

Chapter 1

Introduction

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1.1 Definitions of Innovation

The study of innovation appears in different literatures such as sociology, education, management, etc. In the management literature, two schools of innovation research have been identified by Subramanian and Nilakanta (1996). The first domain is that developed by marketing researchers who are interested in understanding the causes of innovative behavior of consumers, where the consumer is used as the unit of analysis. The second domain of innovation management research is that developed by researchers in areas of organizational theory and strategic management, where the organization is used as a unit of analysis. We have chosen the second domain for the purpose of this study. There are many definitions of innovation in the literature. Damanpour (1991) defines innovation from an organizational perspective:

the adoption of an idea or behavior, whether a system, policy, program, device, process, product or service, that is new to the adopting organization.

Porter and Stern (1999, p. 12) define innovation from a customer perspective as

... the transformation of knowledge into new products, processes, and services — involves more than just science and technology. It involves discerning and meeting the needs of the customers.

Others view innovation as an enabling device for producing new products and processes on a continuous basis (Dougherty & Hardy,

1996). Innovation is about using knowledge to offer a new product or service to customers via lower costs or improved attributes (Afuah, 1998). Such improvements can emerge from innovations that are either of a product or process nature. Adding to the dilemma of defining innovation, there are also questions of whether an innovation is of a radical or incremental nature.

Incremental innovations occur continuously in the organization and lead to minor improvements in products or processes. Jha *et al.* (1996) define continuous improvement (CI) as a collection of activities that constitute a process intended to achieve performance improvement.

In manufacturing, these activities primarily involve simplification of production processes, chiefly through the elimination of waste. In service industries and the public sector, the focus is on simplification and improved customer service through greater empowerment of individual employees and correspondingly less bureaucracy (Samson & Terziovski, 1999; Schroeder *et al.*, 2002). On the other hand, radical innovations are more long-term and strategic in focus, and aim to change key capabilities of the firm, thus creating a new operating paradigm. According to Harrington (1995), “all organizations need both continuous and breakthrough improvement.”

However, according to Harrington, continuous improvement is the major driving force behind any improvement effort. Breakthrough improvement serves to “jump-start” a few of the critical processes. Several researchers are concerned that past research has focused on technological and technical product innovation to the neglect of process and organizational innovation. For example, Harvard Business School researchers Kim and Mauborgne (1999) integrate customer value with technology innovation under the term “value innovation.” Innovation often is least effective when there is application without considering who will value the development, either as internal or external customers. Technology innovation on its own does not address buyer value, thus a new technology might not be accepted in the market as having value for the customer. Technology innovation tends to focus on specific solutions, whereas value innovation focuses on redefining and solving the problem which leads to a customized solution.

Many of the definitions of innovation discussed above are quite broad. A global definition of innovation does not exist; rather, different definitions of innovation are appropriate under different circumstances. A narrow definition of innovation may be a useful tool in researching the activities that lead to greater organizational performance. The following definition of innovation has been articulated by the Author:

Innovation is the application of resources to create value for the customer and the enterprise by developing, improving and commercializing new and existing products, processes and services.

1.2 Evolution of Innovation

Since the 1930s, our view of what constitutes “innovation” has changed. Rothwell (1994) explains the evolution of innovation along five generations of behavior:

First generation innovation (1G) — technology push. This era of innovation was the foundation for the Industrial Revolution. Innovation came with new, technologically advanced products and means of production. Such products were pushed onto the market.

Second generation innovation (2G) — need pull. Innovation during this era shifted to a market/customer focus, a focus where the customer determined needs and production technology responded. Marketing took a pivotal role in generating new ideas.

Third generation innovation (3G) — coupling model. This era of innovation involved a coupling of the push and pull models. The market might need new ideas, but production technology refined them. Alternatively, R&D developed new ideas that marketing refined with market feedback. R&D and marketing were linked.

Fourth generation innovation (4G) — integrated model. An integrated model of innovation saw a tight coupling of marketing and R&D activity, together with strong supplier linkages and close coupling with leading customers.

Fifth generation innovation (5G) — systems integration and networking model (SIN). This model of innovation builds on the integrated model by including strategic partnerships with suppliers and customers, using expert systems, and having collaborative marketing and research arrangements. There is an emphasis on flexibility and speed of development with a focus on quality and other non-price factors.

According to Rothwell (1994, p. 22), fifth generation (5G) innovation has both strategic and enabling characteristics. Strategic elements include time-based strategies (faster, more efficient product development); a development focus on quality and other non-price factors; an emphasis on corporate flexibility and responsiveness; a customer focus at the forefront of any strategy; a strategic integration with primary suppliers; electronic data processing strategies; and a policy of quality control. Enabling factors include a greater level of overall organization and systems integration; a flatter, more flexible organizational structure for rapid and effective decision-making; fully developed internal databases; and an effective external data link.

Rothwell (1994) claims that there are examples of Japanese firms operating on fourth generation innovation, and U.S. firms operating on third generation innovation, but the presence of fifth generation innovation is still emerging. The eight case studies discussed in this book fall between third and fourth generation innovation companies.

1.3 Innovation Capability

As innovation evolved from 1G to 5G, new enabling factors and drivers of innovation have also evolved: e-Commerce, sustainable development and a focus on accelerating new product development. These are taking leading roles in helping to transform knowledge into new products, processes and services. As organizations have downsized and worked on cost reduction for many decades now, and similarly improved their quality and service, they have generally achieved efficiency and process stability outcomes. The next battlefield that will drive international competitiveness and business outcomes of

firms is innovation. Therefore, the burning question addressed in this book is:

What constitutes innovation capability in organizations, and how can it be developed and exploited?

Despite the volumes of research on innovation in organizations, there are no clear, agreed guidelines for creating innovation-driven organizations. Numerous studies have attempted to isolate the important variables facilitating innovation outcomes (Damanpour, 1991). However, there is still much we do not know about how firms can innovate faster and better. We do know that effective innovation requires the construction of an overarching framework of factors conducive to creativity (Kanter, 1989). The absence of such frameworks may lead to a conservative and ineffective innovation culture. Lawson and Samson (2001) define innovation capability as:

... the ability to continuously transform knowledge and ideas into new products, processes and systems for the benefit of the firm and its stakeholders.

Innovation capability provides the potential for effective innovation. However, it is not a simple or single-factored concept, as it involves many aspects of management, leadership and technical aspects as well as strategic resource allocation, market knowledge, organizational incentives, etc. Lawson and Samson (2001) identified several dimensions of innovation capability which are listed below:

- Vision and strategy;
- Harnessing the competence base;
- Leveraging information and organizational intelligence;
- Possessing a market and customer orientation;
- Creativity and idea management;
- Organizational structures and systems;
- Culture and climate;
- Management of technology.

Our aim is to explore each of the organizational innovation capability dimensions above to identify which of these individually or in combination are perceived by best practice innovative organizations as critical to effective innovation. Therefore, an effective organizational design encompassing systems, structures, rewards and strategy will increase the probability of generating new ideas and support their journey toward commercialization.

1.4 Enablers of Innovation Capability

Current and future challenges and opportunities facing business and government organizations are in the fields of sustainable development; e-Commerce; and new product development. Recent work by Porter and Stern (1999) has shown the three identified domains above to be of critically important interest to today's governments and many organizations.

The power of the innovation capability construct is that it is generalizable to all these domains, as it relates to the organizational potential to convert new ideas into commercial and community value. Developing innovation capability in these three domains provides valuable insights as to how the innovation capability construct can be further developed, and will also provide valuable practitioner guidelines. The elucidation and validation of the innovation capability construct in these three fields would add significantly to the bodies of knowledge in each of the three fields, and in the central innovation management literature.

Sustainable Development

Sustainability has clearly begun to assert itself as a driver for innovation. Organizations need to better understand how the emergence of environmentalism and sustainable development impacts on firm's opportunities and capability to innovate.

Ottman and Reilly (1998) suggest that firms have responded and profited with the emergence of environmentalism as a core societal value. "Green" marketing is increasingly being seen as an opportunity

for innovation. Firms require knowledge on how to create new products, how to identify and capitalize on opportunities to innovate, and how to communicate effectively.

Polonsky (2001) argues that going green provides a firm with strategic advantages including lower costs, differentiation and revitalization. Gertakis (2001) has illustrated how the new product design process can integrate environmental factors within a commercial context. Many of these environmental technologies are more widespread in cleaner production and pollution prevention; however, their incorporation according to Gertakis into products is not as extensive. Gertakis cites a number of exceptions to this norm.

For example, Kambrook developed a kettle that has improved energy efficiency and is designed to facilitate disassembly and recycling. Blackmores has redesigned its packaging to reduce material consumption. Dishlex has designed a dishwasher that uses less water, has improved energy efficiency, has reduced material consumption, is “light-weighted” and is designed to facilitate disassembly and recycling. This leads to the question:

How does innovation capability manifest in the sustainable development innovations?

e-Commerce

The arrival of e-Commerce has driven firms to re-evaluate their entire way of doing business, and in many cases, create entirely new forms of competition. e-Commerce acts as both a driver and enabler of innovation within organizations. As a driver of innovation, e-Commerce has underpinned stronger, more rapid and flexible competition forcing firms to restructure competitive boundaries and re-evaluate existing practices, products and services.

As an enabler of innovation, e-Commerce provides immense scope for organizations to discard old processes, diffuse local innovations globally, remove constraints to innovation and create entirely new innovative practices and models. These companies use e-Commerce technologies to profit from their intellectual capital and to evolve at the same or greater pace than the market.

However, many organizations, particularly small to medium enterprises (SMEs) are struggling with the initial stages of e-Commerce policy. It is the lack of an integrated strategy and resources that restricts many organizations from realizing the full potential of this new form of organization. The “digital divide” between large, highly resourced companies and SMEs is a significant impediment to SME performance improvement.

Callahan and Pasternack (1999) in Wheelen and Hunger (2004) report the results of a study they conducted on a sample of senior executives in the USA to identify the impact of the internet on the future organizational model and concluded the following:

- (1) The internet is forcing companies to transform themselves. The concept of electronically networking customers, suppliers and partners is now a reality.
- (2) New channels are changing market access by working directly with the customers.
- (3) The balance of power is shifting to the consumer. Customers are much more demanding, having unlimited access to information on the internet.
- (4) Competition is changing. New technology-driven firms plus older traditional competitors are exploiting the internet to become more innovative and efficient.
- (5) The pace of business is increasing drastically. Planning horizons, information needs, and customer supplier expectations are reflecting the immediacy of the internet.
- (6) The separation between suppliers, manufacturers and customers is becoming blurred with the development and expansion of extranets, in which cooperating firms have access to each other’s internal operating plans and processes.
- (7) Knowledge is becoming a key asset and a source of competitive advantage. For example, physical assets accounted for 62.8 percent of the total market value of US manufacturing firms in 1980 but only 37.9 percent in 1991. The remainder of the market value is composed of intangible assets, primarily intellectual capital (Kanter, 1999; Allee, 2000).

The above discussion on e-Commerce leads to the question:

How does the innovation capability manifest in the new economy (e-Business) firms?

New Product Development

Research on NPD indicates that many of the factors critical to innovation in general are also linked to successful NPD. In particular, factors linked to accelerating the NPD process, such as cross-functional teams and external cooperative relationships, may reflect capabilities specific to innovative organizations. Mabert *et al.* (1992), based on a comparison of six NPD projects, concluded that a knowledgeable leader with sufficient time to devote to the management of the project, shorten the development time of new products.

Most empirical work on NPD has focused on the relationships between various success factors, including new product strategies, and performance measures and risk. As a result, we know for example that firms which emphasized market innovativeness in their product introductions enjoyed higher returns than those which did not (Firth & Narayanan, 1996, p. 334). Past research also indicates that critical factors of NPD are, for instance, a clear, well-communicated new product strategy; strategic focus and synergy; an entrepreneurial climate for product innovation; adequate resources for new products; senior management commitment to and accountability for new product development; and the existence of high-quality, cross-functional development teams in the organization (Powell *et al.*, 1996).

In addition, motivation triggered by competitive pressures, aspects of teamwork such as full-time participation and cross-functionality of teams, outside influences such as vendor participation in the project, and systematic project control, may accelerate the NPD process (Mabert *et al.*, 1992; Sohal *et al.*, 2003).

In order to accelerate the innovation process one needs to understand what factors are critical to the successful execution of the cycle. Omta *et al.* (1997) have demonstrated that if organizations are to be “innovative”, management face the challenge of creating conditions

conducive to meeting the goals of scientific performance as well as the scientists' need for satisfaction and motivation (socio-technical performance). According to Omta (1995),

The best performing companies in [pharmaceutical] development are able to shorten the development phase by more than a year, by use of parallel development and close monitoring of the developmental process. In the more-than-average performers fine-tuning is more precise, and the lateral and cross-functional communication more intense leading to a concurrent process.

Managers need to acquire new skills and management systems to assist them in managing the “knowledge boundaries” of their firms, increasing innovativeness and deriving benefit from strategic alliances and partnerships. Most biotech firms are networked through partnerships, alliances, formal and informal collaborations, and agreements (Koput *et al.*, 1996).

How does innovation capability manifest in the new product development processes in the biotechnology industry?

1.5 Collaboration and Knowledge Transfer

The need to be simultaneously efficient, flexible and adaptive has accelerated the evolution of the network form of organization. Networks composed of multiple specialist companies as their key building blocks have been called “modular corporations” (Miles & Snow, 1992). Multi-firm networks that change their shape often and quickly have been called “virtual corporations.” Many network organizations have also been formed in mature industries because older established companies came to realize that they were too large and cumbersome to respond effectively to competitive demands of today's environment. For example, General Electric was among the first of American companies to restructure in the early 1980s.

The overall objective of the restructuring is to reduce the centralized coordination requirements and create the flexibility necessary to get close to customers and the speed required to meet their demands

in a timely fashion. The restructured companies establish more and smaller business units, form cross-functional teams that are responsible for key processes, and design reward schemes to encourage entrepreneurial behavior on the part of their managers and employees.

Previous research by Soderquist (1996) has identified the “development of networks and partnerships” as a critical success factor (CSF) for improving competitiveness in SMEs. An important method to keep the information and knowledge flowing into SMEs is by locating within an SME cluster. Being able to leverage limited resources by establishing collaborative relationships with similar organizations has proven to be successful in many parts of the world (Baptista & Swann, 1998). This strategy can also be coupled with strategic partnering to network in needed skills and expertise lacking internally.

One of the most frequently cited examples of networking among SMEs involves the “industrial districts” in Italy (Miles & Snow, 1992). Thousands of small firms specializing in various trades both compete and collaborate with each other. For example, one network of 15 small engineering firms formed partnerships in order to develop collective clout in the marketplace. However, each firm was able to remain as a separate legal entity with its own workforce, facilities, accounting systems, etc.

An American variant to the Italian industrial districts is seen in California’s Silicon Valley. The primary motive of these firms in forming networks is to obtain the advantage of “bigness” while remaining small. By remaining small, each network firm in businesses such as biotechnology, semiconductors and a host of others can be highly responsive. It has fewer bureaucratic procedures that must be overcome in order to respond to requests from customers or network partners. Furthermore, each small network firm is a specialist in a particular technology. Usually it is at the leading edge of its area of expertise and is therefore a prime candidate when other firms need a certain type of expertise.

On the other hand, large firms focus on those core competencies in which they can compete on a world-class basis, and they outsource remaining activities to upstream or downstream partners, usually

SMEs. Alternatively, organizations can connect with networked incubators and invest in new ventures that can drive the entrepreneurial spirit into a mature organization (Hansen *et al.*, 2000). With over 350 incubators announced worldwide over the last several years, this emerging organizational structure provides a powerful opportunity to connect with fledgling companies to bring new ideas to market faster. While a mature organization investing in a start-up can provide valuable lessons to young entrepreneurs and a progression path for their new ideas, the challenge lies in allowing the incubator free range and not stifling their creativity with bureaucratic processes.

Terziovski (2003) conducted a cross-sectional study of Australian SMEs. Quantitative data was gathered from a stratified random sample of SME site managers in the Australian manufacturing industry. A total of 550 questionnaires were sent to manufacturing managers from which a response rate of 20 percent was achieved. Networking practice models were developed in order to test the strength of the relationship between key components of networking practice and several dimensions of Business Excellence such as success rate of new products, reduction in waste, quality management, etc.

The data was analyzed using techniques available on the SPSS for Windows software package. Terziovski (2003) concluded that groupings of network practices are required to explain Business Excellence. This means that a single networking practice is not sufficient to explain Business Excellence significantly. The networking practice that has the most significant explanatory power was found to be the establishment of formal support systems such as communication linkages within networks.

The main implication of the research results for SME managers is that a typical manufacturing SME is more likely to improve Business Excellence with a combination of networking practices than without these practices.

1.6 Development of the Case Studies

Qualitative data was gathered using a case study protocol, which was designed specifically for the case study research. An analysis of events

during a three-year period are documented in terms of what happened, why it happened, how it happened, who was involved and the main lessons learnt. The multiple cross-case analysis approach was selected to seek and explain “best practice” implementation of innovation. Multiple case study designs offer the advantage of more information over single case study designs.

However, they also demand more resources and time. According to Yin (1989), the multiple case study design allows “replication” logic. This is the logic of treating a series of cases as a series of experiments, where each case study serves to confirm or refute the conclusions drawn from the previous ones (McCutcheon & Meredith, 1993). Written analysis of multiple case studies may take three well-known forms as outlined by Balan (1994): narrative of each case study to describe and analyze the information; narrative form with multiple cross-case analysis; and where the entire discussion consists of the cross-case analysis. The narrative form with multiple cross-case analyses is adopted in this book. The qualitative research addresses an issue in management that has been discussed by various disciplines but very little integrative research has been conducted in a comprehensive manner. The case studies collectively provide significant new knowledge to the existing research knowledge base and to practitioners in the organization’s “mainstream” and the “newstream” as proposed by Kanter (1989).

The qualitative research findings provide an in-depth understanding of key practices that play a significant role at the various stages of the innovation process. Managers receive the rhetoric via government policy and management theory that innovation is key to continued success. Often the advice focuses on simply telling organizations to provide a larger research budget and to protect their innovations through patents, etc. Research results do not provide any consistency across industry or firm size into the management of both product and process innovation (Wolfe, 1994; Afuah, 1998). Based on the above discussion, the research question motivating this book is:

What constitutes innovation capability in organizations, and how can it be developed and exploited? What are the key drivers of innovative organizations?

1.7 Overview of Book Chapters

Chapter 2 — Development of an Integrated Innovation Capability Model

The unique contribution of this chapter is the development of an integrated innovation capability model (IICM) grounded in the literature. Chapter 2 shows how the innovation capability construct is generalizable to all three domains of new product development, sustainable development orientation and e-Commerce, as it relates to the organizational potential to convert new ideas into commercial and community value. Based on an extensive literature review, the authors conclude that innovation capability can be enhanced through expertise gained in the three domains of NPD, SDO and e-Commerce. Also, common elements of innovation capability bring value to the three domains. Finally, synergistic innovation capability effects are obtained from the integration of the three domains.

Chapter 3 — Strategic Shift from Product Orientation to Innovative Solutions Capability in the German Biotechnology Industry: Sartorius AG

This chapter shows how Sartorius achieved strategic shift from product orientation to innovative solutions capability. Sartorius AG is a leading company in the field of biotechnology and mechatronics. Its strategic shift in its business model from a product-oriented firm to a total solution provider has been a major success factor for maintaining its market position and continuously satisfying its customers through a systematic anticipation of their potential needs based on the company's technology portfolio. The case analyzes key components of the organization's innovation capabilities and examines the company's innovation strategy. Sartorius' main innovation capabilities lie in the systematic integration of customers into the product development process. The authors conclude that innovation needs to be strategic in nature in order to sustain firm-specific competitive advantage.

Chapter 4 — Managing Strategic Change Through Mainstream and Newstream Innovation at Eurocopter, France

This chapter shows how Eurocopter adopts an integrated innovation perspective by re-configuring its core business processes (mainstream) and systematically involving its customers in the product development in pursuit of increased customer value (newstream). The qualitative analysis indicates how the company establishes a strategic network of external partners to tap into additional sources of innovation and thereby enhance its innovation capabilities. Customer involvement has become part of a more far-reaching change in customer philosophy at Eurocopter. The case study findings have important implications for managers. The need for managers to reach beyond their immediate organizational boundaries and find additional sets of resources that can support both product and process innovation is one of the main implications.

Chapter 5 — Leveraging Innovation Capabilities at Caterpillar Underground Mining (UGM) Pty Ltd

This chapter looks at the Australian operation of Caterpillar Underground Mining Pty Ltd (referred to in the case study as UGM) in Burnie, Tasmania, with particular emphasis on how UGM has nurtured its innovation capabilities to achieve a dominant market share and brand positioning. The case examines the relationship between innovation enablers, innovation capability and innovation performance. The analysis demonstrates that sustainable innovation needs to be embedded into the corporate culture, business models and practices, and the process is ongoing and systemic.

Chapter 6 — Drivers of Innovation Capability at Sun Microsystems (SMS)

This chapter shows how SMS develops competitive advantage through an integrated focus on vision, mission, customer focus, innovation capability, cooperation, commitment to quality service and making computer power more affordable. SMS has taken advantage

of the innovation enablers like new product development, e-Commerce and sustainable development to continuously improve its innovation performance and sustain its innovation capability which is the principal source of its competitive advantage.

Chapter 7 — Development and Exploitation of Innovation Capability at a Defence Project Engineering Company (DPEC)

This chapter develops an understanding of how innovation capability is developed at DPEC and how knowledge is transferred in the product innovation process. The qualitative analysis reveals that the process of developing and applying innovation knowledge occurred in two different phases. The first phase built up new knowledge through various innovation practices, such as the design of original products by small divisional teams (SDTs). The second phase captured existing innovation knowledge through reflection, learning and understanding of key steps throughout the process of innovation. Knowledge transfer was seen as critical in reducing the NPD lead time, so as to meet the needs of the customer and the organization in terms of time, cost and quality.

Chapter 8 — Drivers of Innovation Capability for Effective Sustainable Development: Best Practice at Vaisala

This chapter reports the results of a qualitative case study at the Melbourne subsidiary of Vaisala, examining the role of drivers of innovation capabilities for effective innovation output. We draw upon an integrative framework of innovation capabilities that proposes both a single and interactive effect of sustainable development, e-Commerce and new product development on a firm's innovation capabilities. The analysis of the case study data reveals that Vaisala's innovation capabilities rest to a considerable extent on the integration of the three driving factors specified in the conceptual model. The firm's streamlined structure, highly-skilled work force and high knowledge and research intensity serve as supporting capabilities that help to

interlink these enabling factors. Implications for innovation practice and research are discussed.

Chapter 9 — Developing Innovation Capability Through Intellectual Property Strategy in the Australian Biotechnology Industry: Starpharma

This chapter explores Starpharma's strategic view of innovation and how intellectual property contributes to innovation capability to achieve commercial success. Starpharma has a broad view of intellectual property, which encompasses codified and tacit knowledge as well as people and relationships which all simultaneously contribute to the development of innovation capability. The company has the view that without human and fiscal resources to commercialize intellectual property, there would be little value to the organization. The company believes that it is important for its corporate culture to be diffused with values based on intellectual property, as long as these are part of building innovation capability which is the critical source to Starpharma's sustainable competitive advantage.

Chapter 10 — Development of Innovation Capability at Invincible Company in Thailand

This chapter explores the relationship between new product development and e-Business at Invincible Company. The company developed innovation capability through strategies that involved understanding the emergence of innovative ideas and the evolution of specific practices in managing innovation capability. Key successes to innovation included approaches such as the "we do better" strategy, which replaced traditional processes with more supportive ones. Other important aspects undertaken allowed the manager to combine two styles of management, flexible (informal) and formal, to form a new strategy. One of the key findings in this case study was the way in which NPD and e-Business activities were related to the innovation process and how they were applied.

Chapter 11 — Multiple Cross-Case Analysis: Conclusions and Implications

This chapter provides the multiple cross-case analysis of the eight case studies. A balance between “hard” and “soft” innovation practices is necessary for innovation to be successful and sustainable both in the “mainstream” and in the “newstream.” The key drivers of innovative organizations were found to be: committed leaders, a highly developed innovation strategy, a “first-to-market” philosophy of new products and services; supported by effective “top-down” and “bottom-up” communication processes. New Product Development strategy underpinned by cross-functional teams, e-Commerce and Sustainable Development Orientation were identified as effective enablers of highly innovative organizations. The set of sustainable development practices and the firm’s approach to SD are likely to depend on the industry the organization is in. In turn, internal factors such as management style, technology and the firm’s financial position are likely to influence the firm’s approach to sustainable development.

Review Questions

- (1) Why is innovation such a difficult concept to define? Discuss the importance of innovation in driving international competitiveness.
- (2) Articulate the factors that have driven the evolution of innovation from 1st generation to 5th generation innovation.