

# Determinants of Quality in Innovation Processes: Impacts of Human Capitals to the Development of Science and Technology

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## Abstract

At the dawn of the third millennium and the new knowledge economy, organizations consider innovation as a driving force of sustainable development. The literature has indicated that innovation is a source of value. It consists of two main components called: (a) innovation elements and (b) innovation processes. The innovation elements are determined by what the organizations have desired to be, while the innovation processes are regulated by the determinants or factors directed towards them. In this study, factors, which contribute to the innovation process of research, development and commercialization, are being determined. Mathematical expressions are developed to explain how the four components of a business plan the management (or people) style, the product (or technology) characteristics, the market places, and the financial situations relate to the proposed innovation equation. Explanations of the conceptual equation, especially the impact of human capitals to the development of science and technology, are discussed.

**Keywords:** Innovation, Science, Technology, Commercialization, Research, and Development

## 1. Introduction

At the dawn of the third millennium and the new knowledge economy, organizations regard innovation as a driving force in areas as diverse as engineering, business, management, marketing and finance. Technological developments and innovations have the potential to change market dynamics dramatically [3]. Innovation is important to the consumer to satisfy needs and expectations, to the businesses for enhancing competitive advantages and to the world economy for improving in the quality of life of people. Innovation is occasionally seen as an act of individual inspiration. Edvinsson [4] indicated that evolution and innovation, by definition, are unpredictable processes.

Innovators need not be brilliant people or with prerequisite academic qualifications, as is demonstrated by the fact that ordinary individuals have been behind many of the world's lasting innovations.

The basic issues addressed in a business plan of an organization highlight the components of management, product, finance and market, where innovation is an important factor in each of these components. This paper consists of four sections. The next section summarizes the results of a literature review regarding generic components in business plan and innovation process, which leads to the mathematical equation. Discussion and implications of the proposed conceptual

equation representing the innovation process are explained in section 3. Conclusions are described in the last section.

## 2. Review of Management, Product, Finance and Market

### 2.1 Generic components in business plan

Campbell and Collins [1] described four broad areas where innovation is most likely to provide an advantage over the competition. The four areas were products or services, finances, processes, and customer interfaces and channels. These can be compared with the four broad components, which form the basis of any business including:

#### 2.1.1 Management = People (P)

People are the essential asset. Companies should focus on people as the core factor to create a real long-term outlook. They are usually regarded as the most important principals when compared with technology, finance and market. It has been highlighted that knowledge management is about "brain power" and involves the sharing of human experiences - between individuals and groups to generate a variety alternative to the issues that a business faces [10]. People or innovators are being leaders for the success of the innovation processes. The vision for Siemens as shown in their annual report, for example, indicates that innovation relies on dreams, and strong people to make them come true. The company, which has half a million employees around the world, is still following this vision successfully. Stanford University's success in promoting innovation and new ventures, as another example, relies on talented researchers quitting their faculty jobs and taking their ideas off-campus.

#### 2.1.2 Product = Technology (T)

Technology is a tool or application, which is used by some individuals and organizations to create ideas. Attempts to use appropriate technology to capture and manipulate knowledge have been underway for decades [3]. It is more likely to be in use in an interactive and iterative manner by users. For example by integrating technological perspectives into products development. However, the creation of

new ideas does not rely on technology alone; it is dependant on strategic leadership [7]. Therefore, the roles of people utilizing and capitalizing with technologies are essential to the success of an innovation.

#### 2.1.3 Finance (F)

There is a tremendous increase in the number and support of venture capitalists for innovative products. Consultants have pointed out that there is an increase in technology-due-diligence works over the last two years, especially in the hunt for acquiring companies with innovations. Australian Certified Public Accountants (CPA) has encouraged the development of a stronger venture capital market and argued that appropriate tax and accounting standard measures need to be in place to encourage innovation [7]. There is an increase in the funding and backing of innovation from the Australian government [5]. Many Asian countries have also been encouraged to develop innovation and entrepreneurship. For example, there is an increase in the support of innovation schemes provided by the Economic Development Board of Singapore and by the Malaysian government in the development of its Multimedia Super Corridor.

#### 2.1.4 Market (M)

With the increase in competition and influences from external factors, the product life cycle is getting shorter and shorter. A clear example is shown in the computer industry. Companies need to increase the innovativeness of their products for adoption by the customers in the market. Mazur [6] has indicated that market development starts with innovation, focusing on the customer needs and expectation. The recent terrorist attack in America has seen the changes made by the tourism and leisure industries to be more innovative with their marketing strategies. Another example of innovation in marketing is how the Internet has become a new channel of communication (E-marketing), which businesses must use to further develop their markets and to remain profitable.

## 2.2 Innovation Process

An organization realizes innovation as a source of value. The innovation process is

regulated by the total resources and its quality. An invention is the solution to a problem. An innovation is the commercially successful use of the solution [2]. Research is a methodical inquiry or investigation into a subject matter in order to discover facts or principles and generate new ideas. Development is the process of taking or converting these ideas into commercially viable products that are marketable and fulfilling users' needs and wants. Commercialization is the process of making something marketable, resulting in the generation of profit.

The standard innovation equation, therefore, could be derived as:

$$\text{Innovation (I)} = \text{Invention} + \text{Commercialization}$$

where

$$\text{Invention} = \text{Research} + \text{Development}$$

so that

$$\text{Innovation (I)} = \text{Research (R)} + \text{Development (D)} + \text{Commercialization (C)}$$

or

$$I = R + D + C \dots\dots\dots(1)$$

**3. Discussions and Implications**

It is argued that the four components, which make up the business plan, as mentioned above could be related to components in innovation process. For example, the research component may be defined by the following relationships:

$$R = P (T + F + M) \dots\dots\dots(2)$$

where

- P = People,
- T = Technology,
- F = Finance, and
- M = Management

However to a first order of effect, technology may be considered to be the most important

factor in the research component. Therefore the equation becomes

$$R = P (T + f + m) \text{ or } R \propto P \times T \dots\dots\dots(3)$$

Similarly for Development and Commercialization, the relationship holds but for Development the most important factor is finance and for Commercialization it is the market. Thus, the relationships are:

$$D \propto P \times F$$

and

$$C \propto P \times M$$

Combining these relationships which gave us:

$$\text{Innovation} = P (T + F + M) \dots\dots\dots(4)$$

It is imperative to note that it is the quality of these four components that are critical in the innovation process. The quality of technology, for example, relates to factors such as whether it is leading edge technology, the relationships between the company and research institutions, and the fit with the company's capabilities. The quality of financial system also relates to factors such as the timing of the funds, the access to follow-up funding, and the linkages, which the providers of the funds can provide. Finally, the quality of the market relates to factors such as its growth potential, the market niche and the access to the market.

The innovation equation, therefore becomes:

$$\text{Quality of (I)} = \text{Quality of (P)} \times [\text{Quality of (T)} + \text{Quality of (F)} + \text{Quality of (M)}] \dots\dots\dots(5)$$

Diagrammatically this equation can be illustrated as Figure 1.

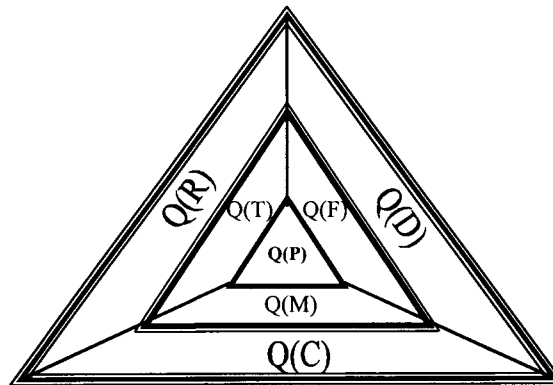


Figure 1 Innovation equation illustration

The important consequence of this definition is that if the quality of people, Quality of (P), is zero, then the innovation will fail irrespective of the other components. However if the quality of the people is high then it is not necessary that high quality be associated with each of the technology, the finance and the market. The people will be able to overcome deficiencies in one or more of these areas. Nevertheless it is apparent that if the quality of these components is high then the quality of the innovation will be high.

#### 4. Conclusions

This mathematical equation demonstrates that though technology, finance and market play important roles in the innovation process, without the right people the innovation processes will not succeed. In many cases, when people review innovations, they emphasize the technology, finance and market and pay less importance to the people involved. It is important to argue that the first priority is to analyze the people. If the people are not correct or if the right people cannot be put in place, then there is little point in proceeding with the innovation. It is also vital to note that although the people are the major factor in the success of innovation process, it is difficult to develop and include the value of the human capital in the balance sheet of the organization. The subsequent research question, which is needed to empirically

explore is “*will it ever be possible to include the value of human capital in the balance sheet or will it remain as one of those components of intellectual capital, which contribute to the difference between the market value and book value of a public company?*”.

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