New Product Development in Start-up Technology-Based Firms (STBFs).

by

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Abstract

Firms undertaking new product development are faced with an environment which is characterised by long lead times from basic research to industrial application, a commercialisation phase with short lead times and an increasingly accelerated rate of obsolescence under the global competition of the new product development process. While this is true for all firms, STBFs face further complications from the inherently higher risks associated with such firms. In examining how STBFs undertake their new product development (NPD), the relationship between corporate strategy, NPD process features and new product success factors specifically need to be considered. An additional consideration is the role that business incubators play in assisting tenant STBFs to undertake their new product development. As such, the theory of how new product development is undertaken by STBFs lies across several disciplines including corporate strategy theory, new product development theory, entrepreneurial theory, technology management theory, economic development theory and business incubator theory. Specifically, the research problem for this research is: *what are the origins and nature of new product development processes within STBFs and how do they contribute to STBF success?*

In undertaking a review of the literature some insights were obtained to specifically explain how STBFs undertake their new product development, the relationship between NPD process activity and new product and firm success and the role of business incubators. As a result, a theoretical framework was developed which in turn, resulted in three research questions:

RQ 1: What elements of NPD are adopted by STBFs when developing new products?

RQ 2: How does the lack of adoption of the elements of NPD contribute to new product and firm failure in STBFs?

RQ 3: How and in what ways do business incubators influence the performance of the elements of NPD adopted by STBFs?

A three-stage qualitative research design within the realism paradigm was used for this research. It combined exploratory interviews with a case study methodology in order to build theory through induction. This was then followed up with a series of interviews to discover which firms had experienced product failure, had discontinued their NPD process and/or had suffered firm failure over the duration of the study. As a result, meaningful insights were able to be obtained into the relationships between the adoption of elements of NPD, new product failure and firm failure in the context of STBFs.

The findings revealed that there were several aspects of the ways in which STBFs undertake their new product development activities which were not identified in the literature. In this respect, it was evident that unlike larger and established firms in which new product development activity is derived out of corporate strategy, STBFs undertake corporate strategy development as a component of new product development. It was also found that the corporate strategy – product development nexus was not linear but rather comprised a number of close inter-relationships between elements of corporate strategy, NPD process features and new product success factors requiring parallel activity. Furthermore, the majority of STBFs adopted only 15 of the 22 best practice elements of NPD proposed as part of the theoretical framework of new product development in STBFs. In addition, it was found that the STBFs that suffered failure over the course of the study adopted comparatively fewer elements of NPD than did their continuing STBF counterparts.

Importantly, it was also found that business incubators provided only a modest positive influence on the performance of NPD activities by their tenant STBFs. Moreover, as STBFs are commonly single product centric, that is their overall new product development effort is focused on a single product or a narrow product line, the relationships between new product development effectiveness, new product success and firm success are closely aligned. More specifically, ineffective support for NPD activities can lead to a potential lack of effectiveness of business incubators in reducing the risk of

failure of their tenant STBFs. This is despite the more general focus of business incubators in assisting tenant STBFs with corporate strategy development.

The main contribution of this theory building research was the development of an empirically confirmed, theoretical and practical model for the development and management of new product development by start-up technology based firms.

Certification of dissertation

I certify that the ideas, research work, results, analysis and conclusions reported in the dissertation are entirely my own effort, except where otherwise acknowledged. I also certify that the work is original and has not been previously submitted for any award, except where otherwise acknowledged.

Signature of Candidate Date

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ENDORSEMENT

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Presentations, conferences and articles resulting from this research

- **Presentation 1**
  August 1999, in the research work-in-progress workshop at the Faculty of Business, University of Southern Queensland, Toowoomba, Australia

- **Presentation 2**
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- **Presentation 3**
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- **Presentation 5**
  November 2003, to the business incubator strategy group, Queensland Government Department of State Development, Brisbane, Queensland, Australia

- **Presentation 4**
  March 2004, in the research work-in-progress workshop at the Faculty of Business, University of Southern Queensland, Toowoomba, Australia

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1 Introduction

1.1 Background to the research

The role played by innovation in a country's economic growth is recognised by governments worldwide and is broadly supported by the economic theory literature (for example, Gans & Hayes 2004; Freeman & Soete 1997; Rienert 1999). This importance is reflected in the fact that innovation contributes approximately 50 per cent of long term economic growth in advanced industrialised countries (OECD 1996). However, Australia remains a relatively poor performer in innovation, evidenced by no gains in its overall comparative international standing since 1996 (Gans & Stern 2003).

At the firm level, new product development plays a major role in a country's overall innovative capacity, with technical adaptation and the accumulation of knowledge being major determinants of productivity and growth within an individual business (Mortimer Review 1997). However, firms undertaking new product development are faced with their own challenges. In particular, the environment in which firms operate is characterised by: long lead times from basic research to industrial application; a commercialisation phase often with short lead times and an accelerated rate of obsolescence under the global competitiveness of the new product development environment (Crawford & Di Benedetto 2002; Litvak 1992; Cooper & Kleinschmidt 1993; Simms 2005).

New product development, of varying degrees of sophistication, can be found in all firm types including large corporations, small and medium sized enterprises (SMEs) and new firms. Start-up firms in particular are an important source of NPD activity and as such are of direct interest to this research. Investigation into start-up firms from an academic perspective has been extensive with most literature surrounding new firm creation being grouped into three broad themes: venture founding (entrepreneurship); strategy (choice of business, finance, planning) and environment (market dynamics and socio-economic aspects) (Lee 1996). However, the literature surrounding how such start-up firms undertake the development of new products is scant.

At the same time, an increasing focus of governments worldwide is their support for the establishment of new firms and new technology firms in particular. This increased focus is derived from the recognition of the importance of new technology firms and their contributions to employment, technological innovation and to the diffusion of new technological knowledge in the economy (for example, Gans & Stern 2003; Licht & Nerlinger 1998; Mortimer Review 1997). One result of this increased focus is the proliferation of a variety of funding grants, skills development and business incubation programs supported by government. Indeed, one particular type of new technology firm, the start-up technology-based firm (STBF), appears to be a particular target for such government programs. For example, Australian governments pay particular attention to fostering the development of entrepreneurial STBFs as a source of new high-technology products (Ausindustry 2004).

However, when one examines the variety of support programs on offer, the main attention seems to be on programs which support new product commercialisation and capital-raising, with little, if any, focus on the NPD process itself within such firms. This fact alone suggests that governments see that the effective management of new product development either has little impact on the ultimate success of STBFs, or alternatively, is already being effectively managed and therefore requires little attention. As the answer to these propositions is unknown, more research needs to be done on the NPD processes adopted by start-ups firms, and STBFs in particular, and consequently this is the focus of this research.

Moreover, the literature establishes the role played by technological innovation, and specifically product innovation (that form of technological innovation resulting in the development of improved and radically changed products), as being particularly important for long term business growth (Hart 2001). Further, this business growth is increasingly being recognized as the result of gaining and maintaining competitive advantage through the engagement of effective new product development strategies (Crawford 1994; Freeman & Soete 1997; Wheelwright & Clark 1992). Reflecting the importance of product innovation, an emphasis has been placed in the extant literature upon the fit between technological innovation and the

internal structure of the organisation as a means of optimising NPD processes (for example, David, Pearce & Randolf 1989; Fry & Slocum 1984). However, for the most part NPD research has largely been in the context of the large corporate environment (Randolf & Sapienza 1991).

Indeed, it is only more recently that new product development research has attempted to examine NPD processes in the small firm environment, in particular that of the SME (Huang, Soutar & Brown 2002). However, as the definition of SME used in the literature is quite broad, embodying any firm with sales up to $20 million per annum and up to 100 employees (Huang et al 2002), such research sheds little light on NPD processes within STBFs. More specifically, recent studies have identified the need for future research to place more emphasis on the development of theory to explain how new product strategies enhance the performance of new technology companies (Shane and Venhataraman 2003).

Additionally, new product research has established that the number one factor driving new product success is the creation of a superior, highly differentiated product that provides unique benefits and superior value to the customer (Codero 1991; Cooper 1994; Cooper & Kleindschmidt 1990; Hansen & Bird 1997). This is in contrast to firms who are undertaking NPD projects which would be considered incremental improvements or even cloned products which although existing in the marketplace, may be new to the firm itself. Importantly, STBFs would be unlikely to be formed for the purpose of developing and commercialising products with relatively poor differentiation and with low unique value being offered to the marketplace. In particular this is true for products considered incremental improvements or cloned products. For instance, the barriers to the ability to raise capital to finance such firms would be substantial as little value would be offered to sophisticated investors.

Moreover, as STBFs face a range of strategic and operational limitations not faced by more mature firms (Kuratko & Hodgets 1992), the ability of such firms to develop superior, highly differentiated products becomes more difficult relative to mature established firms. This is an area not well researched in the new product development literature and therefore a detailed understanding of these difficulties

and their relationship to new product success in STBFs is identified as being in need of further study.

1.2 Theoretical framework for this research

Based on the background discussion, this study addresses the research problem: *what are the origins and nature of new product development processes within STBFs and how do they contribute to STBF success?*

In order to answer this overall research problem, three distinct issues are now addressed in turn: the elements of NPD that are adopted by STBFs; the link between the adoption of these elements and new product success and the role of business incubators in assisting new product development in tenant STBFs. These issues will now be addressed as individual research questions for this research.

To commence, this research proposes that, unlike larger and more mature firms where new product development is derived out of corporate strategy, corporate strategy in STBFs is undertaken as part of new product development. Additionally, it was argued that NPD in STBFs should be considered across a number of process-related dimensions rather than in terms of process-specific activities. That is, the elements of corporate strategy relating to new product development, NPD process features and the adoption of new product success factors are dimensions of NPD that more accurately describe the NPD process in STBFs. In turn, the resulting NPD activity undertaken by STBFs has direct implications for new product success and as a result directly impacts on overall firm success. Additionally, as business incubators can play a positive role in the formation of new firms (Sherman & Chappel 1998), and therefore by extension STBFs, this research further argues that this positive role may extend to the NPD activities of STBFs. Thus, the relationships between corporate strategy and new product development and the effect of these relationships on new product success, as well as the impact of business incubators on NPD activity, was addressed for STBFs in this research.

Based upon a review of the literature within the three background theories of new product development, corporate strategy and business incubation outlined in chapter

2, an initial theoretical framework was developed. This preliminary theoretical framework was subsequently refined as a result of the exploratory interviewing phase of this research. Three research questions were then derived from the refined preliminary theoretical framework.

The first research question was aimed at obtaining an understanding of the elements of NPD adopted by STBFs and was stated as:

RQ 1: What elements of NPD are adopted by STBFs when developing new products?

Next, the literature pointed to the fact that unlike established and more mature firms who undertake new product development in a portfolio environment[1], STBFs are generally single product centric.

As a result, there are likely to be interdependencies between new product failure for a single product and overall firm failure in STBFs. However, the literature has not directly addressed the extent to which new product success, and subsequently firm success, is influenced by the effectiveness of NPD activities within an STBF. Thus, the next research question posed is:

RQ 2: How does the lack of adoption of the elements of NPD contribute to new product and firm successes and failures in STBFs?

While the first two research questions addressed the specific nature of the relationships between the elements of NPD important for adoption by STBFs and the impact of any lack of adoption of these elements of NPD on new product and firm success, they do not take into account the role played by business incubators in assisting tenant STBFs to undertake their NPD activities. Thus, the third research question is:

[1] A portfolio environment is where the firm has multiple new product development projects underway at any one time.

RO 3: How and in what ways do business incubators influence the nature of the elements of NPD adopted by STBFs?

Having outlined the research problem and the three associated research questions, the justifications and contributions of the research are now discussed.

1.3 Justifications and contributions of the research

This research can be justified on a number of grounds. These include: the importance of product innovation generally, as well as the role played by STBFs specifically, to the national economy; the potential academic contributions and the implications of the findings of this research on theory and practice of new product development in STBFs.

Importance to the national economy. STBFs, as a specific type of new firm, have been shown to be significant contributors to national innovative capacity and thus play an important role in the Australian economy.

Prior to the 1990's, improvement in Australia's economic performance has been driven by reforms to traditional micro and macroeconomic drivers such as competition policy, the tax system and modernisation of public infrastructure (OECD 2003). In this respect Australia has enjoyed outstanding economic performance compared to the other leading economic nations. However, the basis of future economic competitiveness will increasingly be driven by technological innovation (Gans & Stern 2003) thus the creation of new products by firms can be seen as a subset of a country's technological innovation system. This will ultimately mean that growth will increasingly rely on the rate at which companies can acquire and deploy new technologies. More specifically, a country's' prosperity and welfare will flow from the ability of companies to create and globally commercialise new products and services (Porter in Gans & Stern 2003).

Despite the increasing recognition of the importance of technological innovation to the national economy, Australia is considered a poor performer in a global context. In the most recent study assessing Australia's innovative capacity compared to

other OECD countries, it can be seen that since the 1980's Australia has transformed itself from an imitator economy (importing ideas and technology from elsewhere) into an innovator economy. However, since the 1990's Australia's technological innovation performance has stagnated compared to other OECD countries and its competitive ranking has slipped from 14th to 17th (Gans & Stern 2003). To reinforce this view that Australia is a poor performer in technological innovation, the literature points to the fact that Australia has also lagged behind most other industrialized countries in the uptake of new technologies in both manufacturing and non-manufacturing industries (Harrison & Samson 2002).

In undertaking such benchmarking studies, small and medium sized enterprises (SMEs) are commonly a major focus. This is due to the fact that the SME sector is, in itself, an important contributor to the national innovation system and in particular that part pertaining specifically to technological innovation. Indeed, it can be shown that over the period 1984-85 to 1990-91, SMEs contributed over three-quarters of the growth in business expenditure on research and development (Bureau of Industry Economics 1993).

Broadly speaking, there are three broad types of SME that may be involved in technological innovation: existing SMEs (Industry Commission Report on Research & Development 1995); spin-off enterprises from large private and public sector organisations (for example, Dahlstrand 1997); and entrepreneurial start-ups to commercialise new technologies, products or processes (for example, Dankbaar 1998; Herron & Sapienza 1992). SMEs involved in technological innovation can, in turn, be regarded in two forms, those undertaking technological innovation for utilisation internal to their firm and R&D intensive firms who will transfer their resulting innovation to other firms for commercialisation, termed technology transfer. For the purpose of this research, technology transfer is regarded as a form of new product development and is specifically considered in section 2.4.3.

Of these new firms, both spin-offs and entrepreneurial start-ups are shown to be significant contributors to the national economy. For instance, in a study of comparative entrepreneurial activity across 31 developed countries, it was estimated that new firms provided up to 15 per cent of total jobs in each of these participating

countries and further, that job creation was highly correlated to the level of start-up activity (Global Entrepreneurship Monitor 2003). In fact, entrepreneurial start-ups are seen to have significant impacts on the markets they target for novel new products and therefore on overall economic growth (Global Entrepreneurship Monitor 2003). While the literature does not provide a complete picture of the importance of STBFs per se, it does confirm the view that STBFs are an important component of the national innovation system.

Thus, it can be seen that enhancing the likely success of STBFs through improvements in their new product development activities can have a significant longer term impact on the national innovation system and consequently on the overall national economy. Furthermore, STBFs require specific attention as a focus of study for two primary reasons. First, STBFs face inherently greater technology risks associated with the nature of the product compared to non-technology based start-ups. Second, STBFs face heightened commercial risks compared to corporate and academic spins-offs. Importantly, the latter usually enjoy corporate support from a parent organisation and hence are better positioned to manage commercial risk (Davenport, Carr & Bibby 2002).

As this research is concerned with how STBFs undertake their NPD activities the result of the research findings also provide a number of potential contributions to academia.

Contributions to academia. The academic contributions made by this research contribute to the body of knowledge of NPD. More specifically, this research extends the theory relating to how STBFs conduct their NPD activity. It does so by first providing new insights into the inter-relationships between corporate strategy, NPD process features and NPD success factors (which up until now have largely been studied in isolation and in the context of large and established firms) and the role currently played by business incubators in assisting tenant STBFs conduct their NPD activity. The research then builds new theory for the management of NPD by STBFs.

In particular, it is the better understanding of the inter-relationships between corporate strategy and new product development as it relates to STBFs that provide the most important of these potential contributions. There are considerable bodies of knowledge about both corporate strategy and new product development and the linkages between them for established and large organisations. More specifically, the literature argues that corporate strategy is the foundation for new product management (for example, Crawford & Di Benedetto 2002). However, when considering entrepreneurial start-ups certain conflicts arise within the literature. The basis of these apparent conflicts is that on the one hand entrepreneurial theory points to the conclusion that the starting point for the establishment of an entrepreneurial new firm is commonly that of a new product concept which, in turn, becomes the starting point for the NPD process (for example, Cooper 1994; Timmons & Spinelli 2004). On the other hand, new product development literature argues that NPD activity evolves out of corporate strategy suggesting a linear progression (for example, Cooper & Kleindschmidt 1993; Cooper 1994). Thus, this would signify a closer relationship between corporate strategy and NPD processes in the context of STBFs than may be suggested in some of the literature.

Finally, an important outcome of this research is the potential implications the findings have for management theory and practice of new product development in STBFs.

Implications for management theory and practice. In considering management theory and practice of new product development in STBFs a number of potential implications can be identified. First, a more precise knowledge of the ways in which corporate strategy impacts on NPD processes and a better understanding of the NPD processes adopted by STBFs can lead to the creation of a best practice model for new product development in such firms. This will have a direct impact on the techniques used by managers of STBFs in managing their product development activities and thus creating greater opportunities for new product success.

Second, the results of the research will help to pinpoint some of the specific areas of limitation faced by STBFs in undertaking product development. More specifically, this also directly relates to NPD processes adopted by STBFs who are tenants of

business incubators and the ways in which business incubators support STBFs in these activities. In turn, this will provide an opportunity for government and other support organisations (for example, industry associations and business incubators) to better define government policy and identify training needs to better support STBFs in their NPD activities.

Summary of findings. The three research questions provided in section 1.2 became the focus of the data collection for this research and assisted in addressing the research problem. In answering these research questions, the findings of this research can be summarised in five broad areas. The specific findings relating to these broad areas are summarised in figure 5.2.

First, the literature review (chapter 2) revealed that STBFs, as a specific type of new technology firm, are an important source of innovative capacity for the national economy. For instance, the literature showed that STBFs are strongly represented as tenants of business incubators and as such, are a cornerstone of government support programs and economic policy development. Despite such an emphasis on STBFs, little research has been done on the effectiveness of the management of new product development within such firms. Therefore, the findings from this research focusing on STBFs and the elements of NPD characterising their NPD activity will add significantly to this body of knowledge.

Second, the findings of this research challenge traditional new product development theory developed from studies focusing on larger and established firms which argues that new product strategy should evolve out of a firm's corporate strategy. The findings from this research clearly show that unlike larger and established firms, in STBFs the creation of a product concept is the starting point for firm creation. Further, it was found that corporate strategy is developed as part of the new product development process.

Third, it was found that there is a close relationship between the specific elements of corporate strategy important to new product development, NPD process features and new product success factors. As a result, these close inter-relationships would indicate the necessity for undertaking NPD in a parallel rather than linear manner across these components of new product development.

Fourth, it was identified from the findings that the firms that failed over the five year term of this study adopted fewer total elements of NPD than the firms which were still in operation.

Finally, it was found that for STBFs which are tenants in business incubators, only a modest positive influence resulted from the support provided by incubators on those firms' NPD activities.

In conclusion, the research showed that a better understanding of how STBFs undertake new product development can lead to a greater likelihood of new product success. Furthermore, while this study did not focus on the other operational and environmental factors that may impact overall firm success or failure, the link between new product failure and overall firm failure was highlighted.

1.4 Methodology

The study conducted research on the complex phenomena of NPD processes in STBFs. In order to achieve the stated objectives of this study, as outlined in section 1.2, and to address the identified gaps in the literature, this study adopted a two-stage research methodology comprising convergent interviews and a subsequent series of qualitative case studies. As a result, the overall research design was guided by a realist epistemology (Marsden 1993; Hunt 1990; Tsoukas 1989) which is appropriate for this study as discussed in detail in section 4.2.

Justification for use of case study methodology. Most of the research in social science is characterised by deductive theory testing based on large sample data (Bonoma 1985). However, such an approach may not be an appropriate first step for this research due to the fact that theory in this study is at a preparadigmatic stage (Perry & Coote 1994). Additionally, the ability to obtain a sufficient sample size in order to conduct quantitative analysis was considered prohibitive for the purpose of this research. In contrast, the use of an inductive theory generating methodology, such as case study methodology, can be justified on a number of grounds as follows.

First, an inductive theory building approach is appropriate for situations with a relatively underdeveloped theoretical base or alternatively, where complex observational tasks are involved to capture the process of interpretation as in the case of this research (Bonoma 1985; Parkhe 1993; Romano 1989). Importantly, the theoretical base specifically addressing the relationship between corporate strategy, NPD process features, new product success factors and STBFs is demonstrated to be a largely unexplored area of research. As a result, the use of exploratory interviews combined with a case study methodology was deemed the most appropriate methodology in order to achieve inductive theory building.

Second, in the early stages of theory development where the phenomena are not precisely known, quantitative methodologies can lead to inconclusive results (Parkhe 1993). For instance, without first having identified the nature of the relationship between the elements of corporate strategy and NPD process features, a quantitative methodology would do little to contribute to gaining meaningful insights into these relationships. Third, the nature of this research question is predisposed to the adoption of case study methodology. The literature suggests that case study methodology is appropriate where the nature of the research question is based upon a 'how' and 'why' type question (Eisenhardt 1989; Yin 1989), as is the case in this research. Specifically, the inductive theory building approach necessitates the need to identify which elements of corporate strategy, NPD process features and new product success factors respectively are adopted by STBFs. Additionally, it allows the researcher to explore why these relationships exist from the emergent themes arising out of the collected data.

Finally, where the researcher is attempting to gain an understanding of dynamic contemporary events in an environment in which the researcher has little or no control, then qualitative methodologies are more appropriate (Eisenhardt 1989; Yin 1993). The nature of the STBFs which are the subject of this study can certainly be described as being both 'dynamic and contemporary', hence the need for both observation and exploration in such an environment, as that provided by a case study methodology.

1.5 Definitions

Several key terms are defined to establish the position taken in this research. These definitions are important because the key terms depend upon the purpose, aims and objectives of the research and put boundaries around the findings (Perry 1998b).

Intellectual Property (IP). The literature identified a diverse range of definitions for intellectual property, from the simplistic to the legalistic. The definition used for the purpose of this research has been adopted from that of Calvert (1995): 'a novel and definable body of knowledge resulting from intellectual effort and giving rise to technology'.

New Products. The literature provided a number of definitions for what constitute a new product. For the purpose of this research there was a need to incorporate a number of elements into the definition. First, 'product' was taken to be either a physical or codified good (as in software code) or alternatively, technology derived from intellectual property. Importantly, it must be deemed by the firm that a financial return is likely to result from its commercialisation in the marketplace. Second, 'new' was taken to be where the product does not already exist in that firm. Specifically, this definition purposefully excluded services which are not directly attached to the above definition of a product. While a service is considered to be in accordance with what would be considered as a product within the literature (for example, Alam 2003), it is outside the scope of this research and was therefore not included within the definition of a product for the purposes of this research. The rationale for taking this approach was that the inclusion of services would require the necessity of including professional services firms into the research design thus making the findings less meaningful in the context of STBFs. Thus, a new product was defined as 'a physical or codified good or technology, which is new to the firm for the purpose of commercialisation'.

New Product Development (NPD) process. The definition adopted for the purpose of this study was that proposed by Khan (2005, p. 596), being 'a disciplined and defined set of tasks and steps that describe the normal means by which a company repetitively converts embryonic ideas into saleable products'. Throughout this

thesis the term 'NPD' was used when referring to the process, activities within the process or elements of NPD. Whereas, 'new product development' was used when referring to broader theory or the management discipline governing NPD.

Start-up Technology Based Firm (STBF). For the purpose of this research, a start-up technology-based firm was defined as an 'entrepreneurial start-up firm involved in the development of breakthrough, or new-to-the-world, technology products and where no control, resource support and corporate governance is provided from a parent organisation'. Specifically, this excluded products which were considered incremental improvements over previous versions of the product already possessed by the firm.

1.6 Delimitations of scope

The scope of this study was limited in four respects: the unit of measure for this research, the classification of the firm, the type of technology of the firm and identification of firms for the study. First, consider the unit of measure for this research. From the literature it can be seen that the unit of measure common to new product development research is that of the 'product'. However, a different approach is taken for the purpose of this research in that the unit of measure is the 'firm'. The rationale for this approach is that unlike larger and established firms where an individual NPD project is usually one amongst a number of projects, in the case of STBFs it is more common that there is only a single NPD project upon which the firm is based. Therefore, NPD success or failure can be measured in terms of firm success or failure.

The next limitation is that of classification type of the firm. In general, most studies on start-ups have not been overly specific and have adopted a variety of different defining characteristics, some of which include:

- life-cycle theory characteristics where a start-up is a specified point within the firm's life cycle (Kuratko & Hodgetts 1992; Terpstra & Olson 1993);
- origin of founding characteristics where start-ups are characterised according to what type of organisation or individual acts as the catalyst for founding, for example, academic institutions and corporate 'parents' (both

termed ‘spin-offs’) or entrepreneurial founders (‘entrepreneurial start-ups) (Kuratko & Hodgetts 1992; Upstill & Symington 2002);

- organisational characteristics such as age, number of employees and so on (Autio 2000); or
- high-technology versus low-technology characteristics (Gans & Stern 2003).

As a result, a ‘start-up’ can incorporate a broad variety of definitions throughout the literature and covering any combination of the above characteristics. Therefore, this research has substantially narrowed the focus of the start-up to that of the STBF. In this way, the definition of what constitutes a start-up borrows features from a number of these more traditional classification approaches as described in section 1.5. This narrowing of focus has permitted the research to be sufficiently focused while at the same time allowing for a sufficient number of cases to be studied within the context of the definition.

The second limitation of this study was that of ‘technology type’. While the classification of firms into high-technology and low-technology firm types provides one level of dichotomy, such a classification approach still remains relatively broad (for example, Lee 1996; Licht and Nerlinger 1998; Shane and Venkataraman 2003). The literature addressed this limitation by providing a classification of firms according to specific technology segmentations, such as software or biotechnology (for example, Abetti 1992). However, the focus of this research was concerned more with product development characteristics rather than technology segmentation characteristics. A key concern in using technology segmentation as the primary classification schema between firms was the potential for bias resulting from structural, industrial and environmental influences specific to one type of technology segment. For example, fundamental industry structures differ when comparing manufacturing to software development. As a result, the primary approach taken in this research was the focus on time-to-market as a means of classification (Cooper 1999). Time-to-market is therefore the primary dependent variable applied in the research design. The actual approach in this classification is discussed in more detail in section 4.5.

Finally, identification of appropriate target firms for inclusion in the study was a potential limitation to the methodology. This was due to the nature of STBFs themselves (primarily being embryonic and with relatively immature existing networks), making them difficult to identify. However, this was addressed by accessing professional networks, such as venture capital firms and business incubators. As a result, a representative sample of target firms appropriate for this research was able to be identified.

In summary, this approach provided the means to create delimitations to the research so as to give the research sufficient scope while at the same time providing some boundaries in order to obtain the most meaning from the findings (Perry 1998b). Thus, the key delimitations applied to the design of this research were: applying a narrow definition to the type of firm which constitutes an STBF; use of time-to-market as the key dependent variable and utilising existing networks to identify appropriate cases for inclusion in the study.

1.7 Outline of thesis

There are six chapters in this thesis which is an adaptation of the framework proposed by Perry (1998b). Chapter 1 provided a background to the study and introduced the research problem and three research questions. This chapter also provided a brief justification for the research and outlines the methodology used. Finally, definitions to the key terms were provided and delimitations of the research outlined.

Chapter 2 provides a review of the literature on the background theories of new product development (section 2.3), corporate strategy (section 2.4) and business incubation (section 2.5). From this review a theoretical framework was developed and then refined subsequent to undertaking convergent interviews. Three research questions were developed from the refined theoretical framework that became the focus of data collection (section 2.6)

Chapter 3 outlines the convergent interviewing phase of this research in which five interviews were conducted. The respondents in this phase were professional

individuals who were involved in new product development (new venture consultants, practioners or venture capitalists) and who, in turn, were exposed to a wide variety of STBFs in the course of their normal professional activities. This approach allowed for a rapid convergence or divergence of opinions for theory building purposes. This chapter outlines the six emergent themes that arose from the convergent interviewing process and which provided support for the research questions that are investigated in greater depth in chapter 4.

Chapter 4 presents the case study methodology which is grounded in the realism paradigm and justifies its use for the purpose of this research (section 4.2). The research plan which includes the criteria used for judging the quality of case study design, the role of prior theory and the case selection process are each outlined (sections 4.4, 4.5 & 4.6). Finally, the research activities including the data collection process, the conduct of case studies and the data analysis methodology are presented (sections 4.7, 4.8 & 4.9).

To optimise the data analysis process an analytical software program called 'Leximancer' was used to identify and map core concepts and themes from the text of transcribed notes. Leximancer was developed by the Centre for Human Factors at the University of Queensland. While this is the first time this analytical tool has been utilised for the purpose of PhD research it has now been accepted in a variety of professional environments and is used by researchers within a significant number of Australian universities. The justification for the use of Leximancer is outlined in detail in section 4.9. The chapter concludes with an outline of the limitations of the case study research and acknowledgment of the ethical issues to be considered in this research (sections 4.10 & 4.11). Additionally two pilot case studies were undertaken to test and refine the interview protocol.

Chapter 5 provides an analysis of the data collected from case studies. Findings for each research question are presented in tables and figures. Quotations from case studies are also included to reinforce the research findings.

Chapter 6 presents the conclusions about each research question and outlines the contributions to the body of knowledge (section 6.2). The research problem is then

solved (section 6.3) and the implications for theory and practice are then discussed (section 6.4). Finally, limitations to the research are discussed (section 6.5) and suggestions for future research directions are made (section 6.6).

1.8 Conclusion

This chapter has provided the background to the research and introduced the research problem and research questions together with outlining the contributions this research has made. Next, the research was justified and the methodology adopted for this research briefly discussed. In turn, definitions for key terms were presented and delimitations of scope were identified. Finally, an outline of the thesis was presented. Chapter 2 will commence with a review of the literature in respect to new product development.

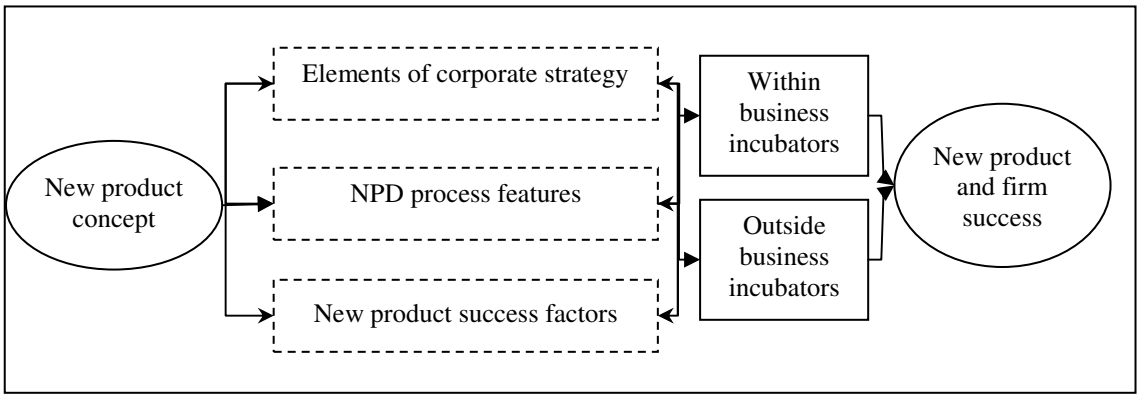
2 Literature review

2.1 Introduction

The purpose of this chapter is to review the extant literature to identify the main issues of this research. First, in order to establish a boundary for this research the definition of start-up technology based firms (STBFs) is presented in section 2.2. Next, the research theory of this research is presented in terms of the three core background theories. These background theories relate to corporate strategy (section 2.3); new product development (section 2.4) and business incubation (section 2.5) from which the preliminary theoretical framework for this research is then derived (section 2.6). Finally, the chapter concludes by summarising the key findings from this chapter and sets the scene for chapter 3 (section 2.7).

Based on the background discussion in section 1.2, the research problem for this research is: *'what are the origins and nature of new product development processes within STBFs and how do they contribute to STBF success?'* This study addressed this research problem by proposing that once a new product concept has been identified, the framework for new product development in STBFs comprises three core components: 1) elements of corporate strategy impacting new product development (for example, Covin, Slevin & Covin 1990; Robinson & McDougall 2001; Baker, Gibbons &Murphy 2002); 2) NPD process features (for example, Ernst 2002; Cooper & Kleindschmidt 1995); and 3) new product success factors (for example, Calatone & di Benedetto 1988; Cooper 1994). Additionally, the interplay between elements within each of these components was also examined in the context of the STBF being located from both within and without the business incubator environment. However, rather than examining the existence of causal relationships, this research examines the extent to which the elements within these components co-exist and the roles they play in new product and firm success for STBFs. These components are summarised in figure 2.1.

Figure 2.1: The components of the proposed framework for new product development in STBFs under investigation in this research



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First, a review of the literature in regards to corporate strategy as it relates to STBFs is presented (section 2.3). Starting with an overview of corporate strategy and its relationship to new product strategy (section 2.3.1), the specific elements of corporate strategy are then identified (section 2.3.2). This was achieved by considering these specific elements of corporate strategy in terms of two themes: operational performance (section 2.3.2.1) and inter-firm relationships (2.3.2.2).

Next, the literature relating to new product development is considered (section 2.4). This comprised a review of the new product development literature in a number of parts. These were:

- product innovation (section 2.4.1);
- the role of new product development in product innovation and a typology of new product development (section 2.4.2);
- an examination of technology transfer as a type of new product development (section 2.4.3) and finally,
- the literature relating to new product success, specifically with respect to new product success factors and success measurement is considered (section 2.4.4).

The literature relating to business incubators is then examined (section 2.5) and commenced with a review of the rationale for business incubators in relation to STBFs (section 2.5.1). Next, the specific nature of technology incubators is considered (section 2.5.2) including the role played by business incubators in

assisting new firms develop their corporate strategies (section 2.5.3) through the assistance provided by networking (section 2.5.3.1) and the provision of business advice (section 2.5.3.1). This section concludes by examining the literature relating to how business incubators influence the performance of new product development by their tenant STBFs (section 2.5.4).

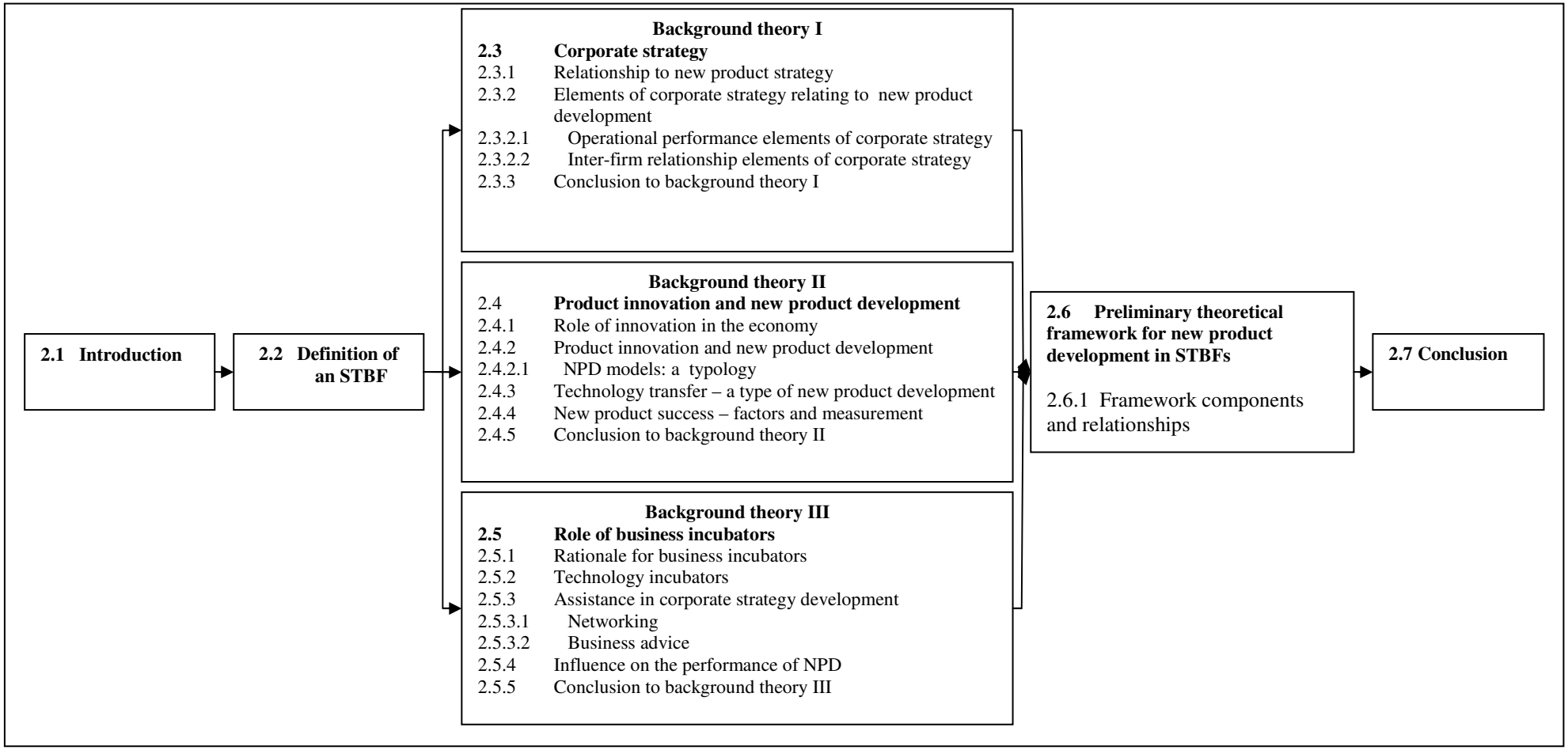
The preliminary theoretical framework (section 2.6.1) was then developed as a result of the literature review. This preliminary theoretical framework outlines the three proposed components of the framework and highlights the relationships between these components. Additionally, it indicates an influence provided by business incubators on tenant STBFs in the adoption and performance of the elements of NPD contained within each of the three components. This section concludes with a consideration of how this framework is likely to impact overall firm success of STBFs (section 2.6.2). Figure 2.2 summarises the structure of this chapter.

2.2 Definition of a start-up technology-based firm

This section discusses the definition of the core subject of this research, that is, the start-up technology-based firm (STBF). The problem in defining an STBF is the term 'start-up'. Rather than providing a precise descriptor of the nature of the firm's activities the term 'start-up' implies a state within a firm's growth cycle (for example, Cooper 1979; Galbraith 1982; Terpstra & Olson 1993; Van de Ven, Hudson & Schroeder 1984; Zahra & Filatotchev 2004).

In this context, the definition of a 'start-up' synthesised from the literature is a firm which is in a position to commence generating operational revenue but has not reached a point of sustainability or maturity. Thus, an organisational state typology approach provides a positional snap-shot of the firm at a point in time on the growth continuum from embryonic, through start-up to growth, and on to the mature firm stage (Kuratko & Hodgetts 1992). However, defining the nature of a 'start-up' in this way does not provide sufficient descriptive precision to apply a definitional boundary around the nature of the STBF which is the particular focus of this research. Thus, it is necessary to expand the definition to incorporate two additional firm characteristics: 'technology-based' and 'entrepreneurial'.

Figure 2.2 Outline of the literature review with section numbers noted



Source: developed for this research

First, being technology-based refers to technology-use in relation to the firm's product. In turn, technology-use refers to one of the contexts in which the literature has classified the application of technology at the firm level. Specifically, the application of technology has been generally classified according to either: R&D intensiveness of the industry in which the firm is located (for example, Hirch-Kreinsen, Jacobson Roberston 2006; OECD 2005); low technology versus high technology (for example, Abernathy, Clark & Kantrow 1981; Kouladis, Sandven & Smith 2006) and technology-use (for example, Koberg, Sarason & Rosse 1996; Sarason & Tegarden 2001). Specifically, being technology-based refers to technology-use in relation to the firm's product.

In turn, technology-use can be considered in terms of whether the firm is technology-intensive or technology-based (for example, Koberg, Sarason & Rosse 1996; Sarason & Tegarden 2001). Technology-intensive firms utilise enabling technology as a basis for producing a resulting product. A further dimension to this definition can also be taken from the new product development literature, in that the nature of product innovation itself is likely to often encompass an incremental improvement rather than a breakthrough, or new-to-the-world technology (Rothwell 1994). An example of enabling technology is the use of computer aided design tools for the manufacture of building products. In this example, the resulting product relies on enabling technology (the CAD tool) in manufacture but the resulting product itself may be 'low-tech'.

The technology-based firm on the other hand, is where high-technology is a fundamental element of the product itself. An example of a technology-based firm is the software firm which developed the CAD software used by the manufacturer of building products given in the previous example. The definition of a firm being technology-based for the purpose of this research incorporates the requirement that the high-technology nature of the product is more likely to be classed as breakthrough, or new-to-the-world (Rothwell 1994). In general terms, novelty is not normally a requirement of being technology-based. After all, a computer software development firm does not need to provide a unique product in the market to be successful, as differentiation can come from a variety of sources such as branding or pricing. However, the product being regarded as breakthrough has a

greater likelihood that the technology itself is the source of differentiation of the product, in turn, implying novelty (Baron & Hannan 2002; Garcia & Calantone 2004).

As explained in chapter 1, this is in contrast to firms who are undertaking NPD projects which would be considered incremental improvements or even cloned products which, although existing in the marketplace, may be new to the firm itself. Importantly for this research, STBFs would be unlikely to be created in the first place to develop and commercialise products with relatively poor differentiation and with low unique value being offered to the marketplace as represented by incrementally improved or cloned products. Thus, for the purposes of this research, technology differentiation (hence novelty), as reflected by a new to the world product, is taken as a core construct of the definition of being technology-based.

An important extension of being technology-based is the inclusion of firms that commercialise a product through a technology transfer process. In such instances the commercialisation function directly involves assets associated with technology differentiation, usually manifested as intellectual property rights (Upstill & Symington 2002). While the intellectual property itself is typically not the final form of the product it is equally valid to consider the intellectual property as a 'product' in its own right. This is by virtue of the fact that there is commonly a change of ownership in intellectual property rights which, in turn, will ultimately give rise to a final-form product. Additionally, when the underlying technology is licensed-in from third parties, this process is recognised as being a legitimate component of the new product development process (Tatikonda & Stock 2003).

The second characteristic to be considered in defining the STBF for this research relates to the support environment of the start-up in its formative years. That is, the extent to which the start-up is provided with resource support from related organisations in its start-up phase. In turn, an important element that determines the support environment provided to a start-up is the source of its creation.

In respect of technology start-ups (both technology-intensive and technology-based), there are three broad firm types examined in the literature: academic spin-

offs; corporate spin-offs and entrepreneurial start-ups (for example, Balazs & Plonsky 1999; Jones-Evans et al 1998; Upstill & Symington 2002).

In the case of the 'spin-off', the new firm has been spun-off from a larger, well resourced and mature organisational 'parent'. When examining the nature of spin-offs, a common element is that there occurs a transfer of resources between the parent and the spin-off (Davenport, Carr & Bibby 2002). However, a level of academic debate has occurred around the relevance of a transfer of resources between the two organisations when taking into account the degree of separation between the parent and the spin-off (Howells & McKinlay 1999; Jones-Evans, Steward, Balazs & Todorov, 1998). Two views have been expressed in the literature in this regard. First, it has been argued that if resource support is provided to any extent by a parent organisation then it should be regarded as a 'spin-off' not a 'start-up'. It is usual that the parent organisation will have a commercial interest in the spin-off and as a result will provide a level of ownership, often reflecting control, and will provide support in the form of resources and corporate governance for the start-up (Davenport, Carr & Bibby 2002).

The opposing view is that if there is a significant degree of separation between the spin-off and the parent then the level of resourcing support provided by the parent is largely irrelevant and the spin-off should be regarded as a 'start-up'. However, the literature clearly points to the importance of resource availability for start-up firms and this resource availability has a significant influence on firm success (for example, Bruno, Leidecker & Harder 1987; Bruno & Tyebjee 1985; Abetti & Rice 1995; Dahlstrand 1997).

More specifically, two specific types of spin-off are considered in the literature; the 'academic spin-off' and the 'corporate spin-off'. Academic spin-offs have their roots in academic research where the new firm has been established to commercialise a technology, product or service developed in the academic institution (Upstill & Symington 2002). It is important to distinguish between the academic spin-off and the technology start-up for the reason that there is commonly a 'blurring' of the boundary between the two. For instance, a technology start-up can have its roots in academia but the start-up risk is borne either by the academic

who has left the institution or a third party who has licensed the technology from the institution. In neither situation however, is the institution regarded as a 'parent' organisation as it neither has an ownership position in the firm nor provides resources.

The corporate environment can also be a significant source of new technology firms in the form of the 'corporate spin-off' (Davenport, Carr & Bibby 2002). The corporate spin-off is similar in nature to the academic spin-off except that the source of the technology is from within the corporate environment, as compared to being developed from academic research. For these reasons, any relationship the new firm has, however far removed, from a 'parent' results in it being regarded as a 'spin-off' and therefore outside the scope for this research.

The entrepreneurial start-up on the other hand is not spun-out from a parent organisation and the primary risk taker is that of the entrepreneur-founder (Bhide 2000; Kuratko & Hodgetts 1992; Gans & Stern 2002; Radosevich 1995). It is this final form of start-up that is the focus for this research for a number of reasons. First, it is reasonable to expect that entrepreneurial start-ups by their very nature represent the greatest commercial and personal risk for the entrepreneur-founder. When considering new product development, the nature of the entrepreneurial start-up may have significant impacts on how the entrepreneur considers the NPD process itself. For instance, it may be that the founder attempts to better manage these risks through over accentuating the need for speed-to-market as a means of mitigating risk. In turn, over accentuating the need for speed-to-market may result in short-cuts in the NPD process in an attempt to obtain earlier financial returns. Alternatively, the reverse may also be true. An overly cautious approach to managing new product development may be adopted in order to eliminate as much technical risk as possible. The ability to objectively balance technical, commercial, market and personal risks is an issue explored in section 2.4. Thus, the entrepreneurial start-up is a key focus for this research. The practical consideration of identifying STBFs as case studies for this research is made easier through intermediate service providers, such as government assistance providers to technology start-ups and business incubators.

Thus, for the purpose of this research, start-up technology-based firms are defined as 'e*ntrepreneurial start-up firms involving the development of a single new-to-the world technology-based product and where no control, resource support and corporate governance are provided from a parent organisation'*.

2.3 Background theory I: Corporate strategy

Introduction. Having clarified the definition of STBFs for the purposes of this research, the first background theory of corporate strategy will now be considered. A particular focus of his section was to identify themes within the corporate strategy literature that also potentially influence the development of technology strategy and hence NPD activity. However, while it was considered necessary to examine the corporate strategy literature in this way, and in particular within the context of STBFs, the literature review was not restricted to identifying themes that are specific to technology firms or the start-up environment exclusively. Such an approach was considered to be too restrictive for the purposes of this study.

As one of the key arguments of this research is that STBFs develop their corporate strategy at the same time as undertaking new product development, an examination of the corporate strategy literature is therefore required. Specifically, it is the relationship corporate strategy has with new product development in the context of STBFs that is the focus of this examination.

Before commencing, it is important to set out the distinctions between new product strategy and new product development. New product strategy establishes the focus of the new product development effort (Narayanan 2001). Importantly, new product strategy is not specific to one project but rather provides the framework by which the firm approaches the development of all new products within the new product portfolio. Moreover, Porter (1984 p. 11) explains that new product strategy addresses the following questions: the 'type of new product to be developed…the types of markets are aimed at….types of technologies employed and …the nature orientation and commitment of the process to undertake'. Further, the answers to these questions are directly influenced by both firm and industry characteristics. New product development on the other hand, can be considered as the process by

which new product development is undertaken and therefore is activity based (Cooper 1984; Meyer & Roberts 1986). In the context of this research, the focus is on examining the NPD activities undertaken by STBFs that will allow us to be able to address the overall research problem established in section 1.2.

Further, it is also necessary to establish a boundary around the review of the associated literature of corporate strategy that is pertinent to this study in order to focus its relevance to new product development. Specifically, the review of the literature relating to this background theory is aimed at examining the extant literature to identify the elements of corporate strategy that impact the NPD processes adopted by STBFs. This is distinct from being a comprehensive review of corporate strategy and its associated disciplines such as strategic management. The fundamental rationale for the need to examine corporate strategy in this way stems from the fact that the literature links corporate strategy with technology strategy. While technology strategy, in turn, broadly encompasses R&D strategy, innovation strategy, knowledge management and new product strategy, it is the specific links to NPD processes as a sub-component of new product strategy that is the primary focus (for example, Cooper & Kleindschmidt 1990; Dodgson 1989; Edler, Meyer-Krahmer & Reger 2002; Martinelli & Waddell 2004). Further, the literature points to a direct relationship between technology strategy and the performance of new ventures. In particular, new technology ventures were shown to gain distinct competitive advantages depending on the technology strategy choices made (for example, Zahra 1996; Zahra & Bogner, 1999).

The approach taken in this section is to present a review of the relevant literature in three sections. First, the corporate strategy literature relating to the general development of new product strategy is considered (section 2.3.1). The next two sections address the literature covering the elements of corporate strategy which relate to NPD processes. These sections are presented according to each of two broad themes and summarised in table 2.3. The first theme, operational performance, is considered in section 2.3.2.1. Next, the literature relating to the second theme, inter-firm relationships (section 2.3.2.2) is considered.

2.3.1 Relationship to new product strategy

Before examining the literature in regards to the relationships between corporate strategy and NPD processes, the relationship between corporate strategy and new product strategy in the broader context must first be established. To commence, one of the problems identified by the literature is that new product strategy modelling has become an object of study only relatively recently. More specifically, prior to the mid-1980s new product strategy research has lacked both conceptual modelling and methods for empirical testing, despite the fact that corporate strategy and innovation have been extensively researched in their own right (Meyer & Roberts 1986). Moreover, the emergent literature established that new product strategy should be an explicit element of corporate strategy (for example, Crawford 1980; Kantrow 1980; Meyers & Roberts 1986). Additionally, later authors have refined this view to argue that new product strategy is derived from corporate strategy (Cooper & Kleindschmidt 1994). One example of this approach is that of Crawford (2000) who proposes the use of a 'product innovation charter' which is derived directly from the content within the firm's strategic plan.

While this view provides significant limitations on how new product strategy is considered in the case of STBFs, nevertheless it does firmly establish the nexus between corporate strategy and new product strategy in the broader context. However, in order to better understand the relationships between corporate strategy and the NPD process environment, the issue of what types of new product strategies a firm may employ must next be addressed. One particular study which summarises this best is that of Cooper (1984) which identified five distinct strategy types: i) a technologically-driven strategy; 2) a balanced strategy; 3) a technologically deficient strategy; 4) a low budget and conservative strategy and finally 5) a high budget and diverse strategy.

While undoubtedly examples of STBFs can be found within each of these five approaches, two in particular stand out as being of particular relevance to STBFs: the technologically-driven strategy and the balanced strategy. Firms with a technologically-driven strategy tend to have a high degree of technological sophistication, orientation and innovativeness. However, they also tend to have a

lack of a market orientation in their strategy, that is, they are technology driven rather than being market driven. The concept of market orientation refers to the need for firms to develop a business culture in which the firm is committed to the continuous creation of superior value for its customers (for example, Narver, Slater & Tietje 1998; Farrell 2000). Therefore a pure market oriented strategy is diametrically opposed to that of a technology driven strategy.

On the other hand, while firms with a balanced strategy also possess a high degree of technological sophistication, orientation and innovativeness, they also tend have a high degree of market orientation, that is, they are market driven rather than technology driven (Cooper 1984; Rothwell 1990). More recently, studies have shown that market orientation facilitates innovations that use advanced technologies and offer greater benefits to mainstream customers and as a result are more likely to result in new product success (for example, Im & Workman 2004; Zhou, Yim & Tse 2005). In this way, STBFs are more likely to possess a new product strategy according to either of these two broad descriptors. This approach to considering new product strategy acts now as a guide in assisting to identify the specific elements of corporate strategy that relate to new product strategy within STBFs. That is, these two approaches to new product strategy become the focus for investigation of the literature: achieving the desired market orientation and achieving technological leadership. These are now considered in section 2.3.2.

2.3.2 Elements of corporate strategy relating to new product development

As outlined in section 2.1, this review of the extant literature relating to the background theory of corporate strategy is not meant to represent a review of the widely researched field of strategic management. Rather, a boundary is placed around the elements of corporate strategy which are identified as having an influence on new product development within STBFs and are presented as two corporate strategy themes: the theme of operational performance and the theme of inter-firm relationships. The literature relating to these themes are considered in sections 2.3.2.1 and 2.3.2.2 respectively.

To commence, however, it is necessary to first consider a definition of what comprises corporate strategy and second, to obtain an understanding of how corporate strategy is created within STBFs. While corporate strategy is a widely researched discipline, there is no single, universally accepted definition of strategy (Ruoco & Proctor 1994). However, there are two common principles in the literature relating to corporate strategy, being:

- that corporate strategy can be regarded as a plan, or a pattern of action, reflecting the organisations' goals and objectives and which integrates these goals with policies and action sequences into a cohesive whole (Kuratko & Hodgetts 1992; Proctor 1997; Quinn 1980); and,
- that corporate strategy provides a framework for directing internal activities for the purpose of helping to achieve corporate goals (Kuratko & Hodgetts 1992).

An additional consideration in better understanding what is meant by 'corporate strategy' is that of strategy terminology. In this context, reference can often be found to other more specific organisational strategies, such as 'marketing strategy' and 'R&D strategy'. While each can be a strategy in its own right, they each also need to be consistent with the firm's overall corporate strategy. When this doesn't occur, adverse effects on corporate performance can result (Kuratko & Hodgetts 1992; Timmons & Spinelli 2004).

The issue of how firms develop their overall corporate strategy is also important. As Porter (1980) points out, every firm, irrespective of size, or level of maturity, will possess a corporate strategy. Such a strategy has either been developed explicitly or alternatively has evolved implicitly within the organisation. An explicitly developed corporate strategy is one which is developed through a deliberate and considered planning process. However, the need for systematic planning will vary with the nature, size and structure of the business (Kuratko & Hodgetts 1992). An implicit corporate strategy, on the other hand, is one which evolves through the professional orientation, skills and experiences of management. While implicit strategy development may not represent the ideal strategy for a firm, such an approach can provide distinct advantages for certain types of firms, such as

new firms. Specifically, an implicit strategy may allow the new firm to be more flexible in responding to emerging market opportunities. This is particularly true when considering opportunities which are largely untested and where the firm has little, if any, market credibility.

The form of corporate strategy that a firm adopts (implicit or explicit) gives rise to the issue of how a firm should evolve its strategy from the implicit to the explicit and then once explicit into different degrees of sophistication as the firm matures. In turn, the issue of strategy evolution can be considered in the context of firm creation and growth. Specifically, this refers to the view taken by researchers that firm creation and growth is a linear and sequential process consisting of identifiable stages, commonly referred to in the literature as the 'Stages Model' for venture founding (for example, Hansen & Bird 1997).

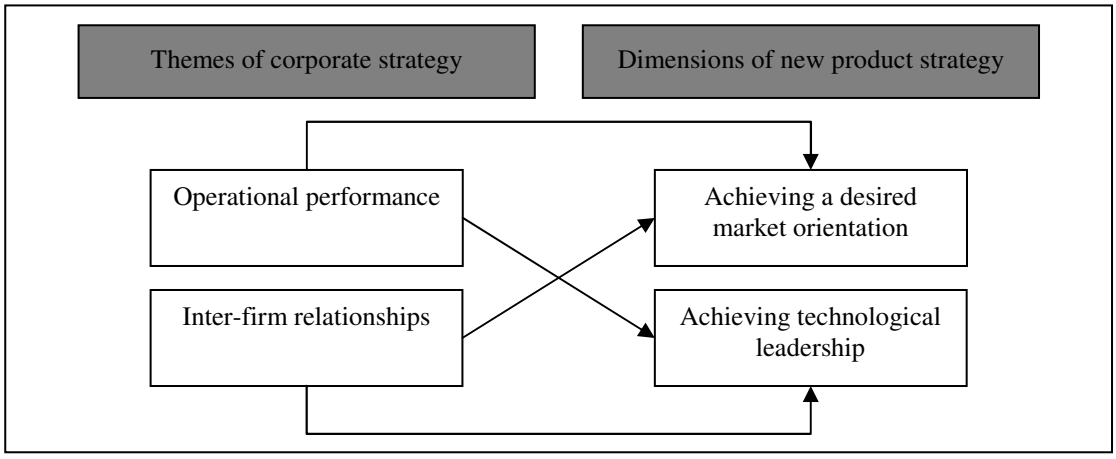
The 'Stages Model' is usually described as consisting of: a technology access stage; an iterative product development stage; a market testing stage; a market entry stage and an organisational growth stage (Galbraith 1982; Kazanjian & Drazin 1990; Rourke & Keeley 1990; Schoonhoven, Eisenhardt & Lymann 1990). The progression of the firm along these stages is dependent upon the accomplishment of specific tasks which themselves can happen simultaneously or in any order (Hansen & Bird 1997). Additionally, the literature also supports the view that the venture creation process is not only linear but also stochastic (Katz & Gartner 1988; Reynolds & Miller 1992). The accomplishment of these tasks can then be regarded as 'market events' (Bird 1992) as they mark accomplishment and symbolise the movement to the next stage towards the market-success goal.

Returning now to how strategy evolves from the implicit to the explicit, the literature shows that it is a commonly held view that the further the firm moves down the 'Stages Model' path, the more important it becomes for a firm to make strategy explicit. This becomes particularly important where significant resources are being devoted to achieving specific tasks within any particular stage (for example, Kuratko & Hodgetts 1992; Hansen & Bird 1997). However, the literature also expresses the view that the specific timing when this should occur is dependent

upon a number of factors such as the competitive environment and technology maturity (for example, Cooper 1997; Porter 1985).

While the literature relating to firm creation theory, and in particular, that of the 'Stages Model' of firm creation, provides an environmental context for the firm itself, a number of key elements of corporate strategy can also be identified. In turn, these elements can be characterised in the context of 'corporate strategy themes'. These themes, together with their corresponding 'dimensions of new product strategy' are summarised in figure 2.3. Additionally, figure 2.3 also indicates the key relationships between the themes of corporate strategy and dimensions of new product strategy as the basis for achieving a focus within the review of the literature relating to corporate strategy.

Figure 2.3 Relationships between themes of corporate strategy and dimension of new product strategy as a basis for a review of the literature



Source: developed for this research

The next section, 2.3.2.1, will now consider the elements associated with the first of these two themes, operational performance.

2.3.2.1 Operational performance elements of corporate strategy

Eight specific elements of corporate strategy relating to the theme of operational performance that relate to new product strategy were identified from the literature (table 2.1). While the literature points to the relationships between these elements

Table 2.1: Summary of the elements of corporate strategy and their relation to the two dimensions of new product strategy

Corporate strategy		New product strategy Dimensions	Authors
Themes	**Elements**		
1. Operational performance (2.3.2.1)	Market entry	Market orientation	• Bekenstein et al 1994 • Robinson & McDougall (2001) • Covin, Slevin & covin (1990) • Cooper, Willard & Woo (1986)
	Aggression versus stealth strategies	Market orientation	• Macmillan & Day (1987) • Porter (1985) • Henderson & Clark (1990) • Marino & DeNoble (1997) • Gans & Stern (2000)
	Market segmentation	Market orientation	• Kotler (1988) • Burgel & Murray (2000) • Cohn & Lindberg (1972)
	Internationalisation of 'born globals'	Market orientation	• Jones (1999) • Sharma & Blomstermo (2003) • Burgel & Murray (2000) • Bell z (1995) • George, Zahra, Autio & Sapienza (2004) • Sapienza, Autio, George & Zahra (2006)
	Technological Leadership	Market orientation Technological leadership	• Mintzberg (1994) • Covin, Slevin & Covin (1990) • Christensen (1997) • Gans & Stern (2000) • Timmons & Spinelli (2004) • Bhide (2000) • Collinson (2000) • Zhou, Yim & Tse 2005
	Entrepreneurship	Market orientation Opportunity driven	• Timmons & Spinelli (2004) • Mintzberg & Lampell (1999) • Dees & Lumpkin (2005) • Zahra & Filatotchev (2004) • Zahra & George 2002
	Operational Systems	Market orientation Technological leadership	• Bell & McNamara (1991) • Amit, Glosten & Muller (1993) • Ledwth (2000)
	Financeability	Market orientation Technological leadership	• Bell & McNamara (1991) • Williams (1998) • Bertram (1996)
2. Inter-firm relationships (2.3.2.2)	Inter-firm cooperation	Market orientation Technological leadership	• Pisano (1991) • Anton & Yao (1994) • Cheesbrough & Teece (1996) • Baldwin & Clark (1997) • Gans & Stern (2000) • Yesheskel, Shenkar, Fiegenbaum & Cohen (2001) • Nambisan (2002) • Baker, Gibbons & Murphy (2002)
	Access to complementary assets	Market orientation Technological leadership	• Teece (1986) • Foster (1986) • Henderson & Clark (1990) • Gans & Stern (2000)

Source: developed for this research

and new product strategy, the various authors also consider that these elements are dependent upon each other. For example, market-entry is dependent on whether or not an aggression or stealth strategy is adopted as well as the extent of technological leadership of the product. Each of these eight operational performance elements of corporate strategy will now be considered in turn.

Market entry. The fundamental presupposition in considering market entry is that firms need to develop strategies which allow them to either penetrate existing markets previously not served by their firm or alternatively, create new markets unknown prior to their venture (for example, Robinson & McDougall 2001). The latter situation is of particular relevance to new-to-the-world products which require the creation of new markets.

Also of particular relevance to STBFs is that establishment in new markets often takes place in an environment characterised by limited financial resources, minimal reputation and also with significant risk. Conversely, for established markets, firms must identify opportunities and implement competitive strategies in industries usually served by established and often large businesses (Cooper, Willard &Woo 1986). Importantly, aggressive market entry into established markets can also become appropriate for new firms with technological advantage. Hence, STBFs may be able to achieve proportionally better success in entering established markets compared to other types of firms entering their respective markets. For example, in one particular study undertaken by Miller and Camp (1985), it was found that the new ventures which demonstrated the most successful financial performance over an eight year period from their inception were those firms that selected high growth competitive markets but in which they had a distinct technological advantage.

An example of this strategy can be demonstrated in the Information and Communications Technologies (ICT) industry. Here, Sun Microsystems utilised a direct market entry strategy in a market that had much larger and more dominant players. In this instance competitors largely discounted the threat posed by Sun, giving them sufficient time to implement their strategy and so build a novel value-chain (Baldwin & Clark 1997). Thus, an aggressive market entry strategy may be

appropriate for STBFs where new-to-the-world products provide a high degree of technological advantage for the firm in the market place.

Aggression versus stealth. Another market related element identified was the need for the firm to consider either an aggression or a stealth strategy in a manner appropriate for the firm (Foster 1986). An attacking strategy is most appropriate where there is a 'level playing field' between the entering firm and the incumbent firm and where the incumbent does not control the complementary assets. In this environment the market entry investment need not be duplicative and may be modest in size (Foster 1986; Gans & Stern 2000; Henderson & Clark 1990). When this strategy is employed, firms have an opportunity to capture market leadership by effectively developing and diffusing technology with the effect of breaking down the competence of market incumbents (Foster 1986). This is of particular relevance to the new product strategy of STBFs who, with new-to-the-world products, are most likely to be able to provide a unique and superior product to effectively break down incumbent market dominance. However, the caveat here is that the resulting product needs to be largely protected from a direct competitive response, at least in the short term. This is mainly achieved through the use of intellectual property protection through the use of monopoly rights such as patent protection. However, the prevention of a direct competitor response in the short term is possible only to the extent that incumbent firms are not actively and aggressively engaged in their own product development initiatives with other novel products which are not likely to contravene the monopoly intellectual property rights of the entering firm. Such is the case in the biotechnology and pharmaceutical industries where large established incumbents have significant on-going product development strategies under the expectation that such situations will indeed arise (for example, Blakely & Nishikawa 1992; Delaney 1993).

Alternatively, stealth is more commonly utilised when new firms introduce new technology products into the marketplace in order to exploit the 'blind-spot' of current market leaders (Foster 1986; Gans & Stern 2000). Incumbents can often overestimate the potential advantages to be derived from further improvement of existing technologies rather than recognising potential benefits to be derived from

emerging technologies with new performance characteristics (Christensen 1997; Gans & Stern 2000). Moreover, a stealth strategy can also be appropriate where the entering firm wishes to reduce the likelihood of an aggressive competitor response in the short-medium term, thus allowing the entering firm to obtain a foothold in the market. The rationale for firms in taking this approach is based on the fact that the very act of bringing the product to the attention of current market leaders can reduce the advantage to the entering firm.

Market segmentation. Segmentation is a vital element of market strategy within the theme of operational performance and one that is directly related to product strategy (for example, Maidique & Hayes 1984; Robinson & McDougall 2001). The initial consideration when determining a segmentation strategy is to identify homogenous submarkets which are distinct from each other in terms of user preferences or customer preferences (Kotler 1988). The common view is to limit activity to a narrow product line in order to establish and maintain competitive leadership in that market (Maidique & Hayes 1984; Covin, Slevin & Covin 1990). Market positioning such as this becomes even more important for smaller firms operating in a specialised one-product, one market niche strategy (Benkenstein & Bloch 1994). This is commonly simplified in the case for the STBFs as they tend to be single-product centric allowing the firm to have greater ability to identify homogenous sub-markets. Moreover, the increased uncertainty associated with technology risk tends to steer STBFs to position themselves to capture technology synergies (Abell 1980). Importantly for STBFs, products in high technology markets are characterised as having ever reducing product life cycles coupled with the need for increasing investment in product development activities (Benkenstein & Bloch 1994). In turn, this becomes a significant driver for incumbent firms to actively seek other firms that potentially provide these technology synergies. That is, STBFs are likely to position themselves more effectively if they are able to provide a technology synergy with incumbents within the market who, in turn, may be looking for such opportunities without the need to incur the full development costs associated with undertaking their own product development.

Internationalisation of 'born globals'. The final market related element is that of internationalisation of born globals. The literature relating to internationalisation of new firms can be considered in two contexts; the effect of international on venture survival and the resulting firm growth effects of capturing markets new to the firm (for example, Barkema, Bell & Pennings 1996; Sapienza, Autio, George & Zahra 2006). However, it is for the purpose of this research, when considering internationalisation, the focus is specifically that of segmentation strategy and relates to the geographic boundaries placed around the firm's chosen market segments (Benkenstein & Bloch 1994; George, Zahra, Autio & Sapienza 2004). More particularly, the question of what geographic boundaries a firm should target in their market entry strategy is of particular relevance to STBFs in particular. In some cases, particularly where the market incumbents' complementary assets are not required for market entry, there may exist a relative ease of entry into the market. Often, this allows firms to enter new geographical markets simultaneously. Indeed, one manifestation of an increasingly globalised world is the emergence of new ventures which have an international outlook from their inception – more recently termed 'born globals' (Jones 1997; Burgel & Murray 1998). This increasing phenomenon is likely to be due to an increasingly rapid accumulation of the knowledge of emerging and existing market opportunities abroad and the increasing effectiveness of international networks (Bell 1995). This is further explored in a study by George, Zahra, Autio & Sapienza (2004) who found market entry capabilities of 'born globals' can be described in two distinct sub-sets; entry organising capabilities and market intelligence capabilities.

Technological leadership. The next element of corporate strategy that relates to new product strategy is associated with the nature of the STBF's, that is, the extent to which the firm exhibits technological leadership as it relates to the product (for example, Amit et al 1993; Bureau of Industry Economics 1993; Bruno & Tybjee 1985; Bird 1992; Covin et al 1990; Christensen 1997; Gans & Stern 2000; Timmons & Spinelli 2004; Kahn, Barczak & Moss 2006).

Entrepreneurship. While it is not in the scope of this literature review to undertake an in-depth review of the extant literature relating to leadership and entrepreneurial

theory, a number of specific observations can be made from the corporate strategy literature highlighting the specific relevance of the two features of this element (that is, leadership and entrepreneurship) to the development of new products.

The first observation was the fundamental difference between entrepreneurship and management in that entrepreneurs are 'opportunity' driven while in contrast managers are 'resource' driven (Bell & McNamara 1991; Covin et al 1990; Macmillan 1985; Maidique 1985; Timmons & Spinelli 2004). This gave rise to the second observation, that the firms' management team should possess a number of broad characteristics seen as vital for the development of effective corporate and product strategy (Bell & McNamara 1991; Maidique & Hays 1994; Rothwell 1974; Macmillan 1985; Timmons & Spinelli 2004). These characteristics of the management team include:

- *Possessing an informal approach, driven by opportunity*. This implies a high degree of flexibility in order to respond to commercial opportunities as they arise;
- *Relevant and appropriate experience*. This implies familiarity with both the underlying product technology as well as the marketplace. Additionally this experience is probably supported by possessing the appropriate technical and general management capabilities; and
- *Possessing capabilities and willingness to cooperate with third party firms as a means of filling gaps in skills, capability and experience.* Effective cooperation in this sense is then a key strategy to help overcome deficiencies in management, as poor management is regarded as being the number one cause of business failure (Williams 1998).

Further to considering entrepreneurship in the context of entrepreneurial characteristics, an important theme arising from the literature was that of 'entrepreneurial orientation' (for example, Dess & Lumpkin 1996; Venkatraman 1989). This concept of entrepreneurial orientation considers entrepreneurial characteristics in the context of a broader definitional boundary. Specifically,

entrepreneurial orientation encompasses five dimensions of the decision making style of individuals within the firm. These dimensions comprise:

- autonomy – the independent action of an individual or team taking a business concept through to completion;
- Innovativeness – willingness to introduce newness and novelty throughout the organisation;
- Proactiveness – the forward looking perspective of a marketplace leader;
- Competitive aggressiveness – an intense effort to outperform competitors; and
- Risk-taking – Making decisions without prior knowledge of probably outcomes. (Covin & Slevin 1991; Dees and Lumpkin 2005; Lumpkin & Dees 1996).

This concept of entrepreneurial orientation is valuable when considering new ventures generally. Specifically, the literature shows that entrepreneurial orientation provides a framework for evaluating the strategic nature of entrepreneurial firms (for example, Lumpkin & Des 1996). However, later studies demonstrate that the relative usefulness of the individual dimensions of entrepreneurial orientation may shift as firms age (Lumpkin, Wales & Ensley 2006). For this reason, it is apparent that the underlying entrepreneurial characteristics of an individual or team holds particular relevance for this study. Moreover, flexibility to capture opportunity, team experience, capability and teaming are important to both the STBF management as well as to the product development effort of the firm. For instance, the possession of a multi-functional, well balanced team according to the individuals' capabilities and characteristics together with team members having clearly identified responsibilities, are shown by the new product development literature as being important contributors to new product success (for example, Cooper 1994). This is considered in more detail in section 2.4.4 in considering new product success factors in relation to new product development.

Operational systems. The next element of corporate strategy within the theme relating to operational performance is that of 'operational systems' (for example, Amit et al 1993; Bell & McNamara 1991). Operational systems refers to the internal process and controls to ensure effective operational control of the business.

Operational control covers all aspects of resource inputs (such as cash, people, technology etc) and outputs (such as products, profits, etc).
Importantly, as Bell & McNamara (1991) point out, operational control needs to ensure that internal systems exist that allows the firm to deliver on corporate objectives in strategic and operational plans. It is for this reason that operational systems and control is relied on so heavily by the final element within the theme relating to operational performance, that of 'financeability'.

Financeability. 'Financeability' refers to the ability of the firm to raise sufficient capital in a timely fashion and at fair market price (for example, Bell & McNamara 1991; Williams 1998; Bertram 1996). Importantly, this does not apply just once in a firm's life but rather is an on-going requirement. This is due to the reality that the more successful a firm is, the more likely it is going to need to obtain additional funding to sustain growth. Financeability then has a potentially large impact on a firm's performance and overall corporate strategy by virtue of the fact that if a firm does not posses an attractive financeability proposition for the investor market then the firm may be forced to adopt less than optimal strategies, for example limiting geographic markets.

The link to the previous element of operational performance, that is, Operational Systems, can be illustrated by a study by Williams (1998) which examined the causes of failure of over 25,000 small firms. In this study, inadequate operational controls was cited as a primary reason for failure in around 56 per cent of cases while undercapitalisation at start-up was quoted as a primary reason for failure in around 23 per cent of cases. Unlike non-technology based small businesses which tend to rely on personal assets of the founders and debt financing, the increased sophistication and associated technology development and/or technology acquisition and internationalisation opportunities means that technology firms are more reliant on investment capital to fund firm growth (Reynolds, Williams & Savage 2000).

2.3.2.2 Inter-firm relationship elements of corporate strategy

Having considered the literature relating to the first theme of operational performance the next theme that emerges from the literature, that is, inter-firm

relationships will now be considered. There is extensive coverage in the literature of technology management, strategic management and economics which examines relationships between technology innovators and market players. In general terms, this research can be grouped into three types: contracting versus integration (for example, Williamson 1985); transaction costs associated with relationship management (Arora, Fosfuri & Gambardella 2001) and competition versus cooperation (Gans & Stern 2000; Nambisan 2002). While transaction cost issues and contracting versus integration issues are more aligned with operational considerations once a strategy has been chosen, it is competition versus cooperation that is of more immediate relevance for this research. This is due to the fact that the market strategy adopted by the firm is essentially selected as a direct result of attitudes by management of the need to compete or cooperate with existing market incumbents and is therefore the core basis of strategy development.

Inter-firm cooperation. Competition versus cooperation issues should be considered in the context of the entire value chain. In this way, the development of corporate strategy is linked to the trade-off decision between establishing a novel value chain and direct competition on the one hand, versus leveraging an existing value chain by integrating the product into an existing value chain, and hence cooperation, on the other (for example, Nambisan 2002). It can be argued that inter-firm cooperation is a key feature of STBFs. This is based on the fact that STBFs do not have parent company support and are therefore more likely to be resource deprived, therefore making direct competition ineffective. Additionally, from a product development perspective a cooperation strategy requires the creation of an inter-firm relationship early in the firm life cycle and usually at the concept creation point in order to effectively link the product to the market-need. This issue will be discussed in more detail in section 2.4.2.

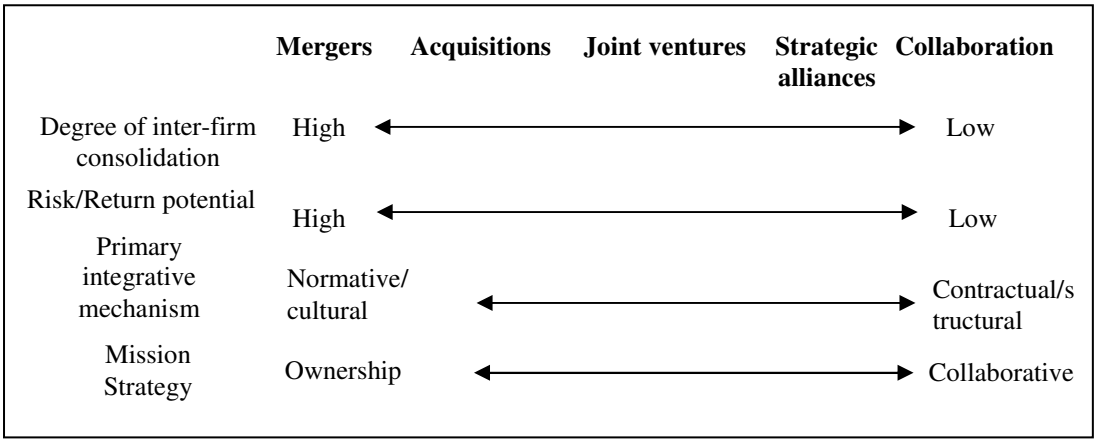
The fundamental basis of a cooperation strategy is that the firm has made a choice to earn its revenue from the incumbent firm and is conferring a range of potential benefits to participants including a softening of market competition, product launch efficiencies, avoiding duplicate product investment and engaging in complementary technology development (Gans & Stern 2000; Yeheskel, Shenkar, Fiegenbaum &

Cohen 2001; Lin 2006; Calatone & Di Benetto 2007). Importantly, this signifies that it is necessary to deliver mutual benefits to each firm in the relationship when a cooperation strategy is embarked upon.

On the other hand, the literature also points to a number of disadvantages in attempting to undertake a cooperation strategy. The foremost of these arises from the 'paradox of disclosure' argument (Anton & Yao 1994). The basis of the paradox of disclosure is that the ability to obtain financial or market leverage from potential collaborators or buyers of the technology depends upon their knowledge of the product or idea. Yet, once that knowledge is possessed by the target firm, they need not buy it in order to exploit it. That is, disclosure increases the buyers' valuation but decreases the innovators' bargaining power through the fear of having their idea expropriated in the absence of formal intellectual property protection. This is of particular relevance to STBFs given the limited financial resources to protect and legally defend intellectual property associated with the product.

Cooperation strategy can take a number of distinct forms including: merger; acquisition; joint venture; strategic alliances and collaboration (for example, Pisano 1991; Chesbrough & Teece 1996). The form chosen by participating firms will depend on the degree of formalisation of the relationship required to achieve the corporate objectives of the relationship (outlined in figure 2.4).

Figure 2.4: Degree of inter-firm formalisation in cooperation strategies



Source: derived from Buono 1991

Of these, joint ventures, strategic alliances and collaboration are specific cooperation strategies of more immediate focus with respect to STBFs generally. Both mergers and acquisitions become a focus only when the founders and/or principal investors are seeking to realise an appropriate exit strategy for their investment (Baker, Gibbons & Murphy 2002).

While strategic alliances have received greater focus by researchers, all three cooperation strategies possess a number of characteristics in common: they require the involvement of two or more partners; have a common commercial objective; and commonly intend to utilise the unique capabilities and assets of the partner (for example, Russ & Camp 1997; Jorde & Teece 1989).

There are, however, a number of fundamental differences between each, associated with the degree of formalisation of the relationship. In the case of joint ventures, this form of cooperation usually involves formalisation of the relationship through the creation of a new legal entity or at least a set of onerous contractual obligations between the partners. Usually, the commercial objective of common interest has a resulting high level of commercial risk associated with it and thus requires formalisation for the participants to minimise and better manage this risk (Baker, Gibbons & Murphy 2002).

Both strategic alliances and collaboration have more in common with each other as there is generally a lesser degree of formalisation than either mergers, acquisitions and joint ventures, even though contractual obligations between the participants my often exist. Further, there is less perceived risk to the firms. However, the fundamental difference between these strategies is time-frame (for example, Russ & Camp 1997). Collaborative activities are usually short-term in nature, for example, to capture a future supply opportunity. Whereas strategic alliances tend to be longer-term in nature and hence, more strategic in their outlook. For these reasons, while it is not unusual for start-ups to be involved in joint ventures, it is much more common for such firms to be involved with both strategic alliances and collaborative partnerships. It can be expected that this situation would likewise extend to STBFs.

Importantly, strategic alliances and collaborative partnerships provide the potential to create direct and indirect opportunities for gaining access to a target partners' skills, technologies, core competencies and even valuable information about a competitor's strategic direction (for example, Badaracco 1991; Calatone & Di Benedetto 2007). The primary argument in favour of both joint ventures and strategic alliances is that they provide participating firms with greater ability to pursue new developments in technologies, products and markets and as a result allow the firm to initiate or adapt to competitive change (Volberda 1996). This is of particular importance to STBFs, as they also face limitations in terms of access to additional professional and technical skills, financial resources and market reach (Abetti 1989). At the same time, start-ups can be actively sought after to participate in strategic alliances and collaboration due to their greater flexibility to exploit opportunities and from their possession of specific technological know-how (Zollo, Reuer & Singh 2002). Therefore, such cooperation strategies can significantly provide additional capabilities not previously possessed by both larger, more established firms, and STBFs individually.

The performance of cooperation strategies, in particular that of strategic alliances, has been researched extensively from a number of perspectives. These include: the transaction-cost perspective (Hennant & Reddy 1997; Oxley 1997); agency theory (for example, Reuer & Miller 1997); the participant benefit perspective (Das, Sen & Sengupta 1998; Hagedorn & Schakenraad 1994; Zollo, Reuer & Singh 2002) and organisational learning theory (for example, Barkema, Shenkar, Vermeulen & Bel 1997; Zollo, Reuer & Singh 2002). Of these, it can be argued that organisational learning theory has the most relevance in terms of this research in the context of STBFs. Indeed, it is often argued that organisational learning is one of the most important motivations behind entering into strategic alliances as it provides a means to access or acquire critical information, know-how or capabilities from the partner (Neill et al 2001; Schilling & Phelps 2005). Further, it can also be assumed that such learning is always an implicit strategic objective for every firm, irrespective of size, that engages in alliance activity and regardless of the stated purpose (Yoshino & Rangan 1995).

However, when considering alliance activity between firms, the size of the firm is also relevant. In particular, the literature points out that the small firm faces a number of difficulties in engaging in cooperation strategies (for example Zollo, Reuer & Singh 2002). To illustrate, it can be argued that creating and maintaining successful alliances involves a substantial administrative, organisational and monitoring overhead which disproportionately disadvantages the smaller firm in the relationship (Hagedorn & Schakenraad 1994). Likewise this argument would also hold true for STBFs. In fact, this disproportionate disadvantage in terms of costs and overheads would probably be accentuated in STBFs compared to small firms in general who may also be operationally more established and mature in the marketplace.

Despite some identified disadvantages associated with a cooperation strategy, such as the paradox of disclosure argument discussed above, overall the literature clearly favours the adoption of such a strategy.

Access to complementary assets. When specialised complementary assets are required, the costs associated with market entry for new products can become substantial, hence reducing the returns to the firm. Therefore, when a competitive strategy is employed, the costs associated with duplicating these specialised complementary assets are borne by the entering firm. However, the realisation by the incumbent firm of the need of the entering firm to incur the costs necessary to establish assets in the event a collaborative relationship cannot be developed between the two firms may often have the impact of weakening the relative bargaining position of the new firm (Teece 1986; Gans & Stern 2000). Despite such a potential disadvantage to the entering firm, an increase in the importance or concentration of control of complementary assets raises the relative returns to cooperation over competition and will thus tend to encourage collaboration with more existing market incumbent firms (Teece 1986; Lin 2006).

In contrast to the level-playing field environment is a situation where incumbent firms control the complementary assets required for successful commercialisation and where duplication of those assets is impractical for the entering firm. An example of such a situation is the games console manufacturing sector of the

information technologies industry. In this situation the market is dominated by only a few, but substantially sized market incumbents such as Sony and Microsoft. In such situations entering firms must capitalise on their technological leadership in either one of two ways, both of which involve cooperation between the incumbent firm and the entering firm. The first form of cooperation is by the entering firm having a research orientation, that is, by becoming an 'ideas factory' (Gans & Stern 2000), outlined in more detail in section 2.4.3. Under this scenario the entering firm has concluded that either their access to the complementary assets required for creating and marketing an end product is too costly or impractical or that the technology created has multiple product or market applications. Thus, the commercially viable alternative is to become an ideas factory whereby intellectual property can be licensed out to existing market incumbents.

The second form of cooperation is where the entering firm will undertake the physical production of the end product but will choose to develop a relationship with a market incumbent to achieve product commercialisation (Calatone & Di Benedetto 2007; Pisano & Mang 1993; Arora & Gambardella 1994; Lin 2006). For instance, in the computer software industry it is common for entering firms to enter into cooperation with market incumbents in order to leverage against existing market relationships within the demand chain. For example, IBM plays such a market incumbent role with software firms which produce synergistic market ready products. In this way IBM provides access to the market for commercialisation but in most instances has nothing to do with production of the end product.

Further, it is increasingly being recognised that market incumbents who enter into cooperation relationships based on a reputation of ‘fairness’ will be able to profit from commercialisation at a higher rate than that of their competitors (Baker, Gibbons & Murphy 2002). Entering into such reputation-based relationships (Gans & Stern 2000) means that rather than taking advantage of the opportunity for expropriating the idea or the unprotected technology, the incumbent firm will often encourage cooperation through its reputation for fairness in exploring cooperation strategies. In this way, incumbents, through their reputation for fairness, encourage approaches by STBFs to explore opportunities. For instance, it is common for large

multinational software firms to have a 'partnering program' through which other firms can enter into a cooperation relationship with that market incumbent. Further, incumbent firms are more likely to explore opportunities for cooperation if they are able to provide commercial benefits through the strengthening of their competitive positions in the marketplace. STBFs may be well positioned to provide this commercial benefit through the technology leadership position offered through their breakthrough, new-to-the-world products.

An example of this approach to partnering is Cisco Systems. Rather than commit most of the firms' R&D investment into internal activity, such as occurs in the automotive industry (Gans & Stern 2000), Cisco employs a strategy of modest internal R & D investment and a proactive approach to systematic technology acquisition (Bunnell & Brate 2000). This approach takes the form of an initial creation of partnerships or strategic alliances which may, in turn, result in strategic investment or eventual acquisition. Importantly, when the partnership does not result in acquisition, Cisco endeavours to maintain a constructive relationship with the start-up, providing on-going benefit for the start-up irrespective of whether an investment occurs or not.

However, when the incumbent firms' complementary assets are unimportant, a different approach a firm may take is that of greenfield competition. In these situations the entering firm can preclude effective imitation, resulting in that firm being free to determine whichever strategy it wishes to pursue (Gans & Stern 2000). In the context of STBFs, this environment can offer significant benefits as the market strategy can be far less reliant on the need for cooperation. An example of this situation is the environment provided by what can be termed 'internet based businesses' where the internet plays a dominant role in customer acquisition. In these types of businesses, the firm can be entirely self reliant in the development of its market strategy. However, as the barriers to competition are much lower it highlights the need for speed-to-market in order to establish a first mover advantage and the need to consistently offer superior value. The issue of speed-to-market as a success factor for new product development is considered in section 2.4.4.

2.3.3 Conclusion to background theory I

In conclusion, a review of the literature in relation to corporate strategy identified a number of specific elements of corporate strategy which directly impact new product development activities. These elements were summarised into two core themes, being operational performance elements (section 2.3.2.1) and elements relating to inter-firm relationships (section 2.3.2.2) and for ease of reference these individual elements are summarised below in table 2.2.

While the literature treats each of the elements of corporate strategy (presented in table 2.1) individually, the complementary nature of some of these elements allows a number of these elements to be combined for the purpose of this research. Specifically, this applies to elements in three areas. The first is segmentation and internationalisation (element 3 in table 2.2). In this case, an internationalisation strategy requires a determination by the firm of which geographic market segments should be a priority for the firm for market entry and therefore becomes intimately linked. The second is leadership and entrepreneurship (element 4 in table 2.2). In this case, leadership is partly determined by the individuals' tendency to exhibit certain entrepreneurial characteristics, such as a propensity for risk taking. For this reason too, these two elements can be considered in combination. Lastly, the two elements of operational systems and financeability are combined. As outlined previously, financeability is intricately entwined with the degree of effectiveness of operational systems and so for this reason both of these elements have been combined.

Table 2.2 Elements of corporate strategy impacting on new product development

	Element	Description
1	Market entry	Strategies to penetrate existing markets or create new markets
2	Aggression Vs. stealth	Achieving market entry in an existing market by attacking market incumbents or alternatively using stealth to exploit 'blind spots' of incumbents
3	Segmentation & internationalisation	Segmentation into submarket potentially applied in a number of ways including geography or product characteristics. Approaches to segmentation directly impacts internationalisation.
4	Leadership & entrepreneurship	Demonstration of being opportunity driven and takes into account entrepreneurial characteristics, experience, managerial capabilities, flexibility and drive for product leadership
5	Operational systems & financeability	Internal systems to manage the enterprise and achieve control. Impacts on ability to raise additional resources.
6	Inter-firm cooperation	Cooperation to achieve product synergies or achieve market penetration
7	Access to complementary assets	Particularly applies to when cooperation is sought to leverage from market incumbents' assets or those of providers in the supply chain.

Source: derived from literature review in section 2.3

The next area of background theory for examination is the literature relating to product innovation and new product development, which will now be examined in the following section.

2.4 Background theory II: Product innovation and new product development

Having reviewed the literature in respect to corporate strategy as it relates to new product strategy and development, the next background theory of product innovation and new product development was examined and is now considered. Specifically, this section examines the concept of product innovation and new product development in three respects: the importance of innovation to the Australian economy (section 2.4.1); the role played by new product development in the product innovation process, including a typology for new product development derived from the literature (section 2.4.2); the relationship between new product development and technology transfer (section 2.4.3) and finally new product success factors (section 2.4.4.).

2.4.1 Role of innovation in the economy

In the broadest sense, innovation is a process which involves newness and leads to the creation of commercial value (Kuratko & Hodgetts 1992, The Warren Centre 1995). More specifically, Drucker (1985) emphasises its importance in the creation of wealth. One of the first economists to recognise the importance of innovation in economic activity was Joseph Schumpeter who saw that a normal economy was not one in equilibrium but rather one that was continuously being interrupted by 'long waves' of technological innovation (The Economist 1999). Schumpeter adopted his theories from the early work of Nikolai Kondratieff who recognised a pattern of periods of some 60 years in length between periods of high sectoral growth alternating with start-up periods of slower growth in the modern world economy (Kondratieff 1984). Similarly with innovation cycles, it was typical that a new growth cycle started once a new set of innovations came into general use, stimulating

investment, but then declined when technologies matured. This 'life cycle' concept has subsequently been delineated for products, processes and technologies (Flynn 1994). Hence, understanding technology life cycles can provide signals for potential changes in product evolution and product process.

Innovation is a holistic activity which includes: product invention and commercialisation; development of an enterprising culture by the organisation; management and organizational change; continuous improvement and adaptation of technology; and the development of new capabilities. Importantly, all of these aspects can in turn act as sources of economic application of new technologies. In other words, innovation is a broad concept comprising a process and not merely a single event, the introduction of a novel production method or process or new product (Industry Commission Report on Research & Development 1994). As pointed out in the Oslo Manual (2005, p.46) produced by the Organisation for Economic Cooperation and Development (OECD), the primary criteria for innovation is that the 'product, process, marketing method or organisational method must be new (or significantly new) to the firm'.

The term 'innovative capacity' has been used extensively in the economic development and innovation policy literature (for example, Pavitt 1980; Suarez-Villa 1993; Furman, Porter & Stern 2002; Gans & Stern 2003). Specifically it refers to a country's potential to produce commercially relevant innovations and focuses on the economic application of new technology. Importantly, innovative capacity can only be created with the collective utilisation of new knowledge by firms within the national economic system. Indeed, there is an inherent link between knowledge creation and adoption to the realisation of technological innovation. As Cohen and Levinthal (1990) point out, a firms' ability to recognise, assimilate and apply knowledge from both inside and outside the organisation is a pre-requisite for technological innovation. Moreover, the capability of an organisation to use knowledge in new ways is encapsulated into the theory of 'combinative capabilities' (Kogut and Zander, 1992). This provides a broader view of the knowledge management problem that underpins innovation, stressing not just the ability to absorb knowledge, but also the ability to combine and reconfigure knowledge in

novel ways. Thus, knowledge management is in itself a substantial component of an organisation's innovation system (Savory 2006).

Additionally, technological innovation is, in itself, increasingly being recognised as an important source of economic growth. For illustration, it has been estimated that approximately 50 per cent of long term economic growth in advanced industrialised economies comes from technological innovation (OECD 1996). The growing importance of high-technology goods specifically is reflected by the fact that in 2000-2001 around 25 per cent of total international trade by OECD member countries was accounted for by trade in high-technology goods compared to 20 per cent in the 1990s (OECD 2003). Moreover, at the whole-economy level, the ability of a country to undertake technological change depends upon the way in which resources are managed and organised at both the enterprise and national levels and in particular the performance of the national research and development effort as a component of the national innovation system (OECD 1992, Industry Commission Report on Research & Development, 1994). However, Australia lags behind most other industrialised countries in the uptake of new technologies in both manufacturing and non-manufacturing industries (Harrison & Samson 1997). Such findings underscore the fundamental importance of innovation generally, but technological innovation in particular, to the national economy.

Furthermore, the literature demonstrates the importance of the link between national innovation capacity, the role played by the firm in this national context and the extension to product innovation. As Porter points out in his foreword to the Gans and Stern benchmarking study (2003, p. 3), '... individual companies are the ultimate engine for innovation, the national innovation environment has a strong influence on whether companies are able to develop and commercialise new products'. The specific relationships between product innovation and new product development will be examined in more detail in the following two sections.

2.4.2 Product innovation and new product development

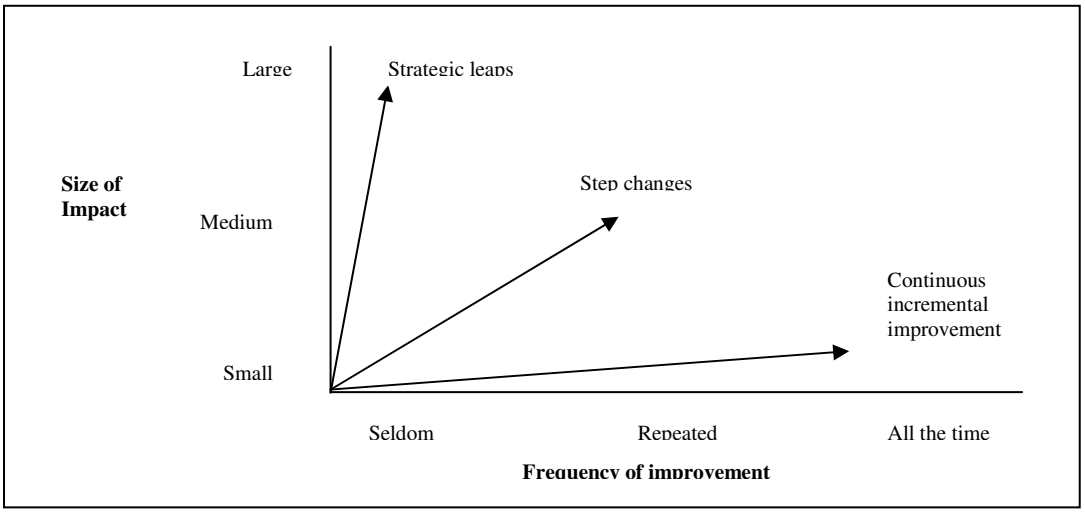
The specific reason that an individual organisation may embark on a product innovation strategy can vary and may include: the utilisation of excess capacity in the organisation (Cooper 1988; Moore & Pessimier 1993); as a response to competitors (Brown & Eisenhardt 1995; Crawford & Di Benedetto 2000; Urban, Hauser & Dholakia 1987); to penetrate new markets (Mahajan & Wind 1992; Cooper 1995) and to use new technologies (Schoonhoven, Eisenhardt & Lyman 1990). However, irrespective of the particular motivation of the firm for undertaking product innovation, the different forms of product innovation remain constant.

When considering product innovation a number of different approaches are outlined in the literature to segment different forms or degree of product innovation. One commonly adopted approach is to consider product innovation in terms of degrees of 'newness'. In this context a new product is one in which they differ significantly in their characteristics or intended uses from products previously produced by the firm (Oslo Manual 2005). In this way a product can be classed as new whether or not the underlying technology is in itself new. For example, the development of the digital camera is an example of a new product based on new underlying technology whereas the MP3 player is a new product although the underlying technology was a combination of pre-existing technologies. On the other hand, improved products can occur through changes in materials, components and other characteristics that improve performance (Lam 2005; Oslo Manual 2005).

Another approach outlined in the literature is to consider product innovation in terms of the degree of change or size of impact caused by the innovation. For instance, strategic leaps are closely aligned to new-to-the-world products with significant firm and market impacts, while step changes or continuous incremental improvement commonly result in lower level impacts to the firm and the market in which they operate (The Warren Centre 1995). The differences between these categories revolve around the trade-off between impact (risk/reward) and frequency of innovation, as outlined in figure 2.5. It can be seen that these trade-off questions are of critical importance to the firm. For example, firms may accept the higher commercial and

technological risk associated with a focus on new-to-the-world products in order to capture higher economic returns. Alternatively, firms may be more risk averse and accept the lower economic returns more likely from continuous incremental improvements.

Figure 2.5: Three categories of innovation



Source: The Warren Centre, 1995

For large and more mature firms, these questions are commonly answered by adopting a 'portfolio' approach to product innovation and thereby spreading risk across a number of product innovation projects and across a range of risk profiles (for example, Cooper 1990).

Moreover, technological product innovation tends to be represented by more strategic leaps than the continuous incremental improvement forms of innovation (Cooper 1986). For example, it was estimated that 40 percent of manufacturers' sales in the United States came from products the firm did not possess five years previously and further, only one development project in four results in a commercially successful product (Booz-Allen & Hamilton 1982; Cooper and Kleinschmidt 1990).

As a result, it is clear from the literature that the development and commercialisation of new products is a significant contributor to national innovation capacity. At the same time however, the impact of this contribution is only of relevance where these

activities result in a successful new product. In particular, the literature cites that the number one criterion for new product success is the commercialisation of a unique and superior product (Crawford & Di Benedetto 2000; Page 1993; Cooper 1999; Cooper & Kleindschmidt 1990). As such, a common theme throughout the literature is the need for the product to deliver added-value relative to the cost of purchase and use. The high failure rate of new product development, reported to vary between 40 per cent and 90 per cent (Cooper 1999; Wind & Mahajan 1997; Hultink, Hart, Robben & Griffin 1997), is a direct result of not being able to meet this requirement. A more detailed review of new product success factors will be provided in section 2.4.5.

Within the literature, product innovation was considered according to a number of different criteria and perspectives including: degree of innovation (outlined in figure 2.3); process features (for example, Cooper 1994; Rothwell 1994) and research versus marketing perspectives (for example, Rothwell 1994; Hart & Baker 1994; Crawford 1997). Specifically, it was the process features within new product development, referred to as the 'NPD Process', which is of particular interest for this research. Moreover, a structured approach to managing the NPD process is one means of reducing the risk of failure in developing new products. As a result, it is not surprising that the aim of the NPD process is to maximise the success rate of new products (Cooper 1994; Jenkins, Forbes, Burani & Banerjee 1997).

However, the manner by which individual firms manage their product development activities, as well as the underlying NPD processes themselves, differs enormously between firms (for example, Cooper 1994). Moreover, NPD as a process is, in itself, in a state of constant revision, adaptation and change (Jones 1997) and this change is an evolutionary one which reflects the changing nature of the organisation, and the increasingly sophisticated technological and competitive environment in which firms operate. Greater organisational, competitive and industrial complexity and the increasing pace of industrial change are forcing firms to be more flexible and responsive to market changes (Cooper 1994; Rothwell 1994). It is therefore important to consider the various models of new product development and the exact

nature of their evolution over time. The next section examines this evolutionary process and considers the various models of new product development.

2.4.2.1 NPD models: a typology

The different criteria and perspectives identified from the literature in relation to the management of product innovation gave rise to different models of new product development. The seminal study which developed the first of these models was Rothwell (1994), in which he outlined five distinct and progressive 'generations of product innovation' representing the adoption of different NPD process features over time. Thus, the 5th generation of product innovation is the latest, having evolved from those coming before. Moreover, the Rothwell approach was developed from a clear research and technical development perspective (Alam 2000) whereas subsequent models which emerged, such as that of Cooper (1994) in which he described his model in terms of three generations of product development, were developed from a marketing perspective. However, the Rothwell five generations model is deemed to be of more relevance for this research as it allows for a more specific and detailed analysis of process-related features of NPD. In turn, it is these changes to the features of NPD over time which demonstrates the evolutionary nature of new product development theory. A summary of the relationships between the five generations of innovation with examples of the key NPD models is provided in table 2.3.

The key to distinguishing among the models is the presence or absence of key NPD process features. It can be seen for this summary that the development of product innovation theory has been a progressive and evolutionary process associated with the improved understanding of NPD processes and the increasingly effective management of uncertainty in innovation (Landau & Rosenberg 1986). Uncertainty can be thought of as a reflection of the degree of complexity in the innovation (Pelz 1985). Consideration of uncertainty in innovation is helpful in that it assists in understanding why different problems occur at different times in the product development cycle. Further, the degree of uncertainty affects the appropriate type and level of management required to plan and to undertake the innovation process.

Table 2.3: Summary of innovation features and NPD process features

Innovation Process	Innovation features	Key NPD Models	NPD process features	Authors
First generation	• Linear process • Technology-push • No long-term strategic framework • R&D decides future technologies • No integration between R & D and business strategies • Operational priorities vary with operational circumstances • Poor measurement and evaluation of success	**Phased Development**	• Linear process from idea to market • Technology driven • Between 4 to 10 phases • Managed by development 'Board' which also controls funding • Not driven by product champion	• Rothwell 1994 • Freeman, Clark & Soete 1992 • Roussel, Saad & Erickson 1991 • Jenkins, Forbes, Burrani & Benerjee 1997
Second generation	• Linear process • Market-pull • Partial strategic framework • No integration between R & D and business strategies • Distinguishes between types of R & D • Judge-advocate management/ R & D relationship • Formalized peer reviews for evaluation	**Market-pull model**	• Linear process • Market need directs R & D • R & D strategy is reactive	• Mowery & Rosenberg 1978 • Rothwell & Soete 1983 • Rothwell 1994 • Roussel, Saad & Erickson 1991 • Jenkins, Forbes, Burrani & Benerjee 1997
Third generation	• Linear process • Holistic strategic framework • Partnership philosophy • Feedback loops • Extensive communication processes • Integration through the use of internal and external networks	**Total Design**	• Linear process driven by identified market need • Starts to integrate business strategy and R & D strategy • Some integration of functional units • Improved internal and external communications • Major emphasis on product design phase	• Coghlan, Coughlan & Brennan 2004 • Rothwell 1994 • Rothwell & Zegveld 1985 • Roussel, Saad & Erickson 1991 • Roussel, Daas & Erickson 1991 • Baker & Sinkula 2005
Fourth generation	• Parallel development • Holistic strategic framework • Partnership philosophy • Extensive communication processes • Full organisational integration • Supplier integration	**Stage/gate systems**	• Parallel development • Stages are multi-functional • Processes decision gates between stages • Requires full integration within the organisation • Faster time to market	• Rothwell 1994 • Cooper 1991 • Cooper & Kleindschmidt 1993 • McGrath, Anthony & Shapiro 1992 • Jenkins et al 1997
Fifth generation	• Holistic strategic framework • Parallel development • Partnership philosophy • Thorough and effective communication processes • Systems integration • Electronic assisted development and modelling • Extensive networking	**Systems integration & networking model**	• Fully integrated parallel development with flexibility and fluidity between stages • Strong linkages with customers and suppliers • Use of expert systems such as simulation modelling • Use of computer assisted design and modelling tools such as CAD • collaboration	• Cooper 1990 • Cooper 1994 • Rothwell 1994 • Jenkins et al 1997 • Crawford 1992 • Dahl & Pedersen 2004 • Bstieler 2006 • Baker & Sinkula 2005

Source: developed for this research, with contributions by Cooper 1990 and Rothwell 1994.

Each of these five generations of product innovation is now briefly considered and an example of a specific NPD model within each is provided. To commence though, it is important to note that whatever the actual NPD model, each comprises three distinct phases: 'inception' – the activities required before a product concept is even developed; 'creation' – from product concept to prototype and, 'realisation' – product manufacture and market introduction. The progression through each of the five generations represents the evolutionary nature of each of these phases over time and with a common goal in mind: to allow firms to get products to market faster with fewer mistakes, to make the most efficient use the firm's new product development resources of the firm's new product development expenditure and to develop the unique and superior product that is going to be successful in the marketplace.

The first-generation of innovation process was linear in nature and characterised by a 'technology push' process. Further, in an operational context, resource allocation was at the discretion of the research and development unit and the expected result of the development process was often not clearly defined. In a strategic management context, the research strategy had no explicit link to business strategy, the organisation had no long-term strategic framework and research and development was treated merely as an overhead cost (Roussel, Kamal & Erickson 1991). An example of a first generation NPD model is that of 'Phased Development'. First created by NASA in the early 1960's, it was the first real attempt at developing a formal NPD process (Smith & Reinersten 1992). Phased Development processes typically incorporated between four and ten phases covering activities from idea generation to market launch. In order to continue from one phase to the next established exit criteria were required to be met. This process is generally overseen by a development 'board' that also controls funding (Anderson & Tushman 1990). The most significant criticism of this model of NPD is that the emphasis is on technical aspects of product and manufacturing, with activity being undertaken under a matrix management structure (Rothwell 1994). Such a structure creates potential conflicts for project members by effectively requiring them to report to two managers: the functional head and the project team leader (Jenkins, Forbes, Burrani & Benerjee 1997).

Next, the second-generation process took place in an economic climate in which industrial innovation tended to become focused on existing technologies rather than on new products (Rothwell 1994). The significant departure from the first-generation model occurs in the operational environment. That is, resource allocation was made on the basis of perceived need and customers were invited to become involved in the firm's priority setting process. This again was a linear process. However, the marketplace became the inspiration for directing research and development but often to the detriment of long term industrial research (Rothwell 1994). The result was the emergence of the 'market-pull' model of NPD which was driven purely from the identification of a market opportunity (Industry Commission Report on Research & Development 1994). One flaw in this model is the lack of recognition of the importance technological capability within the organisation plays in creating product opportunities in the marketplace (Mowery & Rosenberg, 1978). As with Phased Development, the NPD process is generally overseen by a development board, creating an environment not conducive to fostering a product champion. The development team was generally dominated by the functionality of that specific NPD stage (for example, 'manufacturing') with little integration between functional units (Jenkins et al 1997).

The third-generation innovation process resulted from an economic contraction environment characterised by corporate consolidation and rationalisation and a major focus on cost reduction strategies (Rothwell 1994). Such strategies laid the foundation in the first steps to understanding innovation processes in an attempt to minimise new product development failures. At the same time, it was identified that both the technology-push and market-pull processes were inadequate (Cooper 1980; Mowery & Rosenberg 1978; Rothwell 1976; Utterback 1994). In terms of management philosophy, third-generation innovation differs from the first and second-generations in that a spirit of partnership and mutual trust was developed between general management and research and development management for decision making and assessment purposes (Roussel, Kamal & Erickson 1991). Further, a holistic strategic framework was developed in which the research and development strategy is integrated with business strategy across the entire corporation. An example is the 'Total Design' model of NPD which takes a firm from the identification of the market need to selling a product which successfully

meets that need in a more systematic manner (Jenkins et al 1997; Roussel, Daas & Erickson 1991). While it retained some features of the second generation models, such as commencing with a detailed investigation of the market in order to fully understand customers needs, Total Design also possessed new characteristics. The major emphasis within the model is on the execution of the new product design process itself with the added recognition that this process requires input from many functional areas within the organisation, not just from designers and engineers. Most importantly, processes under Total Design are governed from technical development perspective rather than the functional design perspective (Jenkins et al 1997).

The fourth-generation innovation processes demonstrated a growing awareness of the strategic importance of core technologies and the role played by technology strategy to drive the accumulation of new technology for the firm (Dumaine 1989; Rothwell 1994). Importantly, the emergence of IT-based manufacturing led to a growing importance being placed on manufacturing strategy by companies, particularly in respect to global market opportunities (Bessant 1991; Rothwell 1994) and the potential role played by strategic alliances and networking (Dodgeson 1989; Rothwell 1994). Leading Japanese manufacturing companies developed two new features of the innovation process, which underpin the fourth-generation model and by which this model was differentiated from the first three generations: comprehensive integration of suppliers and the various organisational business units as well as parallel development (Industry Commission Report on Research & Development, 1994; Rothwell 1994). In this way, networking efforts by the firm and the improved, parallel, or simultaneous, rather than sequential, product development stages resulted in shorter development times (Dumaine 1989). An example is the 'Stage-Gate' model of NPD where the most significant characteristic is that it is divided into distinct stages which are separated by a review point, or gate (Jenkins, et al 1997). These gates act as control points at which management makes the decision to proceed to the next stage, hold, abandon the project or redirect the project. Gates are predefined and specify project requirements as either 'must meet' or 'should meet' characteristics and are embedded across the multifunctional team and within the parallel development environment (Cooper & Kleinschmidt 1993). Importantly, the model can be

adapted to suit the particular requirements of the product, the nature of the developing organisation and the competitive environment of the marketplace. However, the fact that the model exists as a series of stages does not imply that the Stage-Gate system is a linear, sequential process. The most significant way in which this model differs from models within the first three generations of innovation process is that these stages are organised around multifunctional lines which allow for parallel development stages (Cooper 1990).

Finally, the fifth-generation innovation process has resulted in organisations placing greater emphasis on integration in product and manufacturing strategies, faster times to market and greater organisational flexibility (Cooper 1994; Rothwell 1994). Importantly, fifth generation processes tend to exhibit greater flexibility of the NPD process dependent upon the firm's needs; greater fluidity between often overlapping parallel stages and 'fuzziness' in the decision gates making go/no-go decisions less rigid than previously (Cooper 1994). Additionally, the ability of firms to increase the ability to be first to market with new products can have a major impact on organisational performance, such as increased market share and customer satisfaction as well as potential monopoly profits (Reiner 1989). However, the quest for improved product development times often has the result of increased development costs (Crawford 1992; Graves 1989; Rothwell 1994). This creates an 'optimal' range of development times across which firms can experience minimum associated development costs.

The fifth-generation innovation process built upon on the key features of the fourth-generation process (integration and parallel development) by concentrating on the management of this time/cost trade-off. Compared to earlier generation processes, the management of this time/cost relationship within the fifth-generation process places a greater emphasis on: the integration between organisational structures and internal systems; the use of electronically assisted product development (such as expert systems, CAD/CAE systems and simulation modelling) and improved networking (Industry Commission Report on Research & Development 1994; Rothwell 1994). A key feature of this model is the comprehensive internal and external networking activities of the development team and the organisation as a whole. Linkages with primary suppliers, the involvement of leading-edge

customers in the development process and the willingness to access external know-how, all illustrate the rapid change of organisational attitudes to network development and utilisation (Rothwell 1994). These linkages also became the basis for greater propensity to undertake collaborative development activities (for example, Bsietler 2005; Calatone & Di Benetto 2007; Lin 2006). For these reasons NPD models within the fifth generation process are commonly referred to as 'systems integration & networking models' of NPD.

In summary, any particular model of NPD can be viewed as being represented by evolutionary adaptations of preceding models of NPD. Importantly, each successive generation of innovation process is aimed at delivering products for the firm in a development environment which better manages the cost/time trade-off of development in an ever increasingly competitive marketplace.

2.4.3 Technology transfer - a type of new product development

The previous sections examined the literature with respect to product innovation generally and, more specifically, the role of new product development in product innovation. Next, the role played by technology transfer as one particular type of new product development will now be considered. The reason for the need to examine technology transfer in its own right is that it is common for certain types of STBFs to not commercialise the end product of the NPD process. Rather, the focus is on commercialising an intermediary form of product, that is, knowledge or technology, and it is this knowledge or technology which becomes the marketable product.

Knowledge itself is at the core of a firm's competitive advantage in that knowledge is embedded in business processes and assets and can be reflected in its competencies and capabilities that, in turn, underpin the firm's products and service offerings (Anton & Yao 1994; Badaracco 1991; Cesaroni, Di Minin & Picalugga 2005; Rahal & Rabelo 2005; Teece 1998). The dynamic capabilities of the firm in its ability to combine knowledge assets with other tangible assets it possesses are critical to success. Thus, organisations are paying greater attention to the management of knowledge and are increasingly recognising that knowledge is one

of their most valuable strategic resources (Teece 1998; Zack 1999). Additionally, knowledge can be classed as being either: 'explicit', embodied as the physical capture of data and know-how, or less tangible 'tacit' knowledge created from experience and shared via social relationships (Davenport, Jarvenpaa & Beers 1998; Nahapiet & Ghoshal 1998).

As a result, a firm's approach to knowledge generation will consist of three alternatives: generating the intellectual property internally to the firm, which includes contracted-out R&D; externally acquiring the intellectual property and finally, doing nothing (Abetti 1989; Allen 1985; Arora, Fosfuri & Gambardella 2001; Badaracco 1991; Cesaroni, Di Minin & Picalugga 2005). Firms which take the strategic position of intellectual property acquisition rather then internal development represent a specific target market for firms creating and commercialising intellectual property.

The concept of a firm being an ideas factory was first articulated by Gans and Stern (2000). They identified that such firms create intellectual property, particularly as it relates to a specific future product opportunity, and make the decision not to proceed to develop and commercialise an end-product themselves. Rather the decision is made to transfer that technology to third parties who may be better positioned to do so. The decision to take this approach could be a result of a number of scenarios including the firm concluding that access to the complementary assets required for creating and marketing an end product is too costly or impractical or that the technology created has multiple product or market applications.

Technology transfer. A process which transfers technology or knowledge from one party to another is commonly termed 'technology transfer'. The technology transfer process essentially can be thought of as a 'process of transformation' towards the successful introduction of new products and services (Russ & Camp 1997). Elements within the scope of technology transfer include: the process of conveying research results to potential users (Larson, Wigand & Rogers 1986; Russ & Camp 1997); the transfer of technical knowledge (Cesaroni, Di Minin & Picalugga 2005; Ounijan & Carne 1987; Russ & Camp 1997; Galbraith, Ehrlich &

DeNoble 2006); technology commercialisation and value creation in the international context (Camp & Sexton 1992, Keller & Chinta 1990, Rahal & Rabelo 2005; Russ & Camp 1997); value realisation for research organisations and the possible creation of new business ventures. Further, commercialisation is seen to be a marketing function (Piper & Nagchpour 1996) requiring the utilisation of sound marketing principles and strategies in order to be successful. Thus, for this reason, intellectual property, as it relates to specific end product opportunities, can legitimately be considered to be a product in its own right for the purposes of this research.

Conversely, it has also been argued that managing technology development is different from managing product development (for example, Eldred & McGrath 1997). The basis for this is that technology development is bounded by 'sensed technology' at one end, that is, technology which is largely undefined and with only a loose recognition of commercialisation potential and technology feasibility at the other. The fundamental tenet of this argument is twofold. First, a focus on 'technology development' rather than product development creates a more favourable environment for scientific creativity and thus is more likely to result in breakthrough new products with the potential to create new markets. However, the problem then becomes one of convincing marketing personnel within the organisation that further (and usually greater) levels of investment now need to be made to turn the resultant technology into a product and then to commercialise it. Second, in larger organisations it is not uncommon for management to underestimate the time taken to develop new core technologies, resulting in the technology being inserted prematurely into the product development process, thus causing product development false starts. Additional support for both scenarios is provided by Markham (2002), who clearly identified the gap that exists between technical discovery and product commercialisation which he termed the 'valley of death'.

However, the argument for treating technology discovery and development processes as different and separate from new product development is not one generally supported in the literature (for example Rothwell 1994). Thus, it can be argued that there is a need to include core technology development, that is, the

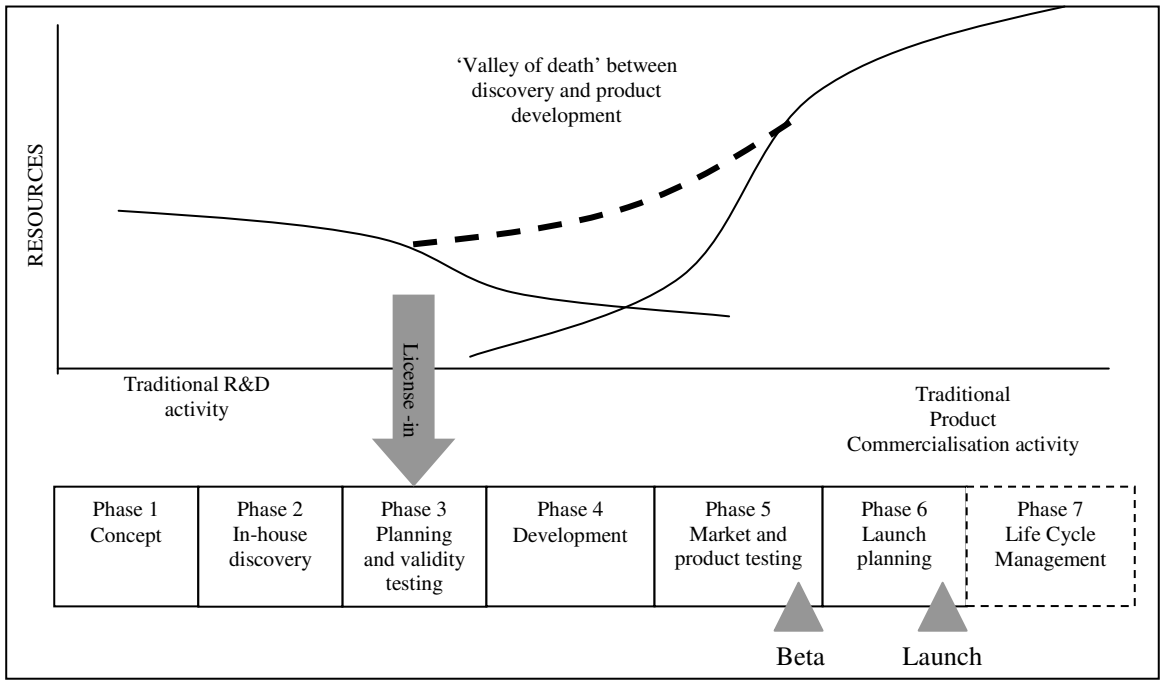
development of sensed technology arising from scientific discovery (for example, technological applications arising from applied research) as a component of the NPD processes. Indeed, in considering the stage-gate model of NPD (Cooper 1990), where development covers all phases from concept generation through to market launch, this would include the activities comprising the early scientific discovery process, so long as the purpose for undertaking the scientific discovery phase was that of ultimate product commercialisation.

Further, all new products require some form of enabling technology, discussed previously in section 2.2. Hence, rather than viewing the two phases on each side of the gap as separate processes (as portrayed by Eldred & McGrath 1997) the discovery-commercialisation process is seen as a continuum of development activity with two distinct phases. In this view, the valley of death is representative of the lack of structure, resources and expertise to drive product development to commercialisation (Markham 2002). Therefore, this highlights the need to treat this two-phase continuum as an entire product development system. Importantly, as the commercialisation process itself is seen to be a marketing function requiring the utilisation of sound marketing principles and strategies in order to be successful (Piper & Nagchpour 1996), these marketing skills need to be applied earlier in the process to assist to bridge the gap between the technical-focused discovery phase and the commercialisation. If this view is overlaid with a fourth or fifth generation product development process, such a process provides the means by which firms can effectively span the gap between discovery and commercialisation.

Figure 2.6 illustrates the relationship between the traditional R&D discovery phase and the product commercialisation activity to overall NPD activity. The ‘gap’ between discovery and product commercialisation signifies the ‘valley of death’ described above.

The question that then arises is to what extent STBFs can gain assistance in bridging this gap by entering into collaborative relationships with market incumbents and other organisations, including the potential assistance provided by business incubators? These issues were explored in depth in sections 2.3.2.2 and 2.5.4.

Figure 2.6 Gap between scientific discovery and product commercialisation through an integrated NPD process



Source: derived from Markham in Belliveau, Griffin & Somermeyer (Ed.)(2004)

In summary, it is important to recognise that in terms of the definition of what constitutes a product for the purpose of this research, it is not a requirement that STBFs need actually produce or manufacture the end product themselves. Thus, in the context of this research, knowledge, both tacit and explicit, and particularly that knowledge manifested within the discovery process, together with technology commercialisation are each intimately integrated within the new product development process. Thus, technology as an intellectual property asset is validly considered to be a 'product' if it is in a form where technology transfer can be effected, that is, the technology can be commercialised. Therefore technology transfer will, for the purpose of this research, be included as a valid form of product commercialisation as part of the NPD process.

2.4.4 New product success – factors and measurement

Having considered product innovation and new product development from a process management perspective, as well as technology transfer as a form of new

product development, the issue of new product success in terms of the factors for success and success measurement now will be considered.

To commence, the literature relating to new product success will first be considered. At the product level, it is widely held that the percentage of new product failures is high, even though the rates of failure vary from study to study, and that any company embarking on a new product development program faces a high risk of failure (Cooper 1999; Wind & Mahajan 1997). To address this high rate of failure, a vast amount of research on new product success has been published in fields of marketing, management, R&D and technology management. While most of these studies relate more to research management processes and firm-level environmental and corporate culture issues associated with product success, it is within the product development literature itself that the factors that determine the outcome of new product development are addressed.

More specifically, insights into the determinants of success and failure in new product development can be gained from several studies in the area (for example, Brown & Eisenhardt 1995; Calantone & Di Benedetto 1990; Cooper & Kleindschmidt 1990; Cooper 1999; Ernst 2002; Johne & Snelson 1988; Lilien & Yoon 1989; Baker & Sinkula 2005). Craig and Hart (1992) categorise the literature relating to new product success factors as either 'generalist' or 'specialist'. The generalist studies seek to identify those variables that have a major impact on new product success or failure and include numerous independent variables in their research design (Rothwell 1976; Cooper 1982; Cooper & Kleinschmidt 1987; Calantone & Cooper 1981; Link 1987; Maidique & Zirger 1990).

On the other hand, specialist studies tend to concentrate their investigations on one specific driver of product success and investigate it in depth for example, the involvement of users and market orientation of NPD and relationship to success. (Rothwell et al 1974; Baker & Sinkula 2005). However, because previous studies addressing NPD success factors have not been all-encompassing, there is not yet a comprehensive theoretical model of the determinants of innovation success. Indeed, most studies to date have focused on identifying those internal and external factors which are in the direct control of management rather than those outside the direct

control of the firm (Ernst 2002). The literature which identifies these elements can be summarised according to five dimensions: three organisational dimensions and two contextual dimensions. First we will consider the organisational dimensions. These include the NPD process dimension (addressing the effectiveness of the NPD process itself), new product development organisation (that is, those structural and management factors internal to the organisation which may directly affect the effectiveness of the NPD process) and organisational culture (that is, those elements which foster a culture of creativity within the organisation).

NPD process dimension. Prior to 1980, the literature tended to focus at the project level of new product development. Two aspects were identified in this early work as having a positive influence on new product development success; the proficiency of undertaking activities within individual phases of the new product development process and the use of market information to direct the NPD process (Cooper 1979, 1980; Cooper & Kleinschmidt 1986, Ernst 2002). Subsequent to the early 1980s, the literature at the project level tended to focus on providing a more detailed analysis of sub-divided phases of the NPD process. As a result, three key elements of the NPD process were identified in the literature as being vital for success.

The first is the need for high quality planning before the development phase commences. Such planning should include: evaluation of the idea; market driven feasibility studies and commercial evaluation as well as the product concept and benefits to customers. Each need to be addressed (for example, Barczak 1995; Calantone et al 1997; Maidique & Zirger 1984; Rothwell 1974; Song & Parry 1997). The second element is the need for undertaking continuous commercial assessment during all phases of the NPD process (Kahn, Barczak & Moss 2006; Parry & Song 1994; Dwyer & Mellor 1991; Stalk 2006). This element is seen as essential for the reason that such assessment is a pre-requisite in formulating go/no-go decisions between phases. This allows for the timely termination of unprofitable new product development projects (Cooper and Kleindschmidt 1995a). The final element is the orientation of the NPD process to the needs of the market and includes undertaking quality market research with respect to understanding customer needs (for example, Baker & Sinkula 2005; Song & Parry 1994; Sounder et al 1997), identifying and analysing market potential (Gottfredson & Aspinell

2005; Maidique and Zirger 1984), competitor analysis (Calantone & Di Benidetto 1988) and undertaking test marketing (Dwyer & Mellor 1991).

NPD organisation dimension. In the later literature from the mid-1980s onwards, increasing attention has been paid by researchers to the role played by the organisation in influencing new product success. Five elements were identified in the literature as being of importance.

The first is that of having a cross-functional team comprising members from different areas of expertise (Griffin 1997; Kahn, Barczak & Moss 2006; Song & Parry 1997; Ernst 2002). Second, is the importance of having an effective project leader possessing appropriate qualifications, authority and ability to devote sufficient time to the project (Balbontin et al 1999; Cooper & Kleindschmidt 1995). The third element is the degree of autonomy given to the NPD team by senior management. A key finding in some studies here is that autonomy and responsibility for the entire NPD process, rather than just aspects or individual phases of the new product development project, and commitment of the NPD team are essential for achieving success (for example, Balachandra 1984; Cooper & Kleindschmidt 1995; Thamhain 1990). Fourth, successful new product development projects have also been identified as possessing intensive communication and interactive relationships among the NPD team members (Balachndra et al 1996; Cooper & Kleindschmidt 1995; Thamhain 1990). The final element relating to NPD organisation is the form of project organisation. Two forms of project organisation were identified in the literature: matrix models and task force models (Barczak 1995; Larson & Gobeli 1988; Ernst 2002). In projects where time to market is of primary importance, the task-force model is the superior form of NPD organisation (Ernst 2002).

Culture dimension. Culture relates to the creative environment in which new product concepts are created. A number of factors emerged from the literature in relation to this. The first is the need for the firm to possess a systematic scheme for suggesting new product ideas that is separate from other company suggestion schemes (Barszak 1995; Cooper 1984; Cooper & Kleindschmidt 1995). The second is the need for an innovation-friendly attitude with an entrepreneurial corporate

climate (Cooper & Kleindschmidt 1995; Voss 1985). The final factor is the need for a product champion in the NPD team (Barczak 1995; Chakriabarti 1974; Cooper & Kleindschmidt 1993; Maidique & Zirger 1984; Song & Parry 1997). However, as Ernst (2002) points out, the product champion need not be the same person as the project leader. Additionally, there is also a need to distinguish the product champion from that of a promoter who makes personal contributions to overall internal barriers blocking new products.

Table 2.4 provides a summary of the literature review with respect to the identified new product development success factors. It is important to note that these success factors are not all-inclusive (some studies such as Balachandra & Friar (1997) identify over 70 factors), but rather represent a summary of the more often cited ones. Further, the automatic adoption of all success factors may sometimes result in contradictions. For instance, the need to achieve 'speed-to-market' as well as the need for 'thoroughness' [in undertaking the NPD process itself]. The contradiction arises here by virtue of the fact that excessive 'thoroughness' often tends to result in extended development times (Cooper 1988; Cooper & Kleindschmidt 1994; Cordero 1991; Hart, Tzokas & Saren 1999; Kahn, Barczak & Moss 2006). An example of this potential conflict can be seen in the biotechnology industry, the literature point out that there is little opportunity to reduce the R&D cycle time given the stringent nature of the regulatory regime, in particular, that of the human pharmaceutical environment (Kessler & Bierly 2002). Therefore, in this instance 'speed-to-market' would be regarded as an inappropriate success factor to adopt.

Thus, the adoption of individual success factors should be considered in terms of appropriateness to the type of firm and type of technology involved in product development. Indeed, as Balachandra (2000) points out, such contradictions are possibly due to the fact that the various studies were considering different sets of projects representing different types of firms in different industry settings. Therefore, depending upon the nature and context of the project, different factors may become more important. Next, the two contextual dimensions influencing new product success: type of innovation and nature of the market will now each be considered in turn.

Types of innovation. In terms of the nature of the product innovation, the degree of newness is an important consideration. In turn, categorisation according to degree of newness can be applied at a number of levels. The first of these is the degree of newness as applied to the product itself. This approach was first proposed by Booz, Allen and Hamilton (1982) being: new-to-the-world products; new product lines to the firm; additions to one of the firms existing lines; improvements/revision to existing company products; cost reductions to existing company products and repositioning of existing company's products. However, while this approach considers the nature of the product itself it did not consider the degree of newness with respect to the underlying technology. Maidique & Zirger (1984) specifically address this by including radical technological breakthroughs, significant technical changes and incremental changes. This view was supported by more recent studies (Montoya-Weiss & Calatone 1994; The Warren Centre 1995) and was discussed in detail previously in section 2.4.1.

A derivation of this approach was that of Kleinschmidt and Cooper (1991) and based on the degree of 'innovativeness' of the product, being: highly innovative products consisting of new-to-the-world products and product lines that are innovative to a company; moderately innovative products new to a firm and excluding new to the world and existing product lines and low innovative products including all product modifications, redesigning products, re-positioning and minor extensions. More recently, Crawford (1997) proposed a five-classification approach comprising: new-to-the-world products; new category entry; additions to product lines; product improvements and repositioning.

A further simplified approach was taken by Balachandra (2000) whereby a dichotomy between incremental and radical innovation was used. In this approach, incremental innovation is where the basic technology and product configuration remain essentially the same and the only enhancements are in relation to performance, appearance or similar characteristics. Radical innovation includes new-to-the-world products in that it is the first of its type into the market or where the principal of operation is considerably different from earlier products (Balachandra & Friar 1999; Cooper 1994). This broader classification approach has since been adopted by a number of

Table 2.4: Summary of NPD success factors identified from the literature

Author	Initial screening	Superior Product concept well defined	Market knowledge & Evaluation	Market orientation	Speed-to-market	NPD process proficiency planning and measurement	Defined decision points	Project team	Team autonomy	Product champion	Communic.	Resourcing	Managemt. Commit.	Planning & Test marketing
Ayag 2005	●	●	●	●										
Balachandra 1984	●											●	●	
Balbontin et al. 1999		●	●	●	●	●		●	●	●	●		●	
Barczak 1995	●	●	●	●	●	●	●	●	●	●				
Barclay & Porter 2005			●											
Calatone80 and di Benedetto 1997			●	●				●					●	
Chakribarti 1974								●	●	●			●	
Cooper 1986		●	●	●	●									
Cooper, Edgett & Kleindschmidt 2004	●	●	●		●	●	●	●						
Cooper and Kleindschmidt, 1990	●	●	●	●	●	●	●	●	●	●				●
Cooper 1994	●	●	●	●	●	●	●							
Cooper and Kleindschmidt 1995	●	●	●	●	●	●		●	●	●	●	●	●	
Dwyer and Mellor 1991	●		●			●	●							●
Griffin 1997			●			●	●				●			
Maidique and Zirger 1984			●	●		●		●	●				●	●
Mosey 2005			●			●						●		
Parry and Song 1994	●		●			●								●
Rothwell 1974	●	●		●				●	●					
Song and Parry 1996	●	●	●	●	●	●								
Thamhain 1990								●	●		●	●	●	
Utterback et al. 1976			●	●										
Voss 1985								●	●	●	●	●	●	
Ireland, Hitt & Sirmon 2003											●	●		
Zhou, Yim & Tse 2005			●	●										

Source: developed for this research

researchers (for example, Baker & Sinkula 2005; koners & Goffin 2005; Radnor & Noke 2006).

Of particular interest to this research was the approach taken by Kleinschmidt and Cooper (1991) described above. The reason for this is the nature of the STBF itself, that is, a focus on the firm being 'technology-based'. In this way, STBFs demonstrate new-to-the-world products or technologies as provided for in the definition of the STBF adopted for this research (section 1.5).

As a result, it was necessary to consider the relationship between the degree of product 'newness' and product success. In a study by Cooper & Kleindschmidt (1993) it was found that success rates were highest for products with highly innovative technology. This was latter confirmed in other studies, such as that of Griffin (1997) who found that product success was intricately linked to products which had a higher the level of technological newness. This was attributed to the fact that such NPD projects were characterised by a longer development time due to higher rates of technological uncertainty and as a result a more thorough NPD process.

Indeed, the degree to which a firm is familiar with the underlying technology of the new product affects the management of the NPD process itself (Balachandra & Friar 1999). For example, when unfamiliar technology is employed, particularly when procured from outside the firm, the make-up of the NPD team is likely to be different, requiring a strong and effective linkage mechanism between engineering and marketing units within the firm and requiring an overall higher level of organisational flexibility (Balachandra & Friar 1999). In turn, effective linkages between the different business units within the firm was also seen as a key determinate of new product success. Thus, it is clear that the degree of newness of the product has a direct influence on the NPD process as well as ultimate new product success. However, it is not clear from the literature that this relationship translates to the context of the STBF or rather, is just particular to large and established firms.

Nature of the market. Although the nature of the target market can cover a broad spectrum, there are essentially two market types for new products: existing markets and new markets. The type of target market will produce differences in success factors for the new product development process (Balachandra & Friar 1999) largely due to differences in relative market uncertainty.

Market uncertainty arises when there is limited or poor quality information available about the target market or customers. Indeed, the NPD process is often viewed as one of uncertainty reduction where market information is generated and used to reduce uncertainties inherent in the process (Allen 1985; Baker & Sinkula 2005; Hart & Baker 1994). There are four types of uncertainty in respect to new product development: uncertainty relating to unrealised consumer (or user) requirements; technology uncertainty; competitor uncertainty and resource uncertainty (Moenaert & Souder 1990; Hart et al 1999). Of these, it is those relating to the market that present the dominant uncertainties and it is the extent to which these uncertainties are effectively managed that determine whether there is a positive impact on NPD success (Hart et al 1999; von Hippel 1986). Thus, the nature of the market will itself influence the type of market information required at all stages in the NPD process.

Importantly, STBFs developing radical, new-to-the-world products will also often have to face the more significant of these risks associated with market uncertainty. In particular, uncertainty relating to unknown customer requirements and potential competitor responses for an unknown product as well as the greater technical risk associated with NPD process itself. Thus, the ability to link the technical development elements within the NPD process to the market requirements throughout the entire NPD process is paramount in order to minimise market uncertainties.

Success measurement. The literature specifically relating to NPD process features does not adopt the measurement as a key feature. However, at the same time generalist studies on new product development show measurement recognised as being important. More specifically, such research has shown that financial measures alone are inadequate measures of overall success and that product success

can be defined and measured across a number of dimensions (de Bretani 1989; Griffin & Page 1996; Hart 1993). For this reason, it is important to identify the specific types of success measure which can be employed and that further, may apply to the specific context of STBFs. Table 2.5 summarises the four common types of success measure that has been applied through the literature. These include subjective versus objective measures, bi and multi–modal measures, financial and non-financial measures and finally, meeting or not meeting expectations.

Table 2.5: Summary of the types of success measures

Success measurement types	Authors
subjective versus objective measures	• Cooper 1979 • Abetti 1987
bi-modal (success or failure), multi-modal (success, failure or marginal success), or continuous measures	• Myer & Roberts 1986 • Litvak & Zirger 1984 • Kahn, Barczak & Moss 2005
financial versus non-financial	• Cooper 1994 • Cooper *et al* 1994 • Maidique & Zirger 1985 • De Brentani 1989 • Griffin & Page 1996
meeting or not meeting management and customer expectations	• Crawford 1979 • Maidique & Zirger 1985 • Edgett & Snow 1996

Source: developed for this research.

When considering which specific measure in table 2.5 should be used in respect to product success, such consideration needs to take into account 'appropriateness'. While success measures can be applied to virtually any operational element of the firm, in order for the measure to be meaningful the measure chosen needs to be appropriate in the context to the element against which it is being applied. As an example, let us consider the success measurement of product performance. In this situation bi-modal measures (success or failure criterion) may not be as relevant as financial measures. Indeed, when we turn our attention to how success measures apply to new products, the literature identifies financial performance measures as often being the most appropriate. For instance, financial measures such as sales, revenue and profit measures tend be the most common form of measures for

success for new product development and are also the most common measures for general firm success (for example, De Bretani 1989; Cooper 1994).

A further consideration is the time-frame against which to apply the relevant measure (Hultink & Robben 1995). When applying financial success measures, such measures are more likely to apply to specifically predetermined time frames such as monthly, quarterly or yearly. However, when time-frames are less certain, more subjective measures, for example a subjective judgement on progression towards goal attainment, may be deemed to more appropriate (for example Griffin & Page 1996).

Furthermore, the importance of time considerations is heightened in measuring product success in STBFs as it is not unusual for the attainment of certain financial performance goals being possible only after relatively lengthy time periods. For illustration, 15 years or more is a common time-frame for getting new biotechnology discoveries to the market (Abetti 1987; Cooper 1994; EVCA 2006). Given such potential lengthy timeframes to determine product success, it is also necessary to adopt a variety of additional success measures for the various stages of the NPD process itself. In this way NPD activity can be continuously monitored to help ensure the NPD process remains 'on track' and thus more likely to result on overall new product success. One example of ongoing success monitoring may be the achievement of a positive testing outcome (a bi-modal success measure) in the technical development stage of the NPD process. As such, success measurement in terms of both overall product success as well as NPD process success was been adopted as a key NPD process feature in this research.

2.4.5 Conclusion to background theory II

NPD process features. When considering the research relating to new product development in section 2.4.2, the literature does not specifically cover new product development in the context of STBFs but rather examines new product development from the context of larger and established firms. However, as pointed

out in section 2.4.2.1, the process features within the later models for NPD, that is, the 4th and 5th generation models are largely regarded as being 'best practice' by researchers due to the evolutionary nature of these models whereby each model is an improvement over its predecessors (Jones 1997; Rothwell 1994).

In this way then, it can be argued that the NPD process features combined from both the 4th and 5th generation models would logically provide a basis for describing best practice of NPD process features for all firms, irrespective of their size and maturity. In particular, these best practice NPD process features which can be applied to STBFs are summarised in table 2.6.

New product success factors. In addition to the 'best practice' NPD process features applying to STBFs, a further dimension of new product development is that of new product success factors. As outlined in section 2.4.4., the literature identifies a broad range of new product success factors but when these are examined in more detail in the context of STBFs only a select number of these have relevance to the STBF. To illustrate, one key factor identified in the literature was the need for the NPD team to have a high degree of autonomy from the corporate management team (table 2.2).

Table 2.6 'Best practice' NPD process features applying to STBFs

Element		Description
1	Speed-to-market	Being first to market is primary consideration for what activities are within the overall NPD process
2	Integrated parallel development	Individual stages are totally integrated are undertaken in parallel for effectiveness and speed-to-market.
3	Well defined decision gates	Stages of NPD possess progress review and decision points as a means to amend the NPD activities or have 'stop/go' decision applied
4	Multifunctional NPD team	All functional areas of skill and expertise are represented
5	Reflects needs of market	The product concept is derived from customer needs or problems
6	Expert systems & modelling	Using technologies and processes such as expert system and outcome modelling to input into task definition
7	Strong customer linkages	Utilisation of customer knowledge and input into NPD design and planning
8	NPD measurement	Use of appropriate measures to track progress and success of NPD activity and determine overall new product success

Source: Derived from literature review in section 2.3

However, in STBFs the corporate management team and the NPD team are often one and the same, making this factor largely irrelevant in the context of such firms. Moreover, in some instances an element which is categorised in one component of the framework may also apply to another component, and as a result were only included in one component so as to avoid duplication. For instance, one element from table 2.2 identified as a key success factor is that of 'market orientation' which exhibits the same characteristics of 'reflects needs of the market' as an NPD process feature. Specifically this refers to the fact that the product needs to address the needs or the problems of the customer. As such, 'market orientation' has been deleted from the list of elements that would classify it as a new product success factor. Thus, from the extensive list of new product success factors presented in table 2.2, those that have relevance for STBFs are distilled below in table 2.7.

Table 2.7 New product success factors of relevance to STBFs

	Element	Description
1	Superior product concept	There is an identified value proposition for the marketplace in order to provide a competitive advantage to the market
2	Initial screening	The product concept has undergone sufficient screening for validity before commencement of technical development phase
3	Market knowledge	The use of market information to direct the NPD effort
4	Sufficient resources	Sufficient resources to complete the entire NPD process before substantive activity commences
5	NPD process planning	Planning of the NPD process before commencement of development and commitment of resources

Source: derived from literature review in section 2.3

Next, the literature in relation to business incubation is now be examined to identify in what ways incubators provide assistance to STBFs in performing their NPD activity.

2.5 Role of business incubators

Having considered the literature in relation to the first two background theories, that is, elements of corporate strategy impacting on new product development

(section 2.3) and product innovation and new product development (section 2.4), the role played by business incubators in STBF development will now be considered. As outlined in section 2.4.1, the relative strengths of large firms in the innovation process results mostly from the resources available to them (Vossen 1998). Conversely, the limited financial resources generally available to STBFs for product development and commercialisation create significant difficulties for STBFs in accessing the required skills and resources essential for optimal new product development. One of the strategies which STBFs can utilise as a response to a lack of skills and resources is the utilisation of the benefits available through business incubators. Moreover, the influence of business incubators with respect to corporate strategy development is increasingly evident in the literature.

2.5.1 Rationale for business incubators

In general terms, business incubation is a development tool, generally government funded and primarily designed to help create and grow new business ventures (Sherman & Chappel 1998). Additionally, the underlying purpose of the various government-supported incubator programs is to cross-fertilise ideas to bring together people and resources to assist in the realisation of commercial potential (Blakely & Nishikawa 1992). This is built on the view that the intent of incubators is to involve government in quickening the pace of innovation by helping firms bring new ideas to market and thus having an overall effect of economic development through the increase of the technological sophistication of their local economies (Osborne 1988).

The various business incubation programs in many developed economies have undergone massive growth over the last decade. For example, in the United States alone the number of incubators has increased from 40 in 1985 to more than 600 a decade later (NBIA 1996). In addition to the access to physical resources, incubators offer assistance to new ventures in a number of generic support services. In particular, business and marketing plans, fund raising, technical advice and a range of other professional services (Sherman & Chappell 1998). In general,

individual business incubators tend to focus on specific functional types of start-up venture. These can be described as mixed use, manufacturing, technology, service and micro enterprise (NBIA 1995). Further, it would seem that technologically-focused incubators, the type of incubator of interest for this research, can be further classified according to technology type, for example, information technology versus biotechnology.

There is, however, a lack of clarity provided by the literature as to the true benefits incubator programs have on both their participating firms and upon their local economies. On the one hand, a number of studies have demonstrated that business incubators are effective business development tools and provide excellent returns on investment (for example, Campbell 1988). Additionally, the literature also points to the positive impacts of business incubators in a local economy sense. For example, improvements in employment rates, export sales and general economic wellbeing are commonly cited positive impacts of business incubators (Centre for Strategy & Evaluation Services Report 2002).

In contrast to these positive findings is the difficulty in measuring success to obtain a true indication of benefit (Sherman & Campbell 1998; Colombo & Delmastro 2002). Specifically, four issues are identified in the literature as contributing to this difficulty. First, the complexity of the start-up process requires the provision of a diverse range of services. For this reason incubators have a diverse range of goals and defined outcomes. Second, the incubator program is prevented from becoming standardized due to the diverse range of incubator types. Third, business incubation programs have traditionally been focused on process rather than outcomes or impacts.

Finally, it is necessary to find effective ways to compare the performance and operations of firms who are incubator tenant start-ups to non-incubator start-ups. For example, the literature commonly cites the improvement in success rates for incubator tenant start-ups over non-incubator start-ups. However, the validity of such a direct comparison is questionable at best as the incubator-manager

commonly performs a level of assessment on viability before the start-up is accepted as a tenant. Thus, the incubator manager is attempting to pick winners before accepting those firms as tenants.

The lack of clarity with respect to true benefits aside, the cited benefits do demonstrate that the assistance provided by incubators to individual firms can add substantial value to the firm. However, the actual value contributed is contingent upon the nature of the firm and the focus of the incubator itself. Specifically, the literature points to two general models for business incubation with incubators in each model having a different focus. The first is the 'Continental European model' which is predominantly publicly funded and focuses on public policy objectives such as regional development. The second is the 'Anglo-Saxon model' which is more focused on the creation of new technology and science based firms (Thierstein & Wilhelm 2001).

2.5.2 Technology incubators

In the context of this research on STBFs, the Anglo-Saxon model of business incubation is of immediate interest. Commonly referred to as technology incubators, the basis for government support of this form of incubator is based around two key arguments. The first argument is that of the market failure faced by technology based firms to obtain equitable access to venture finance, as compared to larger and established firms.

It is commonly cited that this lack of equitable access to finance revolves around three issues: the lack of technical expertise or experience possessed by financial institutions to assess the quality of new ventures in the high technology sector; the lack of a track record of the business for lenders to base their lending decisions and the view of high risk associated with the technology sector (Colombo & Delmastro 2002; Hall 1989; Oakey 1995). Further, a number of empirical studies have shown that there are direct links between constraints in financial capital markets and entrepreneurial behaviour. In particular, these direct links are in the areas of:

influence on new business formation; the level of capital committed by founders and business survival (Colombo & Delmastro 2002; Evans & Jovanovic 1989).

The second argument for government support of technology incubators is that new technology-based ventures play roles in promoting dynamism in advanced economies. This view is based around the recognition that such firms are often the source for radical innovations that can challenge large established industry leaders and which have the potential to revolutionise industries and open new industry segments (for example, Colombo & Delmastro 2002; Oakey 1995).

However, it is also apparent from the literature that not all authors agree with the argument that new technology firms should receive favourable treatment by government policy makers through the establishment of business incubators. The reasoning for this contrary view is twofold. First, there is a lack of agreement on positive externalities and capital market imperfections justifying supporting measures (Cressy 1996; Holz-Eakin 2001). Second, there is a view that new technology firm failure is more attributable to human capital failures rather than failures of capital markets, particularly the erroneous view of the firm founder of his/her own management capabilities (Camerer & Lovallo 1999; Jovanonic 1982).

Conversely, while these reasons were cited for the position against government support for incubators they were also identified as being the types of activities that business incubators are able to assist with. Therefore, the validity of these arguments against support for access to business incubators by technology firms are questionable. For example, the ability of incubators to assist start-up founders with skills training, and in particular management skills, is often promoted as a key 'value-add' provided by incubators to tenant firms. Thus, whatever the merits of these arguments for and against government support of technology incubators, or the resulting confusion surrounding specific arguments, this does not detract from the potential benefits to be realised by new technology firms, and more particularly STBFs, participating in incubator programs.

One of the key functions of technological incubators is their role in assisting technology transfer (Kapij, Dressel & Abbetti 1996; Schoen, Mason, Kline & Bunch 2005). In most cases, the source of the technology originates either from an individual's creativity or from research activities at leading technical universities, and financed by government, industry and by internal grants. Indeed, the most common form of technology incubator is those that are university-based and that are designed to facilitate knowledge transfer from the university to firms located on such facilities (Phan & Siegel 2006). Additionally, universities now actively encourage entrepreneurship among faculty and staff to commercialise new technology at their own expenses and risk, and sometimes under very favourable financial terms. This encouragement by institutions is an important source of technology products for STBFs. For this reason, one of the mechanisms utilized for technology incubators is to locate the incubator near to university facilities or at least to have very strong links and networks with university faculty. In this way, the technology incubator provides a means of linking know-how, technology and capital to leverage entrepreneurial talent. Indeed this is supported by regional economic development theory where growth centre models show that incubator investment (by government) should be made where external economics (agglomeration, localization and urbanization) are the highest. Further, empirical studies suggest the location of other research and development activity is the most important of these externalities (Goldstein & Luger 1990). The result of this focus is an ability to accelerate the development of start-up technology firms and speed the commercialisation of technology (Schoen, Mason, Kline & Bunch 2005; Smilor & Gill 1986). However, there seems to be little in the literature that provides an assessment of comparative performance of firms that are spun out from university-affiliated business incubators and technology parks and those who emerge without such assistance. Some more recent research however (for example, Ensley & Hmieleski 2005), indicates that that university affiliated incubators will display a greater propensity for tenant firms that will tend to be more homogenous in composition, display less developed team dynamics, and as a result, be lower performing than tenant firm of incubators without university affiliation. Such researchers adopt the view that university-affiliated firms will institutionalise

themselves toward the norms of the university and the successful ventures that have been launched through their nurturing, rather than toward their own industry, what they term "localized" isomorphic behavior (for example, Vohorha, Wright & Lockett 2004).

2.5.3 Assistance in corporate strategy development

Now that the general business incubator environment and its relevance to the STBF has been explored, we will next consider the role business incubators play in assisting tenant firms, in particular STBFs, in the development of their respective corporate strategies. In a more recent benchmarking study, a study of European business incubators was conducted which identified that the added value of incubator operations lies increasingly in the type and quality of business support services offered by the incubator and which are primarily aimed at assisting in the development and implementation of corporate strategy (Centre for Strategy & Evaluation Services Report 2002). In particular, the literature points to two dimensions of service as being of critical benefit to tenant firms in the development of corporate strategy: networking and business advice. Each will be considered in turn.

2.5.3.1 Networking

In examining networking in the context of business incubators it must be in the context of the tenant firm itself. As such, firms who are network-centric are commonly referred to as being a 'networked organisation'. That is, firms that have a high degree of integration across formal boundaries of multiple types of socially important individual and organisational relationships (for example, Coghlan, Coghlan & Brennan 2004; Brady & Brennan 2006). Similarly, one theme that has more emerged in the literature is that of the 'networked incubator' (Cooke 1996; Dubini & Aldrich 1991, Collinson & Gregson 2003).

When considering the role of business incubators in fostering tenant firms to become effective networked organisations, one mechanism by which this is achieved is through the provision of business support services. In turn, such support services are commonly provided through networks of professional service and input providers. Thus, these business support services represent a conducive environment for networking to take place, both informally and via access to existing network structures provided by the incubator.

As increasing technological complexity directly results in increased technical and market uncertainty for STBFs, the ability to integrate specialist knowledge and to utilise external expertise becomes of increasing importance and acts as a source of potential competitive advantage for the firm (Collinson & Gregson 2003). Access to existing professional and technical networks is one of the means by which STBFs can fill the identified gaps they have in areas of specialist knowledge and expertise. Indeed, professional service networks, also referred to as know-how networks in the literature (for example, Rice 1995; Office of Strategic Technologies Report 1999), are networks of experts and professional specialists who are provided to clients through the incubator at nil or reduced costs. Such networks include accountants, intellectual property attorneys, business consultants, market specialists, venture capitalists and essentially any professional service of value to the incubator clients. In addition, these activities and exchanges between organisations may also be complex and dynamic and based upon 'value-adding' where value is created through dynamic exchanges between firms (for example, Allee 2000; Finger & Aronica 2001; Stam & Elfring 2006).

General networking theory in relation to knowledge creation is quite advanced with detailed studies having been undertaken since the mid 1970s. In an early summary of the literature, Allen (1984) found that technical professionals, in particular scientists and engineers, were five times more likely to turn to personal networks than to seek information from impersonal sources such as databases. Moreover, the creativity process itself, as the starting point for the new product development process, is enhanced by effective networking. The literature points to the fact that

firms that excel at product development can "multiply the value of their assets by hiring the best inventors, motivating them with challenging work, placing them within collaborative networks, and doing a better job of leveraging their increased creativity" (Fleming & Marx 2006, p. 18).

However, when a firm has an over-reliance on networks internal to the industry in which they operate the risk of 'cognitive lock-in', referring to conformity to formal and informal norms regarding appropriate business conduct, may result (Stam & Elfring 2006). However, the effective use of technology, in particular the internet, to facilitate the exchange of knowledge within and external to existing value networks (for example Andrews & Hahn 1998; Allee 2000; Finger & Aronica 2001). While the use of tools such as the internet, does not overcome technologists' propensity to prefer personal networks rather than impersonal sources of information, it does go someway to mitigating risks of cognitive lock-in arising. This point is of particular relevance to STBFs as it is the experience of managers of technology incubators that the majority of entrepreneurial founders of technology start-ups come from a technical background with technical rather than management training (NBIA 2000).

Social network analysis in particular provides a rich and systematic method of examining informal networks by analysing and mapping relationships among people, teams, departments within organisations and between organisations (Cross, Parker, Prusak & Borgatti 2001; Dahl & Pedersen 2004). Recent studies on relationship mapping have shown that statistical trends can be observed in networked communities formed for collaborative product and business development purposes. For example, in one study by Cross, Laseter, Parker & Velasquez (2006), it was shown through relationship mapping that 15% of network members have 50% or more of the ties within that network, while 40% of the members have only 5-10% of the ties. This demonstrates that simple membership to a network may not directly result in beneficial outcomes for members. Rather, proactive involvement in the network is essential.

In the main, the literature with respect to social network development focuses on either within-firm networks or alternatively between large corporate organisations and third parties (Rogers 1995; Brown & Duguid 199; Stam & Elfring 2006). However, more recent studies have started to address the issue in relation to start-up firms. For instance, the importance for knowledge networks to steer the research, development and commercialisation activities of start-ups has been recognised as being of growing importance due to increased market opportunities and threats arising from heightened technological complexity (for example, Collinson 2000).

Access to the specialist knowledge required by firms and access to that knowledge from networks provide only the first step. How the firm incorporates that knowledge into business processes of the firm is the logical next step. Since the 1970's the importance of knowledge assimilation was identified in the literature as an important component of decision making and as being a strong determinant of firm success. More recently, Cohen & Levinthal (1990) referred to the firms ability assimilate knowledge as 'absorptive capacity' and describe this as an organisations' ability to recognise and exploit external information for its own use. This provides a distinction between gaining access to information and the ability and willingness of the firm to transform that information into knowledge actually embedded into the firm's processes and culture.

A central theme of this knowledge based approach to networking theory within the literature is that of 'context-specificity' and 'organisational embeddedness' which relates to the distinctiveness of inter-firm networks and from which they may gain a relative competitive advantage (Collinson & Gregson 2003). To this extent, networks provide a dual benefit to the STBF: access to individuals and firms providing knowledge of value to the firm and access to the learning experience gained from others in a network in embedding that knowledge in an operational and cultural context. Thus, this explains the emphasis placed by business incubators in providing access to mentor networks, that is, experienced professionals who have successfully faced the challenges now facing the STBF founder.

Additionally, knowledge of more complex issues, such as incentives for knowledge-sharing and knowledge transfer, come into play in gaining an understanding as to how entrepreneurs access particular kinds of specialist knowledge (for example Fleck in Williams, Faulkner & Fleck 1998; Collinson & Gregson 2003; Howells 2000). Importantly, entrepreneurial network theory suggests that possessing strength, complexity and diversity in business relationships influence newly formed enterprise performance with the result of improving the chances of firm survival and growth (Collinson & Gregson 2003; Monsted 1993). Throughout the literature the importance of informal social interaction as a starting point for knowledge acquisition for the entrepreneur is stressed as social networks evolve into business focused networks and then into strategic networks (Collinson & Gregson 2003; Butler & Hansen 1991; Dubini & Aldrich 1991).

The role played in networking by the incubator is fundamentally that of a linkage mechanism between the incubatee and societal resources (Chandra et al. 2003). A study of some 170 incubators by Hansen, Chesbrough, Nitin & Sull (2000) found that one of the most important characteristics of incubator success was the provision of tenant firms with preferential access to a network of companies. It was further found that the two differentiating factors were the existence of an organised network and preferential access to that network. In this context preferential access refers to the removal of barriers in accessing members of a network, rather than a guarantee that positive actions will result for the firm. For example, the preferential access to venture capital networks for an incubator means that they are provided the opportunity to 'pitch' their investment proposal to networks members, not that any network member will actually make the needed investment.

However, while the literature points to the benefits that organised networking can provide to tenants within a business incubator, recent incubator evaluation studies have at best, paid only cursory attention to this aspect. Indeed in the recent evaluation of European incubators, the Centre for Strategy & Evaluation Services (2002) report only addressed networking with respect to the role played by incubators in fostering networking between tenants. Further, this report highlighted

that the physical incubator environment is conducive to cross-fertilization of ideas and networking between tenants. However, it was noted that only in a few instances have individual incubators extended the networking concept to that of external service providers. The importance of this to STBFs is that, for the STBF to obtain true value from networking, the incubator needs to be able to provide preferential access to existing networks of direct relevance to their particular STBF, and more likely of direct relevance to the type of technology/product of the STBF. For example, it is a realistic expectation that a biotechnology STBF will obtain more benefit from linkages provided by the incubator to access biotechnology-focused venture capitalists.

Apart from access to and assimilation of knowledge from network participants, other benefits may also accrue to STBFs from incubator linkages to networks. Indeed, attention to a broader use of the networking theme increasingly arose in some other recent studies. For instance, in a study of 169 incubators in the United States, Hansen and Chesbrough (2000) found that the networked incubator possessing mechanisms to foster cooperation amongst start-ups is likely to be more successful than other incubators. Additionally, in this study, one in four incubators provided a significant level of organised networking between start-ups. This theme is reinforced by Lalkaka (2002), who expressed the view that professional networking, both nationally and internationally, together with partnerships for mentoring and marketing were two key elements in helping new ventures be successful through incubation. Referring back to section 2.3.3 relating to consideration of the benefits of inter-firm relationships, and in particular the benefits afforded to STBFs by entering in cooperation strategies, the role played by incubators in identifying and facilitating access to these potential partner firms could prove invaluable to the STBF.

2.5.3.2 Business advice

The second dimension of business support services that will now be considered is that of the provision of indirect and direct business advice as a value-add service to

tenant firms (Butler & Hansen 1991; Hansen et al 2000; Faulkner & Fleck 1998; Centre for Strategy & Evaluation Services Report 2002). The provision of specialist advice to firms can be categorised into four main forms; business coaching, mentoring, professional services networks (discussed in section 2.5.3.1) and advisory boards (The Allen Consulting Group 2003; Office of Science & Technology Report 1999)

Business coaching is normally undertaken by staff internal to the business incubator, and involves the use of specialised resources or instruction by staff in such a manner that the firm can complete the task themselves. While the effectiveness of this service is limited to the capabilities and experience of the relevant incubator staff, business coaching can be a value contribution to strategy development for the firm.

The second area of business service is mentoring, which utilises the services of a business owner who has had personal experience in similar circumstances. Such a service is generally seen as a high-value service that provides a firm-perceived realistic element for assistance in business decision-making (Tortatzky 1996). Advisory boards however, act in different ways to that of the other forms of specialist business advice provided through incubators. The first of these is as an adjunct to the Board of Directors of the firm.

In this context, the advisory board can interact with the management board by providing high level and experienced strategic and operational advice usually where those skill sets are lacking in the makeup of the firm's management board. The second role of the advisory board is as a precursor to the establishment of a formal management board. As it is sometimes difficult to attract high-caliber, experienced and market-recognised executives to the management board of start-ups, the advisory board can play two roles - the provision of advice to the founder and management as well as to lend market credibility to the start-up (for example, Bell & McNamara 1991).

Importantly, each of these types of specialist business advice can provide a significant source of input into the development of the firm's overall corporate strategy. Given the more common situation where the background and training of the entrepreneurial founder of the STBF is likely to be from a technical capability area, the assimilation of knowledge from qualified and experienced professionals is likely to shape the strategic direction of the firm. It is clear then that incubators play a potentially vital role as a linkage mechanism to these professional networks and sources of specialist business advice for the STBF. Thus, it can be argued that incubated STBFs will have better developed corporate strategies that non-incubated STBFs.

2.5.4 Influence on the performance of new product development

Having considered the role business incubators play in assisting STBFs formulate their corporate strategies in section 2.5.3, the role business incubators play in assisting STBFs with the performance of their NPD activities will now be examined.

As outlined in section 2.5.1, incubators can take a variety of forms, however, when incubators are examined specifically in terms of their assistance in regards to the performance of NPD for tenant firms, a further level of categorisation can be applied according to their focus on specific parts of the innovation process. Accordingly, incubators can then be grouped into three broad categories in relation to the product innovation process: taking a conceptualised idea into a product concept; taking a product idea into a product prototype form and taking prototype products into the market (Chandra, Srivatav & Shah 2003).

However, the literature also shows that the majority of technology support efforts by incubators tend to be limited to linkages to universities and external advisors and with a specific focus on post-development commercialisation (Centre for Strategy & Evaluation Services 2002; Lalkaka 2002; Hansen et al 2000). This focus on the post development commercialisation phase of NPD is then a source of potential limitation of the value provided by incubators to STBFs in their NPD activities.

This limitation is based on the identified need to link the NPD stages associated with technical development to those stages that are market facing (Barczak 1995; Griffin 1997; Cooper & Kleindschmidt 1995).

Despite this limitation, technical assistance may also result through indirect means, in particular through third party support to assist with the design and development of core products and relevant technical alliances (Collinson 2000). As a result, it is through technical support networks that this support is typically provided (NBIA 2000).

For non-incubator STBFs, the extent to which they can effectively access networks in order to utilise outside skills and capabilities for the purpose of their own NPD activities is limited in two respects. First, people outside of the organisation can only be helpful to the extent that their expertise is known to the organisation and they are able to be accessed through a network (Wenger 1998, Cross et al 2001; Schilling & Phelps 2005). This has particular implications for STBFs, as being small and by their very nature new, such firms are reliant on the personal networks of a small number of firm employees and often of only a single person within the firm. Therefore, unless there are alternative support mechanisms for the STBF to access other existing networks the opportunities and benefits provided through networking are likely to be limited.

Secondly, it is not unusual for entire networks to be disproportionately reliant on a single individual within the network (Cross et al. 2001). The implication for STBFs in this respect is that if this phenomenon is represented within their particular network circumstance this is likely to have an adverse impact on the timeliness of input from the network member and by implication adversely affecting development time frames by the STBF in their NPD activities.

As an added complication, in technology industries that are characterised by ever accelerating product life cycles as well as rapid product development, firms may find themselves in a position of continually playing 'catch-up' when trying to

acquire knowledge and undertake all new product development internally (Neill et al 2001). Additionally, firms cannot simply acquire all the knowledge they need from the market as technical know-how which is often tacit in nature. In this way strategic alliances provide value to STBFs as they afford firms the ability to access tacit product development processes of other firms that would otherwise not generally be available. It can therefore be argued that business incubators are able to assist STBFs by overcoming these limitations through facilitating easier access to specialist technical networks which in turn, is reflected in more effective NPD processes.

This area of study has implications for new product development theory in relation to STBFs by virtue of the way that inter-firm relationships, often resulting indirectly from networking activity, can aid or contribute to NPD activity. While the various forms of inter-firm relationship were examined in some detail in section 2.4.2.2, it is when firms adopt cooperation strategies through adopting strategic alliances that would seem to be the most prevalent. Indeed, in a study conducted by Porter (1985) it was found that in around 20 percent of alliances studied, the primary motivation in entering into the relationship was technological development.

There are two broad forms of technological alliance depending upon whether or not they contribute to enhancing the technological capabilities of the firm or whether it is set up to enter non-accessible markets (Nuone & Oosterveld 1988). In respect to new product development activity both are equally important to the STBF as it is often the case that product development activities need to be centered around specific market needs for that product. For example, when introducing a new software application into the market place, differences between regulatory regimes in different markets may require changes to product characteristics and functionality, making the product suitable for specific markets. As a result, software firms are faced with the need to undertake additional product development activity which may not be needed for all markets. When the firm does not possess the required market, technical or regulatory knowledge to effectively undertake this

additional product development activity, this may provide an argument for the firm to examine alliance opportunities to deliver this required capability.

In the main, however, the literature has generally tended to focus on alliance activity and its role in the overall NPD process rather than the impact such activity has on NPD process itself (Hannan & Freeman 1989; Shan, Walker & Kogut 1994; Rothmaerel & Deeds 2001). For example, in a study of some 325 start-ups in the biotechnology sector conducted by Rothaermel & Deeds (2001), the relationship between alliance activity and NPD output was examined with respect to marginal returns from alliance activity through new product development.

In brief, the literature about business incubators generally considers the support provided by business incubators as a valuable contributor to technical development activities in new ventures. However this literature does not discuss the precise manner of support which business incubators may provide to technology start-ups, and as a result STBFs, to improve the management of the NPD process itself. That is, the literature has remained focused on support for specific technical development tasks rather than the new product development as a holistic management process. Moreover, existing coverage in the literature of indirect incubator support activities, in particular the role played by access to networks and cooperation strategies for technical development, does not explicitly analyse the methods of either direct or indirect support provided by incubators to specific NPD activities. However, an inference is that, like their contribution to assisting with corporate strategy development, assisting with networking and inter-firm cooperation will indirectly assist NPD activities of tenant firms.

2.5.5 Conclusion to background theory III

In conclusion, a review of the literature in relation to business incubation, presented in section 2.5, identified a number of ways in which incubators provide assistance to STBFs. However, two areas of assistance were identified that potentially contribute to how STBFs undertake their NPD activities. The first of these was

networking activity through which STBFs may obtain value from third party suppliers, professional advisors and research organisations, in turn contributions to STBF NPD activities. The second area identified in which business incubators can influence an STBFs' NPD activities was through access to professional business advice. When considering new product development, professional advice can either be targeted towards specific areas of technical advice – more likely when an incubator is a highly focused technology incubator, or alternatively aimed at improving the overall management of new product development (section 2.5.4). As a result it is likely that these two areas of assistance may also directly influence how STBFs perform their new product development. Next, the preliminary theoretical framework for new product development in STBFs will be considered in section 2.6.

2.6 Preliminary theoretical framework for new product development in STBFs

Introduction. Having explored the extant literature in relation to the three areas of background theory of: corporate strategy (section 2.3); new product development (section 2.4) and, business incubation (section 2.5), it is clear that STBFs provide a unique environmental setting for undertaking new product development. One basis for this observation is that in larger and established firms, new product development activities are derived from broader corporate strategy. In this way, there is a clear starting point commencing with the creation of corporate strategy, through to the development of new product strategies and then finally moving into NPD processes. This linear process then drives the development and commercialisation of individual product concepts. This is in contrast to the situation of STBFs, where such firms exhibit more of a parallel and opportunistic nature between corporate strategy and new product strategy development and NPD activity. As a result, it is evident from the literature that STBFs need to consider their new product development in the context of a number of components which in combination have a direct bearing on how STBFs actually perform their new product development activity. As such, these components of new product development activity give rise to a framework for new product development in

STBFs. This section develops this preliminary theoretical framework and considers each of the three components in turn before outlining the proposed relationships between elements within these components (section 2.6.1). Additionally, the framework allows for the role played by business incubators in support tenant firms in the adoption and performance of these elements of NPD proposed in the framework. Next, section 2.6.2 then considers the impact this preliminary theoretical framework potentially has on firm success or failure.

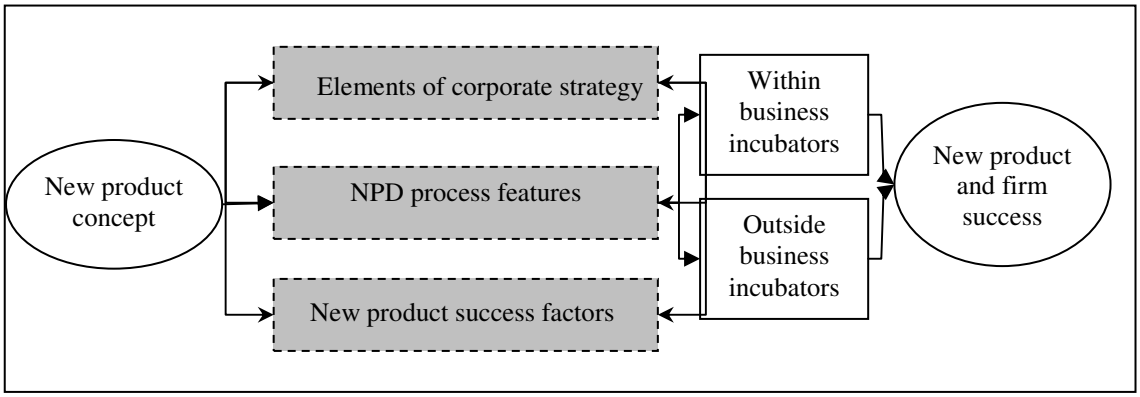
Figure 2.7 summarises the preliminary theoretical framework for new product development in STBFs. Specifically, this provides a schematic depiction of the elements of NPD characterised according to their three components, being: corporate strategy elements; NPD process elements and new product success factors, as well as the role played by business incubators. The elements of NPD have been identified from the review of the extant literature as being likely 'best practice' elements for adoption by STBFs in the performance of their new product development. Furthermore, these individual elements are not performed in isolation from the other elements and may have observable relationships and co-dependencies with, or impacts on, other elements within the framework. Where this occurs, these elements are found within the two areas of intersections (A & B) within figure 2.7. The next phase of this research, the convergent interviewing phase, will allow this preliminary theoretical framework to be further refined. Finally, the case studies will confirm or disconfirm the framework. As an important additional dimension of this research this framework is tested in two environments: where the STBF is located within the business incubator environment and where it is not. Specifically, the role played by business incubators is assessed with a particular focus on the two areas of 'value-add' the literature identified as being of benefit to tenant firms: business advice and greater access to professional networks.

2.6.1 Framework components and relationships

To reiterate from section 2.1, the preliminary theoretical framework for new product development in STBFs comprises three core components, derived from the relevant literature review sections of this chapter, being sections 2.3, 2.4 and 2.5

respectively. These were summarised in figure 2.1 and for ease of reference are re-represented as figure 2.7, with the three components of this preliminary theoretical framework highlighted. The three components of this preliminary theoretical framework are: elements of corporate strategy impacting NPD (component I); NPD process features (component II) and new product success factors (component III).

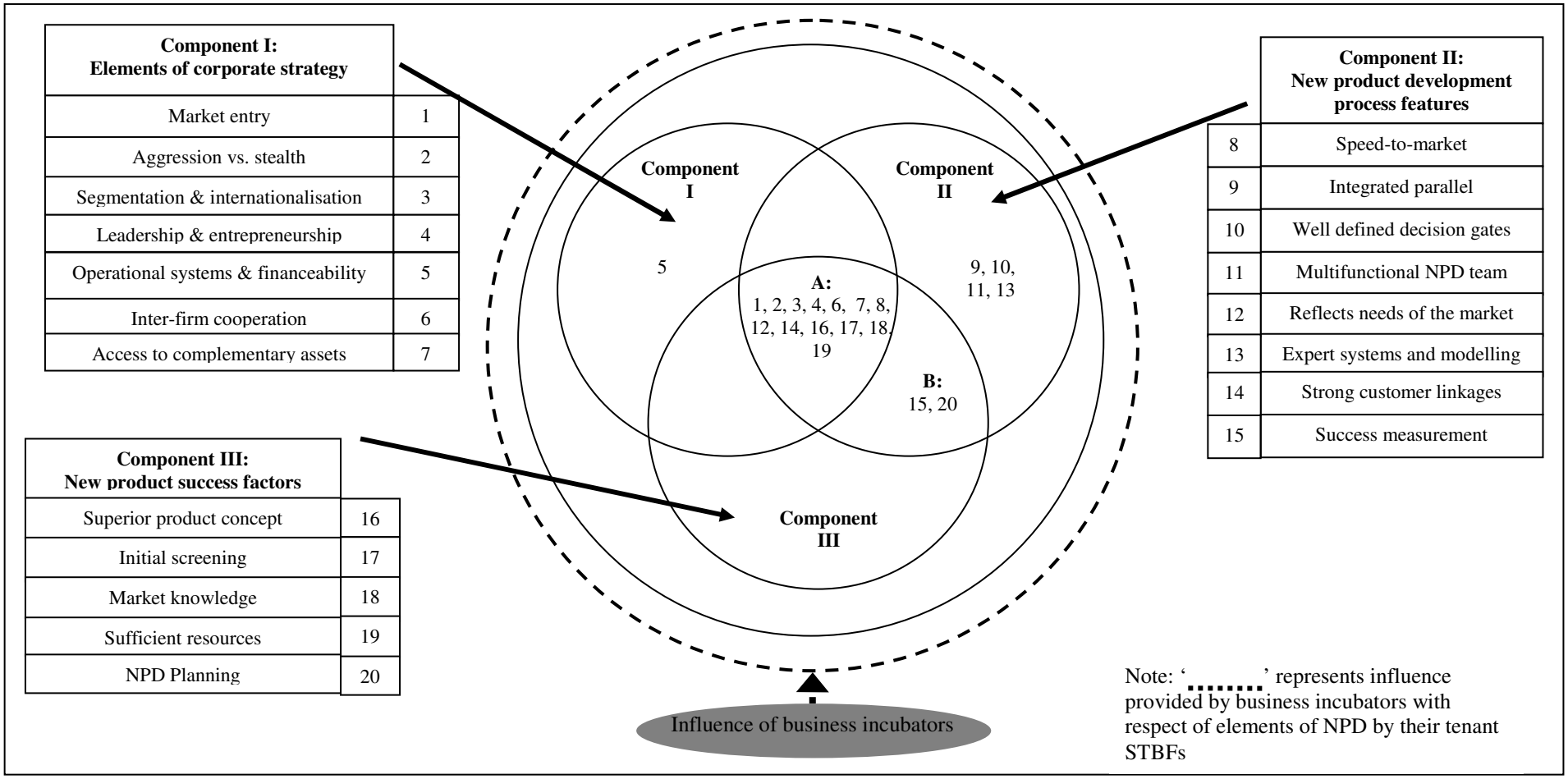
Figure 2.7: Re-represented figure 2.1 highlighting the components of the preliminary theoretical framework



From figure 2.8 it can now be seen that within each of these three components there are a number of associated factors, features or activities. For the purpose of simplicity and consistency these are referred to as 'elements of NPD'. Some elements of NPD within this framework adopt features which are selectively chosen across each of the three areas of theory (discussed in detail in sections 2.3, 2.4 and 2.5) in a holistic way rather than from any one background theory in isolation. One example is the element of NPD 'leadership and entrepreneurship'. For the purposes of this research, this element reflects attributes identified in the literature from both corporate strategy and new product development theory in combination rather than from corporate strategy theory alone.

Attention is now turned to the two relationship areas, referred to as A & B respectively, and the influence of business incubators. Each of the two relationship areas indicates where the nominated elements within an intersection area have corresponding relationships with elements within other components. As such, relationship area A indicates a relationship between all three framework

Figure 2.8 Preliminary theoretical framework for new product development in STBFs represented by three core components of NPD (I, II & III), the influence of business incubators and two areas of relationship between components (A & B)



Source: developed for this research

components (that is, corporate strategy – component I, NPD process features – component II, and new product success factors - component III).

Correspondingly, relationship area B indicates a relationship between components II & III. However, no such relationships are identified in the literature between components I & II nor components I & III of the framework. It is important to note that this following discussion is not meant to convey an exhaustive examination of the extant literature for the existence of all possible relationships between two or more elements in the framework. Rather, it is meant to convey the existence of an observable, or immediately obvious, relationship identified from within the literature relating to the background theories for this research.

At this juncture one observation needs to be made. In a number of instances there would seem to be a level of duplication between a number of individual elements identified in the literature. For instance, speed-to-market was identified as both a 'NPD process feature' as well being a 'success factor' (that is, being within component II & III). For the purpose of constructing a holistic framework this duplication was removed by representing such elements in only one component of the framework. As all instances of duplication occurred between component II and III of the framework, it was decided by the researcher that such elements would only be identified as being in component II and as a result removed from component III. This approach is justified on the ground that was no attempt to prioritise relative importance of one component over another within this research. As such, the resultant component any one duplicated element was removed from held no relevance to this research.

Relationship area A. To commence, the elements within relationship area A will be considered. In order to more effectively examine the relationships in this area, the individual elements will be considered in two themes: 'market-related' elements and 'other' elements. These elements are now summarised below in table 2.8.

Table 2.8 Elements within relationship area A of the preliminary theoretical framework

'Market-related' elements			'Other' elements		
#	Component	Element	#	Component	Element
1	I	Market entry	4	I	Leadership & entrepreneurship
2	I	Aggression Vs. stealth	17	III	Initial screening
3	I	Segmentation & internationalisation	19	III	Sufficient resources
6	I	Cooperation vs. competition			
7	I	Access to complementary assets			
8	II	Speed-to-market			
12	II	Reflects need of the market			
14	II	Strong customer linkages			
16	III	Superior product concept			
18	III	Market knowledge			

Source: derived from figure 2.12

The market-related elements are observed across the three core components of the framework. As such, the common underlying theme identified from the literature is the need for the STBF to possess sufficient knowledge of the needs of customers and the nature and environment of the market before development takes places and to reflect these needs throughout the NPD process governing the development of the product (for example, Balbontin et al 1999; Robinson & McDougall 2001; Cooper & Kleindschmidt 1995; Covin, Slevin & Covin 1990; Scherer & McDonald 1988).

The close relationship across all of these market-related elements highlights the need for STBFs to address all of these elements as part of their overall new product development effort. In particular, this is highlighted by the non-linear nature between the corporate strategy elements (that is, component I elements) and the process or activity-based elements reflected within the elements of component II. The non-linear nature of strategy development and NPD process activities in the STBF context indicates that the market-related elements of component I need to be developed at the same time as obtaining the requisite market knowledge which governs new product development (components II & III of the framework). The potential implications for undertaking NPD without gaining such market

knowledge, through addressing these market-related elements within NPD, results in a greater likelihood of new product failure (for example, Cooper 1994).

The 'other' elements summarised in table 2.8 (that is, elements 4, 17 & 19) each have a relationship across all three components. For illustration, 'initial screening' (element 17) is an element within component III as a new product success factor and comprises the need to undertake a preliminary market, commercial and technical feasibility of the product, before commencing the development process itself (for example, Balachandra 1984; Barczak 1995; Cooper & Kleindschmidt 1995; Parry & Song 1996). As this description indicates, performing initial screening impacts both speed-to-market within component II due to a reduction in the likelihood of 'false starts' (Markham 2002) and also provides sufficient information through the feasibility analysis to consider options for entering into early stage cooperation strategies (such as strategic alliances) to assist product development and market entry (Buono 1991).

Indeed, the element of inter-firm cooperation (element 6) is worth considering in its own right as it possesses two drivers of relevance for this research. The first driver is to achieve market place advantages through accessing one or more market incumbents' complementary assets such as market channels (element 7 in component I). The second driver is inter-firm cooperation to assist with technological and product development activities, that is, the NPD process feature elements under component II (Gans & Sterns 2000; Yesheskel, Shenkar, Fiegenbaum & Cohen 2001; Griffin 1997). More specifically, the NPD process feature of speed-to-market is also potentially impacted, as the effectiveness of accessing a market incumbent's market channels will depend on the firm's ability to engage in partnering and to be able to meet strict product development timelines (that is achieving speed-to-market from new product development).

Further, the importance of speed-to-market to STBFs should also be considered in a broader context. On the one hand the importance of speed-to-market is highlighted due to the need to get the product to market in order to generate cash flow for the

firm but on the other hand the ability to do so is restricted by the availability of resourcing (element 19, component III), either directly through investment capital or indirectly from NPD partners (for example, Scherer & McDonald 1988; Perks & Jones 2003). Again, this is observed in respect to the 'cooperation' element of corporate strategy (element 6, component I), where speed-to-market and resourcing availability are interrelated. Specifically the literature focused on subcontracting, licensing, networking and collaborative technology development as forms of cooperation through which new product development can be undertaken. (Rothwell & Dodgson 1991; Hoffman et al 1998; MacPherson 1997; Ledwith 2000).

A further element of corporate strategy to consider is that 'leadership & entrepreneurship' (element 4) which directly impacts on the extent the NPD process features (component II) are reflected within the overall NPD process. For example, leadership, in terms of being a product pioneer, is related to management's attitudes to speed-to-market (that is being first to market) as well as technological leadership commonly attributable to the use of expert systems in new product development (Rothwell 1994). It was found that the use of expert systems can significantly reduce product lead times as a contribution to first mover advantages (Cooper & Kleindschmidt 1995).

Relationship area B. The other relationship area to examine is that indicated as relationship area 'B' in figure 2.7. Specifically, this refers to the relationship between the element of 'NPD planning' (element 20) as a new product success factor and 'success measurement' (element 15). In essence, the literature clearly establishes that a successful new product is dependent upon how well all activities and tasks within the NPD process are planned and executed (Balbontin et al 1999; Barczak 1995; Calatone and di Benedetto 1997; Griffin 1997). As such, this implies measurement of success criteria in order to be able to determine the effectiveness of the planning an execution of NPD.

Influence of business incubators. As outlined in section 2.5.4, the initial theoretical framework includes the role played by business incubators (represented

as a ‘doted’ line in figure 2.7). Specifically, the role played by business incubators is twofold. First, to assist their tenant firms in adopting the ‘best practice’ elements of NPD as represented in each of the three components. Second, to improve the performance of undertaking these elements compared to the performance experienced by STBFs who are not tenants of business incubators. Specifically, this assistance will be provided by means of the access to business networks as well as through access to business advice provided by the business incubators to their tenants STBFs.

Conclusion. The proposed preliminary theoretical framework for new product development in STBFs, presented in figure 2.7, presents the concepts under consideration in three dimensions. The first dimension is presented according to three core components (components I, II & III) derived from the literature and summarised in sections 2.3.3, 2.4.5, and 2.4.6. The second dimension considered the two relationship areas (A & B), where individual elements impact upon elements in one or more of the other core components within those areas of intersection. The final dimension was the influence provided by business incubators to their tenant STBFs in the performance of the elements of NPD contained within the three components of the framework.

Finally, the apparent relationships between the elements across the three core components of the framework highlight the importance of each of these identified ‘elements of NPD’. Additionally, this importance is further highlighted due to the non-linear nature of the strategy development–new product development pathway embarked upon by STBFs. It was identified within the literature that it is important to link corporate strategy development to new product strategy and hence to new product development. However, it was also shown that the literature treats this as a linear progression as the focus of previous research has largely been in the context of large and established firms. It is argued that STBFs, on the other hand, undertake their new product development in a substantially different way to that of large and established firms (for example, Cooper & Kleindschmidt 1995; Maidique & Zirger 1984; Matinelli & Waddell 2004). As a result STBFs have a greater fundamental

need for their single new product project to be successful, as firm success for the STBF is more closely tied to the success of a single new product development project.

The resulting preliminary theoretical framework presented in figure 2.7, does not argue that any one element contained within this framework is any more important to be adopted by STBFs compared to any other element within framework. Rather, it provides an argument for the adoption of the complete set of elements as a more holistic way to describe NPD activity in STBFs. Further, the identified relationship areas (A & B) between components substantially strengthen this argument to the degree that the extent of their adoption reflects a greater likelihood of achieving new product success.

2.7 Conclusion

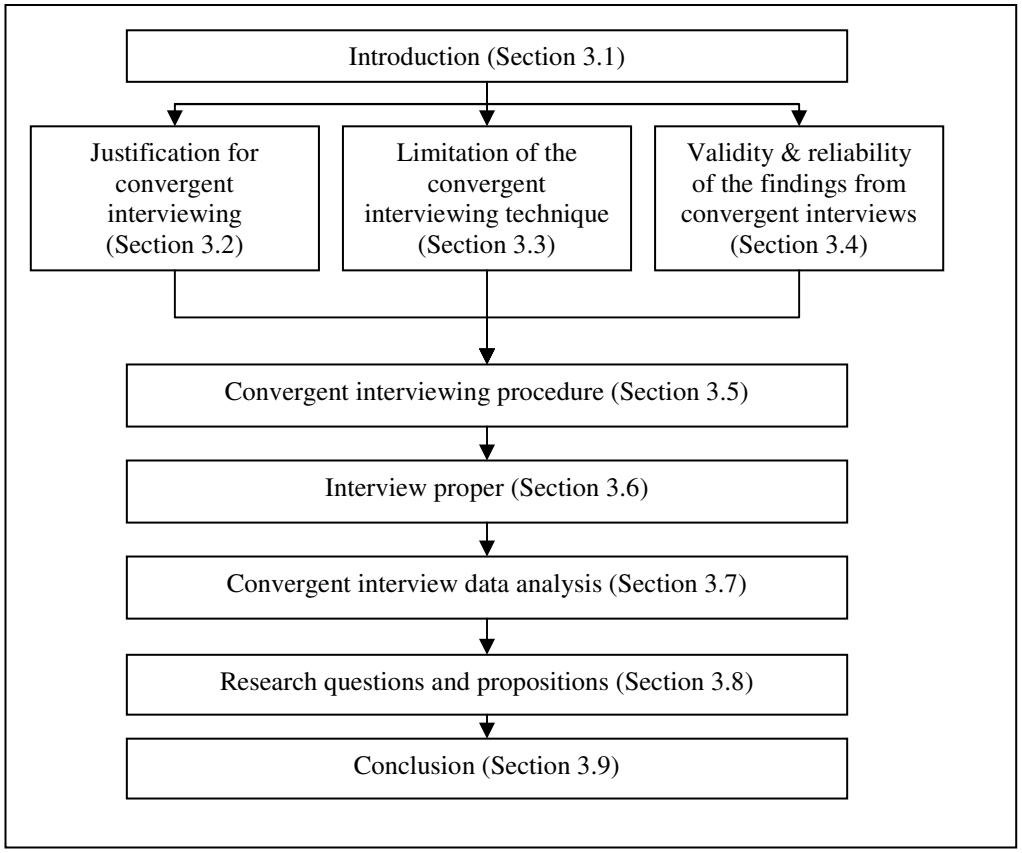
This chapter considered the extant literature pertaining to the three background theories of corporate strategy, new product development and business incubation. From this literature review, it was found that past researchers did not adequately explain how new product development is undertaken in the specific context of STBFs. As a result, a preliminary theoretical framework was subsequently developed which, in turn, was presented as a defining framework for new product development in STBFs. This preliminary theoretical framework will be further tested and, if necessary, refined as a result of the exploratory research phase of this research through the use of convergent interviewing. The convergent interviewing process is outlined and the findings discussed in chapter 3. Chapter 3 will conclude with the forming of three key research questions which in turn, will be addressed through five specific research propositions.

3 Convergent Interviewing

3.1 Introduction

Chapter 2 reviewed the extant literature and developed an initial theoretical framework for new product development in STBFs. This chapter discusses the justification for adopting convergent interviewing and the procedure adopted for this study. It goes on to undertake an analysis of the resultant data from this exploratory research phase to identify issues of convergence or divergence. This chapter then maps the relationships between the emergent themes, refines the theoretical framework and finally derives a number of research questions. Figure 3.1 summarises the topics covered in this chapter.

Figure 3.1 Overview of Chapter 3: Convergent interviewing



Source: developed for this research

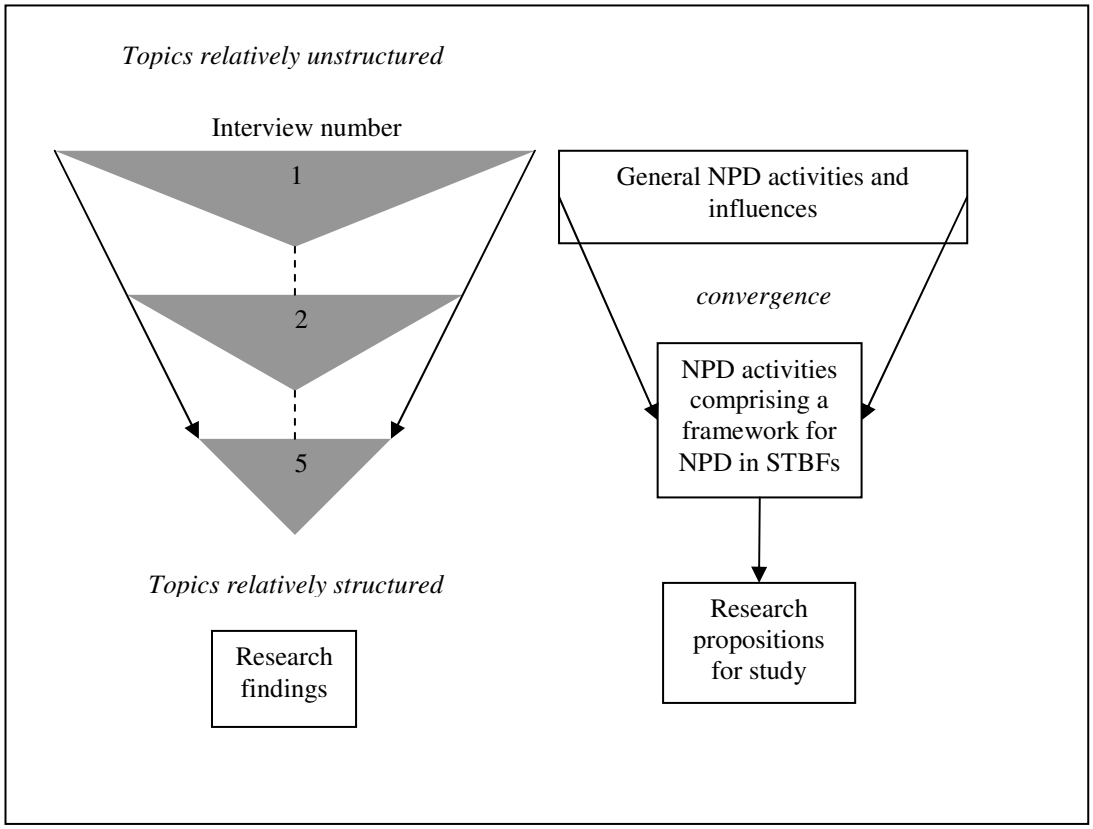
3.2 Justification for convergent interviewing

Convergent interviewing is a dialectic process that looks for two types of patterns in the emerging data. One of these patterns is the convergence that arises through agreement while the other is that relating to discrepancy or divergence in agreement arising from the emerging data (Dick 1990). Convergent interviewing is exploratory in nature and can best be explained as a series of in-depth interviews in which the researcher is able to refine the questions on specific issues after each successive interview (Dick 1990). Convergent interviewing can be used for a number of purposes including exploratory research where the research area is lacking in a theoretical base and established methodology (Nair and Reige 1995).

The particular usefulness of convergent interviewing lies in its ability to combine initially unstructured topic content with a structured and dialectical process (Dick 1990). This provides both flexibility to permit a narrowing of the research focus and academic rigor to add credibility to the interviewing process (Perry 1999; Armstrong 1985). In its initial stages and in order to provide flexibility, each interview should be left almost completely unstructured and questions (wording, content and sequence) are directed by the interviewee (Ritchie and Goeldner 1987). The process becomes more structured as new questions are added to successive interviews as a result of emerging differences in opinion and as the researcher learns more about the topic (Dick 1990). Figure 3.2 shows how this convergence on specific issues develops within each interview and over a series of interviews.

Convergent interviewing was chosen for this phase of the study over other qualitative research techniques and in particular, other interviewing techniques as it has many strengths which contribute to this research. First, because of the cyclic nature of generating new information and refining views through a series of interviews (Dick 1990), convergent interviewing is appropriate for research in areas that examine socially complex phenomena, about which little is known. The new product development process is such a phenomena. In particular, the ability to ensure that important issues, questions and information can be reviewed more than once in the interview process is an important feature.

Figure 3.2 Convergence of the interview process within and between Interviews



Source: developed for this research

Second, convergent interviewing provides flexibility for researchers in new areas of study (Nair & Riege 1995). Most of the research in the area of new product development has been undertaken in the context of larger organisations such as large manufacturing companies (for example, Porter 1994), rather than in smaller, and in particular, start-up firms. One of the reasons explaining this situation is the easier accessibility and greater abundance of primary and secondary data from larger firms for research purposes. However, the lack of such data in the case of STBFs results in a deficiency of established methodology. The flexibility of the convergent interviewing approach allows for a degree of trial and error in developing research propositions.

Finally, this research topic necessitated the discussion and disclosure of a significant amount of confidential information in the interview process. Other techniques, such as focus groups, would create restrictive barriers in the disclosure of such information. Moreover, this form of interviewing allows the interviewer to

pursue new ideas and information and to test recurring ideas (Morgan 1988) that would otherwise be more difficult using the focus group technique.

3.3 Limitations of the convergent interviewing technique

Like all research methods, the convergent interviewing technique is subject to a number of limitations. First, in order to establish the validity of research findings, convergent interviewing must be used in conjunction with other research methods (Gummesson 1991). However, this inherent limitation did not adversely affect this research because convergent interviewing will be used in conjunction with the case study methodology in the second stage of the research as outlined in chapter 4.

Second, increased money and time costs can be a result of the unstructured process of the interview because it may take longer to explore the issues arising from each interview and because the volume of information increases with each interview (Dick 1990). However, the convergent nature of the interview process means that as the process moves into successive interviews, greater structure and focus is achieved. Further, it also improves the ability to progressively explore, in increasing depth, the core constructs identified in chapter 2 which form the basis of the content issues raised by the interviews. This may actually result in lower overall costs of the convergent interview process over other forms of interviewing technique.

Third, it is important to follow certain guidelines in the interview technique so as not to introduce potential bias within the interview (Armstrong 1985; Dick 1990). Bias can create a significant limitation to the convergent interview process as data obtained may become influenced by the subject knowledge, personal interaction and question framing of the interviewer. The potential for interviewer bias was reduced in this research by the interviewer learning the crucial interview skills and practicing over several days prior to undertaking the interviews. Bias can also arise from the respondent (Sekaran 1992) which can be the result of the interviewee not cooperating fully with the interviewer or where the respondents have only limited knowledge of the subject being investigated. Potential respondent bias in this regard was reduced by interviewing only experienced practitioners and leading experts to

ensure that only the most current practices in new product development methodologies governed the perspectives of the respondents.

The final limitation in the convergent interviewing process is that there should be more than one interviewer for each project (Hirschman 1986). This limitation was not able to be eliminated but was minimized in this research project due to the significant body of prior knowledge the interviewer had from professional experience in the field of new product development. This issue is explained in more detail in section 3.4.

In summary, the limitations of convergent interviewing have been minimized as much as possible in the course of this research project and did not outweigh the benefits obtained. The next section establishes the validity and reliability of the findings.

3.4 Validity and reliability of the findings from the convergent interviews

Validity and reliability relates to the quality of the research design which, in turn assumes a level of prior knowledge of the subject. Although convergent interviewing techniques can be used without any prior knowledge of the subject, there may be instances when it may be more appropriate not to commence the interviewing process until some prior theory has been examined (Dick 1990). In order to ensure that a contribution would be made to the existing body of knowledge in regards to new product development theory, a significant amount of prior knowledge was obtained on the subject. Further, this approach was deemed appropriate due to the fact that the researcher already had a level of prior knowledge from extensive professional experience in the field of new product development. However, the prior knowledge was obtained from a practitioners' perspective and not from the academic perspective, where the latest theories are continually being examined.

Additionally, prior knowledge was gained from reading the relevant body of published papers on the related areas of corporate strategy, new product development, technology management and marketing theory. The prior knowledge

gained helped to define the appropriate research design and data collection method (Miles & Huberman 1984; Yin 1994). In addition, prior knowledge assisted in the refining of the research question as well as in the formulation of several of the research issues (Nair & Riege 1995), as described in chapter 2.

As the data from qualitative research is not amenable to quantification and statistical measurement, it may be thought not to be methodologically rigorous (Lopez 1975). However, a number of authors have argued that validity and reliability can be established in qualitative research (Easterby-Smith, Thorpe & Lowe 1991; Patton 1990; Yin 1994; Miles & Huberman 1984). Kvale summed up how validity can be achieved through continuous checking: 'validity is ascertained by examining the sources of invalidity…[and] validation becomes investigation, continually checking, questioning and theoretically interpreting the findings' (1989, p. 77). Several checks were built into the convergent interviewing technique to provide validity and reliability in the research findings (Dick 1990). These checks can be expressed as a series of four logical tests that can be used to establish the quality of any empirical social research: construct validity, internal validity, external validity and reliability (Yin 1994). Table 3.1 outlines the four design tests that were applied to this research.

'Construct validity' refers to the establishment of correct and appropriate operational measures for the concepts and ideas being investigated (Cooper & Emory 1995; McDaniel & Gates 1991; Yin 1994). The convergent interviewing process achieved construct validity through three interviewing tactics. First, triangulation of the interview questions was established in the research design stage through two carefully worded questions that looked at the way new product development processes are established, but from different perspectives.

In this research the different perspectives explored were from that of the academic researcher and NPD practitioners. Second, the convergent interview method contained an in-built negative case analysis where, in each interview and before the next, the technique explicitly requires that the interviewer attempt to disprove emerging explanations interpreted in the data (Dick 1990).

Table 3.1 Tests for validity and reliability of research design for convergent interviewing

Design test	Convergent interview tactic	Phase in which tactic occurs
Construct validity	• Establishment of triangulation of interview questions • Inbuilt negative case analysis • Flexibility of the model	Research design (section 3.5) Data analysis (section 3.7) Research design and data collection (section 3.6)
Internal validity	• Sample selection for information richness	Research design (section 3.5)
External validity	• Sample selection for theoretical replication	Research design (section 3.5)
Reliability	• Structured process for administration of interviews • Structured process for recording, writing and interpreting data • Develop interviewee database	Data collection (section 3.6) Data collection (section 3.6) Research design (section 3.5)

Source: developed for this research, based on Yin 1994.

An example of this was when the academic researchers diverged in agreement from the NPD practitioners. The researcher attempted to disprove emerging explanations prior to the next interview, which if unsuccessful, would confirm the data. Finally, the flexibility of the model allowed the interviewer to re-evaluate and re-design both the content and process of the interview program, thus establishing construct validity.

'Internal validity' refers to the confidence placed in the causal relationship between dependent and independent variables and their influence on other variables (Sekaran 1992; Zikmund 1991). This does not mean that an experiment is always required to establish a direct cause and effect link between two events, for that is difficult to establish in social science research (Perry, Reige & Brown 1998).

Rather, convergent interviewing searches for generative mechanisms that suggest causal relationships only in some limited contexts and only if the data is collected appropriately. In cases where such causal relationships are important, probe questions, in-depth listening techniques and the incorporation of prior theory can assist in establishing them.

'External validity' is concerned with the ability of the research findings to be generalised to outside persons, settings and times beyond the immediate study (Sekaran 1992; Emory & Cooper 1991). A significant level of external validity was achieved in this research project by sampling in terms of analytical generalisation using 'theoretical replication' (Yin 1994). That is, it compared a previously developed theory (as outlined in chapter 2) to the empirical results obtained from the case studies in stage 2 of this research.

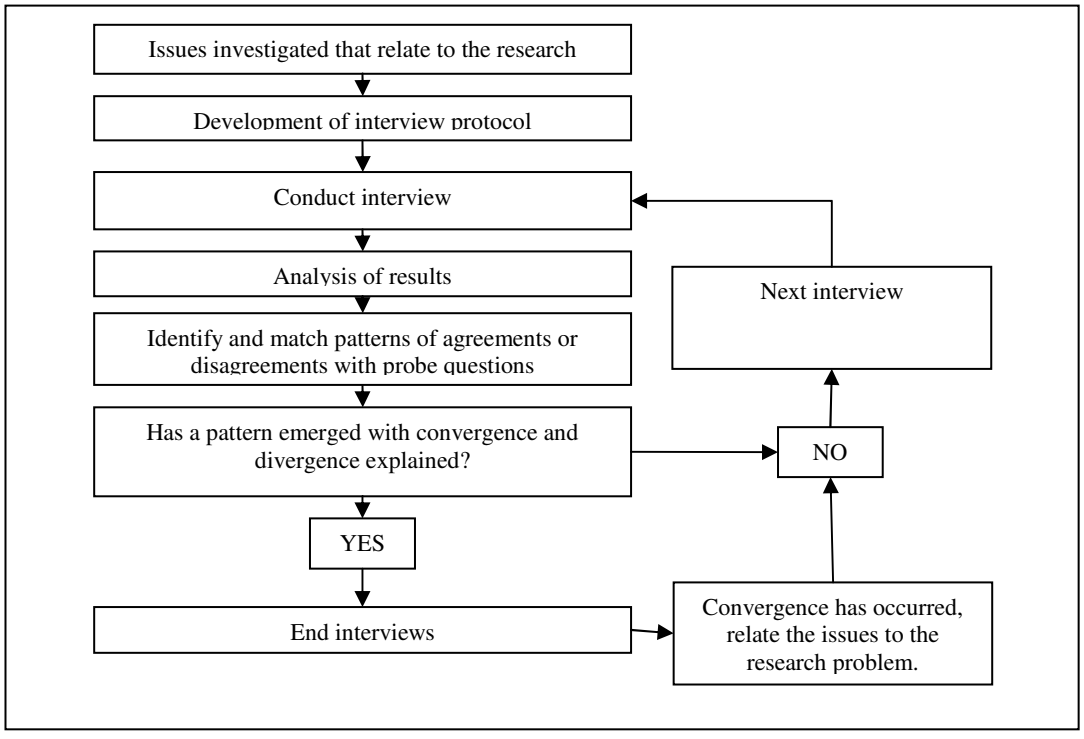
Finally, 'reliability' refers to how consistently a technique measures the concept it is supposed to measure, enabling other researchers to repeat the study and obtain similar results (Sekaran 1992; Emory & Cooper 1991). In this research reliability was achieved through three tactics. First, a structured process for administration of interviews was established. That is, the physical process of designing and administering the interviews is well documented. A second tactic was to organise a structured process for recording, writing and interpreting data, which will be discussed in more detail in section 4.4. That is, the data obtained from the interviews themselves was written-up in a detailed, transparent and accessible manner allowing examination and replication. The third tactic employed involved the procedure of developing an interviewee database. The ability for third parties to be able to repeat the process and arrive at the same results is a good form of ensuring reliability (Yin 1994). A number of other tactics for ensuring reliability are also available, but were not considered feasible in this research. These include the use of a steering committee to assist in the design and implementation of the interview program and the use of at least two interviewers, which allows for cross-checking of findings and interpretations (Dick 1990). In this research the principal supervisor comprised the steering committee.

In conclusion, the methodology employed in this research project helped to ensure that validity and reliability were achieved. In the following section the procedure in undertaking the convergent interviewing process is presented.

3.5 Convergent interviewing procedure

This section examines the methodology employed in performing the convergent interview process used in this stage of this research project. This convergent interviewing process is designed to test and refine the preliminary theoretical framework derived from chapter 2, by comparing the conceptual framework to the views of practitioners and experts in the field. The resulting issues of convergence can then be related to the overall research problem: *what are the origins and nature of new product development processes within STBFs and how do they contribute to STBF success?* The resulting refined theoretical framework then allows the formulation of a number of research propositions (section 3.8) which in turn, will be the focus of this case study research. In brief, the figure 3.3 illustrates the convergent interview process adopted for this research.

Figure 3.3 Convergent interview process



Source: developed for this research from Nair & Reige (1995 and Woodward (1995).

The methodology outlined above adopts the basic steps proposed by Dick (1990) with additional considerations from Nair and Riege (1995), Perry (1998), and Woodward (1997). In developing an interview strategy for convergent interviewing the purposive sampling principle of maximum variation should be used, that is choosing a heterogeneous and representative sample from a target population (Dick 1990). Further, the sample size should be 'data driven' and should contain at least 12 interviewees. However, it can be shown that having less than 12 interviewees is effective if cyclic techniques such as 'snowballing' are utilised (Dick 1990; Patton 1990).

In this research 5 interviews were conducted as convergence or divergence was able to be achieved with this number of interviews through the snowballing technique. Specifically, snowballing allowed the attaining of convergence through the adding of more respondents until there was a stable pattern of agreement (convergence) or disagreement (divergence) on issues, with the disagreements being explained (Nair & Riege 1995). With respect to the issues of divergence, the approach taken by Nair and Riege (1995) was adopted in that disagreements were not discarded but considered a subject of probe questions in all interviews. For illustration, table 3.2 provides an example of the mechanism of identifying new issues as individual interviews progressed which were then incorporated into later interviews.

Table 3.2 Identifying and incorporating emerging issues from interviews

	Interviews				
Issues	**1**	**2**	**3**	**4**	**5**
A	√	√	√	X	√
B		√	X	X	X
C		√	√	√	√
D			√	X	√
E			√	X	√
F			√	√	√

Legend: √ = Agreement X= Disagreement
Source: developed for this research

While some authors discard issues only mentioned once and concentrate sequential interviews on information confirmed in later interviews (for example Dick 1990; Woodward 1995), it is the understanding that arises from trying to explain convergent and divergence that are essential parts of this exploratory study. For illustration, issue B in table 3.2 was first identified in interview 2 but upon which

subsequent interviewees disagreed. Indeed, this approach provided insights for specific new components of the study which were later incorporated into the case study design outlined in chapter 4. That is, not prematurely discarding diverging issues was the key to understanding all issues.

An important part of the snow-balling sampling process for convergent interviewing is the selection of the correct first person to interview. This person needs to be more than just representative (Dick 1990). He or she needs to have the capability to refer the interviewer to others who are familiar with the subject and who may become respondents in subsequent interviews (Nair & Riege 1995). In this research, five interviews were conducted where all interviewees were personally unknown to each other. Of these 5 interviews, two were consultants in the area of new product development, one a practitioner in NPD for a large industrial manufacturing company, one a venture capitalist specialising in technology-based start-ups and the final one a researcher in the field of innovation theory. As each interview progressed, new questions were added based upon the preceding interviews and on the increasing knowledge of the interviewer. The respondents' different backgrounds and areas of expertise, as well as their respective vocational experiences provided a unique blend of skills and perceptions leading to more valid outcomes for the research.

3.6 Interview proper

As the purpose of undertaking convergent interviewing has now been discussed, the steps employed in planning and managing the convergent interviews follow the process outlined in the literature (Dick 1990) and are discussed next.

Informing the respondent. The time at which the interview with the respondent was to be conducted was pre-arranged over the telephone. During the introductory conversation, the interviewer introduced himself and explained the purpose of the research. All potential interviewees were told why they were selected and how the proposed interview would contribute to the research outcomes. A time and date was then set for the interview. Ethical clearances and informed consent was obtained

from each potential respondent (Lincoln & Guba 1985). All potential interviewees agreed to participate.

Timing and setting. Due to the flexible nature of the convergent interviewing process, no predetermined time constraints were imposed on the length of the interview. However, it was important to strike a balance between having sufficient time to obtain the relevant information and being sensitive to the time constraints of the interviewee. Taking this into consideration, a time frame of between one hour and one and half hours was established. All respondents were interviewed at their respective places of work.

Opening question. The opening question proposed for convergent interviews by Dick (1990, p. 30) is *' What do you see as the strengths and weaknesses of...'*. However, other researchers have found that asking for the story of their experiences was a preferred alternative as the interviewees did not need to intellectualise (Nair & Riege 1995). This alternative also provides a broader starting point that may lead to follow-up questions such as strengths and weaknesses of a particular aspect of their new product development experiences. Thus, the following question was used as the opening question to the interview: 'P*lease tell me the story of your experience in new product development'*. This opening question was easy to answer, unambiguous and allowed the interviewee to speak of their particular experiences. The question also helped in making the respondent more comfortable and thus less likely to be defensive about the interview.

Probe questions. The probe questions developed for each interview, as well as the responses to interview questions are summarised in Appendix II. One method of incorporating probe questions into the interview proper is to ask the probe questions at the interview and after the summary (Dick 1990). However, the approach taken in this research was to ask the probe question during the interview process whenever a related issue was raised which assisted with the flow of the interview and to keep the respondents talking. For example, theme 2, that of the 'drive for early market entry governs the NPD process' was initially raised in Interview 1.

Establish initial rapport. The initial aim of each interview was to increase the respondent's active participation through establishing initial rapport (Sekaran 1992). The process undertaken in informing the respondents and seeking participation was the first step in developing rapport with the respondent. This included introduction by the interviewer, an explanation of the objective of the interview and to reassure the respondent of the importance of the research and finally, obtaining ethical clearances and informed consent.

One of the most important issues in developing rapport with the interviewee was that of confidentiality. As three of the five respondents were professional advisors and consultants in the field of new product development, it was important to provide reassurance that they would not be identified as respondents. This also assisted in ensuring frank and unreserved responses to individual questions were obtained. Further, each respondent was offered a draft copy of the chapter involving their interview upon request. None requested this but due to the relevance of the research to their own professional practice, all requested a copy of the research upon its completion.

The introduction was summed up by an explanation that the role played by the interviewer was as an active listener and that the interviewee was the expert (Dick 1990; Lopez 1965). Finally, the respondent was asked permission for the use of a tape recorder to record the interview and was asked if there were any further points of clarification required prior to commencing the interview proper.

Question time. The approach that was taken throughout the interview was to use minimal encouragers, to ask non-directive questions, maintain eye contact, smile expectantly during pauses, repeating questions if needed and referring to earlier issues referred to by the respondent (for example, Emory & Cooper 1991). Further, aspects which may have led to a biased response were actively avoided. In particular, avoiding the interruption of the interviewee, using evaluative comments, asking leading questions, introducing the interviewer's own ideas and being concerned about 'pregnant pauses' (Dick 1990; Wolcott 1990). This was of particular importance in this research as the interviewer had an extensive professional history in the parallel field of technology commercialisation, which

provided insights and perspectives that may have represented sources for potential bias. However, realising this potential limitation during the development of the interview questions and being conscious of this fact during the interview proper reduced the significance of this.

Concluding the interview. At the conclusion of each interview, the respondents were thanked for their participation and asked if they could be contacted again about the research if required. As snowballing was used as a means of obtaining referrals for subsequent interviews, at the point of conclusion in each interview the respondent was asked for a referral to be considered. The respondents were then asked if they had any further questions and the interview was brought to a close.

3.7 Convergent interview data analysis

The strength of the convergent interviewing process lies in the cyclic combination of interview and interpretation, with the final report evolving as the process proceeds (Dick 1990). While remaining relatively unstructured, the questions for the convergent interviews were developed from prior knowledge obtained from the literature review in chapter 2 and were analysed in order to assess the applicability of the theoretical framework developed. Six key themes were examined through the convergent interviewing phase of this research which, in turn, allowed the identification of a range of issues of convergence or divergence arising from the interviews. These issues were identified quickly, and thus it was only necessary to conduct five interviews (section 3.4). The order in which these issues appear has no relation to their respective levels of importance but rather on the order in which they arose. Quotations are from the interviewees with the number in brackets representing the interview number.

Theme 1: Influence of investors on corporate and new product strategy

One factor that was identified as being a potential influence on the process of NPD in STBFs was the role of investors. While the literature review in chapter 2 pointed to the general role played by investors in influencing corporate and new product strategy development, the inclusion of this theme for specific consideration was

primarily a result of the prior knowledge of the researcher. As a result of including this as a theme it was found from interviewees that investors had the potential to influence the corporate strategy development in both positive and negative ways, and are therefore discussed in turn next.

Theme 1(a): Negative influences of investors on corporate and new product strategy

One of the key negative influences identified was the potential adverse impact on corporate and new product strategy when the investors' primary objective is to maximize return on investment (ROI). In turn, a focus on ROI governs the exit strategy and this exit strategy is seen to impact on corporate strategy with the potential for reducing, rather than enhancing, the capacity for achieving long term business success.

Table 3.3 shows the areas of 'negative influence' arising from investors in respect to corporate and new product strategy in STBFs. These issues generated strong agreement between all the interviewees in respect to the need for careful matching between start-ups and investors (angel and venture capital investors). It was felt that there is a tendency for a mismatch between the two in terms of their own respective corporate objectives and aspirations from the investment. It was further felt that investors have the potential to negatively impact effective new product development by having an overemphasis on achieving speed-to-market (table 3.3 row 1) and cost cutting at the expense of sound product development processes (table 3.3 row 3).

Table 3.3 Areas of negative influence of investors on corporate and new product strategy

Row	Issues	Interview					Total Agreement	Total Disagreement
		1	2	3	4	5		
1	Drive for speed-to-market	√	√	√	√	√	5	0
2	Early exit strategy to maximize ROI	√	√	√	√	√	5	0
3	Overemphasis on cost cutting to the detriment of product development		√	X	√	√	3	1
4	Unrealistic expectations by investors		√	X	X	X	1	3

Source: developed from fieldwork *Legend: ✓ = Agreement X= Disagreement*

Theme 1 (b): Positive influences of investors on corporate and new product strategy

On the other hand interviewees also felt that investors can have a positive influence on strategy development by virtue of: the requirement of early development of a detailed business plan (table 3.4 row 1); the insistence on undertaking sound market research to validate the product concept (table 3.4 row 2); and, investors contribution, to assist in accessing skills not currently possessed by the STBF. As one interviewee pointed out: 'it is rare that the management team of technology start-ups will have the necessary commercial experience to make a success of the enterprise, so…. we insist on contributing such expertise as and when we determine it necessary and investment is often tied to having this ability' (3)

Table 3.4: Positive influences of investors on corporate and new product strategy

Row	Issues	Interview					Total Agreement	Total Disagreement
		1	2	3	4	5		
1	Early development of business plan	√	√	√	√	√	5	0
2	Market research to validate opportunity		√	√	√	√	4	0
3	Contribution to management team skills			√	√	√	3	0

Source: developed from fieldwork *Legend: ✓ = Agreement X= Disagreement*

Theme 2: Drive for early market entry

Achieving speed-to-market for the newly developed product was identified as being of high importance by interviewees to both investors and for the success of the STBF. At the same time it was also felt that while speed-to-market is important there is an under-emphasis on speed-to-market from STBF founders. Moreover, it was felt that part of the explanation for this under-emphasis on speed-to-market is due to a lack of understanding of the NPD process (Table 3.5 Row 2). Additionally, it was also felt that there tended to be a singular focus on the technical development phase of NPD rather than looking at NPD as a holistic management process.

This focus on technical development activities was highlighted by one interviewee who expressed the view that; 'Most technology ventures I have seen have simply

gone ahead and developed a product with little product or concept validation and are simply not ready for the market' (2). This view was also consistently expressed by other interviewees: 'inventors have a great deal of difficulty distinguishing the technology from the product and invariably what they think is a product requires substantially more investment in order to get it in a form the market will accept' (3). Table 3.5 shows the key issues which arose in respect to speed-to-market.

Table 3.5 Identifying and incorporating emerging issues from interviews

Row	Issues	Interview					Total Agreement	Total Disagreement
		1	2	3	4	5		
1	Speed-to-market	√	√	√	√	√	5	0
2	Lack of a clearly defined product development process		√	x	√	√	3	1

Source: developed from fieldwork *Legend: ✓ = Agreement X= Disagreement*

Theme 3: Capability of management team

Previous experience was identified as important in contributing to the overall capability of the management team. This was reflected in terms of the ability of management to develop an effective corporate strategy as well as operationalise the resulting business plan. In particular, a key theme identified was the need for previous management experience (table 3.6, row 1) and if this experience was lacking the need for the management team to recognize these gaps in knowledge/experience and to fill those gaps wherever possible (table 3.6, row 2).

This was reflected in the views of one respondent: 'In my experience, CEOs of new technology ventures commonly seem to think that technical capability is more important than management capability. However, if they express this view to a potential investor then not a lot of confidence is instilled that the venture is likely to be successful no matter how sexy the product' (5). This was reinforced by another comment that 'start-up champions rarely recognise that investors are just as interested in the drive and capability of management as they are with the fundamental product and …this view features heavily in any investment decision' (2).

Table 3.6 Management capability characteristics identified as being important

Row	Issues	Interview					Total Agreement	Total Disagreement
		1	2	3	4	5		
1	Previous general management experience	√	√	x	√	√	4	1
2	Identifying areas of weakness		√	√	√	√	4	0
3	Business education			√	√	√	3	0

Source: developed from fieldwork *Legend: ✓ = Agreement X= Disagreement*

Theme 4: Benefits derived from business incubators

It was perceived that the value provided by business incubators to the STBF is somewhat restricted to specific areas of assistance. Access to cheap rent for office and wet lab facilities (shared or small laboratory space) and other physical infrastructure such as internet broadband, were seen as the primary value provided by business incubators (table 3.7, row 1).

Additionally, business incubators were also seen as an effective method of accessing various industry, research and investor networks including angel investors and venture capitalists (table 3.7 rows 2 & 4). However, significant disagreement occurred when the issue of business incubator's contribution to NPD was explored. Specifically, it was felt that business incubators contributed little to linkages to universities for accessing business planning and technical skills not possessed by the firm and specific assistance with NPD management (table 3.7 rows 8 & 9).

While this theme does not add to the preliminary theoretical framework, it does provide support for a number of the elements within the framework when they are conducted within the business incubator environment. In this way, this theme adds to the overall research design in relation to business incubators.

Table 3.7 Areas of value contributed to new product development and corporate strategy development provided by business incubators

Row	Issues	Interview					Total Agreement	Total Disagreement
		1	2	3	4	5		
1	Cheap rent and infrastructure	√	√	√	√	√	5	0
2	Access to investment opportunities		√	√	√	√	4	0
3	Lends management credibility		√	√	√	√	4	0
4	Better access to networks		√	√	√	√	4	0
5	Mentoring role		√	√	√	√	4	0
6	Added value to strategy development		√	√	√	√	4	0
7	Access to training opportunities		√	√	X	X	2	2
8	Access to university links		√	X	X	X	1	3
9	Assistance with product development		√	X	X	X	1	3

Source: developed from fieldwork *Legend: ✓ = Agreement X= Disagreement*

Theme 5: Approaches to managing the new product development process

When examining the common approaches to managing the new product development process by STBFs, three key characteristics were identified. Of particular note was the common view that the vast majority of STBFs tend to be technology-driven rather than market-driven (table 3.8 row 1) and that the approach in managing the new product development process differs according to what industry the firm is in (table 3.8 row 2).

The new product development process itself was also felt to be largely informal and intuitive rather than possessing a formal well documented process (table 3.8 row 3). This was of particular concern to practitioners and the venture capitalist respondents as the informal process lends itself to difficulties in protecting intellectual property, thus impacting on attractiveness to potential investors. Further, the process itself was largely seen as being linear with little real ability to support parallel development activities (table 3.8 row 4) thus impacting on speed-to-market. Interestingly, views on the linear nature did not include the view that STBFs would be more likely to adopt clearly defined decision 'gates' as a mechanism to move from one phase to the next (table 3.8 row 7). Rather, it was viewed that the intuitive nature of the process tends to see an automatic progress

rather than as 'part of a cognitive decision process' (2). Two explanations were proffered for this view. First, lack of financial resources to sufficiently fund a more thorough and formal NPD process and secondly, a lack of experience earlier identified in theme 3 above.

Table 3.8 Managing NPD within STBFs

Row	Issues	Interview					Total Agreement	Total Disagreement
		1	2	3	4	5		
1	Technology driven	√	√	√	√	√	5	0
2	NPD management approach differs according to industry type	√	√	√	√	√	5	0
3	Informal and intuitive process	√	√	√	√	X	4	1
4	Linear process	√	√	X	√	√	4	1
5	Impacts firm success		√	√	√	√	4	0
6	Market research prior to technical development		√	X	X	X	1	3
7	Use of predefined decision gates		√	X	X	X	1	3
8	Possession of technical expertise relevant to the product			√	√	√	3	0

Source: developed from fieldwork *Legend: ✓ = Agreement X= Disagreement*

Theme 6: Benefits of early-stage strategic partnering

Strategic partnering at an early-stage in the start-up's life was viewed as being a valuable strategy for firm success. There were two clear benefits of early-stage partnering identified by the respondents. First, the 'right' partner, that is, a partner with widespread recognition as a market leader by their sector, was seen to contribute credibility to the start-up itself. In undertaking further probing it arose that this was attributed to the perception that a mature market incumbent adds credibility due to that firm's due diligence process in assessing the firm and product with respect to suitability for a potential partnering arrangement (table 3.9 row 1). The second significant benefit seen to arise from early-stage partnering was the early establishment of a channel to market for the product (table 3.9 row 2).

When exploring both of these perceived benefits further, respondents were of the opinion that both of these benefits 'contribute to the likelihood of the venture being

able to bring the product to the market quicker and with a greater likelihood of success than otherwise might have been the case' (4). Thus, early-stage strategic partnering can become a key method of achieving speed-to-market.

However, disagreement occurred in relation to the emergent issues associated with the contribution of strategic partnering to: the technical development phase of the NPD process, as a potential source investment for the firm and the partners' contribution to the skill 'gaps' identified within the STBF. Largely it was felt that strategic partners 'are not interested in education prospective partners' (4).

Table 3.9 Benefits derived by strategic partnering

Row	Issues	Interview					Total Agreement	Total Disagreement
		1	2	3	4	5		
1	Lends credibility to the venture	√	√	√	√	√	5	0
2	Potential channel to market partners	√	√	√	√	√	5	0
3	Partner is an exit strategy for investors		√	√	X	X	2	2
4	Partners contribute technical assistance in NPD		√	X	X	X	1	3
5	Investment source		√	X	X	X	1	3

Source: developed from fieldwork *Legend: ✓ = Agreement X= Disagreement*

Amended Framework. The convergent interviewing phase of this research permitted the refinement of the preliminary theoretical framework for new product development in STBFs and developed in section 2.6. The exploratory nature of the interviews within this phase of the research allowed the confirmation of the findings derived from the literature review and supported the nominated components of the preliminary framework.

Table 3.10 contains a list of the six key themes out of which individual issues were identified. Each of these themes have then been mapped against the three framework components of the preliminary theoretical framework summarised in table 2.11, that is components I, II, III & IV.

Table 3.10 Emergent themes from the convergent interview stage

Theme	Issues of convergence from interviews	Issues of divergence from interviews	Components of preliminary theoretical framework supported
Theme 1: Influence of investors on corporate and new product strategy (Table 3.3 & Table 3.4	*Negative influence* • Speed-to-market at all costs • NPD strategy and availability of resources driven by exit strategy *Positive influences* • Early development of business plan • Need for market research • Contribution of management skills	*Negative influence* • Unrealistic expectations by investors	• Corporate strategy (component I) • Relationship area A *[new element in amended framework]*
Theme 2: Drive for early market entry governs the NPD process (Table 3.5)	• Speed-to-market • Lack of NPD process management product definition	NIL	• New product development process features (component II) • Relationship area A *[confirmation of existing element in amended framework]*
Theme 3: Capability of management team (Table 3.6)	*Important characteristics* • Previous experience • Identifying areas of weakness • Education/training	NIL	• Corporate strategy (component I) • Relationship area A *[new element in amended framework]*
Theme 4: Benefits provided by business incubators (Table 3.7)	Perceived value • Cheap rent/infrastructure • Access to investors • Lends management credibility • Better access to networks • Mentoring role • Assist in corporate strategy development	• Access to research organisations • Assistance with product development	• Influence of business incubators • Relationship area A *[confirmation of existing element in amended framework]*
Theme 5: Management of the new product development process (Table 3.8)	• Technology driven • Approach to NPD management differs according to industry • Informal & intuitive • Linear • Possess technical expertise relevant to product	• Market research prior to technical development • Predefined decision gates	• New product success factors • Relationship area B *[confirmation of existing element in amended framework]*
Theme 6: Benefits of early-stage strategic partnering (Table3.9	• Venture credibility • Channel to market partners • Partner offers an exit strategy	• Partners contribute technical expertise • Investment source • Contribution of management skills	• Corporate strategy (element 6 – component I) • Relationship area A *[confirmation of existing element in amended framework]*

Source: developed from fieldwork

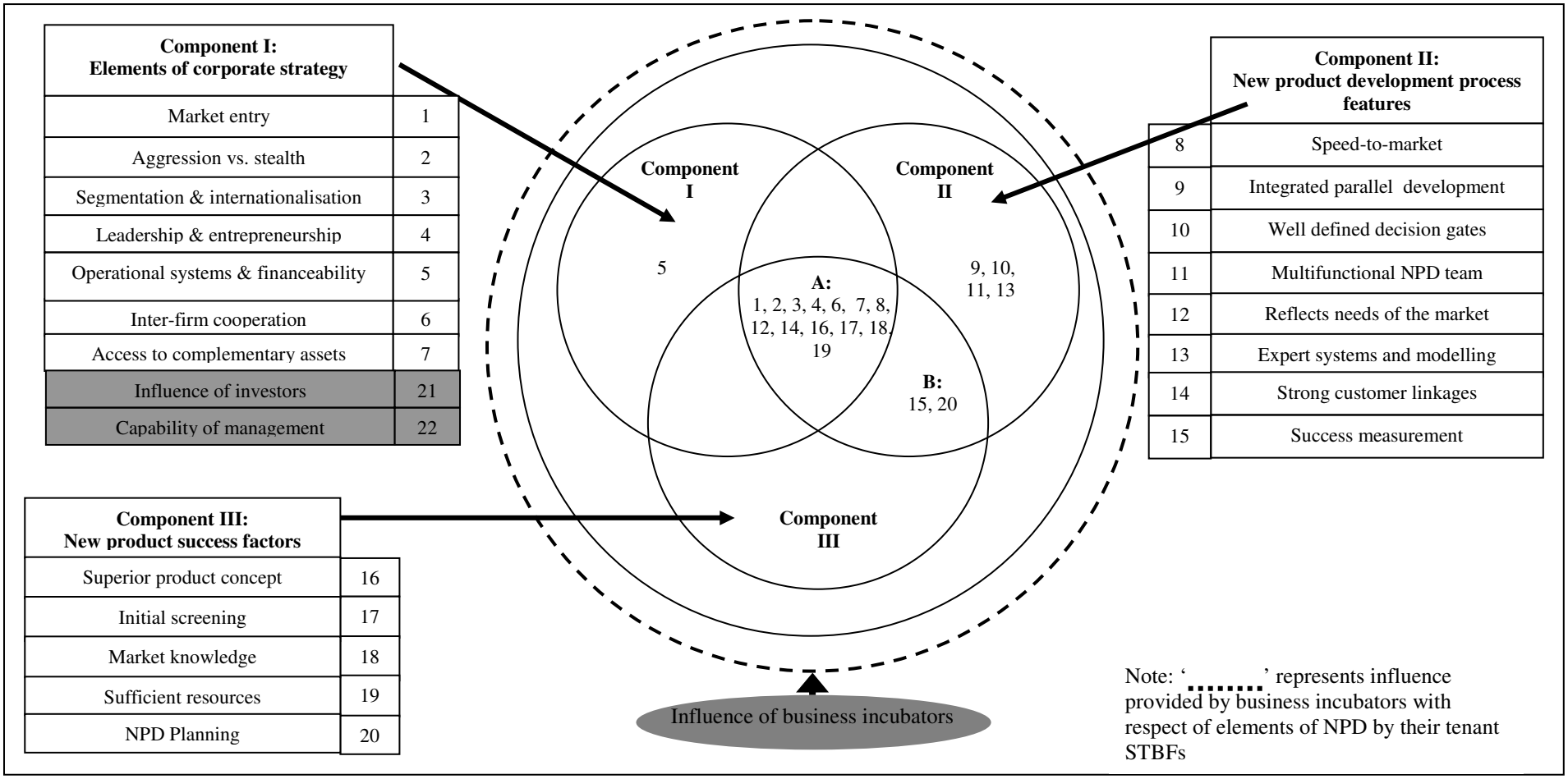
Importantly, the findings from his exploratory phase can also be regarded as being largely representative of similar firms irrespective of geographic region. This means that the subsequent findings from the case study phase can be generalised for most STBFs globally. However, it should be noted that differences may occur when comparing STBFs between developing and developed countries as there may be differences in support mechanisms in STBFs gaining assistance for new product development purposes. However, this should be a consideration for possible further research and does not adversely impact the research design for this research.

Where a theme is expressed as an element previously identified from the literature review of chapter 2 and included in the preliminary theoretical framework, the convergent interviewing allowed a confirmation or a disconfirmation of those elements. Where additional elements have been identified through this exploratory phase, these new elements were then situated within a component felt by the researcher to be the most relevant to that element. Likewise, where these additional elements were identified as having an inter-relationship with elements within other components, these elements were then situated within that appropriate relationship area (that is, the point of intersection between components).

Additionally, this exploratory phase also identified a number of elements not previously identified from the review of the literature which necessitated a refinement of the preliminary theoretical framework for new product development in STBFs. Specifically, these additional elements were the need for a more effective and holistic approach to the management of the entire NPD process (theme 3) and recognition of the influence provided by investors into the management of NPD activities of the STBF (theme 1).

As a result, the theoretical framework was refined to incorporate these additional elements. This amended framework for new product development in STBFs is presented below as figure 3.4. Specifically, the refinements include the addition of two new elements of NPD identified from the convergent interviewing.

Figure 3.4 Refined theoretical framework for new product development in STBFs



Source: derived from Figure 2.12 and refined from findings from the exploratory interview phase with refinements in bold.

These additional elements of NPD include: the 'influence of investors' (element 21) and 'capability of management' (element 22), which are both highlighted in figure 3.4.

The fact that only minor refinements were required to the preliminary theoretical framework does in no way detract from the validity of undertaking the preliminary exploratory phase to this research. Indeed, this would suggest that the literature review was able to identify the majority of the key themes for incorporation into the research design.

3.8 Research questions and propositions

The literature review (chapter 2) and the exploratory phase of this research, which took the form of convergent interviews, has allowed the confirmation of a theoretical framework which will now form the basis of the next phase of this research, that is, the case study research. However, in order to answer the research problem of *what are the origins and nature of new product development processes within STBFs and how do they contribute to STBF success?,* the case study research must now be focused on addressing specific research questions. The three research questions and their associated research propositions will each to be discussed in turn.

From the review of the extant literature undertaken in chapter 2, it was seen that prior research in relation to NPD was focused either on NPD process features, the factors that contribute to new product success, generalist studies on the linear nature of linking NPD activity to corporate strategy, or alternatively upon performance related aspects of NPD activity. More particularly, such studies were in the context of large and established firms where NPD activity was performed in the context of a portfolio of new product projects.

This contrasts sharply with the STBF environment in which NPD is undertaken. In particular, the non-linear nature of the strategy development–NPD pathway means that NPD needs to be described much more broadly than simply NPD process features and include new product success factors as well as the elements of

corporate strategy that have been identified to directly impact overall new product strategy and hence project-specific NPD activity. As a result of the literature review and the subsequent amendments to this framework which arose from the exploratory research phase, three core components of the framework were identified that more effectively describe this overall NPD activity and which is more relevant to the particular nature of STBFs.

When considering the amended preliminary theoretical framework of figure 3.4, three specific areas of enquiry are identified which provide a focus for this research: the elements of NPD which are adopted by STBFs; the relationship between these elements and new product and ultimately firm success or failure and finally, the role of business incubators in assisting STBFs in NPD. As a result, these three areas of enquiry now give rise to three specific research questions and from which a number of associated research propositions are proposed.

First, as the literature does not specifically address which of the elements of NPD are actually adopted by STBFs, the first research question addressing this issue is:

RQ 1: What elements of NPD are adopted by STBFs when developing new products?

Further, the literature points to the finding that it is common for technology-based new firms generally to be founded by technology entrepreneurs who are relatively inexperienced in running businesses and have little formal business education or training. This general observation is also made through the literature relating to both business incubation as well as entrepreneurial theory (for example, Bell & McNamara 1991; CSES Report 2002; Timmons 2004; Williams 1998).

At the same time it can be seen from the amended preliminary theoretical framework of figure 3.4, that a key dichotomy between STBFs is that of the characterisation of firms according to the time-to-market for their respective products as discussed in chapter 2. Accordingly, it is likely that STBFs which have a short time-to-market (that is, less than 2 years) are also likely to adopt fewer

elements of NPD than STBFs with either a medium to long time-to-market. Thus, the specific research proposition in relation to research question 1 is:

RP 1: STBFs which are characterised as having a short time-to-market product will adopt comparatively fewer elements of NPD than STBFs with either medium or long time-to-market products.

Once the issue of which elements of NPD are adopted by STBFs has been addressed, the next logical question relates to how the effect of a lack of adoption of these elements contribute to new product and ultimately firm failure. Thus, the second research question is:

RQ 2: How does the extent of adoption of the elements of NPD contribute to new product and firm successes and failures in STBFs?

The literature supports the view that there is a direct relationship between the adoption of new product success factors and achieving new product success (for example, Cooper & Kleindschmidt 1995). However, as discussed previously, it was argued that in STBFs, reducing the likelihood of new product failure requires maximising the adoption of the total number of elements of NPD included within the three core components of the framework for new product development in STBFs. A further consideration is that STBFs need to reduce the risk of failure of a single product, as distinct from a portfolio of products, in order to reduce the risk of firm failure. Given this, two specific research propositions are now proposed in relation to the second research question:

RP 2(a): STBFs which adopt comparatively fewer individual elements of NPD exhibit a greater likelihood of new product and firm failure; and,

RP 2(b): A lack of adoption of market-related elements of NPD compared to non-market elements of NPD increases the likelihood of new product and firm failure in STBFs.

The final area of enquiry arising from the amended theoretical framework relates to the role played by business incubators in assisting STBFs in undertaking their NPD. Specifically, the roles played by business incubators to assist tenant STBFs in the performance of the elements of NPD adopted across the three components of the theoretical framework is examined. Thus the final research question is:

RQ 3: How and in what ways do business incubators influence the performance of the elements of NPD adopted by STBFs?

It was established from the examination of the literature in chapter 2 that business incubators provide significant assistance to tenant firms in the development of their corporate strategy (for example, Collinson & Gregson 2003; CSES Report 2002). More specifically, technology incubators were seen to play a significant role in technology transfer (Kapij, Dressel & Abbetti 1996). On the other hand, the literature did not address the specific assistance that may be provided to tenant STBFs in undertaking their NPD activities. Despite this apparent gap in the literature, it is further argued that STBFs in such incubators will likewise obtain significantly greater benefit in both adopting the elements of NPD and in the performance of those elements, compared to STBFs who are not tenants. This position is contrary to the views expressed by interviewees in the exploratory research phase (Row 9 Table 3.7). The reason this position is argued by the researcher was the comparative inexperience of respondents with respect to the business incubator environment that, in turn, provided the researcher with little basis for supporting respondents views on this issue at this point in the research. Thus, in order to address this argument two additional research propositions are proposed:

RP 3(a): STBFs which are tenants of business incubators undertake their NPD more effectively – as determined by the number of elements of NPD adopted compared to STBFs which are not tenants; and,

RP 3(b): The comparatively better NPD performance of tenant STBFs is attributed to the services of the business incubator in which they are a tenant.

For simplicity and ease of reference in later sections of this research, these research questions and associated research propositions are now presented in summary form in table 3.11.

Table 3.11 Research questions and associated research propositions

Research question	Research proposition
RQ 1: What elements of NPD are adopted by STBFs when developing new products?	RP 1: STBFs which are characterised as having a short time-to-market product will adopt comparatively fewer elements of NPD than STBFs with either medium or long time-to-market products.
RQ 2: How does the lack of adoption of the elements of NPD contribute to new product and firm successes and failures in STBFs?	RP 2 (a): STBFs which adopt comparatively fewer individual elements of NPD exhibit a greater likelihood of new product and firm failure
	RP 2(b): A lack of adoption of market-related elements of NPD compared to non-market elements of NPD increases the likelihood of new product and firm failure in STBFs.
RQ 3: How and in what ways do business incubators influence the performance of the elements of NPD adopted by STBFs?	RP 3(a): STBFs which are tenants of business incubators undertake their NPD more effectively – as determined by the number of elements of NPD adopted compared to STBFs which are not tenants
	RP 3(b): The comparatively better NPD performance of tenant STBFs is attributed to the services of the business incubator in which they are a tenant.

Source: developed for this research

3.9 Conclusion

In conclusion, this chapter outlined the exploratory methodology of convergent interviewing that was adopted for this research and provided a justification for its use. Further it presented the findings of this phase of the research and presented 6

specific themes which were supported through the process of convergence. As a result, the preliminary theoretical framework presented in section 2.6.4 was refined and became the basis of the next stage of this research, the case studies. Finally, the amended theoretical framework has provided the basis for the development of a series of three specific research questions and five associated research propositions (table 3.11) as the core focus of this research. The next chapter, chapter 4, will discuss the case study methodology adopted for the confirmatory case study stage.

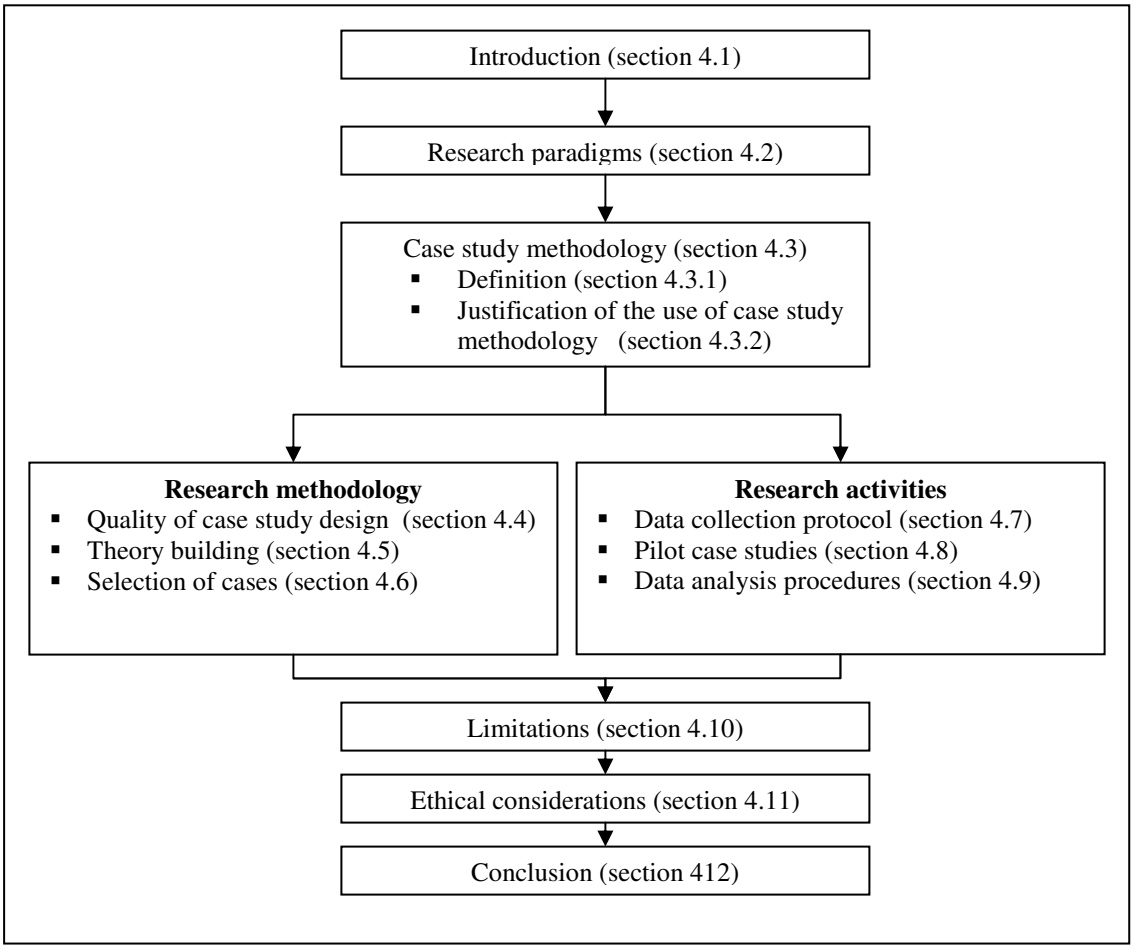
4 Research methodology

4.1 Introduction

Chapter 2 reviewed the extant literature relating to new product development, the relationships between corporate and product strategies as well as business incubators in the context of STBFs and then went on to propose a preliminary theoretical framework for new product development in STBFs. Chapter 3 then discussed the justification for adopting convergent interviewing as an exploratory phase of this research and outlined the procedure adopted for this study. It then went on to undertake an analysis of the convergent interviewing data and refined the initial theoretical framework. It concluded by proposing three research questions and five associated research propositions as the basis for the case study research (section 3.8).

In turn, the purpose of this chapter is to outline the methodology adopted to collect the data to address the five research propositions and answer the research questions. This chapter commences with an examination of the four scientific paradigms of positivism, realism, critical theory and constructivism and shows that the realism paradigm is the most appropriate foundation for this research (section 4.2). Next, the case study research methodology used in the study is discussed (section 4.3) and the research plan is detailed together with the criteria used for judging quality of the case research (section 4.4). The role of prior theory in case study research (section 4.5) and the selection process of cases to be studied are then considered (section 4.6). After this detailed research plan, the protocol for the case study design and data analysis is discussed (section 4.7). Finally, the chapter concludes with a discussion of the limitations of case study methodology as well as details of ethical considerations relevant to this research (4.8). An outline of this chapter is provided in figure 4.1

Figure 4.1 Outline of Chapter



Source: developed for this research

4.2 Research paradigms

All investigations are guided by a set of beliefs and feelings about the world and how it should be understood and studied, that is, a paradigm (Denzin 1978; Denzin & Lincoln 1994). A paradigm can be defined as a set of assumptions linked together in an investigation of the world and thus, 'determine both what problems are worthy of exploration and also what methods are available to attack them' (Deshpande 1983). Further, a paradigm can be described as a view of the world that cannot be proven or disproven by logic from outside that world (Lincoln & Guba 1985).

A paradigm combines both ‘ontology’ and ‘epistemology’. Ontology refers to the form and nature of reality and comprises the fundamental assumptions made about the elements of reality, specifying what exists (Parkhe 1993). Importantly it attempts to answer the question 'how do we know what we know' (Deshpande 1983). Epistemology, on the other hand refers to the nature of the relationship between the knower/inquirer and the known or knowable. These elements of ontology and epistemology lead to ‘methodology’, that is, techniques of how we gain knowledge of reality. Thus, a research paradigm is a set of theories and methods that exhibit the same patterns or elements (Creswell 1994).

This section examines the four major research paradigms of positivism, constructivism, critical theory and realism. It goes on to explain why realism is most appropriate paradigm to apply to this research. Table 4.1 provides a summary of the four key paradigms of social science and their interrelationship with the philosophical assumptions relating to ontology, epistemology and methodology around which discussion on this section is focused.

Positivism. According to the positivist's perspective, the world can be described and measured objectively (Lincoln & Guba 1985) involving a procedure that seeks the facts and causes of phenomena without subjective interpretation (Deshpande 1983). Positivism is referred to as 'naïve realism' (Leong 1985) because it argues that science is able to discover the true nature of reality and that further, there is a single comprehensible reality comprising discrete elements whose nature can be known and characterised (Perry, Alizadeh & Riege 1997).

In addition, the positivist paradigm assumes that, as long as prescribed procedures are being followed, the researcher is independent of the subject being researched, thus providing assurance that biases and researcher values will not influence research outcomes (Guba 1990). This positivist view of the world can also be described as being hypothetico-deductive rather than inductive. That is, hypotheses are deduced from already accepted principles before being empirically tested

Table 4.1 Characteristics and comparisons of alternative research paradigms

	Positivism (1)	**Constructivism (2)**	**Critical theory (3)**	**Realism (4)**
Ontology	*Naive realism-* • An apprehensible reality • Focus on determining cause-effect relationships	*Critical realism-* • 'real' reality but only imperfectly and probabilistically apprehensible. • Reject a prior theory • Commitment to multiple realities	*Historical realism-* • 'reality' is shaped by social and other forces. • Rejection of absolute truth	*Relativism-* • 'reality' is constructed by people and there is no 'truth' • World exists independently of its being perceived • Focus on looking for causal tendencies or generative mechanisms.
Epistemology	*Objectivist-* • 'disinterested scientist' • Findings are true	*Subjectivist-* • Observer is a passionate participant • Research purpose is construction of realities	*Subjectivist-* • Value-mediated findings • Uncovers myths and hidden truth and help people to change the world • Researcher is a 'transformative intellectual'	*Modified objectivist-* • Observer with some level of participation • Finds probably true with awareness of values between them • Focus on exploratory theory building and inductive research.
Common methodologies	Experiments & surveys-Verification of hypotheses; mainly quantitative	In-depth unstructured interviews	Action research; focus groups	Modified experimental - Convergent interviews Structured interviews; Case studies

Source: adapted from Guba & Lincoln (1994); Perry, Alizadeh & Riege (1997); Master (1999).

(Deshpande 1984). Positivists argue that by taking an objective design approach, statistical generalisation can be achieved and replicable findings will therefore be consistent (Guba & Lincoln 1994). Thus, positivists are concerned with using quantitative techniques with deduction representing the primary mode for the testing of propositions to confirm a theory (Deshpande 1983).

The assumptions underlying this paradigm make it inappropriate for this research for a number of reasons. First, positivism does not concern itself with the discovery and development of theory but rather its confirmation (Lincoln & Guba 1985). As a result, under this paradigm there is no need to attempt to understand unobservable meanings and purposes for action, only those whose reality is observable (Perry, Riege & Brown 1998). Further, human behavior is dependent upon those hidden meanings and purposes that may be observed but not understood (Guba & Lincoln 1994). This is illustrated in this research by the fact that the new product development process, particularly those undertaken by STBFs, represents a diverse and complex system, the inner elements of which may be either unobservable or observable but not understood.

Second, the epistemological perspective of this paradigm requires the adoption of research methods that are well structured and can be controlled with no intervention by the researcher in the process (Perry, Alizadeh & Riege 1997). This perspective makes it inappropriate for this research as the subject of discovery requires researcher participation. This participation allows the researcher to consider and understand the nature of the research problem in a real-life social context as well as its emergent properties and features (Gilmore & Carson 1996).

Finally, in this research there was a lack of theory contained within the literature specifically relating to new product development processes as they pertain to STBFs. This paradigm requires inductive theory building where theory and constructs have not yet been established or where they are inadequate (Parkhe 1993; Perry 1998).

Constructivism. Constructivism adopts a critical relativism ontology in which truth about a proposition of the world is constructed based on the belief system held in a particular context (Perry, Alizadeh & Riege 1997). In other words, truth is a subjective belief that one holds about a particular proposition (Peter 1992), thus resulting in multiple realities that are socially and experimentally based rather than objectively determined (Hunt 1993, Leong 1985). The epistemology of the constructivist paradigm is based upon the theory that findings are created in the interaction between the interviewer and respondent and where the interviewer becomes a 'passionate participant' (Guba & Lincoln 1994).

One reason that this paradigm is unsuitable for this research is that this research concerns itself with the organisational processes associated with new product development rather than the subjective nature of the social interactions which may underlie these processes, where perception is reality (Perry, Alizadeh & Riege 1997).

Critical Theory. The ontology of critical theory is one of historical realism in that it is contended that knowledge consists of a series of structural and historical insights that are changed over time (Guba & Lincoln 1994). Critical theory focuses upon analysis and transformation of social, political, cultural, economic ethnic and gender values (Perry, Alizadeh & Riege 1997).

The epistemology of this research paradigm involves an interactive link between the researcher and the subject matter of the research. As a result, the researcher influences the inquiry through his or her values. Like constructivism, reality is based on perceptions and values held by individuals, however, critical theory emphasises the perceptions held by a group of individuals (Guba & Lincoln 1994). In brief, this paradigm in not suitable for this research as the researcher is not aiming to transform current organisational practices by STBFs in undertaking new product development.

Realism. The central principle of realism is its concept of reality. Realists contend that science is interested in the structures and mechanisms of reality, that is, realism is concerned with a 'real world' that actually exists (Perry, Alizadeh & Riege 1997). However, unlike positivism, which posits that reality is apprehensible, realism argues that reality can only be imperfectly and probabilistically comprehensible, due to the researcher's mental limitations and real world complexity (Guba & Lincoln 1994; Perry & Coote 1994).

The realist's philosophy of the world is distinguished among three domains of reality; real, actual and empirical (Tsoukas 1989). The real domain consists of the processes that generate events, where generative mechanisms or causal tendencies exist independently to cause patterns of observable events under contingent conditions; the actual domain is where patterns of events occur (even if those events have been undetected) and the empirical domain is where patterns of events may be experienced by direct observation (Outhwaite 1983; Tsoukas 1989). In essence, the goal of realism research is the discovery of observable or non-observable structures and mechanisms independent of the events they generate.

Furthermore, from the epistemological perspective, the realism paradigm is based upon the researcher looking through a partly open window. The researcher is an integral part of the research process, but remains as objective as possible - he or she can not be completely value-free but can aim to be value-laden (Perry, Alizadeh & Riege 1997).

In conclusion, the realism paradigm is the most appropriate for this research as this research involves the describing of a social phenomenon which consists of both observable and unobservable elements, as realistically as possible (Perry, Alizadeh & Riege 1997). Essentially, it is argued in this section that realism is the preferred paradigmatic basis of this research because the aim of this research is to explain the structure and process of NPD in the context of STBFs.

4.3 Case Study Methodology

The previous discussion of how scientific realism is appropriate for this research is a foundation for the selection of the case study research methodology from within the paradigm of realism. In essence, case study research is the preferred research methodology for the process of theory generation (Eisenhardt 1989; Yin 1994). This section will commence with an examination of the definitions of case study methodology provided by several major authors and then a definition of a case study methodology for this research is proposed (section 4.3.1). Based on this definition, the justification for the use of the case study methodology for this research is established (section 4.3.2). Thus, this section concentrates on the overall case study methodology and provides justification for its use as an inductive theory-building methodology in order to perform the stage of this research which either confirms or disconfirms the developed theory.

4.3.1 Definitions

This section synthesizes various definitions of case study research to construct one suitable to this research. For case study research to be recognised as a formal research strategy it must first contribute to theory generation and second, have a 'logic of design' (Adams & White 1994). In other words, it must be a research strategy which is used when circumstances and research problems indicate it is appropriate rather than being used regardless of the circumstances (Platt 1992).

One of the early definitions of case study research highlighted the use of case study methodology for complex social phenomena within the marketing discipline; *'the qualitative and field based construction of case studies that allows the investigation of a number of important marketing problems which to date have been ignored in theory building and analysis, often because of their complexity'* (Bonoma 1985,

p.206). Building on this definition, Leonard-Barton (1990) considered case study research as a history of a past or current phenomenon drawn from multiple sources of evidence. In turn, Robson (1993) extended the definition further by considering case study as an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence.

When examining these various definitions of case study research, they can be further ascribed in terms of attributes. Most of these attributes can be summarised as being represented by the following characteristics: 'particularistic', 'descriptive or holistic', 'grounded and explanatory', 'heuristic and inductive' (Merriam 1988). A general definition of case study research is its being a rich description (Kaplan 1986) of a management situation over time (Bonoma 1985). However, more recent literature expands on these general characteristics in a number of areas. Yin (1994) defines case study research as comprising four elements. In this he describes case study research as *'an empirical inquiry that 'investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident. Further, that multiple sources of evidence are used and which should not only be looked upon as a data collection tactic or solely as a design feature but also as a part of a contemporary research strategy'* (Yin 1994, pp.13-14).

The common attributes of case study research that make it applicable to this research are summarised in table 4.2. From this summary it can be seen that most of these attributes are appropriate for this research. However, the one key attribute which is not appropriate is that of theory testing. The theory testing attribute involves the inclusion of research questions comprising classification, comparison and cause and affect (Yin 1994). This research concerns itself only with the dynamic of theory building within a social science setting.

Table 4.2 Common attributes of case study research

Attributes	Authors							
	Adams & White (1994)	Bonoma (1994)	Chetty (1985)	Eisenhardt (1989)	Kaplan (1986)	Merriam (1988)	Robson (1993)	Yin (1994)
Concentrates on a specific phenomenon within a real-life context	•	•				•	•	•
Deals with contemporary phenomenon	•	•	•				•	•
Relies on multiple methods and sources of evidence		•		•	•			•
Analyses and presents research findings in a descriptive and analytical manner		•				•		•
Contributes to theory building	•	•		•	•			•
Can be used for theory testing		•	•	•				•

Source: developed for this research

Specifically, case study research builds theory in this research in three ways: by relying on inductive logic (Burnes 1994 and Yin 1994); by using a combination of qualitative research techniques in the form of multiple methods and sources of evidence including interviews and observations (Bonoma 1985; Eisenhardt 1989; Yin 1994) and by using multiple cases and numerous analysis levels (Chetty 1996; Eisenhardt 1989; Yin 1994).

Based upon the several common themes above, the following definition for case study research is adopted for the purpose of this research: *'an investigation of important contemporary issues by conducting in-depth case and confirmatory interviews and consulting multiple evidence sources that allow a researcher to discover common themes and new issues and to gain rich insights into complex social phenomena that are normally not amenable to other methods of investigation'.*

4.3.2 Justification of the use of the case study research methodology

The use of case study methodology can be justified for a number of reasons. First, this research involved the study of the 'preparadigmatic' relationships and associations between the new product development process and the STBF rather than the study of the cause and effect relationships between the NPD process and the STBF. The study of cause and effect relationships can necessitate the use of quantitative methodologies such as surveys and questionnaires which in turn provide a 'how much' and 'how many' approach (Yin 1994).

Second, case study research relates to the nature of the research problem (Yin 1994). The research problems being addressed in this research is: '*what are the origins and nature of new product development processes within STBFs and how do they contribute to STBF success?*' This then requires the use of an exploratory rather than explanatory approach as the research problem focuses on a 'how' and 'why' type question. This 'how' and 'why' nature of the research problem is directly linked with two types of research question: description and association (Banoma 1985). Thus, case study research enables the development of a deep understanding of the factors affecting the phenomena being researched (Borsch & Arthur 1995; Yin 1994).

Third, case study research needs to address the situation being research (Yin 1994). In particular, the situation being researched refers to the organisational interactions between STBFs and the NPD process as well as the environment afforded by the business incubator. Yin (1994) provides an overview of five approaches to research along the subjective-objective continuum and identifies the circumstances in which each is appropriate. Each of these approaches is based upon the degree of control that is required over behavioral events and whether or not the research is focused on contemporary events. Table 4.3 summaries these approaches. In turn, each will be examined in order to determine their appropriateness for this research.

Table 4.3 Summary of research approaches with the circumstances under which each may be used

Research approach	Type of problem addressed	Circumstances for using the research approach	
		Requires control over behavioural events?	Focuses on contemporary events?
Experiment	how & why	yes	yes
Survey	who, what, where, how many and how much	yes	yes
Archival analysis	who, what, where, how many, how much	no	yes/no
History	how & why	no	no
Case study	how & why	no	yes

Source: adapted from Yin (1994)

Whilst the experimental approach addresses the type of research question that is the subject of this study, it would prove impossible to control the complex social dynamics occurring between individuals within the STBF and the managerial decision making processes with respect to the NPD process. Thus, the experimental approach is not suited to this research. Second, as with the experimental approach, surveys require control over behavioural events and for the previously explained reason this approach is also not suitable. Further, the survey approach necessitates a quantitative element in the measurement of incidence or occurrence of a particular event. The nature of archival research also requires a quantitative element but relies solely on describing or explaining contemporary events rather than taking into account past events. The next type of research approach is that of historical research. Whilst it again addresses the 'how' and 'why' type of research problem its nature requires it to focus on past events and ignoring the contemporary, thus making it unsuitable for this research.

The final type of research methodology is that of use of case studies. Case study research allows the researcher to study the 'how' and 'why' type of research problem. Further, the case study approach is best suited for situations where the research is focused on dynamic contemporary events in an environment where the researcher has little or no control (Bonoma 1985; Yin 1994).

In brief, case study methodology was deemed the most appropriate approach for this research due to three principal reasons: this research aimed at exploring, rather than explaining the contemporary events associated with NPD processes within the STBFs; it provided for the study of the 'how' and 'why' type research problem and this research involved complex social dynamics.

4.4 Quality of case study research design

This section discusses the measures that were taken to achieve quality in this case study research. Achieving validity and reliability is an important consideration in research design as it may improve the quality of research design. Further, the literature shows that it is now widely accepted that validity and reliability can be achieved in case study research (Eisenhardt 1989; Gabriel 1990; Miles & Huberman 1994; Parkhe 1993; Yin 1994). Although the tests used are valid for qualitative research, they are not used exclusively for case study research, but criteria of construct, internal and external validity and of reliability are generally used within the paradigm of positivism (Lincoln & Guba 1985).

The literature outlined six criteria for judging research quality specifically within the realism paradigm (Healy and Perry 2000). The first of these, ontological appropriateness, is concerned with the ontological basis of the realism paradigm that assumes that the research is dealing with complex social phenomena involving reflective people (Magee 1985). Ontological appropriateness was achieved in this research by the use of the research problem dealing with a complex social phenomenon that involved a 'how' and 'why' question.

The second criterion, contingent validity, is about the validity of generative mechanisms and the context that make them contingent. In realism, the phenomenon which was the subject of study could not be isolated and controlled therefore causal factors were contingent upon their environments (Pawson and Tilley 1997). In this research, contingent validity was achieved by asking in-depth

questions with emphasis on ‘why’ questions to ensure the effects of context on phenomena were captured through the solicitation of explanatory responses. Further, the study was conducted using theoretical and literal replication in respect to the types of technologies, numbers of cases and speed-to-market.

The third criterion was that of the multiple perceptions of participants and peer researcher. The realism paradigm relies on multiple perceptions in that these perceptions can be considered a window to reality through which a picture of reality can be triangulated with other perceptions (Perry, Alizadeh and Reige 1997). To satisfy this criterion, triangulation of evidence was achieved by collecting data from three sources including convergent interviews, case study interviews and documentation. Additionally, two interviews were conducted in each case to capture multiple perceptions of the participants and key informants also reviewed the draft of the case report that achieved further triangulation as described in section 4.7.

The remaining three quality criterion relate to methodology, these being ‘methodological trustworthiness’; ‘analytical generalisation’ and ‘construct validity’. Methodological trustworthiness refers to the extent to which the research can be audited by using a case study database and by the use of quotations in the report (Healy and Perry 1998). In order to achieve methodological trustworthiness, a case study database was established for this study and quotes were used in the writing and analysis of data in chapter 5. Analytical generalisation relates to theory building rather than theory testing. That is, scientific realism must primarily be theory building rather than theory testing. Finally, construct validity refers to how well information about the constructs in the theory being built are able to be measured. The construct validity in this research was achieved by using prior theory in the research, multiple sources of evidence and by asking key informants to review the case draft.

In conclusion, this section outlined the six quality criteria and how each was addressed within this research. Further, it is argued that this study provides and demonstrates the necessary rigour required for the undertaking of case study research. A summary of the case study techniques for achieving quality are provided in table 4.4.

Table 4.4 Case study techniques for achieving quality

Criteria	Techniques adopted in this research
1. Ontological appropriateness	• Selection of research problem dealing with complex social science phenomena, how and why question (section 1.2)
2. Contingent validity	• In-depth question with emphasis on 'how and why' questions (section 1.2) • Theoretical and literal replication (section 4.6)
3. Multiple perceptions of participants and of peer researchers	• Multiple interviews (section 4.6.1) • Broad questions before probe (section 4.7) • Triangulation of evidence (section 4.7)
4. Methodological trustworthiness	• Case study database (section 4.9) • Use of quotes (section 4.9) • Case selection and interview procedures (section 4.7)
5. Analytical generalisations	• Develop interview protocol from research issues (section 4.5)
6. Construct validity	• Use of prior theory (section 4.5) • Case study data bases (section 4.9) • Triangulation of evidence (section 4.7)

Source: developed from Healy & Perry (2000), Lincoln & Guba (1985); Miles & Huberman (1994); Yin (1994)

4.5 Theory building

Section 4.2 outlined the rationale for using the realism paradigm to be the most appropriate paradigm for this research and section 3.4 established that the case study was the most appropriate methodology within the realism paradigm. In turn, this section discusses the actual process of theory building from case studies and analyses the use of prior theory in the research.

Qualitative research can be considered a continuum of the extremes of both inductive and deductive reasoning processes. 'Grounded theory' is at the induction extreme (Glasser & Strauss 1967). However, this position has been refined by the

realisation that prior theory cannot be ignored in a research design (Jankowski & Wester 1991; Perry 1998b; Strauss 1987). Thus, the process of ongoing theory building requires continuous interplay between induction and deduction so as to lessen the gap between the known and the knowable (Parkhe 1993). That is, a balance of induction and deduction is required in a research design (Perry 1998b). Prior theory provides directions as to what specific data from each case needs to be gathered as well as the scheme for their analysis. This process may help in developing a particular line of theory relevant to new product development by STBFs rather than identifying and documenting all theoretical possibilities. This research attempted to achieve a balance between induction and deduction by incorporating existing theories about the topic of new product development by STBFs as described next.

The primary source of prior theory consulted in this research was the literature review provided in chapter 2 with a particular focus on the background theories of corporate strategy, new product development, technology management and marketing theory. As a result, three research questions were developed and became the focus of the data collection effort.

A common concern in undertaking this type of qualitative research is that an initial theoretical position might lead to biases in theory generation (Wollin 1996). This was addressed in the research by remaining vigilant for the biases that might have resulted from an initial theoretical position. For example, during data collection, respondents were asked to tell the story about their experiences in new product development in the context of STBFs in their own words by the use of open ended questioning. The respondents were also allowed to expand and digress and cover the areas they thought critical (section 3.7.3).

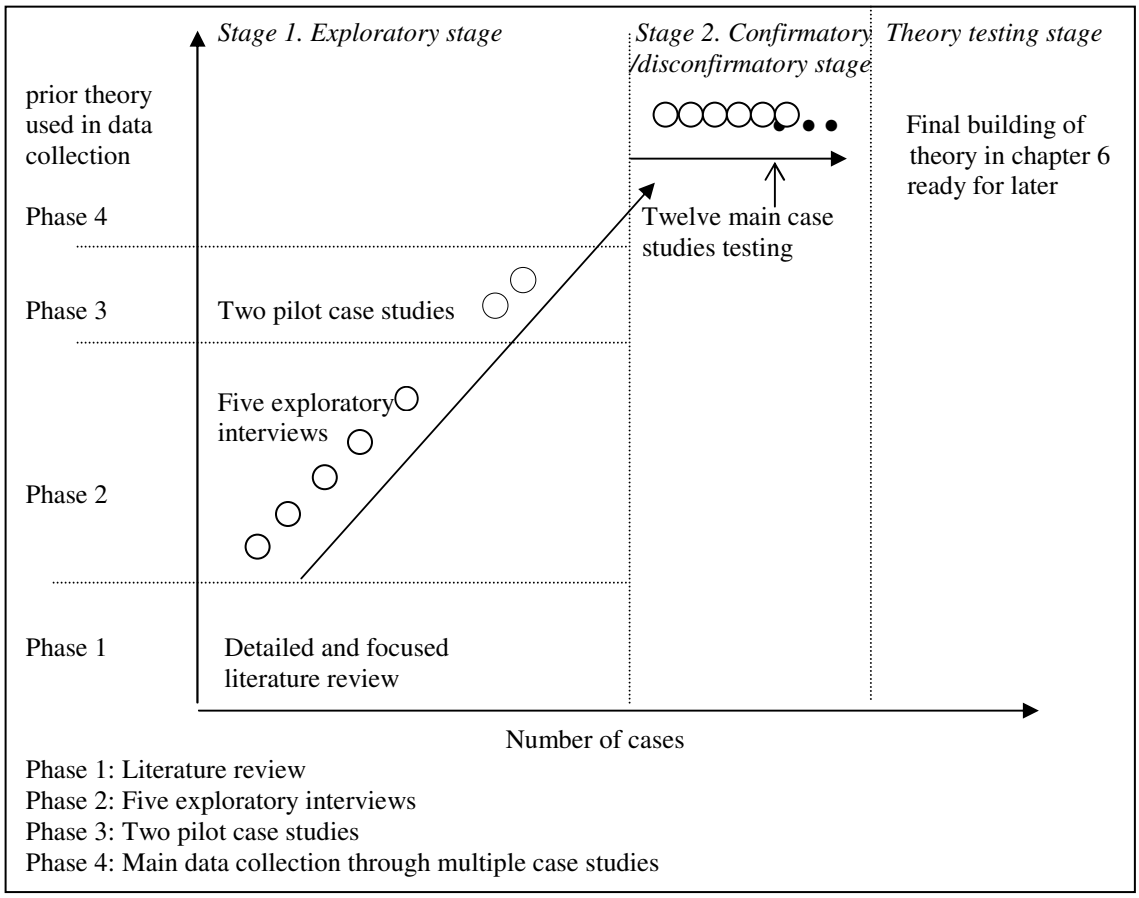
Stages of theory building research. A two-stage process of theory building was adopted in this research, outlined in Figure 4.2 with the y-axis representing prior theory used to shape data collection, while the x-axis refers to number of cases. The

first stage was inductive and exploratory, while the second stage involved case studies which either confirmed or disconfirmed the theory constructed. The inductive stage started with a focused and detailed literature review followed by five exploratory interviews comprising three new product development practioners (2 consultants and 1 product manager), an academic in the product innovation field and a venture capitalist. The purpose of the two pilot studies was to refine the data collection instruments and the interview protocol.

Phase 1- literature review. At the commencement of this research the researcher was conversant with the broader issues in new product development due to his previous professional capacity in product innovation and technology commercialisation. In addition, reading of the literature and consultation with colleagues and supervisor helped identify and narrow the research. This process helped with further refining the research problem. In turn, the initial reading of literature and development of the research problem guided the research into a more focused continuation of the literature review to further develop the theoretical framework (section 2.5). Several databases including ABI Inform, Business ASAP, Emerald, Ebsco and Infotrac, were utilised to undertake the literature review. Next, appropriate research questions were identified and defined in chapter 2 from a review of literature in relation to the theoretical framework.

Phase 2 - Convergent interviews. In this phase five convergent interviews were conducted to develop and further refine the theoretical framework (section 2.5). The literature review (section 2.4) had revealed that there was a lack of study in the area of the new product development in STBFs. Therefore, there was a need to obtain first hand information from the new product development managers and founders of STBFs to compare and contrast their views of new product development with that obtained from the literature. Further, convergent interviewing assisted in development of a theoretical framework and a further refining of the research questions (Zikmund 1997).

Figure 4.2 Stages of theory building in this research



Source: *adapted for this research from Carson et al. (2001), Perry (1998b), Perry & Coote (1994)*

After having gained insights from a focused and detailed literature review, five in-depth personal interviews were conducted, each lasting between 45 minutes and 90 minutes, depending on the extent that respondents wished to elaborate on probe questions. The purpose was to probe the issue of new product development by STBFs identified in the extant literature. As outlined in chapter 3, the interviewing procedure utilised the snowballing technique in order to achieve convergence from the interview process. In this process more respondents were added until there was a stable pattern of agreement (convergence) or disagreement (divergence) on issues, with the disagreements being explained (Nair and Riege 1995). Individuals were targeted that had extensive experience in the field of new product development,

particularly in the context of new technology-based ventures. In addition, the individuals targeted had gained this experience and knowledge from a number of different perspectives, further reducing the affects of possible bias being generated from any one perspective. Respondent A was a partner of a management consulting firm specialising in advising on new technology venture creation. Respondent B was a principal consultant of a new product development consulting firm with a mixture small and medium sized manufacturing and ICT firms as clients. Respondent C was a new product manager of a large Australian industrial company. Respondent D was an academic in the product innovation field. Finally, Respondent E was the Managing Director of a venture capital firm involved in assessing and funding start-up technology firms. The process of this phase of research was described in detail in chapter 3. More details of interview questions and managers' responses are detailed in Appendix I.

Phase 3 - pilot case studies. Pilot case studies can be used to provide general directions for the data collection process (Perry 1998b). Further, pilot studies can assist in determining the usefulness of the interview questions and assessing their reliability and validity. Further, pilot studies also allow the researcher an opportunity to review and revise the research instrument and interview protocol before the main case studies are done (Eisenhardt 1989; Parkhe 1993; Yin 1994). In this research, two pilot case studies were conducted prior to the formal data collection process (section 4.8). Two respondents were identified for each pilot case study, being the manager responsible for new product development and manager responsible for organisational strategy for the firm. The study covered both substantive and methodological issues and was a prototype for the main data collection.

Phase 4 - case studies. The exploratory insights gained from the previous three phases helped the researcher in detailed planning and preparations for the main data collection phase. That is, after the refinement of the interview protocol described in phase 3 above, the final stage is that of undertaking the case studies and analysing

the collected data from 12 cases. The data collected from the first four phases of the research were then analysed in chapter 5. Chapter 6 provides analytical generalisation by providing a discussion on the resulting theories developed.

Subsequently, the process adopted for the resulting theory building follows that outlined by Eisenhardt (1989). Table 4.5 summarises the theory building process applied to this research, with corresponding activities and justifications for their use.

Table 4.5 Activities of theory building from case studies

Steps	Activities	Reasons	Chapter
1. Getting started	• Literature review • Define research question	• Development of a initial theoretical framework for the research	2
2. Selecting cases	• Purposeful sampling	• Cases based on literal and theoretical replication	3 & 4
3. Crafting instruments and protocol	• Develop the case study protocol • Undertaking pilot studies	• Control the contextual environment of the study • Improve reliability • Conceptual clarifications of research design	3 & 4
4. Entering the field	• Multiple data collection method through interviews and documentation	• Better triangulation of evidence • Achieve construct validity	5
5. Analysing the data	• Cross-case analysis • Use 'quotes' from the case studies	• Transcription of data • Achieve reliability • Gain qualitative insight	5
6. Shaping the model	• Tabulate the evidences collected from the case study to shape the emerging theory and model	• Confirms, extends and sharpen the theory • Builds internal validity	5
7. Reaching closure	• Document the emerging theory	• Write-up the theory, supporting it with empirical evidences from case studies	6

Source: adapted from Eisenhardt (1989)

In brief, this research used prior theory and adopted a balance of induction and deduction in case study research design by conducting a detailed literature review, exploratory interviews and confirmatory/disconfirmatory case studies. The process of developing theories from case studies has also been outlined in this section. Next, the process of case selection and sampling is considered.

4.6 Selection of cases

A single case study approach is appropriate when a number of conditions can be met (Yin 1994). The first is where the case represents a critical test of existing theory. The second is where the case represents a rare or unique event and the third is where the single case study is a revelatory case where the investigator has an opportunity to observe previously inaccessible phenomena. This research did not meet these conditions, so a multiple case study approach was chosen as being more appropriate. Moreover, multiple case design has a number of additional advantages over single case studies (Bonoma 1985; Parke 1993; Yin 1994). For example, using a variety of cases from different organisations helps to capture the complexity of the social settings and facilitates comparison of activities across a variety of settings and situations (Adams, Day & Dougherty 1998). Further, a multiple case study approach should be regarded as being 'multiple experiments' rather than 'multiple respondents in a survey' (Yin 1994, p. 45), therefore replication rather than sampling logic should be used. Thus, when using multiple case study research, as in this research, individual cases should be chosen so to predict similar results for predicable reasons (literal replication) or to produce contrary results for predictable reasons (theoretical replication) (Perry and Coote 1994; Yin 1994).

Sampling population and strategies. In order to develop the multiple case study design, the sampling population case selection criteria were identified and specified (Eisenhardt 1989). The importance of specifying the population is due to the need to limit extraneous variations and to sharpen external validity (Wilson & Vlosky 1997). The population of interest for the purpose of this research was new

technology ventures with the case study selection strategy outlined in table 4.6. This population was refined further to be that of technology-based start-ups (to purposefully exclude technology-intensive and spin-off firms as explained in chapter 2). Within this population three types of STBF were defined according to the time-to-market for their respective products: those with a short time-to-market (less than 2 years), those with a medium time-to-market (2-5 years) and those with long time-to-market (greater than 5 years). This strategy of grouping cases into three types of STBF facilitated cross-case analysis within the selected cases and ensured better analytical generalisation to this particular population. Once again this grouping strategy was further enhanced by examining the business development support environment provided within and outside of a business incubator environment.

Table 4.6 Research design for cases to achieve theoretical and literal replications

Time to Market	**Case *with* incubator support**	**Cases *without* incubator support**
Short time to market (less than 2 years)	Case A Case B	Case C Case D
Medium time to market (less than 2 years)	Case E Case F	Case G Case H
Long time to market (less than 2 years)	Case I Case J	Case K Case L
	2 interviews per case	2 interviews per case

Source: developed for this research

This combined grouping approach in the actual selection of cases, in respect to both time-to-market and incubator support was done to achieve literal and theoretical replication. This purposeful sampling approach contrasts with sampling logic,

which is based on the assumption of statistical generalisation of findings to the population (Perry & Coote 1994).

Patton (1990) lists 15 strategies of purposive sampling of which a number have been adopted for this research. First, the strategy of ‘maximum variation sampling’ was selected because it can be used to show unique or diverse variations that have emerged and helps to identify common patterns that cut across variations. In this study, maximum variation sampling was implemented by using ‘time-to-market’ as an important determinant of the cases selected in order to achieve maximum variation between individual cases. Second, ‘stratified purposeful sampling’ was used because it allowed for the comparison of characteristics of subgroups of interest. For this study, comparisons were made between cases situated within and without a business incubator support environment. This strategy also provided literal replication for the study. Finally, the use of confirming and disconfirming cases allowed the case study research to confirm or disconfirm the theory built through the literature review and convergent interviewing phases of theory building.

In brief, the selection of cases for this study used purposive and replication logic rather than sampling logic so as to provide a means of selecting 'information rich' cases worthy of in-depth study and which provided theoretical and literal replication (Perry & Coote 1994).

Number of cases. As outlined in table 3.5, a total of 12 cases were selected for this research. Authors have a variety of views on the question of how many cases should be used in case study research. On the one hand there are authors (for example, Romano 1989; Patton 1990) who argue that the number of cases should be left to the researcher. Derivations of this view include Eisenhardt (1989) who recommends that the basis of the number of should be the point of theoretical saturation. Similarly, Lincoln and Guba (1985) recommend selection of cases to the point of redundancy.

On the other hand, some authors are more specific regarding the number of cases. The range of views expressed in this camp include: Eisenhardt (1989) who suggests 4 to 10 cases as acceptable and who goes on to express the view that less than four cases would make it difficult to generate theory and any empirical findings are likely to be unconvincing; Miles and Huberman (1994) propose that more than 15 cases could cloud the researcher's ability to comprehend local dynamics and Hedges (1985) who puts a maximum limit on the number of cases at 12. For the purpose of this research a total of 12 cases has been selected as being the optimal number to achieve both theoretic and replication logic and is within the range deemed acceptable by other researchers.

Number of interviews. In total, the researcher conducted 33 interviews comprising 2 interviews for each of the 12 main cases and 2 pilot cases and 5 convergent interviews. Other researchers express the view that the number of interviews should lie within a suggested range of 20 to 50 respondents (Griggs 1987; Larsson 1993). However, these views are not taken as absolutes as some authors (for example, de Ruyer & Scholl 1998) suggest that one of the distinguishing features of qualitative research such as case study methodology is that the number of respondents seldom reaches 60. Thus, while Perry (1998) states that case study research should ideally have more than 35 respondents, as this study demonstrates the necessary rigor of good case study design, having 33 interviews rather than 35 does not create a limitation for this research. Indeed, it was identified within the convergent interview phase when examining the target respondents for interviews for the case studies, that some STBFs may in fact have no more than 2 employees at the time of interview. The respondents included two managers of the STBF being the product development champion and senior business development strategist, one of whom was usually the founder.

4.7 Data collection protocol

This section outlines the three key issues which need to be addressed when considering research procedures: describing the data sources; the case study protocol and analysing the data collected.

Data for the case studies in this research were collected from multiple sources as this allowed the investigator to address a broader range of historical, attitudinal, and behavioural issues (Eisenhardt 1989). Further, the use of multiple sources of evidence facilitated the development of a converging line of inquiry, by which the process of triangulation is ensured and from which construct validity can be achieved (Yin 1994).

In case study research, data collection relies on six main sources of evidence: documentation, archival records, interviews, direct observation, participant observation and physical artifacts (Yin 1994). Case study interviews should encourage the respondent to describe the phenomena under investigation (Jarratt 1996). Thus, well-informed respondents can provide important insights into the situation (Yin 1994). For this research, the most primary source of data was the interview with selected managers within the target STBF. This was followed by the analysis of documentation and archival records, such as reports, information memoranda, proposals, schematic representations of the development process, written down review procedures, test marketing report, marketing collateral and other documents related to the new product development activities and strategy development within the organisation.

The case study protocol assisted in improving reliability of the case studies by providing direction for the researcher. It permitted the researcher to control the contextual environment of the study which is an important consideration in the design and application of qualitative research approaches (Emory & Cooper 1991; Yin 1994). The case study protocol for this research is summarised in table 4.7.

Table 4.7 Important issues of case study protocol

Case study protocol topics	Essential components	Chapter numbers
Overview of the project	• Background information about the project • Project purpose and objectives • Relevant readings/literature • Research questions being investigated	Chapter 1 Chapter 1 Chapter 2 Chapter 2
Field procedures	• Prior theory • Access to study sites and interviewees • General sources of information • Procedural scheduling	Chapter 3 & 4 Chapter 4 Chapter 4 Chapter 4
Interview questions	• Specific interview questions • Sources of information	Appendix III Chapter 4
Guide for the case study report	• Outline • Format • Other documentation	Chapter 4 Chapter 4 Chapter 4

Source: developed from Yin (1994, p.66-74)

To address the first protocol topic of the overview of the project, the background of the project and the project purpose and objectives of the study were outlined in chapter 1. Additionally, the literature relevant to the research problem were cited in chapter 2 and based upon this literature the research questions were developed.

A researcher needs well planned field procedures (the second protocol topic). Such field procedures include an adequate plan for access and communication with each respondent, access to required resources for each interview beforehand, proper preparation of time schedule and development of contingency plans in the event of interview cancellation (Yin 1994). For this research, the field procedures were planned well in advance of the interviews as discussed in the next section (section 4.7). A major issue of concern by the respondents was that of ensuring confidentiality. Due to the nature of some of the products under development, trade secrets comprising business processes and technological achievements were a

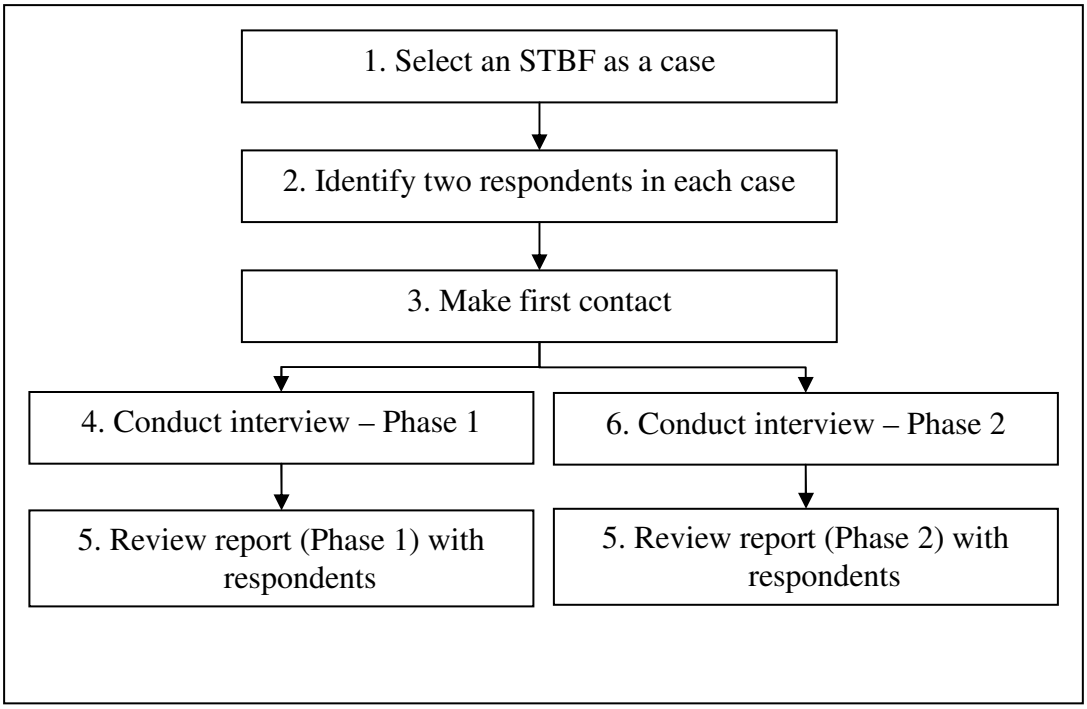
major component of intellectual property protection strategy of some of the STBFs. As such, there was a high level of sensitivity around the issue of confidentiality. Names of organisations and respondents were disguised to maintain confidentiality by coding the names of 12 participating organisations as Case A to Case L to disguise the identity of each firm and respondents.

The third topic of interview questions is the main component of the case study protocol (Yin 1994). The interview questions were developed based upon four research questions discussed in section 2.6 and are provided in appendix III. This interview instrument comprised 6 parts, nominated as parts A to F: Part A introduced the research project and details the ethical considerations; Part B comprised the opening questions to build rapport with the managers and Parts C, D, and E relate to research questions 1, 2 and 4 respectively. Research question 3, relating to support for new product development by business incubators was also answered by Part C but with additional probe questions directed to the incubator tenant cases. Part F addressed the issue of firm failure and was addressed only to those firms which failed over the course of the study. Part G asked general questions of respondents. Some of the responses were put on scales and were triangulated with discussions and altered where necessary to provide a more accurate picture of the importance of their response. This interview protocol was reviewed and was then tested in the pilot case studies (section 4.8).

The fourth topic of case study protocol is related to the format of the case study report and its potential readers. A case study database was developed that contained all the relevant documents and interview notes.

Once the protocol for conducting the research has been established it is then required to establish a systematic process of conducting the fieldwork to collect data which has been applied in this research as shown in figure 4.3. Each of the steps in this figure 4.3 is described in turn.

Figure 4.3 A systematic process of conducting fieldwork in case study research



Source: developed for this research

The first step involved selecting the STBF in accordance to the sampling plan discussed in section 4.8. The firms were identified through a combination of professional networks (such as angel investment networks), indirect inquiry via business incubators and direct inquiry. Initially, 16 companies were identified according to the sampling plan and of these 2 declined, citing concerns over confidentiality as the main reason with the other two not meeting the requirement of having a second interviewee available.

The initial contact with each firm was by way of a telephone call to the most senior manager in the firm (either Chief Executive Officer or Managing Director). From those expressing an interest in participation, a personalized letter was sent with an outline of the research to be undertaken. It was identified through the convergent interviewing that the senior manager (CEO or MD) would also like to have responsibility for either new product development and/or business development

strategy. Within this letter the senior manager was asked to identify another respondent connected with new product development. If this person was the same as the senior manager, then the manager with responsibility for business development and overall business strategy should be nominated. Thus, two managers from each of the 12 participating organisations were identified using 'key informant' method for data collection, frequently used in new product development research (Di Benedetto 1999).

After having identified the two key interviewees, contact was made with them through telephone or e-mail to introduce the researcher, to explain the research, assure them about confidentiality and more importantly to fix the date and time of interviews.

In conducting the actual interview, the interview itself was quasi-structured because this allowed for greater flexibility and gave respondents scope to delineate their views more freely. The interview commenced with a general introduction outlining the purpose, objectives and the interview agenda. As the interview progressed the questions became more structured, particularly in relation to questions addressing the research issues developed in chapter 2. The interview protocol is provided in Appendix II, although the interviews were conducted in such a way as to allow the respondents to expand, illustrate and digress within any question. Further, the questions were not asked in the order they were set out in the interview protocol but rather the questioning order was based on the interviewees' responses (Carson et al. 2001).

Additionally, as outlined in figure 4.3, the interview was conducted in two phases, with the second phase addressing the firm success measurement issues (Question 11-16 of Part F of the Interview Protocol). This second phase was conducted at the end of the study in order to allow a period of time to elapse to identify any STBFs which may fail over the course of the study. In turn, this allowed for an additional dimension to the triangulation of evidence in respect to research question 2

concerned with the relationship between the elements of NPD adopted and firm failure.

As a number of the respondents were extremely sensitive about confidentiality, it was requested that the interviews not be tape-recorded. Thus, it was a necessity to take detailed interview notes for data recording purposes and this was performed for all cases to obtain consistency and accuracy. Each interview lasted between one and a half to two and a half hours and was conducted at each firm's premises at the scheduled date and time. As it was not possible to extend the duration of the interview, it was necessary to conduct follow-up interviews if these were required.

After the completion of interviews the results of the interviews were written down in comprehensive reports and given back to the respondents, inviting them to correct errors of facts and supply additional information. After several follow up telephone phone calls and e-mails all the managers sent back the report containing only very minor corrections, if any.

It is common in studies in new product development that a retrospective methodology is used to obtain data about past new product development projects (Di Benedetto 1999). However, given the nature of the cases within this study (being start-ups), most have either not yet entered the market with their product or have just recently done so at the time of interview. Moreover, one of the purposes of conducting the study was to look for trends and emerging issues in relation to the new product development process rather than success/failure measures.

In brief, a systematic and structured approach was adopted to collect data from multiple sources. This structured process was first applied to two pilot studies, described next.

4.8 Pilot case studies

Prior to the main data collection stage, two pilot case studies were conducted to develop further lines of questioning. Pilot case studies have roles to play in determining the usefulness of the interview questions and assessing their reliability and validity. Pilot case studies also allow the researcher an opportunity to review and revise the research instrument and interview protocol before subsequent case studies are done (Eisenhardt 1989; Parkhe 1993). The pilot case studies are not a pre-test of a questionnaire but are rather like a '*dress rehearsal in which the intended data collection plan is used as faithfully as possible as a final test run*' (Yin 1994, p.74).

Convenience, access and geographic proximity were the main criteria for selecting the pilot cases (Yin 1994). Therefore, one Brisbane based firm and one Gold Coast based firm were selected for these pilot studies. One limitation encountered in the use of a pilot case study approach should be noted. This limitation is related to interview timing associated to questions in the protocol related to firm success measures. Specifically this related to interview questions 11-16 within Part F of the interview protocol. As outlined in section 4.7, these questions were asked of the 12 cases after a substantial period of time in order to identify firms which have failed during this period. However, this limitation does not affect the validity of the pilot study as there is substantial flexibility in the nature of the pilot enquiry. In particular, '*pilot cases can be broader and less focused than the ultimate data collection plan… in order to cover the substantive and methodological issues*' (Yin 1994, p75).

The interview protocol developed for this research and provided in Appendix II was re-examined and was subject to only minor modifications after the completion of the pilot studies. Data from other cases were collected using the data collection procedure detailed in section 4.7. After the collection of data from all the 12 cases, appropriate analyses were conducted.

4.9 Case study data analysis procedures

The data collected from case studies should be examined, compiled or combined with other evidence, so that the answers to the research problems and research questions are vividly clear to the readers, that is, multiple levels and types of data analysis can be employed in this research. Although data analysis is discussed in detail in chapter 5, some of the techniques of data analysis proposed in the literature are briefly described in this section (Eisenhardt 1989; Miles & Huberman 1994; Patton 1990; Yin 1994).

There are a number of software programs available to assist where open coding of qualitative data was required. Among these is the NUD*IST software program, which allows the researcher to condense a vast array of data into categories but allows the researcher to be ‘open’ to creating new themes and changing the initial codes in subsequent analyses (Neuman 1994, p. 407). However, while NUD*IST is a useful tool for organising large amounts of text, it tends to be 'disproportionately time-consuming' (MacMillan and MacLachlan 1999, p.12). Furthermore, as the interview data was recorded in a database immediately after the interviews were conducted, re-transcribing the same data into a separate program compounds this time-consumption. Thus, NUD*IST was not used in this research.

The process adopted for analyses in this research followed a three stage methodology. First, interviews were transcribed from detailed interview notes into a Microsoft Access database developed specifically for this research. Next, the transcripts and notes within Microsoft Access were analysed using the LEXIMANCER software program. LEXIMANCER assisted by identifying, analysing and mapping key concepts from the text transcripts within Access.

Second, the data analysis was undertaken using ‘cross-cluster analysis’ and ‘data display techniques’ (Miles & Huberman 1994; Yin 1994). This was achieved by displaying the data in graphs, matrices and tables to facilitate ease of examination.

It involved tabulating the frequency of different events and placing the information in chronological order. By this process, the researcher compared and contrasted the data patterns and reported the findings visually. This process was also used to identify emerging concepts among clusters of cases and thus played an important supporting technique of LEXIMANCER as the primary concept mapping tool.

Finally, quotes from the case studies were used to assist the reader to gain qualitative insights into the issues being studied (Patton 1990). These qualitative insights were then compared with the extant literature in order to achieve a level of conceptual/theoretical coherence.

4.10 Limitations of case study research

The adoption of case study methodology for this research provided rigor to the research design and was based on sound philosophical positions (Perry and Coote 1994). However, a number of criticisms have been levelled at case study research, a summary of which is shown in table 4.8.

Table 4.8 Criticisms of case research and adopted remedies in this study

Criticisms	Remedies
1. Results in overly complex theories	Develop prior theories and specific research questions
2. External validity	Use theoretical replication logic, compare evidence with extant literature
3. Difficult to conduct	Use case study protocol
4. Less codified	Use structured process for fieldwork and data collection
5. Lack of rigour	Use interview protocol, the questions for which are based on prior theory; rigorous fieldwork

Source: developed for this research from Bonoma (1985), Dick (1990), Eisenhardt (1989), Larsson (1993) and Parkhe (1993)

Theory development is a primary concern of case study research yet the first criticism identified is that case study methodology can lead to overly complex theories (Eisenhardt 1989; Parkhe 1993). To address this criticism, prior theory and specific research questions were developed in chapter 2. The second criticism states that case study method in some situations may not achieve external validity. However, this criticism can be answered by adopting the use of literal and theoretical replication logic (Yin 1994). The third criticism is that the case study research is more time consuming, difficult to conduct and sometimes involve unforeseen logistical problems (Marshall & Rossman 1995; Parkhe 1993). In this research, the researcher overcame this problem by the use of a case study protocol. The fourth criticism is that case study research is less codified than other methodologies (Adam, Day & Dougherty 1998). This criticism was answered in this research by conducting structured fieldwork for data collection (section 4.7). The last criticism, lack of rigour was answered by the careful preparation of interview questions and interview protocol from the extant literature.

4.11 Ethical considerations

The primary purpose of research ethics is to protect participating organisations and persons from any possible disadvantages or adverse consequences that may result from this research (Emory & Cooper 1995; Patton 1990). This was relevant in this study as the researcher obtained information on the business considered 'commercial-in-confidence' including growth and future plans, perceptions, attitudes and behaviors as well as details on products and technologies. Given the nature of the information gathered, this study applied an ethics strategy based on the literature of Miles and Huberman (1994), Emory and Cooper (1991) and Patton (1990), as well as on the ethics guidelines of the University of Southern Queensland's Faculty of Business's Research and Higher Degrees Committee. As a result the following were adopted.

First, interviewees were fully informed about both the intent of the research and were assured confidentiality. A personalized letter was sent to each interviewee that outlined the intent of the research and to reinforce previously stated ethics around confidentiality. The respondents were also briefed about who would have access to the data collected and for what purposes.

The researcher respected the participating organisation's right to quality research and respected their own ethical codes. These ethical codes were primarily practised through the adoption and use of the case study protocol, which helped the researcher in evolving an ethically responsible research program. The acknowledgement of ethical practices has also enhanced the quality of this research.

4.12 Conclusion

This chapter detailed the research methodology adopted case study methodology using a realism paradigm. Specifically, this chapter outlined the methodology adopted in order to collect the data to address these five research propositions and answer the research questions. This chapter commences with an examination of the four scientific paradigms of positivism, realism, critical theory and constructivism and showed that the realism paradigm is the most appropriate foundation for this research. Next, the case study research methodology used in the study was discussed and went on to detail the criteria used for judging quality of case research. A discussion of the role of prior theory in case study research, the selection process of cases to be studied as well as the protocol for the case study design and data analysis was undertaken. Finally, the chapter concluded with a discussion of the limitations of case study methodology and the ethical considerations relevant to this research.

In a similar way to the exploratory research phase outlined in chapter 3, the findings from the case study research phase can also be regarded as being largely representative of similar firms irrespective of geographic region. This means that

the findings from the case study phase can be generalised for most STBFs globally. Thus, the case study methodology described in this chapter was used as a basis of gathering and analysing data to answer the three research questions and five associated research propositions identified in chapter 3. The next chapter deals with the data analysis.

5 Data analysis

5.1 Introduction

Chapter 4 described the case study methodology of data collection. In turn, the objective of this chapter is to summarise and analyse the data collected from the case studies in order that patterns and themes can be identified. This will allow the researcher to answer the research problem of this research, that is, '*what are the origins and nature of new product development processes within STBFs and how do they contribute to STBF success?*

The objective of the data analysis was to identify core themes and to search for structure in the data for the purpose of answering the overall research problem, related research questions and addressing the specific research propositions of this research. This arises from the requirement of qualitative research that the researcher is required to define, theorise, explain, categorise, map and explore the collected data, that is, to look for patterns (Ritchie & Spencer 1994). It is appropriate to use case study research when looking to identify core themes and patterns common to a small set of cases. Thus, this chapter examines the purposefully chosen set of cases in clusters (Miles & Huberman 1994) that share common patterns.

To do this, four main steps were taken. First, the raw data and field notes were typed, edited and corrected to familiarize the researcher with the data. During this process systematic examination of the data for patterns from each cluster was also undertaken by mapping the range, nature and dynamics of phenomena, seeking explanations and searching for emerging themes and key dimensions (Miles & Huberman 1994). Second, relevant documents obtained from the respondents, such as information memorandums, annual reports, prospectuses and business plans, were consulted to assist with triangulation. Third, each case was examined as a whole in order to gain a proper understanding of each respondent's thoughts and views about the factors in the case. Using this 'within-case' analysis process, the background of each case was described. Finally, an analysis of the similarities and

differences between clusters was undertaken and the systematic associations among the clusters of cases were noted. That is, 'cross-cluster' analysis was conducted.

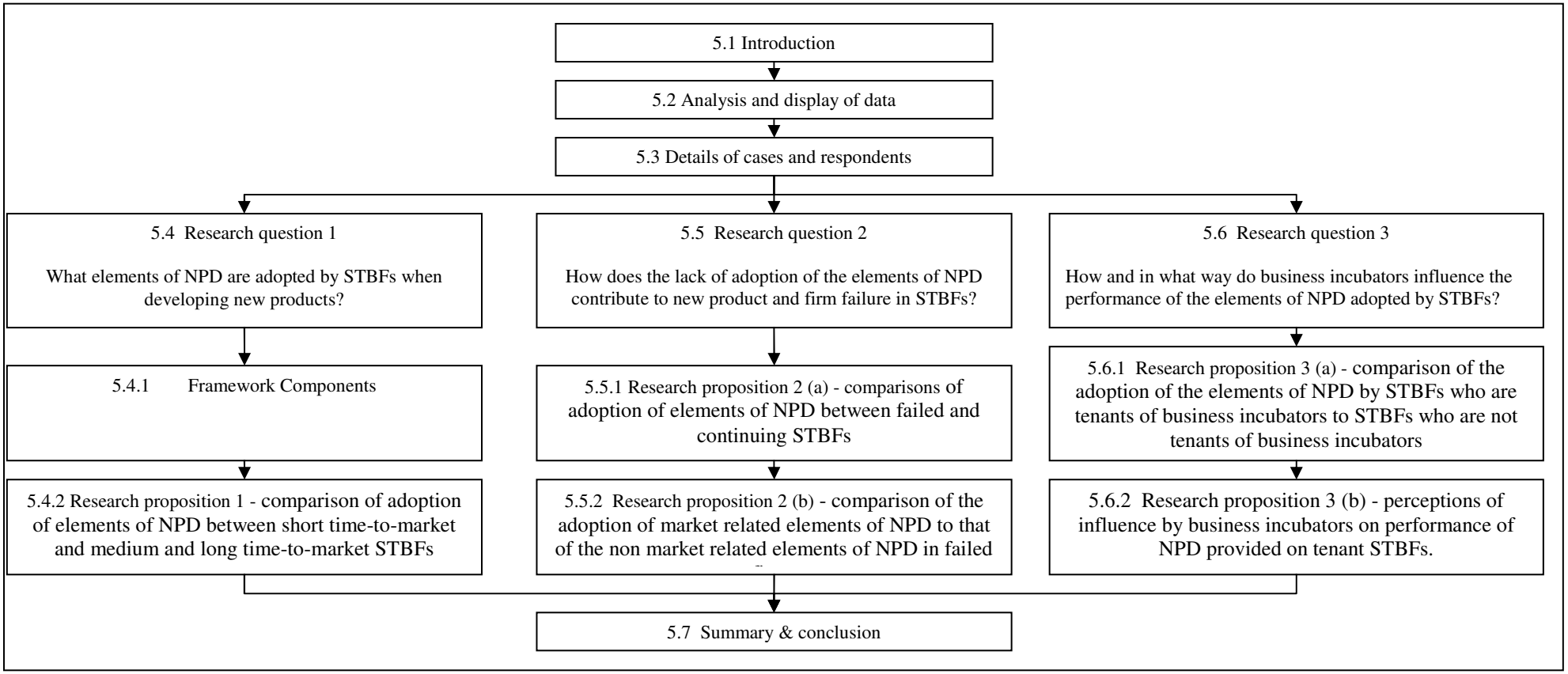
The next section contains a brief overview of the data analysis techniques used and the meaning of symbols and abbreviations adopted in the analysis phase. A brief description and analysis of each case and the details of respondents are given in section 5.3. The details of the cross-cluster analyses are provided in sections 5.4, 5.5, and 5.6 respectively. These sections are related to the three research questions derived from the amended theoretical framework of new product development in STBFs as outlined in chapter 3. Research question 1, that is, *'What elements of NPD are adopted by STBFs when developing new products?'* is examined in section 5.4. Research question 2, that is, *'How does the lack of adoption of the elements of NPD contribute to new product and firm successes and failures in STBFs?'* is discussed in section 5.5. The final research question, that is, *'How and in what ways do business incubators influence the performance of the elements of NPD adopted by STBFs?'* is analysed in section 5.6. Finally, the chapter concludes by summarising the key findings from the research in section 5.7. The structure of this chapter is provided in figure 5.1.

5.2 Analysis and display of data

In this section the detailed content analysis resulting from the within case analysis method as well as the cross-cluster analysis of the pattern of outcomes from the groupings of cases for each of the interview questions are discussed. Question numbers within each section are noted to identify which questions were answered in a particular section. A brief overview of the methods and types of analysis are presented next, along with the meanings of symbols and abbreviations used in this chapter.

Analysis type. A detailed and intensive content analysis was undertaken of interview responses, documents and field notes and matrices were developed from respondents' responses to interview questions (Miles & Huberman 1994).

Figure 5.1 Outline of Chapter 5



Source: developed for this research

Interviewees provided two types of responses to interview questions. The first were responses provided in the form of numbered scaled responses to measure attitudes. In this way these responses provided the interviewees' attitudes to the degrees of importance relating to specific factors. The numbered scaled responses were used in this research to indicate the approximate measure of importance of each factor. As such, responses were not intended to be a precise measure of importance because the interviews were intended to be part of a search for meaning and only the general direction of emphasis is presented, analysed and described.

The second type of response was the verbal response to questions posed to the interviewee. The objective of these questions was to provide an in-depth explanation of what actually occurs in practice in relation to each factor. That is an answer to the 'how' and 'why' of each factor. Extensive notes were taken of responses to questions directed to the interviewee.

As outlined in chapter 3, from the pilot case undertaken it was apparent that a high degree of reluctance existed by interviewees to have interviews recorded. This was in despite of reinforcing guarantees of anonymity and confidentiality by the interviewer. In order to obtain as much consistency in the analytical methodology as possible for the purpose of replication, interviews were not recorded but extensive notes were taken with the respondent given the opportunity to review the handwritten notes. These comprehensive notes were then transcribed into electronic form.

Additionally, extensive use was made of quotations from interview responses (Patton 1990) in order to illustrate the respondents' own experiences and opinions and thus assist in explanation building (Miles & Huberman 1994). For ease of interpretation, quotes are presented in quotation marks identified by their case letter, respondent number and question number. For instance, C:2:B5 identifies case 'C', respondent '2' and question 'B5'.

Both types of responses were presented in tables that allowed for easy recognition of patterns of data. Further, the cases were presented in chronological order as case studies usually cover events over time (Yin 1994). That is, for the purpose of this research the cases are presented according to their relative anticipated 'time-to-market' of their product. All transcript material was coded (Neuman 1997) according to the framework suggested by the research questions developed in section 3.8 and related interview protocol questions (Appendix II).

Scales employed. Numbered scaled responses were used to gather respondent's indications as to the relative importance of issues and factors based on their experiences, beliefs and opinions. The responses were placed on a scale developed for data analysis purposes with the resulting responses being triangulated with the relevant discussion results to ensure an accurate picture of the importance of issues (Carson et al. 2001; Yin 1994). These scales indicated extent of agreement of importance based on triangulated interpretations from the data. The extent of agreement of importance applied to each question requiring a numbered scaled responses was determined using the following scale:

1 = strongly agree
2 = agree
3 = undecided
4 = disagree
5 = strongly disagree

Cross-cluster analysis. In this chapter the emphasis is placed on cross-cluster analysis rather than cross-case analysis because it appeared to be a more appropriate way to understand the phenomena between groups of cases (Griggs 1987; Merriam 1988). The patterns in the data became more evident in cross-cluster analysis without the clutter of the minutiae of cross-case analysis. For this cross-cluster analysis the clusters of cases were identified based on the common patterns that the cases shared (Miles & Huberman 1994). Nevertheless, some cross-case analyses were also conducted when a factor or issue was found to be important to

an individual or small number of cases and when it had been determined as appropriate to highlight specific findings or issues between cases.

In summary, four main steps were taken for data analysis in this chapter. The first step involved the analysis of each of the 12 cases individually to identify any apparent patterns within these cases for each of the research questions. The second step was to summarise the patterns and themes in tables and matrices. The third step involved the identification and discussions of the patterns and themes across the cases through cross-cluster analysis. Finally, a summary of the main findings arising from each of the research questions were presented.

The summary of case selection was to achieve theoretical and literal replication based on two dimensions as discussed in section 4.6. These dimensions were time-to-market for the product and whether or not that firm operated within the business incubator environment.

After having discussed the methods and techniques of data analysis and the presentation of this analysis, the details of individual cases and case study respondents are discussed next in section 5.3.

5.3 Details of case study respondents

The twelve cases were selected in order to achieve theoretical and literal replication, as detailed in section 4.6. These cases were assigned codes to maintain their anonymity. Each of these 12 cases consisted of two interviews to identify cross-cluster patterns and themes, that is, a total of 24 interviews were conducted. Interviewees selected were such that their experience represented an 'information rich' basis for in-depth research (Patton 1990). As such, the two interviews within each case were conducted with the senior manager with primary responsibility for corporate strategy and with the senior manager responsible for product development. Targeting these two individuals provided the gathering of data representing two perspectives: corporate strategy and technical development. This,

in turn, facilitated triangulation of evidence. Detailed information of all the twelve cases has been kept in case study databases including interview transcripts, field notes and copies of all the relevant documents.

This section provides a brief background to the twelve cases so as to set the scene for the later analysis of the research questions in sections 5.4, 5.5, and 5.6. The summary overview of each case represents the within-case analysis and is the first step in case study data analysis (Patton 1990). As the reason for undertaking within-case analysis is to provide background information and a 'context setting' for the analysis of the research questions in the subsequent sections, only minor comparisons are made here to investigate the variations among individual cases. Thus, only a brief summary and description of each case is presented in this section (Carson et al. 2001).

Specifically, the 12 cases derived from the research design and discussed in chapter 4, are grouped into three clusters, each of four cases. In turn, each of these cluster are further grouped into two cases each according to whether they are located internal or external to a business incubator. These clusters are outlined in table 5.1.

Table 5.1: Cluster of cases for analysis

	Located within an incubator	**External to incubator**
Cluster 1 – STM (short time-to-market: less than 2 years)	Cases A & B 2 interviews per case	Cases C & D 2 interviews per case
Cluster 2 – MTM (Medium time-to-market: 2-5 years)	Cases E & F 2 interviews per case	Cases G & H 2 interviews per case
Cluster 3 – LTM (Long time-to-market: greater than 5 years)	Cases I & J 2 interviews per case	Cases K & L 2 interviews per case

Source: developed for this research

Two complementary techniques were used in order to perform this cross-cluster analysis. The first was the creation of a matrix of information according to categories and the tabulating the frequency of occurrence. In this way the researcher was able to compare responses between groups of cases (that is,

clusters). This then allowed the researcher to identify differing points of view between clusters as well as where actions were not performed (such as adoption of an individual element of NPD) (Yin 1994). The second technique was to analyse recorded comments from individual respondents in order to help explain the phenomena identified from the matrix of information.

Multiple sources of evidence and confidentiality. In applying the cross-cluster analysis to the research data it was also necessary to use multiple sources of evidence where possible. Indeed, the need to use multiple sources of evidence in case studies far exceeds that in other research strategies, such as experiments, surveys or histories (Yin, 1994, p. 91). Moreover, confidentiality and anonymity were also of paramount importance to respondents. As such, in order to conform to requests by participating organisations for confidentiality and anonymity associated with all sources of evidence and to satisfy ethical considerations (discussed in chapter 4), the cases are referred as case A through to case L and only the respondents' functional titles have been revealed. Table 5.2 contains these details of the respondents, cases and sources of evidence.

The importance of multiple sources of evidence is highlighted in the data analysis when considering evidence for actual adoption of a number of elements of NPD. In particular, this relates to the fact that actual adoption can only be evidenced subsequent to the launch of the product. For example, the evidence that a firm actually adopts segmentation within its corporate strategy would logically only be possible by examining the ways in which segmentation is implemented subsequent to entering a market. This was addressed by examining the firm's intention through both in-depth questioning as well as evidence available within other sources of evidence such as planning documentation.

Case A was a start-up information technology firm located in a business incubator. The product development activities of the business centred on the development of enhancements to microwave infrastructure for broadband internet provision. The

Table 5.2 Background of the case studies and sources of evidence

Case no.	Interview dates (stage 1)	Failed firm interviews (stage 2)	Industry sector of firm	Time-to-market for product *	Incubator support	Special purpose incubator	Interview respondents' title	Sources of evidence
A	1.12.99, 2.12.99	5.9.04	Information Technology	STM	Yes	Yes	1) Chief Executive Officer 2) Director of Technology	○ Information Memorandum
B	17.11.99		Information Technology	STM	Yes	Yes	1) Chief Executive Officer 2) Director Product Development	○ Business Plan ○ Development Plan ○ Marketing Plan
C	6.10.99	17.9.04	Information Technology	STM	No	N/A	1) Managing Director 2) Marketing Manager	○ Business Plan
D	6.10.99		Information Technology	STM	No	N/A	1) Chief Executive Officer 2) Chairman	○ NIL (no formal plan)
E	15.11.99		Manufacturing	MTM	Yes	No	1) Managing Director 2) Business Development Director	○ Business Plan
F	15.1.00		Manufacturing	MTM	Yes	No	1) Managing Director 2) Marketing Manager	○ Business Plan
G	13.11.99		Environment	MTM	No	N/A	1) Chief Executive Officer 2) Marketing Manager	○ Business Plan
H	17.11.99	NIL	Manufacturing	MTM	No	N/A	1) Chief Executive Officer 2) Manager Business Development	○ Business Plan
I	15.11.99 16.11.99		Biotechnology	LTM	Yes	No	1) Managing Director 2) Chairman	○ Business Plan ○ Intellectual Property Plan
J	18.11.99 & 19.11.99		Biotechnology	LTM	Yes	No	1) Chief Executive Officer 2) Director (Venture capitalist)	○ Business Plan ○ Information Memorandum ○ Research Plan
K	19.11.99	23.9.04	Biotechnology	LTM	No	N/A	1) Chief Executive Officer 2) Marketing Manager	○ Business Plan
L	20.11.99		Biotechnology	LTM	No	N/A	1) Managing Director 2) Business Development Manager	○ Business Plan ○ Research Strategy Plan

*Source: developed for this research * [STM = Short time-to-market (less than 2 years from concept generation); MTM = Medium time-to-market (2 to 5 years from concept generation); LTM= Long time-to-market (greater than 5 years from concept generation)]Stage 1 interviews means the main interviews covering parts A-E of the interview protocol. Stage 2 interviews means the follow-up interviews covering Part F of the interview protocol applied to the 4 identified failed firms.*

business had been in operation for fourteen months and employed seven staff. The operations of the business were initially financed from the issue of private capital to the extent that it was then required to change its status to that of a public company. This change was due to the fact that it reached the limit with respect to the number of shareholders under the rules of the Australian Securities and Investment Corporation (ASIC) applying to public companies. The business had plans to list on the Australian Stock Exchange for the purpose of raising early growth funding, as an initial Public Offering (IPO), within the two years subsequent to the interview point. Interviews were conducted with the Chief Executive Officer and the Director of Technology for the company. While the Chief Executive Officer was also the founder of the business, it was the Director of Technology that had overall responsibility for product development activities.

Case B was an information technology company established for three years and entering into the 'early growth' phase of its lifecycle at the time of initial interview. The business, located in a business incubator, had developed a Customer Resource Management (CRM) product targeted to the Small and Medium Enterprise (SME) market and in particular professional service firms. The business launched its first version of the product twelve months prior to the initial interview and was aggressively developing a series of product enhancements to its core product. The business employed 16 people across three divisions: product development; administration and support and marketing. The founder of the business had been replaced as the Chief Executive Officer but remains the Director of Product Development. Funding for the business came from private investment and the business was approaching a cash flow break-even position. It had plans to raise additional private investment capital to fund an aggressive marketing campaign. Interviews were conducted in person with the Chief Executive Officer and the Director of Product Development.

Case C was a start-up business that had been in operation for two years. It had developed an electronic business (eBusiness) solution comprising an integrated package of five individual but complementary products. According to the

company's Information Memorandum, issued by the Board of Directors to the investor community immediately prior to the time of interview, the business had developed intellectual property consisting of software utilised for improving purchasing and supply arrangements between buyer organisations and supplier organisations. The customer base for this company was medium sized organisations. The firm employed twenty people covering multidisciplinary skill areas of software programming, business development and marketing, administration and management. The business raised venture capital funding for late-stage product development (prototype software had already been developed). The business was on track at the time of initial interview to reach a break even cash flow position within the planned timeframe. The interviews for this case were conducted with the Managing Director (who was also the founder and principal developer) and the Marketing Manager, whose primary responsibility was strategic market development. The responsibility for driving product development resided with the Managing Director.

Case D was an information technology firm whose product development activities centred on innovative applications of web-based Geographic Information Systems (GIS). GIS utilises interactive geographical mapping of underlying data, which, in turn, can take many forms such as property title ownership or land degradation measurements. The firm had been established for eight months and was in late-stage product development. The firm planned to launch the first commercial version of the product in four months time from the point of initial interview. Financing for the activities of the business, including the majority of product development activities, had been derived from private investment including the investor, management partners and an ‘angel’ investor. The firm believed that it could launch the product and obtain organic growth without the need for further funding. The business consisted of four employees with the inventor and Technical Director also taking the role of Chief Executive Officer. The ‘angel’ investor acted as the Chairman of the company. Interviews were conducted with the Chief Executive Officer (who retains the principal responsibility for new product development) and the Chairman of the company.

Case E was a start-up business located in a technology incubator and had been established for eleven months. The business was commercialising intellectual property for advanced manufacturing technologies based around the use of ceramics in industrial applications. The business did not intend to undertake any manufacturing operations in its own right but rather develop applications and demonstrate their utilisation capacity through the construction of pilot facilities. The application rights were then to be on-sold to companies who may wish to acquire the application for the purpose of their own manufacturing operations. The founder of the business was the principal technologist for an international manufacturing company whose inventive capacity led to the technological breakthrough for this particular technology. However, his former employer decided not to progress the exploitation of the resulting intellectual property and as a result he was able to negotiate a commercial arrangement to take ownership of the technology. Funding for the business has come from a variety of sources including founder and angel investment as well as a number of government grants. The business employed four people at the time of initial interview with the founder being the Managing Director. Interviews were conducted with the Managing Director and the Business Development Director.

Case F was a start-up business located in a technology park. The business provided an electronics manufacturing enterprise which had been developing an advanced method of creating Printed Circuit Boards (PCBs). The development did not possess patent protection for its intellectual property but rather relied upon protecting its know-how as 'trade secrets'. The source of the intellectual property was as a result of university research which had not been exploited. The Managing Director was an industry partner providing funding for the university research. The business had been established for three years and had secured funding from an international joint venture partner. The business employed eight people at the time of initial interview. The marketing strategy of the business was based upon sale of licenses to intellectual property rather than undertaking manufacturing in its own

right. Interviews were conducted with the Managing Director and the Marketing Manager.

Case G was a business providing a biological wastewater treatment solution targeting regional and rural communities and intensive animal production operations. The business comprised two key components: the treatment of wastewater and the value-add processing of the by-product as a high value animal feed supplement. The solution was based upon unexploited university research with the ongoing product development emphasis being based upon the potential range of value-added feed supplement products. Funding for the enterprises had been sourced through a combination of investment funds from the founder and government grant funding. The business had been established four years prior to initial interview and employed six people. While the Chief Executive Officer controlled the product development activities, the actual development work was outsourced to a variety of organisations capable of undertaking technical development work. The business had intellectual property protection in the form of Patents Pending. Interviews were conducted with the Chief Executive Officer and the Marketing Manager.

Case H was a start-up business within the manufacturing industry and was located in a technology incubator. The business had been established for seven months at the time of initial interview and had developed as a result of materials research from an Australian university. The product delivered a means of construction utilising an innovative composite material which increases tensile strength while reducing material weight. The founder and Chief Executive Officer was also the principal researcher at the institution and had obtained the full commercialisation rights for the intellectual property. The business was based upon a core group of three products with additional product concepts actively being developed. The business had 18 employees and had received R&D funding from government grants and an industry partner. Interviews were with the Chief Executive Officer and the Corporate Development Manager. It was anticipated it would take 3 years to get the first product to market.

Case I was a start-up biotechnology company located in a business incubator. The company had been established for twenty-four months and was developing a range of novel applications in the agribusiness sector. The products were based upon unexploited university research leading to intellectual property protection in the form of patents. The principal investigator for the core technology was also the owner of the protected intellectual property. As a result of the inability and lack of commitment of the university to commercialise the technology, the owner of the intellectual property had negotiated with the university to be assigned the intellectual property rights and was the founder of the company and principal shareholder. The funding for the ongoing development came from government grants. The company employed three technical people at the time of initial interview and was attempting to raise venture capital financing for full commercialisation. It was anticipated that a further three years of product development and industrial trials were required before a market ready product was to be launched. Interviews were conducted with the Managing Director (founder) and the company Chairman (an investor with a sales background).

Case J was a start-up biotechnology company located within a technology park. The business was based upon technology initially developed within an Australian university, the research for which commenced five years previously. The intellectual property may apply to a variety of medical applications, one of which was for the treatment of arthritis in humans. The project suffered from a lack of funding and as a result the principal researcher founded the start-up. He subsequently negotiated with the institution to progress further development outside of the university. The start-up had received venture capital funding in order to undertake further development. There were seven scientific and technical staff employed by this business at the time of initial interview. These staff were located within the originating institution allowing the use of existing research infrastructure on a fee for service basis. Commercial development activities for the business were controlled by the venture capital firm. It was anticipated that clinical trials would commence in collaboration with a potential joint venture partner within two years.

If successful the first of a series of medical products would be available to the market within five years. Interviews were conducted with the Chief Executive Officer, who was also the principal researcher and founder, and a Director from the venture capital firm.

Case K was a start-up biotechnology company based upon unexploited applied research undertaken within an Australian university. The rights to the technology, comprising a veterinary application for the treatment of racehorses, were obtained by a consortium of three businessmen and further development funding provided to obtain trial results from the resulting product. The business has been in existence for just over three years at the time of interview and veterinary field trials were anticipated to commence within the following six to eight months. It was anticipated first sales would occur five to six years from firm creation. Subsequent to acquiring the commercial rights the company contracted two research institutions to undertake the advanced product development work. The business employed four people with the Chief Executive Officer also holding the responsibility for product development. The research emphasis was on exploring new animal health applications for the technology. Interviews were conducted with the Chief Executive Officer and the Marketing Manager.

Case L was a start-up biotechnology company which had been in existence for three years and was based upon research commenced nine years prior to initial interview within an Australian university. The principal researcher had obtained the intellectual property rights after the university failed to attract an industry partner to facilitate the commercialisation of the technology. Subsequently, the Principal Researcher founded the company, attracted investment from a venture capitalist fund as well as private investors. The technology had application in the medical field and it was anticipated that human clinical trials would commence within eighteen months after the conduct of the interviews. The business intends to launch an Initial Public Offer (IPO) on the Australian Stock Exchange at the conclusion of the first round of clinical trials. Interviews were conducted with the Managing Director, who maintained control over new product development, and the Business

Development Manager, whose primary responsibility venture development and preparation for the IPO process.

The operational context of each of the cases has been provided within both the case summaries and Table 5.3. Within each of these cases the interviews were conducted using an interview protocol, where each section commenced with broad questions in order to allow the researcher to search for new categories and insights. Further, this process also permitted the respondents to expand and digress during the conversation of the interview (Carson et al. 2001). In this approach the broad grouping of questions within the interview protocol did not follow any particular order and the rationale for adopting this procedure was to avoid imposing the logic of a priori framework on the respondents. As such, before discussing research question one, the respondents were asked general and broad questions (question B1 to B10 of the interview protocol in Appendix II) to establish rapport (Dick 1990) and to establish the operational context of their respective organisations.

To further establish the operational context of each of the cases, a number of broad cross-cluster observations can also be made in relation to the elements within the operational context summarised in Table 5.3. The first observation is in relation to the source of the technology underpinning the product itself. In relation to the cases within cluster 1 and cluster 2, that is those cases with products which were categorised as having a short time-to-market (less than two years), the technology source was exclusively from personal endeavour with the STBF. In contrast the source of technology for the majority of cases which were categorised as having medium or long time-to-market products was external to the STBF. In the main, the actual source of technology was from academic and research institutions that originally employed the principal founder. In each case the employing institution elected not to further develop the technology for the purpose of commercialisation and as a result the technology had been licensed or acquired by the former institutional employee who in turn, established the STBF.

Table 5.3 Operational context of each of cases within each cluster

Cluster	Case	Technology source (Protocol question B4)		Basis of product or technology description (Protocol question B5)		% of total staff time devoted to NPD (Protocol question B2)					Completed NPD Stages (Protocol question B8)				Type of innovation (Protocol question B9)		Form of product (Protocol question B10)	
		Licensed in	**Personal endeavour**	**Features**	**Benefits**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**1**	**2**	**3**	**4**	**1**	**2**	**Physical**	**Technology**
1	A	-	✓	-	✓	90	70	-	-	-	✓	✓	✓	-	✓	-	✓	-
	B	-	✓	-	✓	100	90	90	-	-	✓	✓	✓	✓	✓	-	✓	-
	C	-	✓	✓	-	100	80	-	-	-	✓	✓	✓	✓	✓	-	✓	-
	D	-	✓	✓	-	100	-	-	-	-	✓	✓	✓	-	✓	-	✓	-
	NET	**0**	**4**	**2**	**2**						**4**	**4**	**4**	**2**	**4**	**0**	**4**	**0**
2	E	✓	-	-	✓	100	-	-	-	-	✓	✓	-	-	✓	-	✓	-
	F	✓	-	-	✓	100	50	30		-	✓	✓	✓	✓	✓	-	-	✓
	G	✓	-	-	✓	100	100	90	70	-	✓	✓	✓	✓	✓	-	✓	-
	H	✓	-	-	✓	100	-	-	-	-	✓	✓	-	-	✓	-	✓	-
	NET	**4**	**0**	**0**	**4**						**4**	**4**	**4**	**2**	**4**	**0**	**4**	**1**
3	I	✓	-	✓	-	90	90	-	-	-	✓	✓	-	-	✓	-	-	✓
	J	✓	-	-	✓	95	90	90	70	70	✓	✓	-	-	✓	-	-	✓
	K	✓	-	-	✓	90	80	-	-	-	✓	✓	-	-	✓	-	-	✓
	L	✓	-	-	✓	95	90	80	-	-	✓	✓	-	-	✓	-	-	✓
	NET	**4**	**0**	**1**	**3**						**4**	**4**	**0**	**0**	**4**	**0**	**0**	**4**
TOTAL		**8**	**4**	**3**	**9**						**12**	**12**	**8**	**4**	**12**	**0**	**8**	**6**

Source: responses to operational context questions for each case

The other observation is that the cases regarded as having had a long time-to-market product, that is greater than five years to market, tended to have 'technology' as their specific form of product and thus relied on one or more forms of technology transfer as a means of commercialising their products. The explanations from respondents related to the fact that the structure of the biotechnology industry, represented by firms with long time-to-market products, was characterised by: a) a high cost in duplicating assets and systems necessary for physical product development (J:1:B10); b) the presence of significant barriers to entry for new market entrants (J:1:B10) and c) advantage being taken of earlier cash flow opportunities provided from technology licensing rather than product and sales of physical product (I:2:B10).

Having summarised all of the individual cases and the case study respondents, the patterns of data relating to the first research question are discussed in the next section.

5.4 Research question 1: what elements of NPD are adopted by STBFs when developing new products?

The first research question looks at what elements of NPD are adopted by STBFs. Specifically this research question examines the elements contained within the three core components of the theoretical framework of new product development in STBFs as described in figure 3.4. Thus, research question 1 is:

> *What elements of NPD are adopted by STBFs when developing new products?*

The resulting data was analysed from two perspectives: the respondents' attitudes to the importance of adoption of the elements of NPD and the extent to which those elements were actually adopted. The reason for this approach is that there may be a difference between the STBF management team recognising the importance of a specific element and the extent to which a particular element is actually adopted. The importance of the data from this research question was that it provided the researcher with the insights into the adoption practices with respect to the elements of NPD

which were identified in the literature as being 'best practice' for STBFs. It was identified from the literature in chapter 2 that the greater the overall adoption of elements of NPD the greater the likelihood of new product success. Thus, the analysis of the data not only identifies which elements were adopted but also where a difference between the attitude of importance and actual adoption occurred. Additionally, the data also provided insight into why particular elements were not adopted, especially when they were also seen by the respondents to be important for their STBF.

When considering attitudes of importance to adoption it was identified in the design of the research methodology (chapter 4) that two different forms of measurement would be required. The rationale for this was recognition that for some attitudes, particularly those relating to component II – NPD process features and component III – new product success factors, are more definitive and therefore could be directly measured against numbered scaled responses. However, analysing attitudes to less well defined criteria, such as those relating to Component I - elements of corporate strategy, required more probe questioning, therefore attitudes were analysed according to 'positive mentions' by respondents of specific features relating to each individual element. In this way, cross-cluster analysis across each of the three core components of the framework remained valid due to the ability to perform meaningful comparisons between clusters and across the three components.

5.4.1 Framework component analysis

In order to answer the first research question, it was necessary to analyse the data relating to the three core components of the theoretical framework of new product development in STBFs. As such, each of the core framework components will now be examined in turn.

5.4.1.1 Component I analysis

To commence, the results of the data analysis relating to the elements of corporate strategy impacting new product development (component I) were examined. The summary of the analysis of field data (derived from Part D of the interview protocol – Appendix II) for component I is presented in table 5.4. The attitudes to the importance of adoption (column 'i') and actual adoption (column 'ii') are compared for each case. With respect to attitudes of importance, the numbered scaled responses have been converted to a '✓' (where average responses are recorded as either an 'strongly agree' or 'agree' that is a 1 or 2 numbered scaled response) or '×' (where average responses are recorded as either an 'undecided', 'disagree' or strongly disagree that is, a 3, 4 or 5 numbered scaled response). Each element is discussed in turn.

Market entry. This element consists of two components: the identification of a market opportunity with the resultant development of an entry strategy appropriate to the firm and the nature of the product. From table 5.4 (element 1) it can be seen that there were very few differences between firms' attitudes in relation to the importance of adopting this element and the incidences of actual adoption across all three clusters. However, this relationship differed when we compare clusters 1 and 2 to that of cluster 3 cases. Specifically, in cluster 3 it is noted that for three of the four cases (cases I, K, & L) this element was considered to be unimportant for the firm to consider at this stage. Moreover, none of these cases in cluster 3 could provide any evidence that this element had actually been adopted or that they were intending to adopt it.

The respondents provided some insights for this finding through answers to a number of probe questions. Firms within both clusters 1 and 2 had more clearly defined their target markets relating to their products whereas cluster 3 firms had identified a broader market opportunity but had not identified specific strategies by which the product was to enter the market. This could be attributed to the long period of time from product inception to market entry for firms within this cluster. For example, one respondent from cluster 3 explained this by stating that: 'the nature of the market changes significantly over the period we are talking about from initiating development

Table 5.4: Attitudes of importance to adoption and actual adoption of the component I elements of NPD

	Element	Cluster 1										Cluster 2										Cluster 3										T	
		A		B		C		D		T		E		F		G		H		T		I		J		K		L		T			
		i	*ii*	*i*	*ii*	*i*	*ii*	*i*	*ii*	***i***	***ii***	*i*	*ii*	*i*	*ii*	*i*	*Ii*	*i*	*ii*	***i***	***ii***	*i*	*ii*	*i*	*ii*	*i*	*ii*	*i*	*ii*	***i***	***ii***	***i***	***ii***
1	Market entry	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	×	×	✓	×	×	×	×	×	**1**	**0**	**9**	**8**
2	Aggression vs. stealth	✓	✓	×	×	×	×	×	×	**1**	**1**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	✓	✓	✓	✓	✓	✓	×	✓	**3**	**4**	**8**	**9**
3	Segmentation & internationalisation	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	**12**	**12**
4	Leadership & entrepreneurship	✓	✓	×	×	×	×	×	×	**1**	**1**	✓	✓	×	×	✓	✓	✓	✓	**3**	**3**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	**8**	**8**
5	Operational systems & financeability	×	×	✓	✓	×	×	✓	✓	**2**	**2**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	**10**	**10**
6	Inter-firm cooperation	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	✓	×	✓	✓	✓	✓	✓	×	**4**	**2**	✓	×	✓	×	✓	×	✓	×	**4**	**0**	**12**	**6**
7	Access to complementary assets	×	×	✓	×	✓	×	✓	×	**3**	**0**	✓	✓	✓	×	✓	✓	✓	✓	**4**	**3**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	**11**	**7**
21	Influence of investors	×	×	×	×	×	×	✓	✓	**1**	**1**	✓	✓	✓	×	✓	✓	✓	×	**4**	**2**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	**9**	**7**
22	Capability of management	×	×	×	×	×	×	✓	✓	**1**	**1**	×	×	✓	✓	✓	✓	✓	✓	**3**	**3**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	**8**	**8**
Total reflected in attitude		5		5		4		7		**21**		8		8		9		9		**34**		8		9		8		7		**32**		**87**	
Total demonstrated			5		4		3		6		**18**		7		6		9		7		**29**		7		7		7		7		**28**		**75**

Source: Analysis of field data (where 'i' indicates where the average numbered scaled response between both respondents is 2 or less within each case, and 'ii' is where that element is observed to be actually adopted and 'T' is the total of actual adoptions within the cluster)

The numbered scaled responses have been converted to a '✓' (where average responses are recorded as either an 'strongly agree' or 'agree' that is a 1 or 2 numbered scaled response) or '×' (where average responses are recorded as either an 'undecided', 'disagree' or strongly disagree that is, a 3, 4 or 5 numbered scaled response).

to actually entering the market' (K:2:D1). As such, firms in this cluster, represented by long time-to-market products in the biotechnology industry, felt that the identification of the market opportunity and quantifying such an opportunity was more important than developing a specific market entry strategy and that this was reflected in the lack of adoption of this element within cluster 3 cases.

Aggression vs. stealth. The next element within the market dimension to consider is the element of 'aggression vs stealth'. This relates to the purposeful adoption of either an aggression or stealth strategy as a feature of market entry. As previously explained in chapter 2, the importance of this element was not whether aggression was chosen over stealth but rather that there was a 'purposeful decision' made to adopt either strategy deemed to be most appropriate for the firm. As such, the chosen strategy needed to be reflected in the firm's business plan or other corporate strategy documentation to support whether or not it was indeed a 'purposeful decision'. Again, like the first element, there were very few differences between the views of importance of the adoption of this feature and actual adoption. It was also apparent that the adoption of an aggression or stealth strategy was seen to be less important by cluster 1 firms compared to firms in clusters 2 and 3 (Table 5.4 element 2). This pattern was also reflected in the pattern of adoption as evidenced by a purposeful decision being made on either strategy.

Two themes emerged from the interviews relating to this element. The first theme was the view of the importance of intellectual property protection in determining which strategy was adopted. This was reflected within cluster 2 & 3 cases where it was felt that intellectual property protection provided greater confidence that aggressive market entry could be successfully supported and sustained due to monopoly rights from patents (for example, I:1:D2; J:1:D2; and L:1:D2). The second theme was that of funding to support an aggression strategy. In particular, cluster 1 firms reflected the view the availability of sufficient funding was the primary driver in considering an aggression or stealth strategy. Moreover, it was also felt that any potential investor would help shape the final strategy (for example, C:2:D2) and therefore little attention was paid to this element. For

example, one of the respondents from Case A expressed the view that aggression was a 'likely approach' but that this would ultimately be 'dependent upon capital raising success' (A:1:D2). Further, this view was also driven by fear of the potential response of existing market incumbents (that is, competitors). Specifically, this fear was based upon the potential need to match competitor responses in marketing and promotion and thus causing an excessive drain on funding reserves.

Segmentation & internationalisation. Next, for the element of 'segmentation and internationalisation' (table 5.4 element 3), the data showed that this element was viewed as being of high importance and there was evidence that this element was actually adopted by the majority of firms across all cases in the three clusters. However, upon undertaking a more in-depth analysis, it would seem that while internationalisation appeared to be common across all clusters, segmentation was more prevalent in clusters 1 and 2 compared to firms in cluster 3. For instance, geographic segmentation was a common element mentioned by respondents in cluster 1. One comment was 'We have an international market but the target markets are the North American and UK markets due to the similar regulatory environment for our product' (A:1:D3). In contrast, geographic segmentation was either not raised or not considered important by case respondents in cluster 3. Further it would seem that, at least for cluster 3 firms, segmentation and the degree to which intellectual property can be protected (reflected as a feature of product leadership) are closely related. As expressed by one respondent 'our product will be targeting an international marketplace so segmentation between geographic regions is largely not needed. This is because of our IP [intellectual property]. Our patent covers us in 20 countries worldwide and we will be entering a number of markets at once' (J:2:D3).

The issue of internationalisation also seems to reflect views with respect to market opportunity. The 'born global' nature of certain types of STBFs as outlined in section 2.3.2, was demonstrated by all cases in cluster 3 (cases I, J, K & L). For illustration, 'Our market opportunity is very much international and we intend to have strategic partners who have the muscle and the market presence to allow us to

penetrate these international markets. While this is likely to be staged, there has been no thought on the logical order in which this will occur' (I:1:D2). While geographic segmentation was not a clear feature for clusters 2 & 3, there was a heavier emphasis on customer based segmentation in these firms compared to those in cluster 1 (table 5.3, element 1). One comment was 'Our market research provided a sound basis by which to segment our market based upon customer needs' (G:1:D2). Thus, the findings for this element showed that the element of segmentation and internationalisation was universally adopted across all clusters with clusters 2 & 3. This strongly reflects internationalisation with customer-based segmentation and with cluster 1 more focused on geographic segmentation.

Leadership & entrepreneurship. The next element examined was that of 'leadership & entrepreneurship'. This element addressed the extent to which STBFs were able to demonstrate aspects of technological leadership with respect to their product as well as the key attributes of entrepreneurship as it relates to the commercialisation of the product. The basis of this discussion is to explore the degree to which three underlying attributes were reflected by the firm. The first two attributes were chosen as indicators of product leadership: relatively high technological barriers to replication of the product by potential competitors and intellectual property protection for the product. The other attribute chosen as an attribute of entrepreneurship as it relates to the product was that the product is opportunity driven. The extent to which these attributes were reflected in other sources of evidence, such as business plans, was also a key consideration.

When this question was explored in more depth (summarised in table 5.4 row 4), the extent to which leadership could be demonstrated differed in a number of ways between the firms in the three clusters. First, as the anticipated time-to-market increased, product leadership could be more clearly demonstrated. In particular, cases within cluster 1 appeared less able to demonstrate leadership attributes compared to cases in both clusters 2 and 3.

A further observation can be made by comparing responses between interviewees, that is 'within case' analysis. In regards to the element of product leadership, it was observed that there were a number of divergences of opinion between the respondents within individual cases. In examining some of the detailed responses between interviewees provided from this question in the interview protocol (Question D4 of the interview protocol), it was observed that this divergence arose within two cases within cluster 1 (cases A & C). In both cases the product development executive held the view that there existed significant barriers to replication of the product. This contrasted with the view expressed by the manager responsible for corporate strategy development who commented that their products had low barriers to replication by potential competitors (A:1:D1 and C:2:D1). This would suggest that those STBFs did not have a consistent view internally of their technology leadership for their respective products. One implication for this lack of consistency is that it would be very difficult to achieve a common vision within the firm of what is needed from the product development effort.

Operational systems & financeability. The next element to examine was that of 'operational systems and financeability', referring to the existence of the appropriate management and process control systems to ensure effective operational control of the business in order to satisfy potential investors. The findings from analysing the data relating to this interview question indicated that this element was widely in place across all clusters but is less prevalent in cluster 1 where two of the four firms did not regard this element as being important at this stage of their business and as a result did adopt this element (table 5.4, element 5).

However, more in-depth probing indicated that the rationale provided by the respondents did not provide a satisfactory explanation for this position by either of the two firms. Specifically, both firms were at the later stages of their NPD process, suggesting a contradiction of being 'too early at this stage of their business development' (A:1:D5). Rather, both firms had a view that any investment would result from assessments of the technology itself rather than the business itself: 'we

have a strong technology position and this will satisfy a savvy investor. Besides, the investor will want to assist in ensuring such systems are set up properly' (C:2:D5).

Inter-firm cooperation. In considering the next element within component I, that of 'inter-firm cooperation', the data showed that this element largely occured across all clusters to an equal extent (table 5.4 element 7). However, differences occured between clusters in regards to the type and purpose for which cooperation occurs. The nature of the collaboration for cluster 1 tended to be shorter term in nature, with a focus on more immediate commercial opportunities: 'We identified some immediate opportunities in the marketplace and as such are talking to a number of firms with whom we can partner to lend us credibility and enhance our combined value to these customers' (C:1:D6). Moreover, the nature of these relationships for this purpose tended not to include significant resource commitment from the third party: 'This partnership is purely for this identified opportunity. It would be nice to think it could evolve beyond this to include investment or other forms of financial assistance but it will depend whether we are successful with this opportunity first - I suppose it's a credibility thing' (B:1:D6).

In addition to these more immediate market opportunities, cooperation for the purpose of product development was also prevalent across each of the clusters. However, while product development was the only theme within inter-firm cooperation that converged strongly across all clusters, it would seem that the nature of this cooperation differed within each cluster. As already noted, cooperation in cluster 1 tended to not include investment, which was also reflected in new product development activities: 'Our identified partner has agreed to assist with some reconfiguration of the product so that it better fits with their existing client base. This will involve contribution of some of their staff time to work with our software developers' (A:1:D6). This contrasted with the nature of product development cooperation for cluster 3 cases: 'We have put in place a JV [joint venture] relationship with a third party who will see our product into the marketplace. They are intimately involved in our on-going product development and have contributed significant resourcing to this end' (K:1:D6).

Further, the nature of the cooperation in cluster 3 in particular, tended to be longer term and involved more onerous and formal contractual commitments such as that required by joint ventures. In these situations both firms contributed resources for both product development and market entry: 'We are examining a specific JV opportunity [joint venture] with an existing player in the market. If this comes to fruition this party will be assisting with funding for very specific development activities. This will then give them a exclusive access to the product for this market' (I:1:D4).

Access to complementary assets. The next element within component I, 'access to complementary assets', should be considered in association with the previous element of inter-firm cooperation. The relationship between both elements was reflected by the reason given by a number of firms for entering into a cooperation strategy is to access complementary assets of market incumbents. This was evident for firms operating in industries with high infrastructure costs needed for production equipment, such as, manufacturing and biotechnology industries as represented by cases in clusters 2 and 3. In this way, cooperation offered a number of advantages: 'Rather than make the very substantial investment required to establish manufacturing and distribution infrastructure it makes much more sense for us to enter into relationships with firms who already have this capability – it just needs to be a 'win' for both of us' (F:1:D7).

In contrast, cluster 1 firms, characterised by low costs of duplication of complementary assets, did not exhibit the adoption of this element (Table 5.4 Element 7). Further, it can be seen that cluster 1 firms exhibited a significant divergence between the attitudes of the importance of the need to adopt access to complementary assets and the incidences of actual adoption. In the three cases where such divergence occurred (Cases B,C & D), each firm expressed the recognition of the need to access complementary assets from the perspective of existing channels to market provided by market incumbents through cooperation strategies (B:1:D6; C:2:D6 & D:1:D6). The fact that the adoption of access to

complementary assets was not exhibited as having been adopted by cluster 1 firms can be partly explained by the view that the development of such relationships for this purpose can commence at a later stage in the NPD process – essentially just prior to, or at, the product launch stage (for example, A:2:D6).

Influence of investors. The next element, 'influence of investors' was then examined. The analysis of the field data, summarised in table 5.4 (element 21), suggests two findings. The first was that where firms have attracted third party investment there was a significant influence on the development of corporate strategy provided by such investors. In all such cases, this influence was both expected and seen to be of importance for the firm as a means of contributing to gaps in knowledge and skill. For illustration, Case H suggested that the investor 'placed high expectations that sufficient knowledge of the market was obtained through additional market research prior to releasing funds' (H:1: D8). Additionally, this influence was extended to all aspects of the firms' operations towards which the funding would be applied, including specific NPD activities (D:1:D8; G:1:D8; J:2:D8; L:1:D8).

The second finding was that in some instances this investor influence was seen to be somewhat of a detrimental influence for the firm in achieving success. However, desperation for funding to ensure at least short term survival meant that most of these firms had to adapt to counter this negative effect (D:1:D8 & L:2:D8). In part, this is explained by the views expressed by an investor to a respondent that it is more important to 'get to a cash flow position even if the product is only 70 per cent right', thus signifying an overt desire to be first to market at all costs. However, it would also seem that the resultant risk of a 'false start' for any product launch was not something considered in any depth (D:2:D8). This same respondent explained this as a 'mismatch' between realistic times attached to product and firm success and expectations of investors, especially for long term investments such as in the biotechnology sphere (G:2:D8).

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Capability of management. The final element to consider in component I of the framework of new product development in STBFs is 'capability of management'. The analysis of the evidence for the existence of this element was undertaken by examining capability across three key functional skill areas (marketing and business development, product or technical development and aspects of operational management) as well as possession of experience of at least one of the management team in a similar business as their STBF. Similar to other elements, the evidence of the existence of this element was also measured against the view of importance that such skill areas and experience would be for the firm. The resulting data is summarised in table 5.4 (element 22).

The analysis of the data showed a contrast between cluster 1 to that of both clusters 2 & 3. In cluster 1, only one of the four firms showed capabilities across these functional areas. In each of the three cases where it was not evidenced, there was either a lack of marketing skills or no evidence for any experience in similar business types (Cases A, B, & C: D9). In each of these cases the management team comprised experienced technologists and it was also viewed as not being of great importance to the firm at this stage. In particular, these skills were seen as being able to be contributed by industry partners through collaboration but the requirements of them were largely undefined.

In contrast, only one firm in both clusters 2 and 3 (that is, Case E) did not reflect this element. For other firms in these clusters, where internal gaps in functional skill areas were identified steps were undertaken to ensure that such gaps were contributed external to the firm such as through contract relationships with service providers (for example, Case G). In other instances these skill gaps were filled through a secondary management structure, such as through technical advisory boards or the Board of Management. For illustration, one case had placed a partner from a senior accounting and consulting firm on their Board of Management to ensure appropriate operational systems were in place (L:1:D5 & D9). Also in contrast to cluster 1, all but one case in clusters 2 and 3 expressed the view that it

was important to have adequate capabilities represented across all key functional areas.

To summarise, the findings for the adoption of the elements of component I of the framework of new product development in STBFs, show that three specific conclusions can be reached. For ease of reference, table 5.5 summarises these findings and is a re-representation of table 5.4 in summary form.

First, in examining attitudes of importance of adopting component I elements it can be seen that there were only minor differences between the total possible instances where a case could record an 'important' outcome and that actually reported by respondents. This is derived from comparing the 108 total possible instances across all cases and elements within this framework (that is, 12 cases x 9 elements) and the 87 incidences where it was actually recorded as being 'important' (table 5.5 Column IV (*i*)). This demonstrated that there was no substantial divergence in opinions of respondents as a whole as to the relative importance of each of these elements of NPD. As such, respondents largely did not need to be convinced that the elements of NPD being assessed were important to be adopted by their respective firms.

Table 5.5 Summary of comparative findings for component I elements

	Elements	*Column I*		*Column II*		*Column III*		*Column IV*	
		Cluster 1		**Cluster 2**		**Cluster 3**		**Total**	
		i	*ii*	*i*	*ii*	*i*	*ii*	***i***	***ii***
1	Market entry	4	4	4	4	1	0	**9**	**8**
2	Aggression vs. stealth	1	1	4	4	3	4	**8**	**9**
3	Segmentation & internationalisation	4	4	4	4	4	4	**12**	**12**
4	Leadership & entrepreneurship	1	1	3	3	4	4	**8**	**8**
5	Operational systems & financeability	2	2	4	4	4	4	**10**	**10**
6	Inter-firm cooperation	4	4	4	2	4	0	**12**	**6**
7	Access to complementary assets	3	0	4	3	4	4	**11**	**7**
21	Influence of investors	1	1	4	2	4	4	**9**	**7**
22	Capability of management	1	1	3	3	4	4	**8**	**8**
Total reflected in attitude		**21**		**34**		**32**		**87**	
Total demonstrated			**18**		**29**		**28**		**75**

Source: *analysis of field data (where 'i' indicates at least one respondent expressing positive mention as to the importance of adopting that element and 'ii' is where that element is observed to be actually adopted)*

Secondly, of the 87 instances where it was reported by respondents that they felt it was important to adopt these elements in their NPD, the actual adoption evidenced was 75, a difference of 12, or less than 14 per cent (Table 5.5 column IV), again this variance would appear to be marginal. Additionally, only one element (element 6) can be seen to not have been significantly adopted across the majority of STBFs in the study (table 5.5, element 6, Column iv (*ii*)).

However, when considering the evidence for actual adoption of component I elements observable differences did occur between clusters. Of particular note was that of cluster 1 where 6 of the 9 elements were seen to be not adopted by at least 50 per cent of the cases in the cluster. Indeed, of the 9 elements being examined it was only the elements of market entry strategy (table 5.5 element 1), segmentation and internationalisation (table 5.5 element 3) and inter-firm cooperation (table 5.5 element 6), which were adopted by that cluster. This contrasted with both clusters 2 and 3. In cluster 2, only inter-firm cooperation (table 5.5 element 6) and the influence of investors (table 5.5 element 25) were not been adequately adopted. Whereas in cluster 3, it was the elements of market entry strategy (table 5.5 element 1) and inter-firm co-operation (table 5.5 element 6), that did not appear to have been adopted.

Thus, in conclusion to the analysis of the adoption of component I elements of NPD, only one element, that is, 'inter-firm cooperation' (table 5.5 element 6) was not adopted across the majority of STBFs in the study. However, when comparing clusters, cluster 1 (represented by short time-to-market products from the information technology industry) adopted a greater number of component I NPD elements than the firms in either clusters 2 or 3.

Having analysed the findings relating to component I of the theoretical framework for how STBFs undertake their new product development, the next component of this framework, component II, will now be examined.

5.4.1.2 Component II analysis

The findings of the data analysis relating to new product development process features (component II) adopted by STBFs is now examined. As discovered from the review of the extant literature in chapter 2, it was found that the accepted models of new product development can be considered in the context of the various 'generations' of product innovation, which in turn are represented by progressive models of new product development. Importantly, each successive model of new product development was considered an improvement over those that went before. As such, eight elements consisting of eight NPD process features, were identified as being relevant to STBFs and make up component II of the framework.

The summary of the analysis of data (derived from Part C of the interview protocol – Appendix II) for component II is presented in table 5.6. This table summarises the attitudes of importance of adoption (column 'i') and evidence of actual adoption (column 'ii') for each case. Each element within this component in then discussed in turn. Like the approach taken in analysis of the data for component I in the previous section, the numbered scaled responses have been converted to a '✓' (where average responses are recorded as either an 'strongly agree' or 'agree' that is a 1 or 2 numbered scaled response) or '×' (where average responses are recorded as either an 'undecided', 'disagree' or strongly disagree that is, a 3, 4 or 5 numbered scaled response). Each of the elements across the clusters is examined in turn.

Speed-to-market. The first element in component II of the framework to consider is that of 'speed-to-market'. First, it was shown that speed-to-market was adopted universally across clusters 1 & 2 whereas in cluster 3 speed-to-market was not adopted by any of the STBFs (table 5.6 element 8). Likewise, this pattern was also reflected in the attitudes of importance of the need to adopt this element by respondents, with all firms in clusters 1 and 2 either 'strongly agreeing' or 'agreeing' that speed-to-market was important to adopt in their NPD process. In

Table 5.6: Attitudes of importance to adoption and actual adoption of the component II elements of NPD

	Element	Cluster 1										Cluster 2										Cluster 3										T	
		A		B		C		D		T		E		F		G		H		T		I		J		K		L		T			
		i	*ii*	*i*	*ii*	*i*	*ii*	*i*	*ii*	***i***	***ii***	*i*	*ii*	*i*	*ii*	*i*	*Ii*	*i*	*ii*	***i***	***ii***	*i*	*ii*	*i*	*ii*	*i*	*ii*	*i*	*ii*	***i***	***ii***	***i***	***ii***
8	Speed-to-market	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	×	×	×	×	×	×	×	×	**0**	**0**	**8**	**8**
9	Integrated parallel development	✓	✓	✓	×	✓	✓	✓	✓	**4**	**3**	×	✓	×	×	×	×	×	×	**0**	**1**	×	×	×	×	×	×	×	×	**0**	**0**	**4**	**4**
10	Well defined decision gates	✓	✓	×	×	✓	×	✓	✓	**3**	**2**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	**11**	**10**
11	Multifunctional NPD team	×	×	×	×	×	×	×	×	**0**	**0**	×	×	✓	✓	✓	✓	✓	✓	**3**	**3**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	**7**	**7**
12	Reflects needs of the market	✓	×	✓	✓	✓	✓	✓	×	**4**	**2**	✓	✓	✓	×	✓	✓	✓	✓	**4**	**3**	✓	✓	✓	✓	✓	✓	×	✓	**3**	**4**	**11**	**9**
13	Experts systems and modelling	×	×	×	×	×	×	×	×	**0**	**0**	✓	✓	✓	✓	✓	×	×	✓	**3**	**3**	×	×	×	×	×	×	✓	✓	**1**	**1**	**4**	**4**
14	Strong customer linkages	✓	×	✓	✓	✓	×	✓	×	**4**	**1**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	×	×	×	×	×	×	×	×	**0**	**0**	**8**	**5**
15	Success measurement	×	×	✓	✓	×	×	×	✓	**1**	**2**	✓	✓	✓	✓	✓	✓	×	×	**3**	**3**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	**8**	**9**
Total reflected in attitude		5		5		5		5		**20**		6		7		7		5		**25**		4		4		4		4		**16**		**61**	
Total demonstrated			3		4		3		4		**14**		7		6		6		6		**25**		4		4		4		5		**17**		**56**

Source: *Analysis of field data (where 'i' indicates where the average numbered scaled response between both respondents is 2 or less within each case, and 'ii' is where that element is observed to be actually adopted and 'T' is the total of actual adoptions within the cluster)*

The numbered scaled responses have been converted to a '✓' (where average responses are recorded as either an 'strongly agree' or 'agree' that is a 1 or 2 numbered scaled response) or '×' (where average responses are recorded as either an 'undecided', 'disagree' or strongly disagree that is, a 3, 4 or 5 numbered scaled response).

contrast, cluster 3 cases were either 'undecided', disagreeing' or 'strongly disagreeing' that adopting speed-to-market was important.

However, as 'time-to-market' was selected as a basis for case selection and grouping firms into respective clusters in the research design, such a divergence is explainable. Specifically, as long time-to-market was a specific firm selection criterion, it was logical to expect that such firms would not view speed-to-market as a critical feature to adopt to ensure product success. Indeed, this was further explained by an in-depth analysis of interview data. One theme that emerged from cluster 3 cases was the issue of the importance of 'timing' rather than 'speed'. This related to the view that it was seen to be more important to be able to get to the market to optimise cash flow

opportunities before the expiry of patents (therefore with no competition) rather than getting the product itself to the market faster. For illustration: 'We have some protection from competition for our product due to our patents so it is much more important to get the product right before licensing the technology than it is to get it to the market quickly' (L:2:C2).

However, different views on the importance of speed-to-market were expressed from cases in clusters 1 and 2. In turn, these responses provided some insight into why the adoption of this element was more evident in these two clusters. First, competition was seen to be much more of an issue due to the lack of formal intellectual protection: 'First mover advantages are significant …and even if the product is only 90 per cent right, get it to the market first and fix it later - so long as it meets customer expectations' (B:1:C2). The second insight was that there was a drive to achieve an early cash flow position to resource the firms activities. This was particularly so where investors had not yet been secured (for example, C:1:C2; E:2:C2).

Integrated parallel development. The next NPD element within component II considered is that of the adoption of 'integrated parallel development'. In

examining the summary findings presented in table 5.6 (element 9), it was apparent that significant differences occured between cluster 1 and both clusters 2 and 3 in terms of views of importance of the need to adopt this element and its actual adoption. First in terms of views of importance, cluster 1 cases either 'strongly agreed' or 'agreed' that parallel development was an important principle of the NPD activities. This was in contrast to cases in both clusters 2 and 3 who were either 'undecided', 'disagreed' or 'strongly disagreed' that it was important to adopt this element.

Moreover, in two cases (case B and case E) there was a divergence between the view of importance and actual adoption in practice, each differing in reasons on why this occurred. In regards to case B, while it was viewed by the respondent as being important it was not actually adopted. In this instance the probing of respondents revealed that this was due to financing restrictions and that a linear process 'allowed the firm to get further and would cost less that parallel activities' (B:2:C4). In the other case where this divergence occurred, the element was actually adopted when it was viewed as relatively unimportant. Probing revealed that this was due to the influence of a potential early stage investor who ultimately decided not to make an investment. However, it was felt that it was 'easier and less costly to continue with parallel development without changing mid-way through the NPD process' (E:1:C4). Additionally this also explained the earlier response relating to influence of investors back in section 5.4.2 in the examination of component I elements where it was reported by this same firm that investors had not influenced strategy development. As this potential investor had not actually made an investment the result of no influence was subsequently reported.

Further exploration of the findings revealed that two themes emerge from the data analysis. The first theme was the influence of speed-to-market in the respondents' support for parallel development activities. Cluster 1 cases mentioned that speed-to-market was essential and as a result, 'it was essential to undertake parallel development in order to get our product to the marketplace as soon as possible' (A:2:C4). At the same time however, there was a realisation that there existed, 'a

lack of skills in specific areas of expertise and the lack of adequate resourcing meant that individuals within the organisation would have to undertake multiple tasks across these different skill areas' (C:1:C4) However, this view was only evident in cluster 1 and to a lesser extent in cluster 2.

In contrast, cluster 3 firms held a different view as to why they adopted sequential NPD stages rather than parallel. The basis of this was that they saw sequential development as being 'more logical, systematic and efficient' (J:1:C4). Moreover, one emergent theme was that investors were able to exercise a greater level of control by linking the availability of resources to the achievement of certain development milestones in a linear and sequential NPD process that wouldn't be available to the same extent in a parallel process (K:1:C4). This would suggest a lack of understanding of the role of decision gates in the NPD process.

Well defined decision gates. The next component II element is the adoption of 'well defined decision gates' between new product development stages (table 5.6 element 10). In analysing the data from the interviews it can be seen that overall, all except one case (that is case B), acknowledged the need to have a systematic review process embedded within the NPD process and which was actually adopted by the firm. However, the strength of agreement differed significantly between cluster 1 respondents compared with clusters 2 and 3 respondents. Indeed, all cases in clusters 2 and 3 adopted this element in practice whereas two of the cases in cluster 1 had not. In part, the explanation for this was closely linked to the parallel development nature of new product development: 'because we are undertaking a number of development activities at the same time, a formal review process would be too time consuming at this critical juncture' (C:2:C6). Thus, speed-to-market considerations became a reason for not adopting decision gates in cluster 1.

Additionally, it would seem that for a number of cases in cluster 1, the review process was more of an implicit and informal process. For example, this can be illustrated by one quote: 'as I am the one providing the majority of the investment capital for the venture and as I have the technical expertise… I make a mental

'check list' of elements within the development process I want to achieve before proceeding to the next step' (B:1:C6).

Multifunctional NPD team. The possession of a 'multifunctional NPD team' is the next element considered. Again, there occurred significant differences between cluster 1 and both clusters 2 and 3 when considering both the attitudes of importance of the need to adopt and actual adoption of this element. Cluster 1 cases felt it was not an important criterion to possess a multifunctional team in order for the resulting new product to be successful, which was also reflected in the lack of adoption of this element by all cases in the cluster. This attitude was also reflected in the identified skills and experience gaps across the three functional areas of capability for which this element was determined, that is, the functional areas of technical, marketing and commercial skills and experience.

In general terms, the new product development teams in cluster 1 exhibited a great deal of knowledge and experience in relation to the technical development aspects of their product. Moreover, it was also felt by respondents that specialist skills in the marketing and commercial functional areas could be either learnt or acquired on an 'as needed' basis. However, in only one of these cases was funding actually directed towards acquiring external marketing skills (case B). In one case, formal business-related training was felt to add no value to the firm: 'I have been able to quickly learn the marketing skills necessary to manage this area and as I have sound experience in business generally I don't think the company misses out by not having someone with a degree. We need practical experience not academic theory' (B:1:C8).

On the other hand, firms in clusters 2 and 3 were much quicker to recognise the importance of bringing in the key functional skills not possessed by existing team members. In particular this was achieved by the use of consultants or establishing an 'advisory board' which would act as a reference body to call on as needed for guidance (for example J:2:C8). Moreover, the possession of a well rounded team with specific areas of capability was also driven by anticipated requirements of

funders, particularly venture capitalists : 'We recognised early on that in soliciting funding from the VC [venture capital] community we needed to show what our teams true skills and capabilities were. To this end we established a business advisory board to advise the management team on all aspects of product development and commercialisation' (K:1:C8).

Reflects needs of the market. The next element, 'reflects needs of the market', was concerned with the need to link the firm's NPD processes to the identified needs of the market. Table 5.6, element 12, summarises the findings in relation to this element of NPD for which, in turn, a number of observations can be made. First, an analysis of the data showed that across all firms, this element was adopted widely and all but one firm viewed the element as being important to adopt.

However, there was a significant divergence between the attitudes of importance of the need to adopt and actual adoption of this element, particularly in cluster 1. While all cases in this cluster either 'agreed' or 'strongly agreed' that this was an important element to adopt, two of the cases (cases A & D) could not provide evidence that it was actually adopted. In-depth probing of respondents of the cases provided two specific insights in relation to the adoption of this element. The first was that occurred a lack of adequate financial resources to undertake thorough market research to the extent that target clients could be surveyed or consulted to confirm that the firm's product addresses a particular problem or opportunity of the clients or users (A:2:C10). The other insight arose from Case D in that the team members within the firm involved in the new product development process held specific views on problems faced by users but which seemed to be based largely on a number of untested assumptions: 'our experience provides us with the necessary confirmation of market needs' (D:2:C10).

In contrast to cluster 1, one firm in cluster 3 actually demonstrated the adoption of this element without either respondent feeling that it was important to do so. In this instance, the reason provided for this was the insistence of the investor to undertake further market research to 'quantify the problem faced by the target user group'

(L:1:C10). A further insight provided by the other respondent in this same case revealed a 'technology push' to its overall product development strategy. Specifically that: 'This is a radical use of new technology and as such we are about creating new opportunities based on the application of this technology in the market. These opportunities will become self evident to the market as the technology matures' (L:2:C10).

Expert systems and modelling. The next NPD process feature addressed in the data analysis was that of the use of expert systems and modelling tools. As outlined in section 2.4, expert systems and the use of modelling tools were critical NPD process features common to fifth-generation NPD models. From the analysis of the data it can be seen that this NPD element was not widely adopted across all STBFs in this study, with only 4 of the 12 cases demonstrated the adoption of this element (table 5.6 element 13). Moreover, three of these cases occurred in cluster 2 in which it was specifically the use of computer aided design tools for products targeted towards the manufacturing industries that were utilised in regards to this element. This was explained by one respondent; 'this industry extensively uses computer aided design tools and our business is no exception in this. These tools also allow us to involve industry partners in some of the technical development activities in relation to prototype design activities' (F:1: C12). In contrast, while Cluster 1 firms in particular saw little added value in adopting expert systems or computer modelling as an element of NPD, there was a general lack of understanding of their potential importance in adopting them as NPD process features (C:1:C12).

Strong customer linkages. The adoption of the element of 'strong customer linkages' was closely aligned to element 12 (that is, 'reflects the needs of the market'). However, the differentiating feature was that customer linkages implied the active involvement of customers in aspects of new product development, such as design and testing (chapter 2). As can be seen from the summary of the data in table 5.5 (element 14), while the majority of firms (8 out of the 12 cases) either 'agreed' or 'strongly agreed' with the view that it was important to adopt this element, it was evidenced to be adopted in only five of the twelve cases. Again, it

was cluster 2 where the majority of this adoption occurred (all four cases in the cluster). A common theme arising from the data was that it was felt that it was 'relatively easy to engage with customers' in manufacturing related industries (E:1:C14) due to the more 'physical nature' of the product as 'we were dealing with practical physical products rather than science' (G:1:C14).

Success measurement. 'Success measurement' is the final NPD element within component II of the framework to consider. As outlined in chapter 2, success measurement was based on both subjective and objective criterion. However, an important feature was the need for it to be applied throughout the entire NPD process. The data analysis for this element revealed that both the attitudes of importance of adoption and incidences of actual adoption are similar across all clusters (table 5.6 element 15). However, it can also be seen that adoption was weakest in cluster 1 compared to clusters 2 and 3. Examination of the data resulting from the in-depth probe questions from respondents suggested that this was not a purposeful strategy by cluster 1 firms, but rather was 'something that wasn't given much consideration as the product either meets requirements or doesn't' (C:2:C16). However, responses from cluster 3 respondents showed that measurement was more readily applied throughout the entire NPD process but was very predominate in the context of the decision gate evaluation (for example, I:1:C16; J:2:C16).

To summarise, the findings for the adoption of the elements of component II of the framework of new product development in STBFs, showed that two specific conclusions could be reached. First, in examining attitudes of importance of adopting these component II elements, it can be seen from table 5.7 that the difference between the total possible instances where a case could record an 'important' outcome and that actually reported by respondents as being important was relatively minor. This is derived from comparing the 96 total possible instances across all cases and elements within this framework (that is, 12 cases x 8 elements) and the 61 incidences where it was actually recorded as being 'important' (table 5.7 Column IV (*i*)).

Table 5.7 Summary of comparative findings for component II elements

Elements		*Column I*		*Column II*		*Column III*		*Column IV*	
		Cluster 1		**Cluster 2**		**Cluster 3**		**Total**	
		i	*ii*	*i*	*ii*	*i*	*ii*	***i***	***ii***
8	Speed-to-market	4	4	4	4	0	0	**8**	**8**
9	Integrated parallel development	4	3	0	1	0	0	**4**	**4**
10	Well defined decision gates	3	2	4	4	4	4	**11**	**10**
11	Multifunctional NPD team	0	0	3	3	4	4	**7**	**7**
12	Reflects needs of the market	4	2	4	3	3	4	**11**	**9**
13	Experts systems and modelling	0	0	3	3	1	1	**4**	**4**
14	Strong customer linkages	4	1	4	4	0	0	**8**	**5**
15	Success measurements	1	2	3	3	4	4	**8**	**9**
Total reflected in attitude		**20**		**25**		**16**		**61**	
Total demonstrated			**14**		**25**		**17**		**56**

Source: analysis of field data (where 'i' indicates at least one respondent expressing positive mention as to the importance of adopting that element and 'ii' is where that element is observed to be actually adopted)

Additionally, of the eight elements under examination, three of these elements: integrated parallel development (element 9); expert systems and modelling (element 13) and strong customer linkages (element 14) were not adopted by the majority of cases across all clusters. Moreover, when examining the adoption of individual elements between clusters, the findings for both cluster 1 and cluster 3 showed that only 50 per cent or less of the elements (that is, 4 elements or less) were adopted by the majority of cases within those clusters (that is, summary totals under sub-column ii within each of columns I & III of table 5.7). Indeed, the summary data for cluster 1 showed that only the first two elements; speed-to-market (element 8) and integrated parallel development (element 9) are adopted by more than two of the cases in this cluster. The overall adoption rate is slightly better in cluster 3 with four of the eight elements being adopted by more than two of the cases in the cluster. Specifically, the elements that were adopted were: well defined decision gates (element 10); multifunctional NPD team (element 11); needs of the market (element 12) and success measurement (element 15). This contrasts markedly with cluster 2 where all except one element, integrated parallel

development (element 9), was adopted by the majority of cases in the cluster (column II in table 5.7).

Having considered the findings from the data analysis for the adoption of the elements of NPD contained in component II (NPD process features) of the framework of new product development in STBFs, the data relating to the next component of this framework, that is component III, was then analysed and is now presented.

5.4.1.3 Component III analysis

Next, the findings of the data analysis relating to the adoption of new product success factors, that is component III, was then examined. The review of the extant literature in chapter 2 found that a number of NPD success factors had a high degree of correlation or similarity to some NPD process features, for instance, 'speed-to-market'. In order to eliminate duplication when considering all NPD elements across all components of the framework, these elements were removed as NPD success factors. As a consequence, five NPD success factors were included within component III.

The summary of the analysis of field data (derived from Part E of the interview protocol – Appendix II) for component III is presented in table 5.8. This table has summarised the attitudes of importance of adoption (column 'i') and evidence of actual adoption (column 'ii') for each case. Each element within this component was discussed in turn. Like the approach taken in analysis of the data for component I in the previous section, the numbered scaled responses have been converted to a '✓' (where average responses are recorded as either an 'strongly agree' or 'agree' that is a 1 or 2 numbered scaled response) or '×' (where average responses are recorded as either an 'undecided', 'disagree' or strongly disagree that is, a 3, 4 or 5 numbered scaled response). Each of the elements across the clusters will be examined in turn.

Table 5.8: Attitudes of importance to adoption and actual adoption of the component III elements of NPD

	Element	Cluster 1										Cluster 2										Cluster 3										T	
		A		B		C		D		T		E		F		G		H		T		I		J		K		L		T			
		i	*ii*	*i*	*ii*	*i*	*ii*	*i*	*ii*	***i***	***ii***	*i*	*ii*	*i*	*ii*	*i*	*Ii*	*i*	*ii*	***i***	***ii***	*i*	*ii*	*i*	*ii*	*i*	*ii*	*i*	*ii*	***i***	***ii***	***i***	***ii***
16	Superior product concept	×	×	×	×	×	×	×	×	**0**	**0**	×	✓	×	✓	×	✓	×	✓	**0**	**4**	×	✓	×	×	×	×	×	×	**0**	**1**	**0**	**5**
17	Initial screening	✓	✓	✓	×	×	×	×	×	**2**	**1**	✓	×	✓	×	✓	×	×	×	**3**	**0**	×	×	×	×	×	×	×	×	**0**	**0**	**5**	**1**
18	Market knowledge	✓	×	✓	✓	✓	×	✓	✓	**4**	**2**	✓	✓	✓	×	✓	✓	×	×	**3**	**2**	×	✓	×	✓	×	×	×	✓	**0**	**3**	**7**	**7**
19	Sufficient resources	✓	✓	✓	×	✓	×	✓	×	**4**	**1**	✓	✓	✓	×	✓	×	×	×	**3**	**1**	×	×	×	×	×	×	×	×	**0**	**0**	**7**	**2**
20	NPD Planning	✓	✓	×	×	✓	×	✓	✓	**3**	**2**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**4**	**11**	**10**
Total reflected in attitude		4		3		3		3		**13**		4		4		4		1		**13**		1		1		1		1		**4**		**30**	
Total demonstrated			3		1		0		2		**6**		4		2		3		2		**11**		3		2		1		2		**8**		**25**

Source: Analysis of field data (where 'i' indicates where the average numbered scaled response between both respondents is 2 or less within each case, and 'ii' is where that element is observed to be actually adopted and 'T' is the total of actual adoptions within the cluster)

The numbered scaled responses have been converted to a '✓' (where average responses are recorded as either an 'strongly agree' or 'agree' that is a 1 or 2 numbered scaled response) or '×' (where average responses are recorded as either an 'undecided', 'disagree' or strongly disagree that is, a 3, 4 or 5 numbered scaled response).

Superior product concept. The first element examined within component III, a 'superior product concept', is now considered. The first finding from analysing the data was that this element was not seen by any STBF in the study as being important to adopt. Initially, this was somewhat a surprising finding when considering the high degree of reliance on intellectual property protection, particularly patents, exhibited by cluster 3 firms. In turn, given the requirement for achieving patent protection necessitates a high degree of 'novelty', it could be argued that possession of a patent would therefore indicate product leadership and as a result a 'superior product concept'.

However, the fundamental requirement for possessing a superior product concept as outlined in the literature was the need to articulate a superior 'value proposition' to firm's the target market compared to what could be achieved by competitors. The possession of intellectual property protection in the form of patents does little to significant such a value proposition from the perspective of the customer. Despite the common view that possessing a superior product concept was not important, this element was in fact demonstrated by cluster 2 firms. Probe questioning revealed that a common theme was again the influence, or expected influence, of investors that drove these cluster 2 firms to be able exhibit this feature. One quote was, 'our joint venture partner insisted in further market research so we could quantify the 'unique selling proposition' of the product' (F:1:E2). Thus, the external influence of investors was the reason that this element was adopted while at the same time being viewed as unimportant by respondents.

Initial screening. The next success factor was that of undertaking 'initial screening' of the product concept prior to the commencement of technical development. Only 5 of the 12 firms (table 5.8 element 17) felt that it was important to adopt this success factor. However, despite these firms expressing the view of importance of the need to adopt this element, only one firm (Case A) actually exhibited the adoption of initial product screening. This seemed to be largely based upon an assumption that respondents knew the market adequately and as a result there was no need to further screen target customers or users (for

example, C:1:C4 and H:2:C4). Two additional themes also arose from probe questioning. The first was the view that screening could just as effectively take place later in the NPD process (B:2:C4). The other was specific to that of cluster 3 firms where it was felt that the technology application itself largely creates the market opportunity. That is, the product was technology driven. As a result, concept screening with potential customers or users would 'achieve very little' (K:2:C4).

Market knowledge. The next success factor was that of obtaining sufficient 'market knowledge' before commencement of new product development. The summary of the data analysis (table 5.8 element 18), shows that the majority of firms in the study (7 out of 12 cases) either 'agreed' or 'strongly agreed' with the view that it was important to obtain this market knowledge through extensive market research. However, it was only in clusters 1 and 2 where this view was reflected.

A number of themes arose from the in-depth exploration of respondents. The first was the previously expressed 'technology driven' nature of products in cluster 3 which resulted in the feeling that adequate knowledge was already possessed without the need for focused market research effort. The second theme arose out of the divergence between the views of importance and actual adoption of this element. Two different reasons were cited for this divergence. In cluster 1, it was universally viewed to be important however adoption was only exhibited by two of the four firms. The reason given was a 'lack of sufficient resource' to fund extensive market research prior to commencement (A:1:C6). In cluster 3, the divergence between views of importance and actual adoption was the opposite to that of cluster 1 in that firms in cluster 3 universally felt it unimportant to undertake extensive market research. However, three of the four firms actually exhibited adoption of this element. The common reason for this situation was again the influence of investors in 'insisting that extensive market research was undertaken to validate the market opportunity' (L1:C6).

Sufficient resources. The next element to consider is that of the possession of 'sufficient resources' to finance all activities of the entire NPD process prior to the commencement of new product development. The attitudes of importance to the adoption of this element largely mirror the pattern which emerged in the previous element. That is, the majority of firms viewed the element as being important (seven of the twelve firms), but these views were held by cluster 1 and 2 firms to the exclusion of cluster 3. Additionally, there was also significant divergence between the views of importance and the actual adoption of this element (table 5.8, element 19).

Largely, it was felt that while is was important, practically this was unlikely to occur in start-up firms and only occurs in larger and well established firms (B:1:C8). Indeed, in only two cases was this element actually exhibited (case A and E). Firms in cluster 3 on the other hand, felt that the long term nature of the NPD process for their products allowed a more structured approach to finance raising where it was anticipated that 'at least 2 'tranches' of funding would be required to see them through the entire NPD process' (K:1:E8).

NPD planning. The final element in component III of the framework was that of 'NPD planning'. This related to the need to undertake the planning for the entire NPD process prior to commencement. In considering the responses to the views of importance of adopting this element, in all but one case it was 'agreed' or 'strongly agreed' that it was important to undertake thorough planning of the NPD process (Table 5.8 element 20).

This pattern was also mirrored in the actual adoption of this element. However, while no attempt was made to judge the effectiveness of this planning but rather to show that planning was evident, there is a need to distinguish process planning from the later launch planning activities related to this element. This dichotomy is best illustrated in cluster 3, where, while thorough process planning was evident, this was not extended to launch planning. It would seem that this is due to the long term nature of new product development for these firms. For illustration: 'getting a

physical product to market is a fair way off yet and things tend to change … so we will worry about this closer to the event' (K:1:E10).

To summarise, the findings for the adoption of the elements of component III of the framework of new product development in STBFs show that a number of specific conclusions can be reached. For ease of reference, table 5.9 summarises these findings and is a re-representation of table 5.8 in summary form.

First, in considering the responses relating to attitudes to the importance of the need to adopt these component III elements, it can be seen that the difference was substantial between the total possible instances where an element could be regarded as being important and that *actually* recorded as being important. This is derived from comparing the 60 total possible instances across all cases and elements within this framework (that is, 12 cases x 5 elements) and the 30 incidences where it was actually recorded as being 'important' (table 5.9 Column IV (*i*)). This demonstrates that there was a substantial divergence in the opinion of respondents as a whole as to the relative importance of adopting these elements of NPD. This outcome is an indicator that actual adoption was therefore likely to be correspondingly low.

Table 5.9 Summary of comparative findings for component III elements

	Elements	*Column I*		*Column II*		*Column III*		*Column IV*	
		Cluster 1		**Cluster 2**		**Cluster 3**		**Total**	
		i	*ii*	*i*	*ii*	*i*	*ii*	***i***	***ii***
16	Superior product concept	0	0	0	4	0	1	**0**	**5**
17	Initial screening	2	1	3	0	0	0	**5**	**1**
18	Market knowledge	4	2	3	2	0	3	**7**	**7**
19	Sufficient resources	4	1	3	1	0	0	**7**	**2**
20	NPD Planning	3	2	4	4	4	4	**11**	**10**
Total reflected in attitude		**13**		**13**		**4**		**30**	
Total demonstrated			**6**		**11**		**8**		**25**

Source: *analysis of field data (where 'i' indicates at least one respondent expressing positive mention as to the importance of adopting that element and 'ii' is where that element is observed to be actually adopted)*

Additionally, of the five elements under examination, three of these elements: possession of a superior product concept (element 16); initial screening of product concept (element 17) and sufficient resources for the entire NPD process (element 19), were not adopted by the majority of cases across all clusters. Moreover, when examining the adoption of individual elements between clusters, the findings from both cluster 1 and cluster 3 showed that a substantial number of individual elements were not adopted by the majority of cases within those clusters (that is, summary totals under sub-column *ii* within each of columns I & III of table 5.9). Indeed, the summary data for cluster 1 (table 5.9) shows that no individual success factor was adopted by more than two of the cases in the cluster, whilst the overall adoption rate was marginally better in both clusters 2 and 3. In both of these clusters two elements were actually adopted by greater than two firms (that is, elements 16 and 20 in cluster 2 and elements 18 and 20 in cluster 3 respectively).

Having considered the findings from the data analysis for the adoption of the elements of NPD contained in the three core components of the framework of new product development in STBFs, it is now possible to answer the first research question and to respond to the first associated research proposition. To refresh, the first research question was: *What elements of NPD are adopted by STBFs when developing new products?*

To answer this research question a summary of all findings across the core components of the theoretical framework for how STBFs undertake their new product development is now provided below as table 5.10. This summary table indicates which elements have been evidenced to have been adopted, as well as which elements were viewed as being important to adopt, by the majority (that is, at least seven) firms in the study.

It can be seen that there is only a marginal difference between the number of elements viewed as being important to adopt and the actual adoption of those elements (comparing columns *i* & *ii* in table 5.10).

Table 5.10 Adoption of elements of NPD by STBFs

Elements of NPD		Element viewed as 'important' *(Column i)*	Element adopted *(Column ii)*
Component I			
1	Market entry	✓	✓
2	Aggression vs. stealth	✓	✓
3	Segmentation & internationalisation	✓	✓
4	Leadership & entrepreneurship	✓	✓
5	Operational systems & financeability	✓	✓
6	Inter-firm cooperation	✓	✗
7	Access to complementary assets	✓	✓
21	Influence of investors	✓	✓
22	Capability of management	✓	✓
Total Component I		9	8
Component II			
8	Speed-to-market	✓	✓
9	Integrated parallel development	✗	✗
10	Well defined decision gates	✓	✓
11	Multifunctional NPD team	✓	✓
12	Reflects needs of the market	✓	✓
13	Experts systems and modelling	✗	✗
14	Strong customer linkages	✓	✗
15	Success measurements	✓	✓
Total Component II		6	5
Component III			
16	Superior product concept	✗	✗
17	Initial screening	✗	✗
18	Market knowledge	✓	✓
19	Sufficient resources	✓	✗
20	NPD Planning	✓	✓
Total Component III		**3**	**2**
Total all components		**18**	**15**
Total possible		**22**	**22**

Source: Synthesis of data summaries provided in tables 5.4, 5.6 and 5.8 with '✓' indicating adoption of 7 or more firms and '✗' indicating adoption of 6 or les firms

Where respondents indicated a view that an element was important to adopt but did not do so, the primary reason cited was a lack of resourcing possessed by those STBFs to affect adoption.

More specifically, the findings as to the adoption of all elements of NPD answers the first research question. That is, that 15 of the 22 elements (table 5.10 column ii) proposed as being necessary for effective new product development were adopted by the majority STBFs. From this observation it was also evident that a substantial number of elements (that is, 7 of the 22 elements) across all three components were not adopted by the majority of STBFs in the study. Specifically, these were:

- inter-firm cooperation (element 6 of component I);
- integrated parallel development (element 9 of component II);
- expert systems and modelling (element 13 of component II);
- strong customer linkages (element 14 of component II);
- a superior product concept (element 16 of component III);
- initial screening of product concept (element 17 of component III); and,
- NPD planning prior to commencement (element 19 of component III).

Again a lack of resources featured highly as a primary reason cited for this general lack of adoption. Additionally, it was also found that a lack of recognition of importance of adoption was also a key reason cited for a lack of adoption of particular elements.

5.4.2 Research proposition 1 – comparison of adoption of elements of NPD between short time-to-market and medium and long time-to-market STBFs

Having answered this first research question, the issue of the degree of adoption of the elements of NPD needs to be explored in more detail in order to address the research proposition associated with the first question as proposed in chapter 3.

Specifically, the first research proposition (RP1) stated that: *STBFs which are characterised as having a short time-to-market product will adopt comparatively fewer elements of NPD than STBFs with either medium or long time-to-market products.*

The best way to address this research proposition is to extend the summary provided in table 5.10 for the inclusion of cluster data. It can be seen from table 5.11 that there were indeed substantial differences between the rates of adoption of the elements of NPD for STBFs which were characterised as having a short time-to-market for their product (cluster 1) compared to STBFs which were

characterised as having either a medium or long time-to-market for their products (clusters 2 & 3 respectively).

Moreover, in comparing the clusters the firms with short time-to-market products (that is, column *i*) adopted 5 of the 22 elements compared with the firms with medium and long time-to-market products which adopted 16 and 13 elements of NPD respectively (columns ii & iii of table 5.11). This represented a very substantial difference in firms with short time-to-market products as compared to the other two clusters of firms. Thus, research proposition 1 was upheld from the findings of this research.

Table 5.11 Adoption of elements of NPD compared across clusters

Elements of NPD		Element adopted		
		Cluster 1 (Col. i)	***Cluster 2 (Col. ii)***	***Cluster 3 (Col.iiii)***
Component I				
1	Market entry	✓	✓	×
2	Aggression vs. stealth	×	✓	✓
3	Segmentation & internationalisation	✓	✓	✓
4	Leadership & entrepreneurship	×	✓	✓
5	Operational systems & financeability	×	✓	✓
6	Inter-firm cooperation	✓	×	×
7	Access to complementary assets	×	✓	✓
23	Influence of investors	×	×	✓
24	Capability of management	×	✓	✓
Component II				
8	Speed-to-market	✓	✓	×
9	Integrated parallel development	✓	×	×
10	Well defined decision gates	×	✓	✓
11	Multifunctional NPD team	×	✓	✓
12	Reflects needs of the market	×	✓	✓
13	Experts systems and modelling	×	✓	×
14	Strong customer linkages	×	✓	×
15	Success measurements	×	✓	✓
Component III				
16	Superior product concept	×	✓	×
17	Initial screening	×	×	×
18	Market knowledge	×	×	✓
19	Sufficient resources	×	×	×
20	NPD Planning	×	✓	✓
Total elements of NPD adopted		**5**	**16**	**13**
Total elements of NPD not adopted		**17**	**6**	**9**

Source: *Synthesis of data summaries provided in tables 5.4, 5.6 and 5.8 with '✓' indicating adoption of greater than 2 firms in that cluster and '×' indicating adoption of 2 of less firms in that cluster*

5.5 Research question 2: how does the lack of adoption of the elements of NPD contribute to new product and firm successes and failures in STBFs?

The immediate focus of considering this component of the research was the relationship between any lack of adoption of elements of NPD and firm success or failure. As such, this focus means that no attempt was made to identify and examine all possible factors which may give rise to firm failure. Thus, research question 2 was:

> *How does the lack of adoption of the elements of NPD contribute to new product and firm successes and failure in STBFs?*

To commence it is important to reiterate from previous discussion in section 2.2 that this research takes the approach that STBFs are 'single product centric'. That is, by definition STBFs have only a single product around which the firm is based. This is distinct from a firm with a portfolio of products and which is more common to larger and more mature firms. As a consequence of being single product centric one would expect a strong association between the failure of a new product, or discontinuity of NPD process, and firm failure.

In considering the elements of NPD not adopted and firm failure in chapter 3, two relational dimensions of the research question became apparent which, in turn, gave rise to two associated research propositions. These were: the relationship between the overall lack of adoption of elements of NPD and firm failure and the lack of adoption of the market-related elements of NPD and firm failure. These are now addressed in sections 5.5.1 and 5.5.2 respectively. However, it is first important to establish the context for examining firm failure for the purposes of this research.

In order to identify the firms that failed a subsequent follow-up interview was conducted where possible. Where no contact was possible, a search of the Australian Securities and Investment Corporation (ASIC) database was conducted

to confirm business deregistration. The resulting analysis of the data comparing firms that had failed to those that were still continuing contributed valuable insights to answer this research question and provided a basis on which to address the two associated research propositions.

Consideration here needs to be given as to the nature of product failure. First, once failed firms had been identified it was important to consider whether NPD was discontinued prior to product launch or rather the product failed subsequent to product launch. At the same time, it also needs to be recognised that an effective NPD process can give rise to a different form of the new product as a result of product changes resulting from the ongoing testing, screening and customer/user validation (section 2.4.2). Such changes to the product are a direct result of either the NPD process itself or alternatively from changes in strategic direction of the firm. For this reason, the research protocol for the subsequent interviewing stage identified instances where either:

- the failed firm had launched a product but the product had failed;
- the failed firm had discontinued the NPD process prior to launch or,
- where a firm experienced NPD discontinuity but not firm failure.

First, the failed STBFs together with the exact nature of their product failure needed to be identified. The summary of all STBFs in the study with respect to firm failure, NPD progress and product failure is provided in table 5.12. In the instances where the firm had failed, all NPD stages are shaded. It can be seen from this summary that over the 5 year period from initial interviews to the subsequent interview (as outlined in the research methodology provided in chapter 3), 8 of the 12 firms were still in operation, with four firm failures being case A (Row 1 table 5.12), case C (Row 3 table 5.12), case H (Row 8 table 5.12) and case K (Row 11 table 5.12). Further, it can be seen that the only cases where either NPD was discontinued (case K) or a firm had launched a product but which had subsequently failed (cases A, C and H) were identified as failed cases.

Table 5.12 Current position at subsequent interview of cases in relation to firm failure and NPD stages completed

Row	Cluster	Case	NPD stage				NPD Discontinued	Product Launched but failed	Firm Failure
			1	2	3	4			
1	Cluster 1 - STM	A	✓	✓	✓	✓		✓	FAIL
2		B	✓	✓	✓	✓			-
3		C	✓	✓	✓	✓		✓	FAIL
4		D	✓	✓	✓	✓			-
5	Cluster 2 – MTM	E	✓	✓	✓	✓			-
6		F	✓	✓	✓	✓			-
7		G	✓	✓	✓	✓			-
8		H	NO NPD DATA					✓	FAIL
9	Cluster 3 - LTM	I	✓	✓	✓				-
10		J	✓	✓					-
11		K	✓	✓			✓		FAIL
12		L	✓	✓					-

Source: Analysis of field data (with a '✓' indicating activity in that that NPD stage or NPD discontinuity)

The immediate observation that can be made from the summary of this analysis is that firms which anticipated having a time-to-market of five years or less (clusters 1 & 2) had indeed completed all stages of the NPD process and had achieved a launch of their product into the marketplace (NPD 'stage 4' in table 5.12). In the instance of case F which did not expect to launch a physical product, but rather license technology, it had also completed an initial licensing agreement. Likewise, of the cases which anticipated a time-to-market of greater than 5 years (cluster 3), only one case, that is Case I, (Row 9 Table 5.12) had progressed beyond the NPD stage indicated five years previously (Table 5.12).

In exploring reasons for firm failure, particularly as it may have related to the firm's NPD activities, two approaches were taken in the analysis. The first approach was that of direct questioning of cases which had failed regarding the possible reasons for firm failure. Specifically, of the four firms which had been classed as having failed, it was possible to conduct interviews with an original respondent from three of the four firms in order to attempt to discover the reasons for the firm's failure. No data was available for Case H except to the extent that a product had been launched in the marketplace and was therefore not a discontinued

NPD process. The second approach was to make a comparison of the elements of NPD which had been adopted between continuing firms and failed firms.

Table 5.13 provides a summary of the responses obtained from firms able to be interviewed.

Table 5.13 Reasons cited for failure

Case	Lack of finance	Lack of satisfactory progress for investors	Insufficient cash flow	Technical development goals not met
A	✓		✓	
C	✓		✓	
H	NO DATA AVAILABLE			
K	✓	✓		✓

Source: analysis of field data

The initial response from respondents interviewed cited lack of finance as the principal reason for failure. While availability of sufficient resources is a success factor in its own right, more in-depth exploration exposed a number of underlying reasons attributed to deficiencies in NPD activities as possible root causes.

Each of the first two cases (Case A and Case C) cited the primary reason for failure as the inability to generate sufficient cash flow. The underlying reason for this situation was an underestimation of the length of time of the sales cycle for their products in their respective markets. This directly indicated a lack of sufficient market knowledge in not identifying this as a critical success factor for their sales strategy. It was further revealed that at no point had either firm actually engaged the market to screen their product concept prior to development and that, as a result, there was a gap in their knowledge of the requirements of the market (A:1: F2; C:1: F2). In the situation of Case K, the lack of finance was due to the inability to raise second stage venture capital. Again, on further exploration, the underlying reason for this seemed to be the inability to meet the agreed technical milestones within the technical development stage.

This situational analysis provided a basis for understanding failed firms within the study and then provided a basis for addressing the two research propositions related to this research question. As such, the data was analysed and the findings are now presented in respect to research proposition 2(a).

5.5.1 Research proposition 2(a) – comparison of adoption of elements of NPD between failed and continuing STBFs

As seen in the previous section, the approach taken to answer research question 2 was to focus the data analysis on the relationships between new product failure, firm failure and the extent to which the elements of NPD were not adopted by STBFs.

Further, the literature revealed that there was a nexus between the adoption of the elements of NPD, particularly those relating to new product success factors (component II of the theoretical framework), and firm success (section 2.4.4). The logical extension of this relationship gave rise to the argument that there is a direct relationship between the lack of adoption of all NPD elements within the theoretical framework, new product failure and hence firm failure in STBFs. To reiterate, research proposition 2 (a) stated that, '*STBFs which adopt comparatively fewer individual elements of NPD exhibit a greater likelihood of new product and firm failure'*.

In order to address this research proposition, a comparison of the elements of NPD which were not adopted was now made between continuing STBFs and failed STBFs. This comparison is undertaken by comparing the extent to which the elements of NPD have been not been adopted between the failed firms and continuing firms. Table 5.14 provides a summary of the data for comparison purposes. A '✓' indicates adoption and 'X' indicates no adoption of the individual elements and with summary totals expressed as both number of incidences of adoption and non-adoption as well as percentages of adoption and non-adoption for both the failed and continuing firm groups.

From this summary, a number of observations can now be made. The first observation relates to explanation for failure cited by respondents across the failed firms. In-depth exploration of the responses provided by interviewees showed that the principal reason cited for firm failure was that of a lack of finance. Additionally, it would seem that the short time-to-market nature of some of these failed firms was also a compounding factor. In particular, these firms seemed to be more willing to rely on debt financing than firms with medium and long time-to-market products on the expectation of realising an early positive cash flow position. For illustration, one respondent stated that: 'at the outset, a lack of finance didn't concern us too much, as we expected to be able to obtain a positive cash flow position to service debt'. Moreover, while a 'lack of resources' was reflected in two of the seven NPD elements (elements 19 and 21), the possession of a superior product concept, obtaining sufficient market knowledge, concept screening, NPD success measurement and expert systems and modelling were also reflected in a lack of adoption.

The second observation related to the patterns of adoption between failed and continuing firms across the three components of the theoretical framework. In considering the total incidences of adoption of elements of NPD, it can be observed that there was a substantial difference between the failed and continuing firm groups (50 percent compared to 64 percent respectively). Furthermore, an examination of the findings comparing adoption in the context of components I, II and III of the theoretical framework shows that these comparative lower rates adoption for failed firms occured across each of the three components of the theoretical framework.

Table 5.14 NPD elements adopted by continuing firms compared to failed firms

	ELEMENTS OF NPD	INCIDENCES OF ADOPTION OF ELEMENTS OF NPD															
		Failed Cases							Continuing cases #								
		A	C	H	K	Total (A)	Total (NA)		B	D	E	F	G	I	J	L	Total (A)	Total (NA)
COMPONENT I																		
1	Market entry	✓	✓	✓	×	3	**1**		✓	✓	✓	✓	✓	×	×	×	5	**3**
2	Aggression vs. stealth	✓	×	✓	✓	3	**1**		×	×	✓	✓	✓	✓	✓	✓	6	**2**
3	Segmentation & internationalisation	✓	✓	✓	✓	4	**0**		✓	✓	✓	✓	✓	✓	✓	✓	8	**0**
4	Leadership & entrepreneurship	✓	×	✓	✓	3	**1**		×	×	✓	×	✓	✓	✓	✓	5	**3**
5	Operational systems & financeability	×	×	✓	✓	2	**2**		✓	✓	✓	✓	✓	✓	✓	✓	8	**0**
6	Inter-firm cooperation	✓	✓	×	×	2	**2**		✓	✓	×	✓	✓	×	×	×	4	**4**
7	Access to complementary assets	×	×	✓	✓	2	**2**		×	×	✓	×	✓	✓	✓	✓	5	**3**
21	Influence of investors	×	×	×	✓	1	**3**		×	✓	✓	×	✓	✓	✓	✓	6	**2**
22	Capability of management	×	×	✓	✓	2	**2**		×	✓	×	✓	✓	✓	✓	✓	6	**2**
	COMPONENT I TOTAL					22	**14**										53	**19**
						61%	**39%**										74%	**26%**
COMPONENT II																		
8	Speed-to-market	✓	✓	✓	×	3	**1**		✓	✓	✓	✓	✓	×	×	×	5	**3**
9	Integrated parallel development	✓	✓	×	×	2	**2**		×	✓	✓	×	×	×	×	×	2	**6**
10	Well defined decision gates	✓	×	✓	✓	3	**1**		×	✓	✓	✓	✓	✓	✓	✓	7	**1**
11	Multifunctional NPD team	×	×	✓	✓	2	**2**		×	×	×	✓	✓	✓	✓	✓	5	**3**
12	Reflects needs of the market	×	✓	✓	✓	3	**1**		✓	×	✓	×	✓	✓	✓	✓	6	**2**
13	Experts systems and modelling	×	×	✓	×	1	**3**		×	×	✓	✓	×	×	×	✓	3	**5**
14	Strong customer linkages	×	×	✓	×	1	**3**		✓	×	✓	✓	✓	×	×	×	4	**4**
15	Success measurements	×	×	×	✓	1	**3**		✓	✓	✓	✓	✓	✓	✓	✓	8	**0**
	COMPONENT II TOTAL					16	**16**										40	**24**
						50%	**50%**										63%	**37%**
COMPONENT III																		
16	Superior product concept	×	×	✓	×	1	**3**		×	×	✓	✓	✓	✓	×	×	4	**4**
17	Initial screening	✓	×	×	×	1	**3**		×	×	×	×	×	×	×	×	0	**8**
18	Market knowledge	×	×	×	×	0	**4**		✓	✓	✓	×	✓	✓	✓	✓	7	**1**
19	Sufficient resources	✓	×	×	×	1	**3**		×	×	✓	×	×	×	×	×	1	**7**
20	NPD Planning	✓	×	✓	✓	3	**1**		×	✓	✓	✓	✓	✓	✓	✓	7	**1**
	COMPONENT III TOTAL					6	**14**										19	**21**
						30%	**70%**										48%	**52%**
	TOTAL ELEMENTS ADOPTED	11	6	15	12	44			9	12	18	14	18	14	13	14	112	
	TOTAL ELEMENTS NOT ADOPTED	**11**	**16**	**7**	**10**		**44**		**13**	**10**	**4**	**8**	**4**	**8**	**9**	**8**		**64**
						50%	**50%**										**64%**	**36%**

Source: Synthesis of data summaries provided in tables 5.4, 5.6 and 5.8. [(A) denotes adoption and (NA) denoted non-adoption).

In summary, the findings from the data analysis relating to adoption of elements of NPD now permit research proposition 2 (a) to be confirmed. That is: *STBFs which adopt comparatively fewer individual elements of NPD exhibit a greater likelihood of new product and firm failure.* Specifically, the evidence for confirming this research proposition is found in the summary of the data analysis presented in table 5.14 as outlined above. Research proposition 2 (b) will now be addressed in the next section.

5.5.2 Research proposition 2(b) – comparison of the adoption of market related elements of NPD to that of the non market related elements of NPD in failed firms

An important phenomenon identified from the literature review (chapter 2) was the identification of the fact that in general a disproportionate number of the founders of technology start-up firms were technologists with little or no business training or experience (chapter 2). Additionally, nothing in this literature review suggested that this phenomenon did not also apply to founders of STBFs. As a result it is logical to then assume that STBF founders are also likely to be technologists. As a result it can also be argued that STBFs are more likely to adopt process or technical related elements of NPD rather than market related elements. Furthermore, as the importance of the adoption of market related elements of NPD was established in the literature as fundamental to new product success (section 2.4.4), this then gives rise to the argument that such a propensity to adopt process-related features at the expense of market related features would be a contributor to new product failure. Moreover, as discussed earlier, it has been seen the STBFs are single-product centric, therefore new product failure translated into firm failure. Indeed, as previously explained in section 5.5.1, there was a correlation in this study between firms exhibiting new product failure, as demonstrated by NPD discontinuity, and firm failure.

To reiterate, research proposition 2(b) stated that: 'a *lack of adoption of market-related elements of NPD compared to non-market elements of NPD increases the likelihood of new product and firm failure in STBFs'*.

As such, the next step is to compare the adoption of the market related elements to the non-market related elements of NPD in the context of failed firms. Table 5.15 provides a synthesis of the findings relating to the adoption by STBFs of the elements of NPD, as previously presented in tables 5.4, 5.6 and 5.8 respectively and that in turn provides a basis for this comparison. Specifically, the approach taken in this analysis has been to examine the NPD elements which have NOT been adopted by the majority of failed firms. The summary of these results is provided in table 5.14 where '✓' represents an incidence of adoption and an '✕' represents an incidence of non-adoption. From this approach a number of observations can be made allowing research proposition 2(b) to be addressed.

First, when comparing the proportional rate of non-adoption between market and non-market related NPD elements it is evident that there is a marginal difference between the two groups. Specifically, 41 per cent of the total possible incidences (8 elements X 4 cases – table 5.15) were non-adopted market related elements of NPD. This compares to 54 per cent of the total possible incidences (14 elements x 4 cases – table 5.15) non-adopted non-market related elements of NPD. Furthermore, two of the eight non-adopted market related elements of NPD (elements 16 and 18 of table 5.15) were not adopted by the majority of failed firms, that is, either three or all failed firms. On the other hand, five of the fourteen non-adopted non-market related elements of NPD (elements 21, 13, 15, 17 and 19 of table 5.15), were not adopted by the majority of failed firms.

While this phenomenon was of interest, it was by considering the overall pattern of non-adoption that greater insight into the findings was obtained. The first insight related to the co-dependency between individual elements of NPD which was first considered in chapter 2. This co-dependence between elements means that the impact on the firm of adopting or not adopting any one particular element cannot be

considered in isolation from other elements but rather in terms of a potential cumulative effect across a number of elements. For instance, a lack of adoption of the element of 'success measurement' (element 15) may be important in its own right, it is its co-dependency with other elements (such as, the lack of initial screening) which may have a cumulative effect in influencing new product failure.

Table 5.15 Comparison of market related elements of NPD to non-market related elements for failed firms

Elements of NPD		Adoption of NPD elements					
		Failed Cases					
		A	C	H	K	Total (A)	Total (NA)
MARKET RELATED ELEMENTS OF NPD							
1	Market entry strategy	✓	✓	✓	×	3	1
2	Aggression vs stealth	✓	×	✓	✓	3	1
3	Segmentation & internationalisation	✓	✓	✓	✓	4	0
8	Speed-to-market	✓	✓	✓	×	3	1
12	Needs of the market	×	✓	✓	✓	3	1
14	Strong customer linkages	×	✓	✓	×	2	2
16	Superior product concept	×	×	✓	×	1	3
18	Market knowledge	×	×	×	×	0	4
Total market related NPD elements		**4**	**3**	**1**	**5**	**19**	**13**
						59%	**41%**
NON-MARKET RELATED ELEMENTS OF NPD							
4	Leadership & entrepreneurship	✓	×	✓	✓	3	1
5	Operational systems & financeability	×	×	✓	✓	2	2
6	Inter-firm cooperation	✓	✓	×	×	2	2
7	Access to complementary assets	×	×	✓	✓	2	2
21	Influence of investors	×	×	×	✓	1	3
22	Capability of management	×	×	✓	✓	2	2
9	Integrated parallel development	✓	✓	×	×	2	2
10	Well defined decision gates	✓	×	✓	✓	3	1
11	Multifunctional NPD team	×	×	✓	✓	2	2
13	Experts systems and modelling	×	×	✓	×	1	3
15	Success measurements	×	×	×	✓	1	3
17	Initial screening	✓	×	×	×	1	3
19	Sufficient resources	✓	×	×	×	1	3
20	NPD planning	✓	×	✓	✓	3	1
Total non-market NPD related elements		**7**	**12**	**6**	**5**	**26**	**30**
						46%	**54%**

Source: Synthesis of data summaries provided in tables 5.4, 5.6 and 5.8 where a '✓' indicates adoption and '×' represents an incidence of non-adoption. [(A) denotes adoption and (NA) denoted non-adoption within the 'Total' column).

For example, its impact on the ability to measure 'success criteria' within decision gates may result in an inability to modify the NPD process and the product itself. Indeed, this exact example was alluded to by one of the respondents: 'in hind-sight…if we had more effective measurement criteria built into the NPD process together with a more comprehensive screen process...it would have contributed greatly to reducing the chance of failure' (A:1:C2).

Therefore, in examining the summary provided in table 5.15, it can been seen that in terms of total incidences of possible adoption of elements of NPD in the failed firms, it is proportionately the non-market related elements that were not adopted to a greater extent than the market related elements of NPD. Thus, in conclusion, research proposition 2(b) is not supported. Moreover, it can also be seen that there is only a modest difference between the total elements of NPD adopted compared to those not adopted in the failed firms (48 per cent compared to 52 per cent respectively). From this finding it can be seen that very little importance could be placed on this difference between the adoption of the market related or non-market related elements of NPD.

To summarise, research question 2 was answered in two parts. The first was through addressing the two specific research propositions just discussed. The first of these research propositions, that is, RP2(a): 'STBFs which adopt fewer individual elements of NPD exhibit a greater likelihood of new product and firm failure', is supported. In particular, it was found that failed firms exhibited a greater proportionate lack of adoption of component III elements, that is, new product success factors, compared to component I or II elements within the theoretical framework. The second research proposition, that is RP 2(b): 'a lack of adoption of market-related elements of NPD compared to non-market elements of NPD increases the likelihood of new product and firm failure in STBFs', was not supported.

The second part in answering the research question can be derived from the additional findings relating to identifying the main reasons cited for firm failure.

These were lack of financial resources to fund the entire NPD process prior to commencement (element 19); the influence of investors due to a perception of a lack of satisfactory progress though the NPD process, even when the ability to effective measure such progress is not evident (related to elements 8, 20 and 21) and, finally the firms inability to meet technical development goals through the individual NPD processes (relating to elements 15 and 23).

Having analysed the data relating to research question 2, the final research question, that is, research question 3 is now considered.

5.6 Research question 3: How and in what ways do business incubators influence the performance of the elements of NPD adopted by STBFs?

One issue identified from the literature review in chapter 2 related to the impact of business incubators on their tenant firms. Specifically, the literature pointed to the positive influence provided by incubators on the development of corporate strategy of tenant firms. As such, it was determined by the researcher that it was a critical aspect of this study to examine the extent to which this positive influence extended beyond that provided to corporate strategy development into the other elements of NPD in tenant STBFs. Thus, the final research question to be answered in this study related to the role played by business incubators in the performance of NPD by their tenant firms. That is, research question 3 was:

> *How and in what ways do business incubators influence the performance of the elements of NPD adopted by STBFs?*

To commence to answer this research question, two specific research propositions were proposed. The first related to the differences in the adoption of elements of NPD between STBFs which were tenants compared to those which were not tenants of business incubators. The second research proposition related to differences in performance of those NPD elements between STBFs who are tenants

compared to those which are not tenants of business incubators. Each will now be addressed in turn in sections 5.6.1 and 5.6.2 respectively.

5.6.1 Research proposition 3(a) – comparison of the adoption of the elements of NPD by STBFs who are tenants of business incubators to STBFs who are not tenants of business incubators

The starting point in answering this research question is to first compare the differences in the overall adoption rates of the elements of NPD between STBFs which are incubator tenants to those which are not. The first research proposition relating to research question 3 was based on the argument that the identified positive influence provided by business incubators to their tenant firms extends to the influence on the adoption of elements of NPD by tenants STBFs. Specifically, research proposition 3(a) stated that:

> *STBFs which are tenants of business incubators undertake their NPD more effectively – as determined by the number of elements of NPD adopted compared to STBFs which are not tenants.*

The findings relating to this research proposition were derived from reanalysing the data obtained from the previous research questions. As a result, table 5.16 provides a summary of this analysis by representing the adoption of individual elements as a comparison of tenant STBFs with non-tenant STBFs. Further, this comparison was undertaken across clusters with '1', '2'and '3' representing cluster 1, cluster 2 and cluster 3 respectively.

In considering the findings summarised in table 5.16, a number of observations can now be made which go toward addressing research proposition 3(a). The first observation is that there was only a marginal difference between the total elements of NPD adopted between business incubator and non-business incubator STBFs with 79 and 76 instances of adoption observed respectively ('Total NPD elements adopted' in table 5.16).

The second observation is that there is a similar pattern of difference in the adoption of elements of NPD between individual clusters within the business incubator tenant group and the non-business incubator tenant group. That is, in both groups it is cluster 2 (firms with medium time-to-market products) which exhibit the greater number of incidences of adoption of NPD elements (that is, 32 instances in each group – table 5.16). Further, it was cluster 1 firms (firms with short time-to-market products) that exhibited the least number of incidences of adoption of NPD elements (20 and 18 incidences respectively – table 5.16). Specifically, table 5.16 shows that the pattern of adoption of elements of NPD was similar between firms who are incubator tenants and those who are not.

Table 5.16 The adoption of the elements of NPD compared between business incubator tenant STBF clusters and non-business incubator tenant STBF clusters

		Element adopted							
		Business Incubator STBFs in each cluster				Non-Business Incubator STBFs in each cluster			
		1	2	3	T	1	2	3	T
Component I									
1	Market entry	2	2	0	**4**	2	2	0	**4**
2	Aggression vs. stealth	1	2	2	**5**	0	2	2	**4**
3	Segmentation & internationalisation	2	2	2	**6**	2	2	2	**6**
4	Leadership & entrepreneurship	1	1	2	**4**	0	2	2	**4**
5	Operational systems & financeability	1	2	2	**5**	1	2	2	**5**
6	Inter-firm cooperation	2	1	0	**3**	2	1	0	**3**
7	Access to complementary assets	0	1	2	**3**	0	2	2	**4**
23	Influence of investors	0	1	2	**3**	1	1	2	**4**
24	Capability of management	0	1	2	**3**	1	2	2	**5**
Total Component I		**9**	**13**	**14**	**36**	**9**	**16**	**14**	**39**
Component II									
8	Speed-to-market	2	2	0	**4**	2	2	0	**4**
9	Integrated parallel development	1	1	0	**2**	2	0	0	**2**
10	Well defined decision gates	1	2	2	**5**	1	2	2	**5**
11	Multifunctional NPD team	0	1	2	**3**	0	2	2	**4**
12	Reflects needs of the market	1	1	2	**4**	1	2	2	**5**
13	Experts systems and modelling	0	2	0	**2**	0	1	1	**2**
14	Strong customer linkages	1	2	0	**3**	0	2	0	**2**
15	Success measurements	1	2	2	**5**	1	1	2	**4**
Total Component II		**7**	**13**	**8**	**28**	**7**	**12**	**9**	**28**
Component III									
16	Superior product concept	0	2	1	**3**	0	2	0	**2**
17	Initial screening	1	0	0	**1**	0	0	0	**0**
18	Market knowledge	1	1	2	**4**	1	1	1	**3**
19	Sufficient resources	1	1	0	**2**	0	0	0	**0**
20	NPD Planning	1	2	2	**5**	1	2	2	**5**
Total Component III		**4**	**6**	**5**	**15**	**2**	**5**	**3**	**10**
Total NPD elements adopted		**20**	**32**	**27**	**79**	**18**	**32**	**26**	**76**

Source: *Synthesis of data summaries provided in tables 5.4, 5.6 and 5.8 indicated cases where the element of NPD is observed t o be actually adopted in business incubator tenant STBF clusters (BI) and non- business incubator tenant STBF clusters (NBI).*

This finding allows research proposition 3(a) to now be addressed. Specifically, the analysis of data from this research showed that there was no substantial difference in the adoption of elements of NPD between firms which were tenants of business incubators compared to firms which were not tenants. Hence, research proposition 3(a) was not supported.

Now that research proposition 3(a) has been addressed, the next aspect to consider is the perception of positive influence on tenant firms by business incubators on performance of NPD. This is addressed in the next section.

5.6.2 Research proposition 3(b) – perceptions of influence by business incubators on performance of NPD provided on tenant STBFs

It was found in section 5.6.1 that there was no substantive difference between the business incubation and the non-business incubation environment in regards to the total adoption as well as the pattern of adoption of NPD elements. As a result, the relationship between NPD performance and business incubation now needs to be considered.

In the literature review of chapter 2, it was found that business incubators provided a substantial benefit to tenant firms in the development of their corporate strategy and in undertaking their general business development activities. In general terms, these benefits resulted from the easier access to specialised business services, in particular business advisors and business networks, provided through business incubators to their tenant firms. It can be argued then that similar benefits would also occur in respect to the performance of undertaking NPD activities by tenant firms. Thus, research proposition 3(b) stated that: '*the comparatively better NPD performance of tenant STBFs is attributed to the services of the business incubator in which they are a tenant'*.

Not withstanding the results obtained in the previous section, no insight was derived from the analysis of the data as to the existence or otherwise of any

differences in the perceived quality of performance of new product development between business incubator and non-business incubator tenant STBFs. However, as outlined in chapter 4, the research methodology relating to this aspect of the research examined the perceptions of respondents as to whether or not a positive influence was experienced rather than an attempt to measure or quantify actual NPD performance. This approach allowed the researcher to address the issue of whether or not the assistance and support services typically provided by business incubators provided a positive influence on the performance of the elements of NPD adopted by the tenant firms. More specifically, the researcher asked probe questions of respondents as to whether the performance of any one particular element was enhanced due to the activities of the business incubator over and above what would have been experienced if they had not been a tenant.

Obviously such questioning is only meaningful in the context of the tenant firms of business incubators within the study, that is, cases A, B, E, F, I and J. As such, table 5.17 presents the summary of the data analysis that was obtained from the probe questions posed to business incubator tenants from Part A of the research protocol.

A number of observations can now be made from table 5.17 which addresses research proposition 3(b). The first is that the data analysis showed that business incubators provided only a marginal positive influence on the performance of the elements of NPD which were adopted by tenant STBFs. Of the 79 instances of adoption of elements of NPD across the six tenant STBFs it is only in 21 instances (or 27 per cent) that at least one respondent felt that performance was improved due to the activities or services of the business incubator (table 5.17 – 'Total' columns *i* & *ii*).

The second observation is that of the 21 instances where a positive influence was perceived by at least one respondent, 15 of these instances (that is 72 per cent of the reported instances) were associated with component I NPD elements. As these component I elements were related to corporate strategy (section 5.4.1.1) this would support the finding from the literature review of the positive role played by

Table 5.17 Comparison of adopted elements to those elements on which the business incubator had a positive influence

	ELEMENTS OF NPD	Case A		Case B		Case E		Case F		Case I		Case J		Total	
		i	*ii*	*i*	*ii*	*i*	*ii*	*i*	*ii*	*i*	*ii*	*i*	*ii*	*i*	*ii*
COMPONENT I ELEMENTS															
1	Market entry	✓	✓	✓	✓	✓	✓	✓	✓	×	×	×	×	**4**	**4**
2	Aggression vs. stealth	×	✓	×	×	×	✓	×	✓	×	✓	×	✓	**0**	**5**
3	Segmentation & internationalisation	✓	✓	✓	✓	×	✓	×	✓	✓	✓	✓	✓	**4**	**6**
4	Leadership & entrepreneurship	×	✓	×	×	×	✓	×	×	×	✓	×	✓	**0**	**4**
5	Operational systems & financeability	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓	**4**	**5**
6	Inter-firm cooperation	×	✓	✓	✓	×	×	×	✓	×	×	×	×	**1**	**3**
7	Access to complementary assets	×	×	×	×	×	✓	×	×	×	✓	×	✓	**0**	**3**
23	Influence of investors	×	×	×	×	×	✓	×	×	✓	✓	✓	✓	**2**	**3**
24	Capability of management	×	×	×	×	×	×	×	✓	×	✓	×	✓	**0**	**3**
Total Component I		**2**	**5**	**3**	**4**	**2**	**7**	**2**	**6**	**3**	**7**	**3**	**7**	**15**	**36**
COMPONENT II ELEMENTS															
8	Speed-to-market	×	✓	×	✓	×	✓	×	✓	×	×	×	×	**0**	**4**
9	Integrated parallel development	×	✓	×	×	×	✓	×	×	×	×	×	×	**0**	**2**
10	Well defined decision gates	×	✓	×	×	×	✓	×	✓	×	✓	×	✓	**0**	**5**
11	Multifunctional NPD team	×	×	×	×	×	×	×	✓	×	✓	×	✓	**0**	**3**
12	Reflects needs of the market	×	×	✓	✓	×	✓	×	×	✓	✓	✓	✓	**3**	**4**
13	Experts systems and modelling	×	×	×	×	×	✓	×	✓	×	×	×	×	**0**	**2**
14	Strong customer linkages	×	×	×	✓	×	✓	×	✓	×	×	×	×	**0**	**3**
15	Success measurements	×	×	×	✓	×	✓	×	✓	✓	✓	✓	✓	**2**	**5**
Total Component II		**0**	**3**	**1**	**4**	**0**	**7**	**0**	**6**	**2**	**4**	**2**	**4**	**5**	**28**
COMPONENT III ELEMENTS															
16	Superior product concept	×	×	×	×	×	✓	×	✓	×	✓	×	×	**0**	**3**
17	Initial screening	×	✓	×	×	×	×	×	×	×	×	×	×	**0**	**1**
18	Market knowledge	×	×	×	✓	×	✓	×	×	✓	✓	×	✓	**1**	**4**
19	Sufficient resources	×	✓	×	×	×	✓	×	×	×	×	×	×	**0**	**2**
20	NPD Planning	×	✓	×	×	×	✓	×	✓	×	✓	×	✓	**0**	**5**
Total Component III		**0**	**3**	**0**	**1**	**0**	**4**	**0**	**2**	**1**	**3**	**0**	**2**	**1**	**15**
TOTAL ELEMENTS WITH A POSITIVE INFLUENCE ON PERFORMANCE		**2**		**4**		**2**		**2**		**6**		**5**		**21**	
TOTAL ADOPTED ELEMENTS			**11**		**9**		**18**		**14**		**14**		**13**		**79**

Source: *Analysis of field data (where 'i' indicates whereat least one of the respondents indicate a positive influence on performance, and 'ii' is where that element is observed to be actually adopted and represented from tables 5.4, 5.6 and 5.8)*

business incubators in assisting tenant firms with the development of corporate strategy. Moreover, when the instances of a positive influence being perceived by the tenant STBFs in this study were examined in more detail, it was be seen that the majority of such instances (9 of the 15 instances) were closely related to elements pertaining to market factors, in particular:

- Identification of an appropriate market entry strategy (element 1);
- Consideration of market segmentation and internationalisation (element 3);
- Inter-firm cooperation – particularly as it related to market entry (element 6).

In particular, an in-depth analysis of the data highlighted the fact that tenant firms had an expectation that incubators would provide a higher level of assistance in helping to forge inter-firm relationships to assist the tenant firms with commercialisation, particularly market entry (elements 1 & 6). For example, Case A was observed to adopt inter-firm cooperation but felt the incubator provided no assistance in this activity even though it was expected that the incubator would 'actively facilitate partnering' (A:1:D6).

The remaining instances in relation to component I NPD elements were the positive influence contributed to the adoption of effective operational systems and positioning of the business to achieve 'financeability' (element 5) and a greater ability to manage the influence of investors in those firms (element 21).

Similarly, it was also these market-related elements of NPD from which a positive influence on performance was perceived in the context of component II and component III elements of NPD. Specifically, it was element 12 (reflecting the needs of the market in the NPD process) as well as element 18 (obtaining of knowledge of the market prior to commencing NPD) that demonstrated the majority of the remaining instances of a positive influence being reported. The final element for which a positive influence was reported was that of element 15 (adoption of success measurements).

Now that the instances of the perception of a positive influence by tenant STBFs has been analysed, we can now explore the responses to the probe questioning of respondents in order to obtain meaningful insight into this phenomenon.

Responses to the in-depth probing of respondents provided a number of key insights. First, one of the common features of STBF tenants was the requirement by business incubators that firms develop a detailed business plan as a priority activity. As a component of the business planning process there was heavy emphasis on the need to undertake comprehensive and systematic market research. For illustration, one respondent mentioned that 'demonstration of having undertaken appropriate market research was a requirement of the application process to become a tenant' (B:1:E6). Indeed this was a common theme within a number of responses expressed by interviewees (for example, A:1:E6; E:1E6; and F:1:E6). Moreover, the extent of this activity would seem to have been greater due to the influence of the business incubator. For example, one respondent felt that the business incubator advisors: 'tested our market assumptions to an extent that made us re-evaluate who our target market actually was… which just would not have happened without going through this process with these advisors' (J:2:E4).

While it was the existence of positive perceptions on the influence of performance that was the focus, the probe questioning also allowed for the identification of a number of negative perceptions in the role played by incubators. In particular, this related to unfulfilled expectations of assistance in the performance of the process-related NPD elements and also the NPD management process more generally. For illustration, one respondent commented that: 'the links that the incubator stated it had with universities led us to believe that these relationships would provide us easier access to technical experts within these organisations – which wasn't the case' (E:2:C8). Similar views were expressed by other respondents in relation to an expectation that the business incubator would provide a level of guidance in respect to the process of managing the overall NPD process (B:2:C2 & E:1:C2).

In summary, the findings from this research did not support research proposition 3(b). That is, business incubators provided only a modest positive influence on the performance of the elements of NPD by tenant STBFs.

5.7 Conclusions

In conclusion, this chapter has analysed the data collected on the new product development activities of twelve STBF cases via 24 in-depth interviews with target respondents within those firms (section 4.6). This analysis of data was done through detailed content analysis and cross-cluster analysis to show patterns of the results for each of the three research questions developed in chapter 3. In order to answer these three research questions, five research propositions were proposed which, in turn were based on the findings and conclusions from the literature review conducted in chapter 2.

In summary, research proposition 1 was supported as the findings showed that firms with short time-to-market products adopted only 5 of the elements of NPD compared to 16 elements (for firms with medium time-to-market products) and 13 elements (for the firms with long time-to-market products) respectively. In general terms however, the research found that the majority of STBFs adopted 15 of the 22 elements of NPD. Moreover, it was also found that STBFs exhibited no preference for *when* the individual components of the NPD framework should be conducted, but rather it was seen to be necessary to undertake each of the components in parallel.

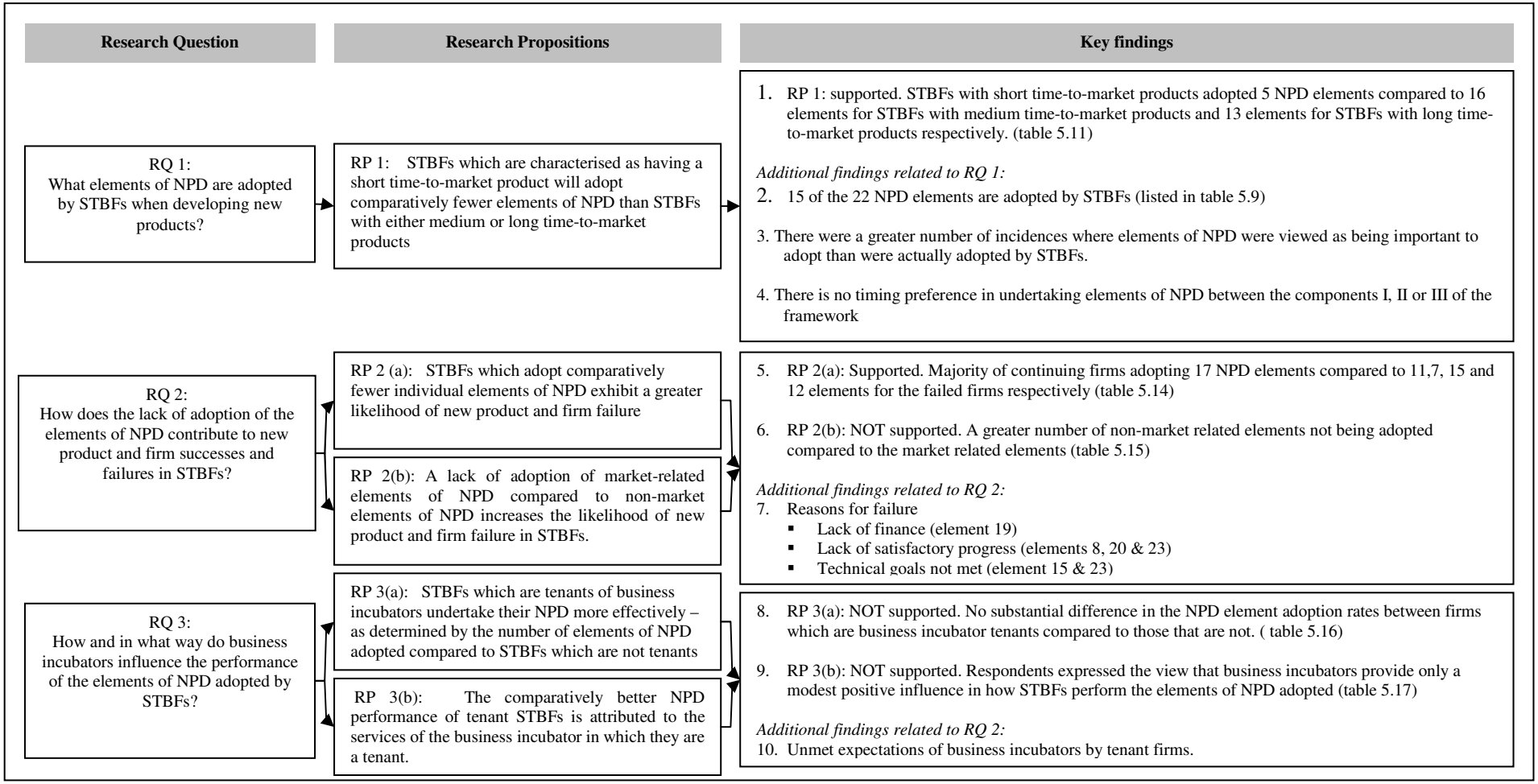
With respect to the second research question, it was found that research proposition 2(a) was supported in that the majority of continuing STBFs adopted a greater number of elements of NPD compared to the failed firms. In addition, it was also found that research proposition 2(b) was not supported in that a greater number of non-market related elements of NPD were not adopted compared to the market related elements. Furthermore, the principle reasons cited for new product and firm

failure were; a lack of adequate resources, a lack of satisfactory progress and not meeting necessary technical goals.

Finally, with respect to the third research question, neither research proposition 3(a) nor research proposition 3(b) were supported by the findings. Specifically, it was found that there was no difference in the NPD adoption rates between STBFs who were tenants of business incubators compared to those who were not. Furthermore, for the elements of NPD that were adopted, business incubators were found to provide only a modest positive influence on the ways tenant firms performed those elements of NPD compared to firms who were not tenants. Overall, these findings supported the view by respondents that tenant firms had unmet expectations of the positive role that business incubators would play in their NPD activity.

These research propositions, together with a summary of findings from the data analysis were presented in figure 5.2.

Figure 5.2 Summary of research findings



Source: Synthesis of research findings from chapter 5.

6 Conclusions and implications

6.1 Introduction

This chapter reports on the research undertaken and the research findings which address the research problem: *what are the origins and nature of new product development processes within STBFs and how do they contribute to STBF success?*

In Chapter 1, the research problem was outlined and it set the scene by presenting the importance of product innovation to the national economic wellbeing. It then went on to describe the relative importance of STBFs within the national innovation system (for example, Freeman & Soete 1997; Rienert 1999; Gans & Stern 2003). The research problem was introduced by presenting the argument that unlike larger and more mature firms where new product development is derived out of corporate strategy, in the case of STBFs corporate strategy is developed in conjunction with new product development. It was further argued that just as business incubators can play a positive role in the formation of STBFs, particularly in regards to the development of corporate strategy, likewise business incubators enhance the performance of new product development by their tenant STBFs.

Chapter 2 reviewed the extant literature relating to the research problem and identified the gaps in the theory. The chapter began with the development of a definition of STBFs (section 2.2) and then went on to examine the literature relating to the three background theories. These background theories were corporate strategy (section 2.3); product innovation and new product development (section 2.4) and business incubation (section 2.5). This literature review demonstrated that there has been extensive research undertaken into new product development theory generally and NPD processes in particular. However, this research has generally been in the context of large and established firms and, to date, there has been little research into NPD processes in the context of STBFs. Moreover, it was seen that there are close relationships between the elements of corporate strategy impacting on NPD, NPD process features and new product success factors within such firms.

The core constructs of these relationships were then developed into a preliminary theoretical framework at the end of chapter 2.

Chapter 3 then went on to outline the first stage of the research methodology used for this research, namely convergent interviewing. The justification for the use of convergent interviewing for this exploratory stage of the research (section 3.2), its limitations (section 3.3) and then the validity and reliability of this methodology (section 3.4) were first discussed. The chapter then went on to discuss the actual convergent interview procedures adopted in section 3.5, the interview proper (section 3.6) and then the presentation of the data and the refined theoretical framework (section 3.7). Finally, the refined theoretical framework presented in chapter 3 allowed the researcher to then derive three research questions and five associated research propositions that together provided a focus for the investigation (section 3.8). The resulting data from this exploratory research stage was then presented, which in turn permitted the identification to six themes (section 3.6). The resulting research questions and research propositions are presented again as a summary in table 6.1.

Table 6.1 Summary of research questions and associated research propositions

Research questions	Research proposition
RQ1: What elements of NPD are adopted by STBFs when developing new products?	RP1: STBFs which are characterised as having a short time-to-market product will adopt comparatively fewer elements of NPD than STBFs with either medium or long time-to-market products.
RQ2: How does the lack of adoption of the elements of NPD contribute to new product and firm successes and failures in STBFs?	RP2(a): STBFs which adopt comparatively fewer individual elements of NPD exhibit a greater likelihood of new product and firm failure
	RP 2(b): A lack of adoption of market-related elements of NPD compared to non-market elements of NPD increases the likelihood of new product and firm failure in STBFs.
RQ3: How and in what ways do business incubators influence the performance of the elements of NPD adopted by STBFs?	RP3(a): STBFs which are tenants of business incubators undertake their NPD more effectively – as determined by the number of elements of NPD adopted compared to STBFs which are not tenants
	RP3(b): The comparatively better NPD performance of tenant STBFs is attributed to the services of the business incubator in which they are a tenant.

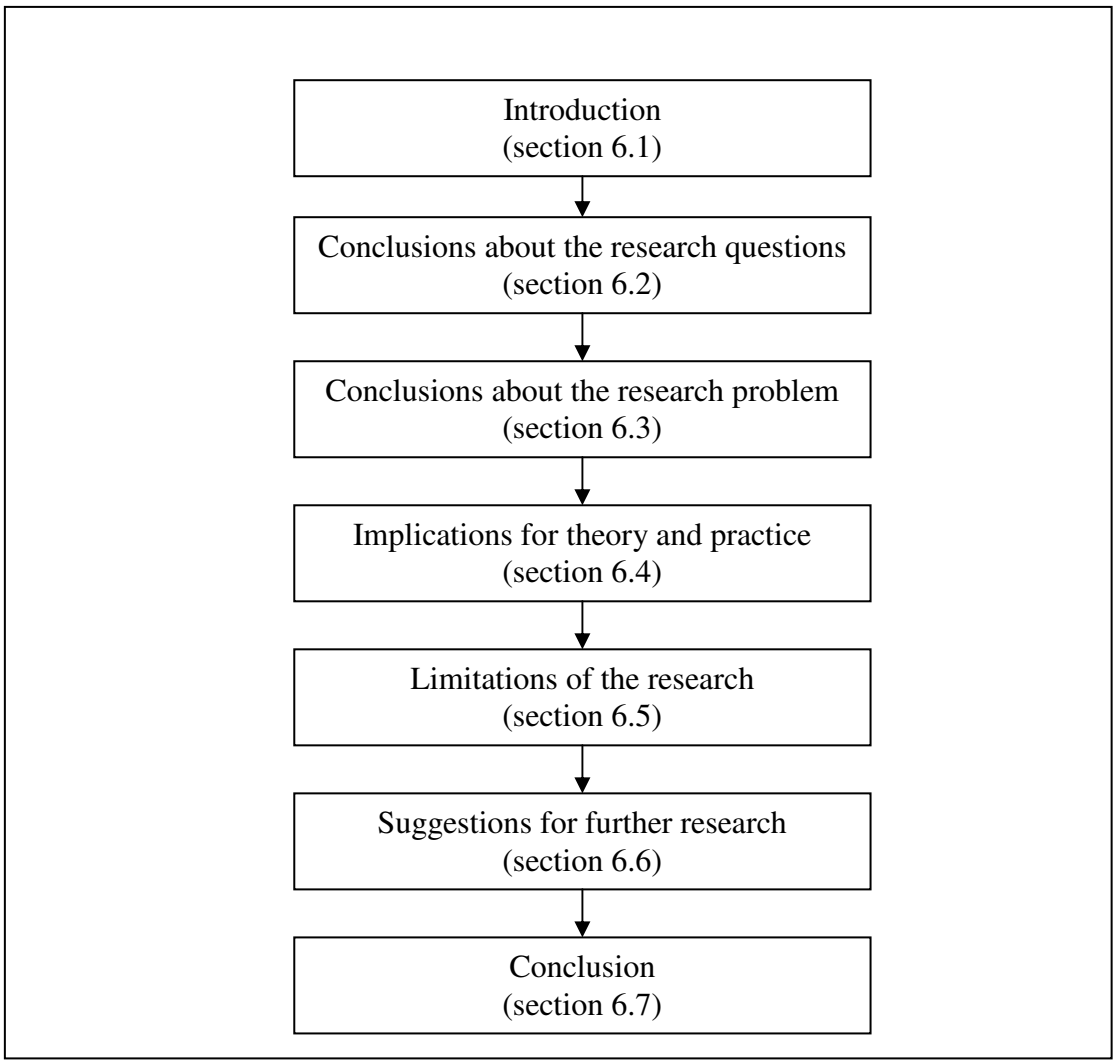
Source: developed for this research

Chapter 4 commenced with an examination of the four scientific paradigms of positivism, realism, critical theory and constructivism and showed that the realism paradigm is the most appropriate foundation for this research (section 4.2). Next, the case study research methodology used in the study, together with an explanation of the two-stage interview process adopted for this research, was discussed in section 4.3. The detailed research plan was detailed with criteria for judging quality of case research (section 4.4). The role of prior theory in case study research (section 4.5) and the selection process of cases studied in this research (section 4.6) was then discussed. After this, the protocol for the case study design and data analysis were outlined in section 4.7, and concluded with a discussion of the limitations of the case study methodology as well as details of ethical considerations adopted in this research (section 4.8).

Next, the analysis of the field data from the twelve case studies was presented in chapter 5. The interview protocol which governed the field data collected from the two-stage interview process (described in chapter 4) with respect to each case is provided in Appendix II. The process by which the data was obtained and analysed was outlined in section 5.2. This was followed by a detailed analysis of each of the cases in section 5.3. Subsequently a cross cluster analysis of the data was performed and presented against each of the three research questions, together with their associated research propositions, in sections 5.4, 5.5 and 5.6 respectively. The chapter concluded with a general synthesis of the findings from each of the three research questions answered in the chapter (section 5.7).

This final chapter first discusses the conclusions and implications reached in relation to the three research questions identified in chapter 2 (section 6.2). Next, conclusions about the overall research problem are presented (section 6.3) followed by a presentation of the findings' implications for theory and practice (section 6.4). The limitations to this research are then discussed (section 6.5) and finally, the chapter concludes with suggestions on areas for further research (section 6.6). Figure 6.1 provides a summary of this chapter.

Figure 6.1 Outline of chapter 6



Source: developed for this research

6.2 Conclusions about the research questions

The following section examines the conclusions reached about the three research questions and compares them to the literature that was reviewed in chapter 2. That is, this section compares and contrasts the study's findings with the literature in order to outline the contributions of this research to an understanding of how STBFs undertake their new product development. Each research question is discussed in turn and the key conclusions of this research against each of the research questions addressed. Table 6.2 lists the research question (column i), the corresponding

research findings relating to the research question (column ii), and the extent to which the findings are made explicit in the literature (column iii). The extent to which the findings are made explicit in the literature is indicated by means of 'no' in column iii of table 6.2, indicating that the finding is not explicit in the literature and therefore represents a significant contribution. An indication of 'limited' in column iii of table 6.2 indicates that the finding is explicit in the literature but not to an extent that adequately explains the phenomenon. The order of the finding related to each research question does not infer any level of importance in relation to the other findings.

Table 6.2 Conclusions about new product development in STBFs

Research question (i)	Findings (ii)	Made explicit in the literature (iii)
RQ 1	1.1 STBFs with short time-to-market products adopted fewer elements of NPD than STBFs with medium and long time-to-market products (table 5.11) being: • 3 of 9 corporate strategy elements of NPD (component I) • 2 of 8 process feature elements of NPD (component II) • 0 of 5 new product success elements of NPD (component III)	No
	1.2 The majority of STBFs in the study adopted 15 of the 22 elements of NPD (table 5.9) being: • 8 of 9 corporate strategy elements of NPD (component I) • 5 of 8 process features elements of NPD (component II) • 2 of 5 new product success elements of NPD (component III)	Limited (section 2.4.2)
	1.3 There were a greater number of incidences where elements of NPD were viewed as being important to adopt than instances where they were actually adopted by STBFs.	No
	1.4 There was no timing preference in undertaking elements of NPD in relation to the components of the framework	No
RQ2	2.1 Failed STBFs adopted fewer elements of NPD than did the continuing STBFs (table 5.14)	Limited (section 2.4.2)
	2.2 The proportionately greater lack of adoption of market-related elements of NPD compared to non-market elements of NPD increased the likelihood of new product and firm failure (table 5.15)	No
	2.3 Other identified factors leading to new product and firm failure were: • Lack of finance for entire NPD process • Lack of satisfactory progress across NPD process • Not meeting technical milestones	Limited (section 2.4.2)
RQ3	3.1 There was no substantive difference in the level of adoption of elements of NPD between STBFs which were tenants of business incubators compared to those which were not (table 5.16).	No
	3.2 Business incubators provided only a modest positive influence to tenant STBFs in the performance of the elements of NPD adopted. (table 5.17)	No
	3.3 Business incubators did not meet the expectations of tenant STBFs in respect to assistance with their NPD activities.	No

Source: derived from data analysis presented in chapter 5.

Each of the findings relating to the research questions will now be detailed in turn, commencing with those related to research question 1.

6.2.1 Conclusions about research question 1

This section details the conclusions relating to research question 1 about the elements of NPD which are adopted by STBFs and whether or not there are any differences in levels of adoption between STBFs with short, medium and long time-to-market products. This section shows that there are four conclusions from the research relating to research question 1, as summarised in table 6.2. Each of the conclusions will now be discussed in detail.

Conclusion 1.1: STBFs with short time-to-market products adopted fewer elements of NPD than STBFs with medium and long time-to-market products. In order to understand this phenomenon it is now necessary to consider the basis of differences between the STBFs with short, medium and long time-to-market products. In referring back to Table 5.10, it can be seen that there were only minor differences in the levels of adoption of the elements of NPD between STBFs with medium and long time-to-market products. On the other hand, the STBFs with short time-to-market products, as represented in cluster 1, exhibited the adoption of substantially fewer elements of NPD than cluster 2 or cluster 3 cases. Specifically, it was found that the STBFs with short time-to-market products adopted 5 NPD elements compared to 16 elements by STBFs with medium time-to-market products and 13 elements for STBFs with long time-to-market products respectively. In a direct way, this finding supported research proposition one (RP1) proposed for this research question: 'STBFs which are characterised as having a short time-to-market product will adopt comparatively fewer elements of NPD than STBFs with either medium or long time-to-market products'. Furthermore, not only is this pattern of adoption found across the elements of NPD as a whole but this same pattern is also found within each of the respective components of the framework when considered individually (Table 5.10).

One possible explanation for the difference in the rate of adoption of elements of NPD when comparing STBFs with short time-to-market products to STBFs with medium or long time-to-market products, was the different product and industry orientations between the clusters of firms. As summarised in table 5.2, cluster 1 STBFs are all information technology firms, with cluster 2 being largely represented by firms operating within the manufacturing industry (the only exception being Case G) and cluster 3 STBFs being represented within the biotechnology industry. To an extent, there is a close relationship between the manufacturing and biotechnology industries as they both involved the ultimate production of a 'hard' physical product, irrespective of their forms (hardware, components or medications respectively). On the other hand, all the information technology firms produce 'software' which is far less tangible in nature. Moreover, it is observed throughout the new product development literature that the history of new product development theory evolved through studies on large established firms and more often those within the manufactured goods environment (for example Cooper, 1994; Rothwell 1994).

As a result, it can be argued that manufacturing firms in this study have a better grasp of the management of the NPD process due to the greater accessibility to the existing body of knowledge relating to new product development management. As outlined in section 2.4.2.1, the early generations of NPD largely originated from a distinctly manufacturing environment (Schindler & Eppler 2003), making the management discipline of new product development much more of an embedded culture within that industry compared to comparatively newer industries such as information technology.

This is also demonstrated by the common practice of the Director of Technology positions within software firms (commonly termed the Chief Technology Officer) having a predominant focus on software engineering as distinct from new product development as a holistic management discipline. This argument is supported by figures from the Product Development & Management Association, the key organisation for NPD professional certification, that showed that software industry

professionals represent a mere 3 per cent of its international membership compared to 26 percent for service industries and the remainder (71 per cent) from all other industries (PDMA 2006). However, while the specific issue of comparative NPD skills possessed by management of firms in different industry sectors is outside of the scope of this research it is posed as a suggestion for future research and discussed further in section 6.6.

The importance of this conclusion is that it demonstrates a greater propensity for STBFs to take short-cuts in the NPD process in the drive for achieving speed to market. However, the questions as to whether or not these short cuts are intentional or rather are an artefact of the nature of the industry (that is, primarily information technology) in which these STBFs operate can not be answered by this research.

Conclusion 1.2: The majority of STBFs in the study adopted 15 of the 22 elements of NPD. One of the key aims of this research question was to identify the elements of NPD within each of the three components of the theoretical framework which were adopted by the majority (that is, seven or more) of the STBFs in the study. As a result, it was found that STBFs did not adopt all of the elements of NPD that were identified as being 'best practice' in the new product development literature. More specifically, table 5.10 shows that the majority of cases only adopted 15 of the 22 elements of NPD. Moreover, this finding confirms the new product development literature undertaken in the context of established larger firms, outlined in section 2.4.2. Specifically, the importance of this finding is that it showed that it was common for such firms not to adopt all NPD process features and new product success factors identified as 'best practice' in undertaking NPD.

As outlined in section 2.3, the literature relating to the various models of NPD can be regarded as 'evolutionary' in nature. Thus, each model of NPD builds and improves on previous models of NPD (for example, Alam 2000; Landau & Rosenberg 1986; Rothwell 1994). However, these models of NPD possess a significant limitation when considering the special case of STBFs. This limitation is that these models are restricted to NPD process features (elements of NPD within

component II of the theoretical framework) and to a lesser extent new product success factors (elements of NPD within component II of the theoretical framework). This is further supported by more recent literature which ahs examined the ability of SMEs to have the capability of performing effective product design. For instance, Moultrie, Clarkson & Probert (2005), demonstrate that critical design-related activities are often poorly performed by SMEs. Specifically, these studies build on earlier work, such as that by Bruce, Cooper, R., and Vazquez (1999), which show that resource limitations and perceived barriers to involving external specialists result in 'silent design' where engineering or marketing staff undertake design work themselves often missing critical steps in the process due to insufficient expertise.

Largely, such models are based on the assumption that the elements of corporate strategy relating to new product development have already been undertaken as part of corporate strategy development prior to the commencement of NPD activity. This assumption is based on the fact that NPD models were developed in the context of larger and more established firms rather than STBFs as previously discussed. However, on the other hand, the theoretical framework of how STBFs undertake their new product development proposed in this research goes beyond just the NPD process features and new product success factors. Rather, the framework argued for the necessity to include elements of corporate strategy to be developed in parallel with the adoption of those same NPD process features and new product success factors.

Table 5.10 highlighted which elements of NPD are not adopted by the majority of STBFs in the study. Specifically, it was found that there were seven elements of NPD not adopted by the majority of STBFs, being:

- one element of corporate strategy (element 6 - inter-firm cooperation);
- three elements of NPD process features (element 9 – parallel development, element 13 – expert system and modelling, and element 14 – strong customer linkages); and,

- three elements of new product success (element 16 – superior product concept, element 17 – initial screening and element 19 – sufficient resources)

Just as the evidence for adoption of the elements of NPD can be viewed as a positive indication of NPD effectiveness for STBFs, the converse argument can then be made in relation to any observed absence of elements of NPD in STBFs. In this way, it can be concluded that the overall lack of adoption of elements of NPD provides a negative influence on the effectiveness of NPD activities in STBFs. As observed from the findings in section 5.5, two primary reasons were cited for a lack of adoption of these elements of NPD: a 'lack of understanding' or appreciation of their relative importance in optimising chances for new product success and/or a lack of resources to do so. This will be discussed in more detail in relation to the conclusions to research question 2.

Conclusion 1.3: a greater number of instances where elements of NPD were viewed as being important to adopt than instances where they were actually adopted by STBFs. A further conclusion from the research findings was that for the majority of STBFs in the study, there was found to be a greater number of incidences where elements of NPD were viewed as being important to adopt than instances where they were actually adopted by STBFs. That is, while a number of STBFs in the study viewed it as being important to adopt certain elements of NPD in practice did not actually do so.

However, when the data at the cluster level was examined it was found that this was only true within clusters 1 and 2. This finding was generally explained by the insufficient financial resources possessed to allow the STBFs to actually adopt elements of NPD to the extent necessary to achieve 'best practice'. Specifically, these were:

- Component I - 87 instances of views of importance compared to 75 incidences of actual adoption (table 5.5) and

- Component II - 61 instances of views of importance compared to 56 incidences of actual adoption (table 5.7).

On the other hand, Component III cases adopted fewer elements of NPD than the incidences reported of views of importance to adopt elements of NPD. Specially, this was:

- Component III - 30 instances of views of importance compared to 25 incidences of actual adoption (table 5.9).

This contrary finding was due to the fact that respondents in these firms felt that investors possessed undue influence on the NPD process (table 5.11) and thus forced management to undertake particular NPD activities not deemed as being entirely necessary. Nevertheless these adoption requirements imposed by investors were explicitly or implicitly tied to funding conditions.

In addition however, as outlined in conclusion 2 to this research question, there was also a general lack of understanding of the importance of adopting all of the elements of NPD considered 'best practices' across all cases. Additionally, the lack of appreciation of the relationship between the extent of adoption of elements of NPD and new product success was found.

The importance of this finding is that this gap between attitudes of importance in adopting elements of NPD and actual adoption would indicate there are barriers to STBFs adopting best practices in regards to NPD. However, the extent to which these barriers can be overcome by education or government support programs provide an implication to new product development practice.

Conclusion 1.4: There was no timing preference in undertaking elements of NPD in relation to the components of the framework. This conclusion relates to the fact that, in part, it was argued that the elements of corporate strategy need to be undertaken as part of the overall framework of new product development rather than developed prior to undertaking the NPD process. It was seen in chapter 2 that

the new product development literature is largely concerned with new product development performance in large and established firms rather than small emergent firms such STBFs.

As such, this literature argued that new product strategy, and hence NPD activity, should be guided by and result from corporate strategy. This linear staging between corporate strategy and traditional NPD activity has been found to be not as relevant to STBFs. Furthermore, it was found that a number of elements of corporate strategy should be regarded as part of the overall NPD process. Additionally, respondents pointed to the fact that the starting point for venture creation was the identification of a product opportunity being the first stage of the NPD process (Table 5.4). In turn, while this demonstrated a gap in the extant literature relating to new product development theory, this starting point is more in line with traditional 'venture creation theory' literature as discussed in section 2.3.2 (for example, Hansen & Bird 1997; Katz & Gartner 1988; Reynolds & Miller 1992).

6.2.2 Conclusions about research question 2

This section summarises the conclusions relating to research question 2 about the relationships between any lack of adoption of elements of NPD and firm failure. This section shows that there were three conclusions from the research relating to research question 2, as summarised in table 6.2. Each of the conclusions are now discussed in detail.

Conclusion 2.1: Failed STBFs adopted fewer elements of NPD than did the continuing STBFs. As outlined in section 2.3.4, there was a significant body of knowledge within the NPD literature which identified the factors important for new product success (for example, Brown & Eisenhardt 1995; Calantone & Di Benedetto 1990; Cooper & Kleindschmidt 1990; Cooper 1999; Ernst 2002; Johne & Snelson 1988; Lilien & Yoon 1989). However, these studies have largely been in the context of large and established firms and where NPD is more likely to be undertaken in the context of a portfolio of products. As a result, the failure of a

single product in such firms has a comparatively lesser impact on the firms' viability than STBFs which, by definition, are single-product centric. That is, when an STBFs product fails, the chances are the STBF itself faces a greater likelihood of firm failure. Thus, the degree to which elements of NPD are reflected within the NPD activities of STBFs are of relevance in achieving new product, and ultimately firm, success. Conversely, any lack of adoption of the elements of NPD is likely to have a significant impact on new product and consequently overall firm failure.

The findings of this research support research proposition 2(a) which shows that there was a direct relationship between lack of adoption of elements of NPD and firm failure. Specifically, table 5.14 shows that the failed firms exhibited 50 per cent of incidences of non-adoption compared to 36 per cent for the continuing firms. That is, failed firms exhibited 14 per cent more incidences of non-adoption across all elements of NPD compared with continuing firms. This finding has direct importance for NPD practice by highlighting the need for STBFs to adopt NPD best practice in order to reduce the overall risk of firm failure.

Conclusion 2.2: there was a proportionately greater lack of adoption of market-related elements of NPD compared to non-market elements of NPD in failed firms. This conclusion concerns the research findings, summarised in table 5.15, which compared the relative rates of non adoption between the market related elements and non-market related elements of NPD in failed firms. The basis of the need to examine this phenomenon is derived from the argument that STBFs are largely founded by 'technologists' and are therefore more likely to adopt non market-related elements of NPD (section 5.5.2). This argument directly gave rise to research proposition 2(b) that 'a lack of adoption of market-related elements of NPD compared to non-market elements of NPD increases the likelihood of new product and firm failure in STBFs'.

However, the research findings showed that this was not the case. Indeed, it was found that there was proportionately a greater lack of adoption of the non-market related elements of NPD compared to the market related elements of NPD for failed

firms (54 per cent to 41 per cent respectively – table 5.15). This finding is a significant contribution to the body of knowledge of new product development theory as such comparative studies in relation to functional categories of elements of NPD could not be found in the literature. Additionally, this would suggest that, in terms of capabilities and experience, entrepreneurs founding STBFs are more likely to be technology orientated than market orientated and thus may require additional educational support mechanisms.

Conclusion 2.3: Other reasons for new product and firm failure identified included a lack of finance, lack of satisfactory progress and not meeting technical milestones within NPD. This conclusion concerned itself with the primary reasons cited for new product and firm failure. Specifically, four reasons for failure were cited (table 5.13). However, two of these (lack of finance and insufficient cash flow) were fundamentally similar so have been combined for the purpose of this analysis. The reasoning for this was that the resources to finance both NPD activity and operational activity in STBFs can come only from one of two sources: external financing (either debt or equity) and/or cash flow from operations, that is, through revenue from product sales (section 5.5). Additionally, it was also discovered that lack of financing arose from the lack of adoption of critical elements of NPD which, in turn, resulted in the lack of ability to obtain investment or cash flow. In particular, this lack of adoption was specifically related to one of the component III elements of NPD, that of initial screening of product concept prior to commencing technical development (element 17).

Other reasons cited for new product and firm failure were the perceived 'lack of satisfactory progress' viewed by investors and not meeting 'technical milestones'. In the instance of a lack of satisfactory progress, this related to general business development progress and would seem to result from different expectations between the firm and investors on timing for market entry, which also relates to a lack of adoption of element 21 (not meeting investor expectations). Further, technical milestones related specifically to STBFs achieving 'success points' within the technical development stage of NPD. The importance of this finding lies in the

fact that these instances arose from failure to meet test criteria initially set by the firm and also in not meeting customer expectations in the testing phase.

6.2.3 Conclusions about research question 3

This section details the conclusions relating to research question 3 about the relationship between business incubators and NPD undertaken by tenant STBFs. This section shows that there are three conclusions from the research relating to research question 3, as summarised in table 6.2. Each of the conclusions will now be discussed in turn.

Conclusion 3.1: There was no substantive difference in the level of adoption of elements of NPD between STBFs which were tenants of business incubators compared to those which were not. This conclusion arises from the research findings that show there was no substantive differences in the adoption of elements of NPD between the two groups and summarised as table 5.16. As a result, this conclusion contributes to the body of knowledge about business incubators and the potential roles they play in assisting NPD activity of tenant firms. The literature points to the value contributed by business incubators to broadly assisting new firms, including STBFs, in the early phases of their establishment and growth and in particular in the development of corporate strategy (Blakely & Nishikawa 1992; Colombo & Delmastro 2002; NBIA 1996; Osborne 1988; Sherman & Chappel 1998). Additionally, the emergence of technology incubators targeted towards supporting technology firms and their specific technology transfer activities was seen to be a result of two key factors. The first was the associated higher inherent commercial and technological risks associated with high technology firms and the second was the inability of such firms to access investment and debt finance to resource their activities (Colombo & Delmastro 2002; Evans & Jovanovic 1989; Hall 1989; Kapij, Dressel & Abbetti 1996; Oakey 1995; Smilor & Gill 1986).

However, the literature is far less clear on the nature of NPD-specific support provided by business incubators to tenant firms for their NPD activities specifically.

Indeed, the literature suggests that rather than providing holistic support for new product development, support tended to be focused on specific activities within the NPD process. Further, the nature of this support was largely dependent upon the specific focus of the business incubator. For example, Chandra, Srivatav & Shah (2003) point out that incubators can be grouped into three broad types according to where they provide assistance within the NPD process: taking a conceptualized idea into a product concept; taking a product idea into a product prototype form and taking prototype products into the market. This was discussed in some depth in section 2.5.2.2.

This conclusion shows that being located as a tenant within a business incubator does not influence whether or not STBFs will adopt any particular elements of NPD. This finding was explored in section 5.6.2 and summarised table 5.16 which showed that there were 79 and 76 incidences of adoption respectively between the two groups.

Conclusion 3.2: Business incubators provide only a modest positive influence to tenant STBFs in the performance of the elements of NPD adopted. The literature shows a significant body of research on the benefits derived from business incubators with respect to the development of corporate strategy. However, this research has not investigated whether assistance from business incubators extended to providing benefit to the performance of NPD process features and product success related elements of NPD (components II & III of the framework). This would indicate a significant gap in the literature addressing this issue.

This conclusion relates to the perceptions of respondents as to whether or not business incubators provided a positive influence on the performance of the elements of NPD adopted by tenant STBFs. The research findings outlined in section 5.6.2 show that only a marginal positive influence was perceived to have occurred in relation to the performance of the elements of NPD which were adopted by tenant STBFs. Specifically, of the 79 instances of adoption of elements of NPD across the six tenant STBFs it is only in 21 instances (representing 27 per cent) that

at least one respondent felt that performance was improved due to the activities or services of the business incubator.

The fact that STBFs who were tenants of business incubators did not report a greater perception of positive influence provided by business incubators on the performance of the elements of NPD adopted by tenant STBFs was somewhat surprising. This is particularly in light of the evidence found in the literature for supporting the positive role business incubators play in assisting tenant firms develop their corporate strategy (section 2.5.3).

From this finding it was apparent that such benefits do not similarly apply to NPD activity for tenant STBFs. Moreover, the findings also show that substantial differences in respondents' perceptions of benefit provided by business incubators in the performance of NPD also arose when considering elements of NPD in the context of their respective components of the framework. For instance, when component I elements were examined, it was these corporate strategy elements of NPD that the greater perceived benefit occurred.

Specifically, 72 per cent of total reported incidences of a perceived benefit arose from these component I elements of NPD, that is, the corporate strategy elements of NPD (table 6.17). Moreover, of these component I elements of NPD, the majority of reported instances of positive perception of benefit (9 of the 15 instances) were closely related to elements pertaining to 'market factors', in particular:

- Identification of an appropriate market entry strategy (element 1);
- Consideration of market segmentation and internationalisation (element 3);
- Inter-firm cooperation – particularly as it related to market entry (element 6).

As performance measurement was not within the scope of this research, the evaluation of performance was limited to the respondents 'perceptions' as to whether or not benefit was derived from business incubators in the performance of NPD. As a result, this conclusion was contrary to research proposition 3 (b) which

proposed that STBFs that are tenants of business incubators perform their NPD more effectively than STBFs which are not tenants of business incubators. Thus, research proposition 3(b) was not supported.

Conclusion 3.3: Business incubators did not meet the expectations of tenant STBFs in respect to assistance with their NPD activities. The final conclusion derived from the findings of this research relates to the expectation of assistance provided by business incubators in respect of their NPD activity. As outlined in section 2.2, STBFs by definition have a focus on the development and commercialisation of new-to-the world product innovations. Therefore, effective new product development is a core firm objective in order to achieve new product, and hence firm, success. On further exploration with respect to this finding it was identified that there was a relatively low level of perceived benefit by tenant STBFs (conclusion 3.2) in regards to assistance for these firms' new product development activity. The expectations held by tenant firms were particular to three areas of expected assistance: effective linkages to knowledge experts; linkages to value partners for commercialisation and new product development management.

The first unmet expectation related to the business incubator's assistance to tenant STBFs by access to knowledge experts. Each of the incubators involved in this study provided links to research organisations in specified technical areas (in particular universities), for example, information technology. However, such linkages were developed in the context of broad institutional relationships as distinct from targeted areas of possible technical assistance that could be provided by those institutions. As such, respondents questioned the value of the relationship between the business incubator and research organisations with respect to their particular product development effort (section 5.6.2). Specifically, respondents felt that existing relationships between the business incubator and the research organisation were of limited value to their specific products.

The second unmet expectation was in relation to linkages provided to 'value partners' for commercialisation. As can be seen from table 6.17, business

incubators provided little assistance in facilitating inter-firm co-operation with a perceived benefit being contributed only in 1 of the 6 tenant STBFs (that is Case B). However, at the same time, tenant firms held an expectation that incubators would have provided a higher level of assistance than was actually experienced (section 5.6.2).

The final unmet expectation related to assistance provided to tenant STBFs to the firm's management of the NPD process. One of the key areas of assistance provided by incubators, as identified in the literature in section 2.5.3.2, was the evaluation of management performance and assistance by incubators to rectify perceived weaknesses through the provision of business advice (for example, Butler & Hansen 1991; Hansen et al 2000; Faulkner & Fleck 1998; CSES Report 2002). Further, an expectation of tenant firms was that the provision of assistance in the form of business advice would extend to the management of the NPD process which did not occur.

Finally, with respect of conclusions 3.1, 3.2 and 3.3, the importance of these findings is that this provides strong evidence that business incubators need to deliver substantially more assistance to their tenant STBFs in NPD management support.

6.3 Conclusions about the research problem.

From the conclusions outlined above and which were in turn, derived from the data analysis undertaken in chapter 5, it is now possible to address the overall research problem of this thesis: *what are the origins and nature of new product development processes within STBFs and how do they contribute to STBF success?*

A preliminary theoretical framework was developed in chapter 2 as a result of the review of the extant literature and presented in figure 2.12. Importantly, it was found that the literature did not address the specific manner in which STBFs undertake their new product development activities.

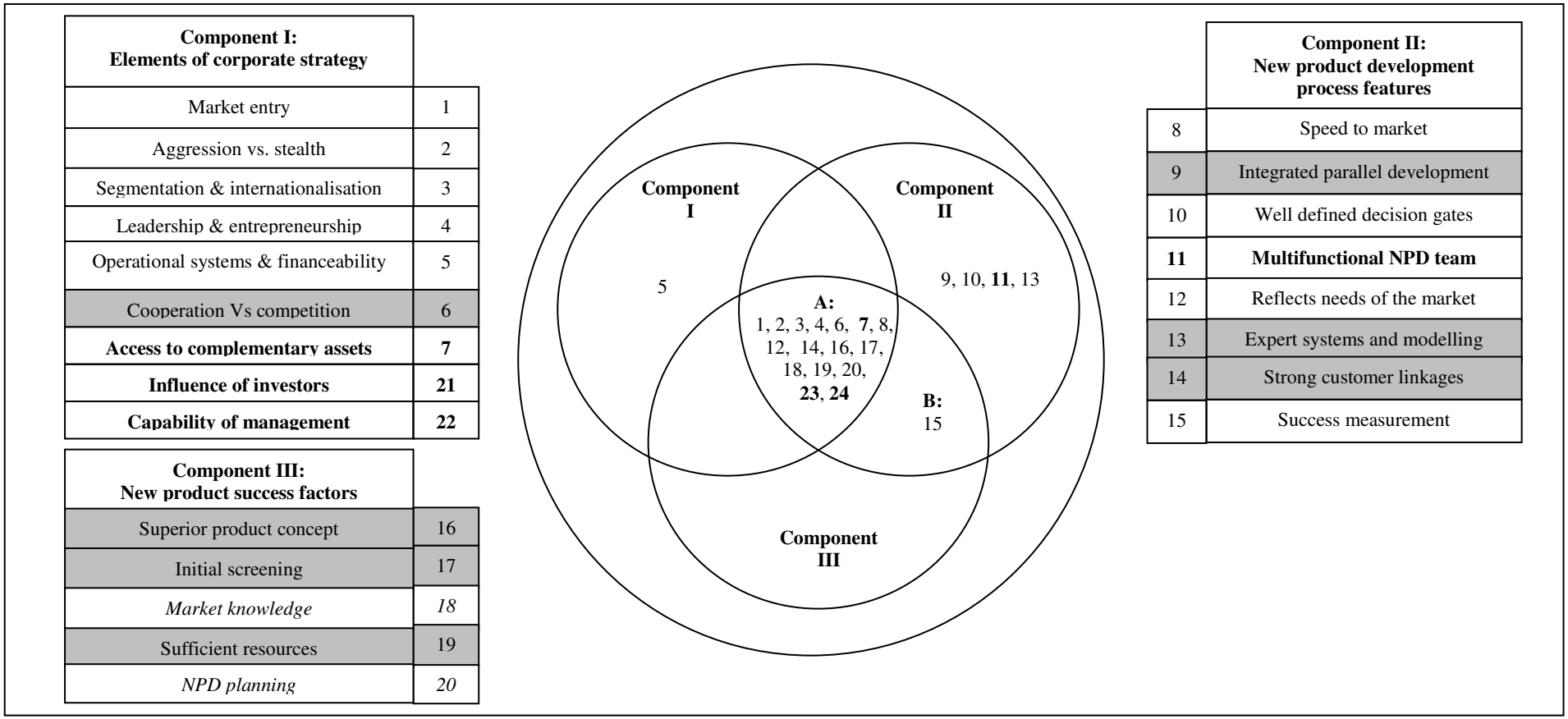
Next, this preliminary theoretical framework was reviewed and refined as a result of the findings from the exploratory research phase presented in chapter 3. As a result, a 'refined theoretical framework' was then presented as figure 3.4. The underlying premise of the refined theoretical framework was the argument that new product development in STBFs comprised elements grouped according to three components of NPD, being elements of corporate strategy, NPD process features and new product success factors. It was further argued that STBFs that are tenants of business incubators will adopt more of these elements of NPD and perform these elements more effectively than those who are not tenants.

As a result of the data analysis and the conclusions derived from the findings, a final framework of new product development in STBFs can now be presented. This is provided as figure 6.2 which summarises the elements of NPD that are actually adopted by the majority of STBFs in this study. The purpose of producing this final framework of new product development in STBFs is that it can now form a base-line for further comparative studies in NPD specifically directed at STBFs.

In turn, the final framework outlined in figure 6.2 includes the key elements of NPD identified in the literature as being elements of 'best practice' for adoption by NPD irrespective of firm size and maturity. However, in examining this framework it can be seen that seven elements of NPD across the three components of the framework were evidenced as being not adopted by the majority of STBFs. These elements of NPD not adopted by the majority of STBFs were;

- Inter-firm cooperation (element 6)
- Integrated parallel development (element 9)
- Expert systems and modelling (element 13)
- Strong customer linkages (element 14)
- Superior product concept (element 16)
- Initial screening (element 17), and
- Sufficient resources (element 19).

Figure 6.2 Final framework of new product development in STBFs where elements of NPD are evidenced to be adopted by the majority of STBFs in the study and showing relationships between elements within each component of the framework



Source: derived from research findings summarised in table 5.16. Key:

- Shaded elements are not evidenced as being adopted by majority of STBFs.
- Bolded elements are evidenced as adopted in the majority of business incubator tenant STBFs but NOT in the majority of non-business incubator tenant STBFs.
- Elements in italics found only in the majority of non-business incubator tenant STBFs and NOT in the majority of business incubator tenant STBFs.
- All other elements evidenced as adopted by majority of STBFs in both groups.

Additionally, the research findings show differences in the pattern of adoption between STBFs depending on their classification as having products being short, medium or long time-to-market. Specifically, firms with short time-to-market products adopted substantially fewer elements of NPD compared to firms with either medium or long time-to-market products (table 5.11). Moreover, it was also shown that there is a link between the STBFs that failed during the course of this study and the lack of adoption of elements of NPD.

Further, when considering the role played by business incubators in supporting tenant STBFs undertake their NPD activities it was clear that this support can be described as minimal at best. Importantly, the adoption of elements of NPD was marginally greater across the STBFs who were tenants of business incubators compared to those that were not. This would indicate that business incubators provided some benefit to their tenant STBFs by influencing the adoption of elements of NPD. However, the in-depth examination of this phenomenon in the data analysis of chapter 5 showed that the difference between the two groups was not sufficiently great as to indicate an overall benefit derived by STBFs from the incubator environment itself (table 5.16). This was also reflected in the perceived benefit provided by business incubators to firms in the performance of the adoption of those elements of NPD (section 5.6.2). The final theoretical framework presented in figure 6.2 has therefore been amended to remove business incubators as a source of influence in the adoption and performance of elements of NPD for their tenant STBFs.

Additionally, it was argued from the development of the final framework of new product development in STBFs that the elements across the three components of the framework need to interact closely and that there is a definite relationship between a number of elements in their adoption by STBFs (intersection areas A & B in figure 6.2). Indeed, it was found that 17 of the 22 elements of NPD interact with, or are dependent on, at least 1 of the other elements in each of the other 2 components of the framework (intersection area A of table 6.2). As a result, it can be seen that corporate strategy needs to be considered as part of the framework of

new product development in STBFs in as much as the component I elements of NPD (that is, the element of corporate strategy relating to NPD) interrelate with component II & III elements of NPD. In considering the specific case of STBFs, this contrasts to the findings from the NPD literature which suggested that new product strategy and, resultant NPD activity, should be derived out of corporate strategy.

In conclusion, the final framework of new product development in STBFs identified the elements of NPD that should be adopted in order to minimise new product and firm failure. Importantly, the research findings from this research, and the subsequent conclusions drawn, highlight the gaps in the literature when considering how STBFs undertake their new product development process. In turn, the final framework of new product development in STBFs has a number of implications for theory and practice that will now be discussed.

6.4 Implications for theory and practice

The research findings from this research have been presented in the context of the research problem and the associated three research questions. As a result there are a number of implications for new product development theory, business incubation theory, case study research methodology and implications for practice. Next, each of these will be considered in turn.

Implications for new product development theory. The development of product innovation theory and new product development in practice has been represented as an evolutionary process. The evolutionary nature of the process involves the increasingly improved understanding of product innovation processes and the effective management of uncertainty in innovation (Landau & Rosenberg 1986). This is particularly true given that uncertainty can be thought of as a reflection of the degree of complexity in the innovation process (Pelz 1985). It was found that the various approaches to product innovation theory since the 1950s can be considered in terms of five progressive generations of the product innovation

process (Rothwell 1994). These generations of product innovation are reflected by studies on the various NPD models which, in turn, attempted to provide a better understanding of NPD processes to achieve better management of innovation uncertainty (for example, Anderson 1996; Booz, Allen & Hamilton 1982; Cooper 1990; Cooper & Kleinschmidt 1993; Jenkina, Forbes & Durani 1997; Mowery & Rosenberg 1978; Smith & Reinersten 1992).

In considering the body of knowledge relating to new product development, we saw in chapter 2 that, to date, most of the new product development studies have tended to focus on the NPD process within larger and established firms rather than smaller and newer firms (for example, Cooper 1995). Some insights into the particular problems faced by STBFs in respect to their NPD activities can be obtained from more recent new product development studies undertaken in the context of small and medium sized enterprises (SMEs). For example, Huang, Souter & Brown (2002) found that SMEs did not have the same level of proficiency in undertaking new product development as did larger firms. However, this research found that STBFs, as a subset of the SME environment, face specific challenges in respect to their NPD activities not faced by other firms, including those in the broader SME context. In particular, it found that the majority of STBFs adopted only 15 of the 22 best practice elements of NPD (figure 6.2) identified in the literature as being important to achieve new product success. Further, STBFs with short time-to-market products were evidenced to have adopted even fewer elements of NPD than STBFs with either medium or long time-to-market products (that is, 5 of the 22 elements – table 5.11). As the STBFs with short time-to-market products in this study were all within the information technology sector, this new knowledge has specific and immediate implications for new product development theory in the context of such firms.

Furthermore, the fact that new product development theory has been largely drawn from studies relating to larger and established firms, rather than new firms (such as STBFs) is reflected in the traditional linear relationship between corporate strategy and NPD activity with respect to the timing of when these activities should be

undertaken. In particular, the view proposed in the new product development literature (section 2.3) that new product strategy and resulting NPD activity for an individual firm should arise 'out of' a firm's pre-established corporate strategy (Balachndra et al 1996; Barczak 1995; Cooper 1991; Cooper & Kleindschmidt 1995) can now be seen to be at odds to the findings of this research when considering STBFs. Rather, this research found that corporate strategy development and NPD activity occur in a parallel manner in STBFs.

Finally, this research contributes to new product development theory by identifying the relationship between the adoption of elements of NPD, new product and firm success (section 5.5.1). In particular, it showed that 17 of the 22 elements of NPD were closely interrelated with NPD elements in one or both of the other components of the framework. Moreover, the research highlighted the distinction between managing new product development in an environment of a firm having a single product focus (as occurs in STBFs), in contrast to firms where an individual product is more likely to be one within a portfolio of products (as is more common with larger and established firms). Next, the implications for corporate strategy theory will now be considered.

Implications for corporate strategy theory. Compared to new product development theory, corporate strategy theory has been more researched in the literature. This is particularly true with respect to the new venture creation environment (which relates directly to STBFs) when contrasting the literature relating to the two bodies of knowledge of corporate strategy and new product development. Specifically, corporate strategy development as it relates to the new venture creation environment has been examined from a number of perspectives such as: the economics; psychology; sociology; decision making and cultural views of the entrepreneur (for example, Acs & Audrestch 1990; Aldrich 1990; Busentiz et al 1996; Hansen & Allen 1992; Katz 1992).

These differing perspectives of the development of corporate strategy provide a greater level of maturity and depth of understanding to new venture creation theory

than was possible from the new product development literature. More particularly, specific aspects of new venture creation theory, such as that provided by the 'stages model' of firm creation (for example, Bell & McNamara 1991) provides a more ready accommodation of the product innovation cycle for new firms by showing the progression from concept creation into the various stages of firm establishment. However, at the same time, the corporate strategy literature still possessed a number of limitations in adequately explaining NPD activity. In particular, it did not adequately address the ways in which corporate strategy interacts with, and influences, specific NPD activities upon which new ventures, such as STBFs, depend.

A specific implication for corporate strategy theory that arose from this research was that the resulting framework helped to more adequately identify and explain the interactions between the specific elements of corporate strategy relating to new product development and the other elements of NPD contained in components II and III of the framework.

Implications for business incubators. Business incubators are seen as significant contributors to a nation's economic growth through the support they provide to start-up firms (Blakely & Nishikawa 1992; NBIA 1996; Sherman & Chappel 1998; Osborne 1988). The literature suggested a number of theories that relate to the benefits provided to start-up firms, namely: skill development theory (Camerer & Lovallo 1999; Jovanonic 1982); technology transfer theory (Kapij, Dressel & Abbetti 1996; Smilor & Gill 1986); networking theory (Collinson 2000; Cross, Parker, Prusak & Borgatti 2001) and corporate strategy development (NBIA 1995; Sherman & Chappell 1998).

In considering these various theories relating to business incubators (section 2.5), a number of the theories can be identified as relating to new product development theory. For example, technology transfer as a form of new product development (section 2.3.3) was directly addressed in the business incubator literature.

Specifically, this asserted that one of the key functions of technological incubators is their role in assisting technology transfer (Kapij, Dressel & Abbetti 1996).

However, this research found that STBFs who were incubator tenants experienced only modest positive influence on their NPD activities through the support provided by the business incubator in which they were a tenant. This was in contrast to the literature where a number of studies have demonstrated the benefit that incubators play in general business development and corporate strategy development (for example, Sherman & Chappell 1998). In particular, the benefits for tenant firms were derived from two areas of activity of business incubators: networking with other firms and research organisations in order to access skills and knowledge not possessed by the firm (section 2.5.1) and access to business advice (section 2.5.3.2).

The resultant research findings have implications for business incubator theory by highlighting areas that can now be viewed as deficiencies in the assistance provided by business incubators to STBFs with respect to their NPD activity. In particular, these areas of deficiency relate to the two specific roles business incubators can play in assisting tenant STBFs. The first is the potential role of business incubators to impart to tenant STBFs a better understanding of those elements of NPD regarded as 'best practice' that should be adopted in order to reduce the likelihood of new product and consequently firm failure. The second is the potential assistance business incubators can provide to tenant STBFs in actually performing those elements of NPD ultimately adopted. As a result, the identified deficiencies relating to business incubation support for NPD activity should now become a focus for further research. Such research would then contribute to the body of knowledge relating to potential new mechanisms and theories for business incubator support of new product development undertaken by their tenant firms.

Implications for the case study methodology. There are two implications for the case study methodology adopted for this research: the recommendation for its continued use and the confirmation of the appropriateness of this methodology for this research.

First, this research used a convergent interview technique (Dick 1990) in the first stage of data gathering. This convergent interviewing stage gathered opinions from both academics and practitioners in the fields of new product development and start-up firms. As discussed in section 3.2, the particular usefulness of convergent interviewing lies in its ability to combine initially unstructured topic content with a structured, dialectical process. In turn, this provides both flexibility to permit a narrowing of the research focus, and academic rigor to add credibility to the interviewing process (Dick 1990; Perry 1999, Armstrong 1985). Convergent interviewing provided important insights into the research problem for this research. This was particularly in relation to issues faced by STBFs in undertaking their NPD activities. Its further use is therefore recommended.

Second, this research used case study methodology within the realism paradigm that assisted in theory building rather than other deductive methods to test theory. The result of adopting the realism paradigm was that it allowed the research to be conducted in areas in which there were identified gaps in the literature. Data was collected through in-depth interviewing of STBF respondents providing both management and business development perspectives of new product development. This provided an opportunity to gather data from respondents with differing perspectives of the same issue. The analysis of this data provided a richer understanding of the dynamics of new product development undertaken by STBFs. Additionally, it addressed the issue of whether the identified dynamics were different between clusters of firms according to the relative time-to-market of each firm's respective products.

Implications for practice. This research also has implications for the practice and management of new product development from two perspectives: the STBFs in undertaking their new product development and business incubators in their provision of services to assist STBFs in performing their new product development. These implications are summarised below in table 6.3.

Table 6.3 Implications for STBFs in the management of new product development

Practice perspective	Description
STBF management	• Better understanding of the co-dependence between corporate strategy and NPD process features
	• Better understanding of the non-linear development process for new products
	• Identification and better understanding of the 'best practice' elements of NPD that should be adopted in order to optimise chances of new product and firm success.
Business incubators	• Better understanding of the 'best practices' elements of NPD that should be adopted by tenant STBFs and to which incubator services should be targeted.
	• Better understanding of how business advice and networking assistance can be provided to enhance new product development in tenant STBFs
	• Better alignment of government policy in support for business incubators in the provision of assistance to tenant STBFs in undertaking their NPD activities

Source: developed from the data analysis in chapter 5 and derived from figure 6.2

The implications for the management of STBFs should be stressed. First, the dynamics and the co-dependencies between the three components of the final framework of new product development in STBFs (figure 6.2) comprising corporate strategy, NPD process features and new product success factors, is an area that has previously received little attention. Second, a better understanding of the non-linear nature of corporate strategy development and NPD activity means a greater chance of reducing the risk of new product failure. As discussed previously in chapters 2 and section 6.2, these first two issues were mainly attributable to the single-product focus of STBFs, as distinct from the multiple-product portfolio respective as well as large and established firm perspective. As such, the lack of attention to this area of research has resulted in the provision of little practical assistance to STBFs in managing their NPD activities. Finally, the key implication for STBF management is a better understanding of the NPD elements that should be adopted to increase the chance of new product, and hence firm, success.

Lastly, the findings from this research has direct implications for how governments' develop business support policy targeting business incubators. This is particularly true with respect to the relevance of individual programs aimed at assisting tenant

STBFs as well as the need for additional program funding for specific NPD support initiatives. In summary, a greater focus on the effective management of the NPD activities of tenant STBFs' means greater benefits derived by those firms from the services provided by business incubators.

6.5 Limitations

This research investigated the new product development processes adopted by STBFs. The findings arising out of this research were focused on STBFs as one specific form of start-up firm and not on other forms of start-up such as non-technology start-ups or new firms who have existing proven products or services and who then undertake further new product development. As such further research would need to be conducted on these alternative forms of start-up to confirm whether the findings from this research are also applicable to those firm types.

In-depth interviews were conducted with STBFs which were chosen to be representative of STBFs within a category defined according to time-to-market for their respective new products and represented by the three clusters within this research. Adopting this approach to firm categorisation resulted in cases being situated within specific industry sectors. For example, clusters of firms represented by short time-to-market products were exclusively operating in the information technology industry. Therefore, a potential limitation may be that the findings were a phenomenon of firms in that industry rather than being representative of all STBFs more generally within that particular time-to-market categorisation. However, this limitation was overcome through probe questions asked of the interviewees to ascertain whether any specific findings were attributable to the general industry environment in which their respective STBFs operated.

In summary, delimitation of scope was achieved by a narrowing of focus in two respects; a focus on only certain types of new firm, that is the STBFs, and firms that were technology-based only and not technology-intensive. Further, the characterisation of these firms according to time-to-market for their respective

products provided a very clear and succinct focus to the research. In brief, the limitations for this research were capably addressed and so did not diminish the value of the findings.

6.6 Suggestions for further research

To reiterate, this research employed an inductive approach through the adoption of the case study methodology to provide analytical generalisations in order to build theory. Further research was then undertaken to test the theory developed in respect of the framework for how STBFs undertake new product development as presented as figure 6.2. As a result of analysing the findings from this research, five suggestions for further research arising from this study are proposed.

The first suggestion for further research is to expand on the findings of this research by next applying a deductive approach which utilises statistical generalisations (Yin 1994). Such statistical generalisation would then provide a further level of in-sight into specific findings and thus also providing a greater focus on a narrower field of enquiry. One suggestion of how this could be applied is to focus on the extent to which the number of elements of NPD found to be adopted by STBFs (that is 17 of the 22 elements) is statistically indicative of STBFs in general.

Next, the research methodology of this study provided a means of comparing STBFs between clusters of firms according to their categorisation of time-to-market for their respective products (chapter 3). It may be valuable to undertake a similarly natured study, that is inductive theory building approach, but applied to categories of STBF by industry type. An example of this would be the ability to compare and contrast firms which face similar competitive, technological and commercial risk environments between firms of the same cluster. Such an approach would require a broader sample size of homogenously categorised STBFs. While this approach may provide some difficulty to the researcher in identifying a sample size of firms suitable for the study, the resulting findings would provide further significant insights.

Additionally, one of the more significant findings of this research was that business incubators provided only a modest positive influence to STBFs in their NPD activities (section 6.2.3). Therefore it would be valuable to undertake further research to address a range issues impacting business incubators in the context of the NPD-specific assistance they may be able to provide to their tenant firms. Some suggestions are: the extent to which new product development skills and capabilities are evident within business incubator management teams; the role of incubators in educating tenant STBFs in respect of 'best practice' new product development and contributions of incubators to networking theory in the specific context of new product development. While these suggestions are by no means meant to be an exhaustive set they do, nevertheless, provide a starting point for further investigation.

Finally, this research identified that there was a clearly identified level of co-dependency between most of the elements of NPD contained within all three components of the framework. As such, more research needs to be conducted on this phenomenon to identify specific co-dependencies across all start-up firm types, not just STBFs.

6.7 Conclusion

This chapter compared the literature to the findings for the three research questions. The areas of contribution from this research were identified and conclusions drawn on the research problem. The answer to the research problem for this research that is, *what are the origins and nature of new product development processes within STBFs and how do they contribute to STBF success?,* was presented as the final theoretical framework in figure 6.2.

In brief this research explored the links between the elements of corporate strategy relating to new product development, NPD process features and new product success factors in STBFs. Further, the research explored differences in adoption

rates and performance of these elements of NPD in the context of business incubators and stand-alone STBFs. The resulting framework was built from prior theory and research to represent the process of new product development found in STBFs. This framework can now provide a basis for further research into new product development within STBFs as well as other forms of start-up firm.

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APPENDIX I

CONVERGENT INTERVIEWING PROTOCOL

Interview Protocol

Date: ……. Time:…….

Interviewee:……...……

Position:……..…….

Introduction

Thank you for taking the time to participate in this university research project. This research project investigates the development of new product development processes by start-up high technology firms.

Ethical concerns

All data collected in this interview is treated as confidential and remains anonymous. As an additional safeguard measure, your company, nominated interviewees, and any other identifying details will be disguised in the final research report to achieve anonymity.

Could I please tape record this interview as will assist me with my data analysis? If yes, please feel free to push the 'pause' button of the tape recorder at any time during the interview.

Do you have any other questions regarding the objective or procedure of this interview? Please note that you may terminate this interview at any time that you wish.

This protocol is not a questionnaire but merely provides a framework for the interview and was progressively developed as result of convergence or divergence from preceding interviews.

Convergent Interview Question Set	
Q1	Please tell me the story of your experience in the New Product Development?
Q2.1	Do you think there are negative influences placed on the development of corporate and new product strategy provided by investors in STBFs, if so what are they?
Q2.2	Do you think any of these negative influences extend to the NPD process, if so how?
Q2.3	Do you think there are positive influences placed on the development of corporate and new product strategy provided by investors in STBFs, if so what are they?
Q 2.4	Do you think any of these positive influences extend to the NPD process, if so how?
Q 3	How important do you think achieving speed to market is for STBFs in developing their new products?
Q 4	What would you describe as being important management characteristics possessed by STBF management teams?
Q 5	What would describe as being the key areas of value of business incubators to STBFs?
Q 6	What factors or features would best describe the management of the NPD process by STBFs?
Q 7	Do you think early stage strategic partnering provides value to STBFs, if so in what ways?

APPENDIX II

CASE STUDY INTERVIEW PROTOCOL

INTERVIEW PROTOCOL

New Product Development in Start-up Technology-Based Firms (STBFs).

CONFIDENTIAL

Peter Beven
Department of Marketing
Faculty of Business
University of Southern Queensland
TOOWOOMBA QLD 4350

INTERVIEW PROTOCOL

Case reference:……..Interview number:……..……

Date: …….Start time:……Finish time:…….

Company:……..…….

..

Interviewee's

name:...……..……

Interviewee's

Title:……..…….

Description of Interviewee's role ……..……

Tape recording of interview: YES ☐ NO ☐

PART A: INTRODUCTION

Thank you for taking the time to participate in this university research project. This research would not be possible without your participation.

Purpose of this research

This research project investigates the development of new product development processes by start-up high technology firms. The benefits of this research will be implications for firms such as yours in undertaking new product development activities and ultimately improving chances of new product success.

Ethical concerns

All data collected in this interview is treated as confidential and remains anonymous. As an additional safeguard measure, your company, nominated interviewees, and any other identifying details will be disguised in the final research report to achieve anonymity. Undisguised information about participants in this research will not be made public nor given to a third party.

Could I please tape record this interview as will assist me with my data analysis? If yes, please feel free to push the 'pause' button of the tape recorder at any time during the interview.

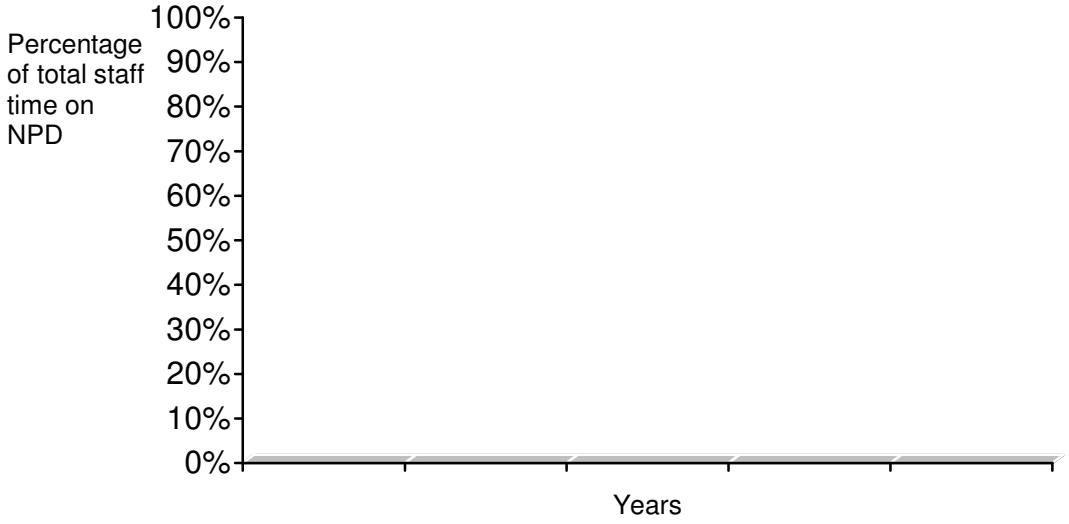
Do you have any other questions regarding the objective or procedure of this interview? Please note that you may terminate this interview at any time that you wish.

This protocol is not a questionnaire but merely provides a framework for the interview.

PART B BACKGROUND

1. Could you tell me of *the story of your experience* in the development of your business?

2. Could you please give me a chronological outline of the degree of effort, as represented by a proportion of total staff time, placed on NPD activities as compared to non-NPD activities of the firm?



3. Were there any significant events which may have occurred along the way which impacted on the degree of effort, as represented by a proportion of total staff time, placed on NPD activities as compared to non-NPD activities of the firm and if so what were they?

4 **From *what source* has the underlying technology or product concept been developed (e.g., university, personal endeavour etc.)?**

5 **Please briefly describe your product** *(Probe for: user benefits)*

6 **Is your product targeted to any specific industry sector, if so which ones?**

7 **Could you please indicate the anticipated time to market for your product** *(check appropriate box)* **and explain why you anticipate your product taking this time to market?**

1. Short time to market (<2 years)	2. Medium time to market (2-5 years)	3. Long time to market (>5 years)
☐	☐	☐

8 **At what stage of the NPD process is your business currently at?** *(check box)***:**

1. Concept	2. Technical development	3. Product prototype & validation	4. Launch
☐	☐	☐	☐

9 **Please indicate whether your product is** *(check box)***:**

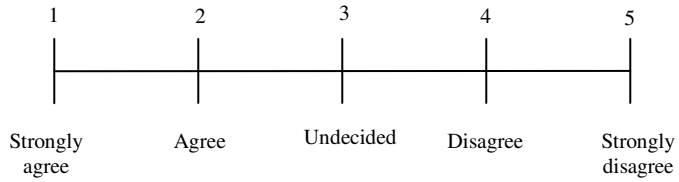
1. New to the world	☐	2. An incremental improvement to an existing product	☐

10 **Please indicate whether you intend to commercialise a physical product or technology** *(check box)***:**

1. Physical product	☐	2. Technology	☐

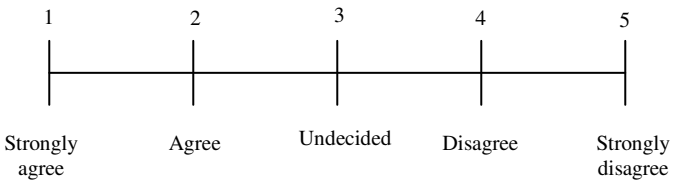
PART C NEW PRODUCT DEVELOPMENT PROCESS FEATURES

1. **Speed to market is a priority for your firm and is reflected in your NPD processes** *(circle response which most closely reflects your attitude)?*



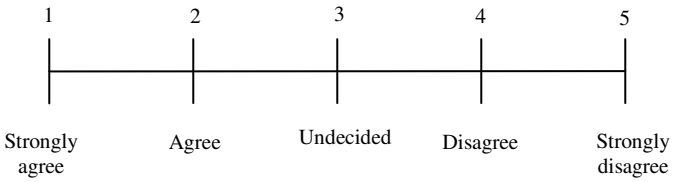
2. **Could you please describe to what extent speed to market is a priority for your firm?**
(Probe for: speed versus timeliness to market)

3 **It is important for your firm to undertake its development activities, represented by each of the NPD stages, in a parallel rather than in a linear and sequential way** *(circle response which most closely reflects your attitude)?*



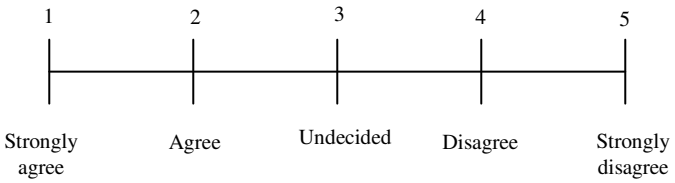
4. **Could you please describe how your NPD process is staged?** (*Probe for: extent of parallel development)*

5. **Before progressing with each stage of NPD it is important to systematically plan and review progress in the current stage before committing resources to the next stage of NPD activity** *(circle response which most closely reflects your attitude)?*



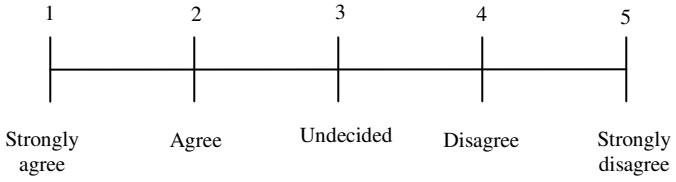
6 **Could you please describe at which points in the NPD process a review of progress is made (if any) and how decisions of committing resources to subsequent NPD activities are made?** *(Probe for: Decision gates, formalised process; success measurement, business incubator assistance)*

7. **It is important to have a multifunctional NPD team with technical, marketing and commercial skills and experience** *(circle response which most closely reflects your attitude)?*



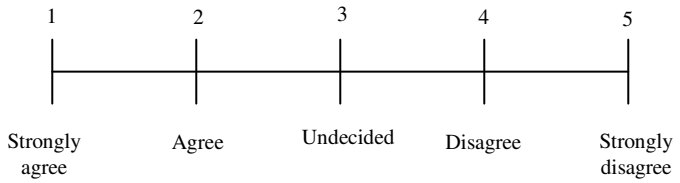
8 **Could you please describe the extent to which your NPD team is multifunctional?**
(Probe for: skills across disciplines and experience, business incubator assistance)

9 **It is important to for your product to reflect the needs of the market** *(circle response which most closely reflects your attitude)?*



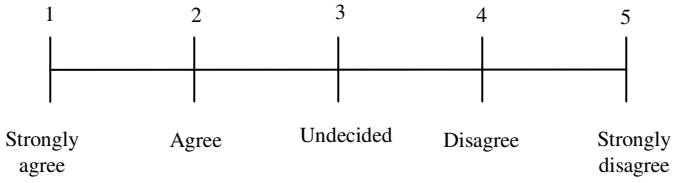
10 **Could you please describe the extent to which your firm involves addresses the needs of the market and how?** (*Probe for: product represents identified problems or needs of customers/users, business incubator assistance)*

11 **It is important to make extensive use of expert systems and modelling techniques in your NPD process** *(circle response which most closely reflects your attitude)*



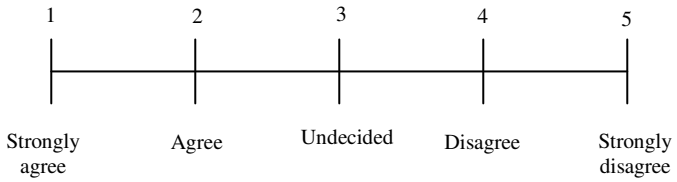
12 **Could you please describe to what extent you use expert systems and modelling techniques in your NPD process. Do you know of tools in the marketplace you could be utilising but you have barriers in accessing these tools?** *(Probe for: Resource barriers and other access issues, business incubator assistance)*

13 **It is important to involve potential customers, suppliers and users in the NPD process** *(circle response which most closely reflects your attitude)*?



14 **Could you please describe the extent to which your firm involves potential customers, suppliers and users of your product in your NPD process?** (*Probe for: Linkages with the market, business incubator assistance)*

15 **It is important to track and measure NPD activities to determine success at various stages of NPD** *(circle response which most closely reflects your attitude)*?



16 **Could you please indicate in what way firm success is measured in relation to your product development activities?** (*Probe for: stage, product testing, product audits, any fail points (how overcome), changes to measures, business incubator assistance)*

17 **Could you please indicate the extent to which you were able to access professional networks to assist with NPD?** *(Probe for business incubation role or other)*

18 **Could you please indicate the extent to which you accessed professional advisors to assist with your NPD?** *(Probe for business incubation role or other)*

PART D ELEMENTS OF CORPORATE STRATEGY IMPACTING ON NPD

1. **Could you please outline the nature of your target market and broadly define how your firm intends to enter the market?** (*Probe for: analysis of market; degree of competition, product positioning, technological advantage)*

2. **Could you please describe specific strategies in relation to aggression or stealth for market entry?** *Probe for: aggression vs. stealth)*

3 **Could you please outline how and on what basis you have segmented your market and the extent your market strategy reflects the international opportunities for your product?** (*Probe for: basis of segmentation and "born global" characteristics & timing)*

4 **Could you please describe in what ways your firm reflects (or degree to which it intends to reflect) its leadership?** (*Probe for: technological leadership, opportunity driven)*

5 **Could you please what types of operational and administration systems you have in place for your firm?** (*Probe for: administration, financial, reporting)*

6 **Could you please outline to what extent you intend to engage in *cooperation* with other firms?** (*Probe for: market effort; NPD effort; aggression versus stealth strategies, complementary assets; competitor response and duplication)*

7 **Could you please outline to what extent you will need to rely on any complementary assets of market incumbents?** (*Probe for: market channels, NPD, infrastructure assets)*

8 **Could you please describe in what ways investors influence the organisation** (strategy development, NPD activities, speed to market)**?**

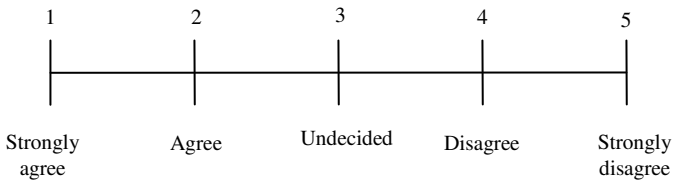
9 **Could you please describe in the skills and experience of founders and key management team** *(probe for: functional area skills, training/education)***?**

10 **Could you please indicate the extent to which you were able to access professional networks to assist with your corporate strategy development?** *(Probe for business incubation role or other)*

11 **Could you please indicate the extent to which you accessed professional advisors to assist with your corporate strategy development?** *(Probe for business incubation role or other)*

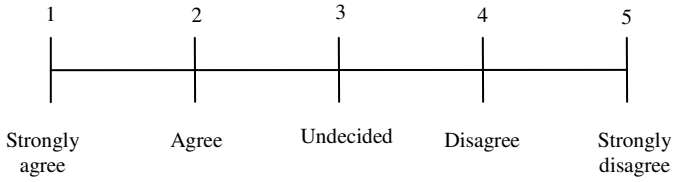
PART E NEW PRODUCT SUCCESS FACTORS

1 **It is important for your product to be superior to other product options as reflected by the superior value proposition to your target customers compared to that of competitors** *(circle response which most closely reflects your attitude)**?***



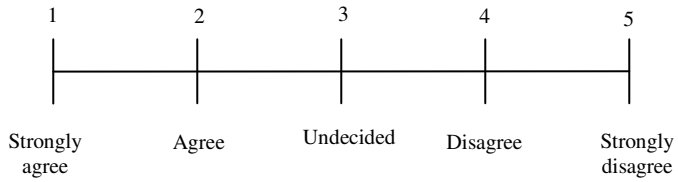
2 **Could you please describe what activities you undertook in determining the superiority of your product concept?** *(Probe for: engagement with customers/users, attribute analysis, market research)*

3 **It is important to screen for the validity of your product concept through preliminary market testing with potential clients or users *prior to* commencing any technical development** *(circle response which most closely reflects your attitude)***?**



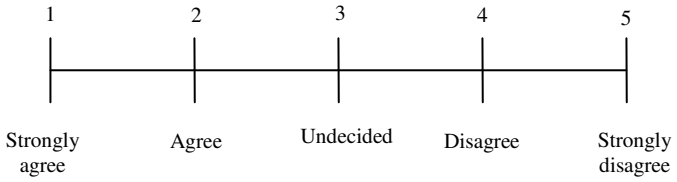
4 **Could you please describe how you screened to test the validity of your product concept?** *(Probe for: marketing testing, market analysis)*

5 **It is important to undertake extensive market research *prior* to commencing technical development** *(circle response which most closely reflects your attitude)***?**



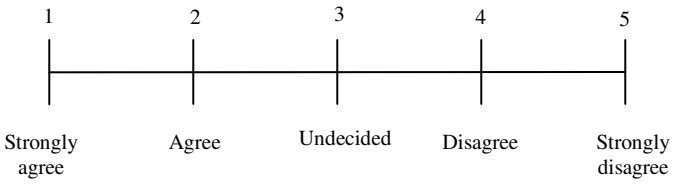
6 **Could you please describe to what extent you undertook market research on your product concept and at what stage(s) this was undertaken?**

7 **It is important that your firm has sufficient financial resources to carry it through the entire NPD process, including commercialisation, prior to commencing NPD activities** *(circle response which most closely reflects your attitude)***?**



8 **Could you please describe to what extent financial resourcing limitations has affected your NPD processes (if at all) to date? Do you anticipate needed to obtain additional financing in order to achieve successful product commercialisation?** *(Probe: consequences of lack of resourcing; stage where financing secured).*

9 **As part of your commercialisation phase, it is important to thoroughly *plan* your NPD process and how the product is to be launched in the marketplace *(circle response which most closely reflects your attitude)?***



10 **Could you please describe how you intend to undertake your product launch phase**? (*Probe for: process planning; pre-launch planning)*

11 **Could you please indicate the extent to which you were able to access professional networks to assist with your adoption of any these success factors?** *(Probe for business incubation role or other)*

12 **Could you please indicate the extent to which you accessed professional advisors to assist with your adoption of any these success factors?** *(Probe for business incubation role or other)*

PART F FIRM SUCCESS MEASURES

1. Could you please indicate, at what stage you are *currently* at in your NPD cycle *(check box)*

1. Concept	2. Technical development	3. Product prototype & validation	4. Launch	5. Firm Failure
☐	☐	☐	☐	☐

2 If your firm has since failed what reason do you attribute as the main cause of this failure?

3. Could you please indicate in what way firm success is measured in relation to any financial criteria? (*Probe for: cash flow expectations, sales projections, other income sources (grants), and investment)*

4 **Could you please indicate in what way firm success is measured in relation to any assessment requirements for satisfactory progress?** (*Probe for: time expectations (time to market), product development criteria, first sales, inter-firm relationships)*

PART G GENERAL QUESTIONS

1 Are there any questions I could have asked?

2 Has answering these questions helped you think about how you may be able to improve your NPD process? If so, how?

3 Is there anyone else you can thing of it would be worthwhile me talking to?

4 If I need to clarify any point, do you mind if I come back to you?

YOUR CONTIBUTION TO THIS RESEARCH IS GREATLY APPRECIATED

THANK YOU