial training, information services, and even the mass media. The literature also highlights the importance of implementing the existing stock of knowledge and feedback received from the production process and markets to the R&D process¹. All R&D activities can be classified as: a) "basic research" - resulting in a flow of new knowledge in the form of research papers and memoranda, which is essentially of general nature, for example, research on properties of a material, b) "applied" research, which addresses a particular objective, and results in the flow of new knowledge relating to specific applications, for example, the search for new materials for a product, c) 'experimental development' that can result in models, drawings, designs, manuals and prototypes of new products, or pilot plants and experimental equipment for new processes. All three types of R&D may be carried out by the government research laboratories, universities, research institutes and research departments of the company. Research and development often leads to inventions that sometimes lead to innovations.

Schumpeterian innovation can be defined as the commercial exploitation of an invention. His pioneering work on innovation established the distinction between inventions and innovations. An invention may be an idea, a design for a new or improved device, product, process, or system [6]. However, such inventions, which can also be patented, do not necessarily lead to technological innovations. An innovation in the economic sense is accomplished only with the first instance of commercial exploitation of the new product, process, or system or

¹ For a detailed exposition on R&D systems, inputs and outputs in research, invention, development and innovation see the introduction in Freeman & Soete [6].

device [6 p. 6]. Therefore, innovation includes the entire process of research, development, invention and exploitation in a market or society².

Innovation is closely related to the theory of economic development. It is postulated that economic development is stimulated by the emergence of new combinations or discontinuous innovations that are economically more viable than the old ways of doing things [7]. The role of innovation in the process of development is expressed in the paradigm shifts that they produce, "which is replete with vitality, motivated by a small circle of personalities, and which does not consist in continuous adaptation" [8 p. 103]. The main emphasis is on the "small circle of personalities" or entrepreneurs, who according to Schumpeter, are the main drivers of innovation.

However, Schumpeter J. A. [9], in a significant departure from the previous work, redefined innovation as an activity, which need not be radical and unpredictable. The new interpretation reduced the role of the individual entrepreneur in the process of innovation - perhaps in keeping with the times - as the innovation process was becoming more institutionalized, de-personalized and automated, which means that innovation had become an ongoing activity of businesses rather than a break from their regular business activity.

With the institutionalization of innovation and its recognition as a continuous activity, two broad categorizations of innovation have emerged - a) incremental innovation or sequential innovation, b) radical innovation. Incremental innovation is the exploitation of an existing technology in a way, which consists of several small improvements resulting in the refinement or expansion of existing products or processes [6]. These improvements are limited to making the product or process a little better, faster or cheaper. Therefore, incremental innovations mainly focus on cost reduction or feature enhancements of products and processes. On the other hand, radical innovations are of exploratory nature. Technologies and approaches required for radical innovations are fundamentally different and they enable: a) performance of functions that were previously not possible, b) performance of functions currently possible in a way that is significantly better than the old. They spawn several incremental innovations. Thus, radical innovations may involve the development of new businesses or product lines - on the basis of new ideas or technologies or substantial cost reductions that transform the economics of a business.

Any definition of innovation, whether technological or non-technological, product or process innovations, is subordinate to the basic characteristics of innovation [10]. Innovation is a market phenomenon, where its nature

and dimensions are determined by the structure of competition in the markets where the innovating company operates. Thus, innovation, from the point of view of the firm, is primarily a response to its competitive environment. Through innovation, the company contributes to changing the composition of the business environment of customers, competitors and other related companies. There are three characteristics that underlie the concept of innovation implicitly: a) that innovations are deliberate implementations of new ways of doing things, b) that the innovations are "new" or novel, and c) that they are at least partially codified.

Schumpeter J. A. [9] believed that the monopoly is favourable for innovative development because research and development (R & D) required large resources and large markets. This view can no longer be sustained, particularly in the software industry, where most often the smaller companies are the aggressive innovators and the larger ones are mere imitators. Studies show that smaller software businesses account for a disproportionate share of innovations, albeit, in terms of the number of innovations vis-à-vis their R&D expenditure [11].

The dual hypothesis of Schumpeter J. A. [9] namely, firm size is positively correlated with innovative activity, and monopoly is more conducive to innovative activity were subjected to rigorous empirical verification in the extant literature [[12]; [13]; [14]]. Studies of these researchers have gone beyond the Schumpeterian tradition of research on innovative activity that includes firm characteristics, industry characteristics and demand, and technological capability.

To sum up, the concept of innovation covers five areas: (i) the introduction of a new good or a new quality of a good (product innovation), (ii) introduction of a new production method, including a new way of managing a commercial product (process innovation), (iii) opening a new market (market innovation), (iv) the purchase of a new source of supply of raw materials or intermediate inputs (input innovation), and (v) implementation of a new organizational structure (organizational innovation).

Although traditionally the concept of innovation has been predominantly biased towards the manufacturing sector, with the emergence of National Systems of Innovation and other general concepts of innovation, the definition of the concept itself has got broadened to accommodate the widespread use of the term in various sectors and functions. Today, innovation is understood as a multifaceted concept, which covers not only technological innovation but also institutional, organizational, and managerial innovation, and their support systems and cultural attitudes [15]. This broader understanding of innovation is all pervasive, regardless of company size and nature of the industry.

² There are other innovations that have immense social value but have been generally unaccounted in economic data of most nations because there is no monetary exchange **Invalid source specified.**

For the purpose of our study, we use a broader definition as we try to answer the research questions. In our definition, innovation includes all those activities of a firm which results in a new or better product, process, business model, or organisational, managerial framework for the company.

In the next section, we discuss innovation from the context of the software industry.

IV. INNOVATION IN THE SOFTWARE INDUSTRY

The conceptualisation of innovation in software is consistent with the established definitions of R&D and innovation in existing literature. Within the subject of technological innovations, 'technology integration' is an important strategy for innovation in software. In the Personal Computer (PC) software industry, for example, one of the greatest innovations of Microsoft, the Windows 95 Operating System, was a result of technology integration. Introduced in the mid 1990s, it incorporated a few new components unavailable in its past product – the MS DOS. However none of the additional elements were new to the market. Microsoft had just incorporated the disparately available existing technologies to make another product³. Technology integration is an approach to innovation in which the innovating firm assimilates already existing technologies to develop innovative products [16]. The 'technology integration' approach of innovation is particularly appropriate for software, where communication between various systems and processes generally require some level of integration [17]. The approach is fundamentally about problem solving and product development by leveraging existing technologies or technology paradigms⁴.

Another approach for innovation in software industry is through product platforms⁵ [18]. It has been observed that innovating firms tend to evolve their products into platforms rather than relying on single product innovations. Although numerous start-up firms are dependent on single products, some of them also leverage their product into platform for creating an ecosystem around it. By developing, maintaining, and further enhancing the platform, a product firm lessens its reliance on a single item. The platform approach, thus, influences the innovation management in the firm because the innovations that are to be integrated into the platform originate from R&D other than the R&D activities related to the firm.

³The Windows 95 OS included several new features, which were disparately existent. The concepts of multi-threading, multi-tasking, and file system organization were well known by 1965. The idea of window based graphical user interface, mouse interaction, pop-up & drag drop menus had all been invented by the late 1970s.

⁴For example, a product may involve integration of two different components. One of which may be developed in the C language (of the *structured programming* paradigm) while the other component may be developed in Java language (of the *object oriented programming* paradigm).

⁵ Microsoft, for example, initially introduced the *Windows* operating system, which it used as a platform for launching the MS Office suite of products among others.

Within the technological innovations framework various types of innovations that may take place in a software product/services firm are listed in Table 1 **Error! Reference source not found.**

Table 1: Types of innovation in software [17]

Type of Innovation	Product / Service characteristics	Example
Customized Innovation	Products/Services are customised to meet specific clients' requirements and needs; products/services may be developed from 'scratch'.	Customized solutions provided by Infosys, TCS, et al.
Ad hoc Innovation	Implementations of some products require adaptation to client's specific needs. In such cases, to a certain extent, the problem is 'co-solved' by an interactive process between the client and the vendor. Further, the experiences of this innovative process of co-development may be codified for future use by other clients.	ERP implementations provided by companies like Oracle, Peoplesoft, SAP.
Technology Integration	New products /services may be obtained by integration or new combinations of standardized components of existing service elements or products.	End to end solutions provided by IBM, HP, Accenture.
Differentiation Or adjunct Innovation	New / differentiated products or services may be launched through addition of new features or amended peripheral services.	Newer and / or several versions of Windows Operating System launched by Microsoft.
Delivery Innovation	While retaining the basic function and characteristics of the service or product, the mode of delivery or interaction with the client is changed.	Offshore development & technical support. The Global Delivery model adopted by Indian firms.

The different types of innovation specified in the Table 1, above, do fulfil our definition of innovation outlined above.

For instance, they produce new or novel software like formation of new product platforms that could include development of new software code or rolling out major improvements to the current source code⁶ (*product innovation*). Further, the products of innovation may beget new business opportunities for the software product or service (*market innovation*). Technology integration may also entail new method of doing things like integration of new or existing algorithms or programs or products into a new system for enabling faster development of software product and services (*process innovation*). Lastly, a better approach for doing things in the company may also be called *organizational innovation*.

V. CONCLUSION

From the above discussion, it can be concluded that innovation in software may be in the form of novel changes in software code i.e. lines of instructions controlling the operation of a computer. It could also be an algorithm or a technology making it possible to integrate existing computer programs, for example, a suite of products bundled together as a single product. Innovations in software could be as embedded applications or software solutions that may be pertaining to diverse market segments, for example, network and web security software, enterprise solutions, 3D modelling software, databases and customized software solutions. Further, from our study, it can be concluded that innovation in software industry fits the broader definition of innovation as discussed in the text above.

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⁶ Source code is commonly referred to the *programming language* instructions that are subsequently compiled through a compiler into binary code that dictates the operations of a computer.