Information Systems Strategy and Knowledge-Based Small and Medium-Sized Enterprises: An investigation within the Australian Biotechnology Industry

Volume Two

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5.1 Introduction

In this chapter, an in-depth discussion of the analysis of the primary investigation data is provided. Analysis from the familiarisation and pilot interview stages was critically reflected on to further refine the primary investigation strategy and procedures. As a result the insights generated from the familiarisation and pilot interview stages have been discussed in the research methodology chapter.

A detailed explanation of the process adopted to analyse the data allows the reader to both evaluate and understand how concepts were developed and conclusions were derived. The data collected was primarily qualitative in nature. Consistent with the reflective process adopted throughout the research (Section 4.2.2.1), this chapter seeks to describe and make explicit the analysis process and procedures adopted. A key issue in qualitative data analysis is to be explicit and make visible the manner by which the conclusions were derived from the data. Thus the methods used need to be systematic, disciplined, transparent and described (Coffey and Atkinson, 1996). The key findings of the data analysis process will be interpreted and discussed in a subsequent chapter (refer to Chapter 6).

The data underwent a two-stage analysis process in order to address multiple limitations of applying grounded theory techniques, within an interpretive multiple case study design. In the previous chapter, data analysis procedures were discussed and a walkthrough of their application was provided (Section 4.6). This chapter assumes the reader is familiar with the techniques and strategies discussed in Section 4.6. The first stage of data analysis involved treating the data obtained from the twelve cases as a meta-case (Section 4.6.2.1). The purpose was to gain some high-level insights into the nature of ISS across the twelve cases. The second stage involved a more detailed level of analysis exploring ISS at the case level and also the similarities and differences between the cases (Section 4.6.2.2).

The chapter is divided into two main sections and correspond to the two stages of analysis.

- Section 5.2 describes Stage One of data analysis, which involved treating the data from the twelve cases as a meta-case. The process and analysis are detailed in the following subsections.

  - Section 5.2.1 - provides an overview of the coding process as it applied to the context of this research. A three-stage coding was used to systematically reduce and organise the codes, pooled from the twelve case transcripts and analyse the data as a meta-case. At the conclusion of the axial coding process, the research questions and objectives were drawn-upon to guide the selective coding process and orient the selection of the axial codes.

  - Section 5.2.2 - provides an in-depth discussion of the four core categories, which emerged through analysing the data from the twelve cases as a meta-case. The core categories of role of IT, business activity facilitation, outsourcing and convergence of R&D knowledge and IT are discussed in detail with references made to relationships
both within each of the core categories and possible relationships between the four core categories.

- Section 5.2.3 - describes how the four core categories - role of IT, business activity facilitation, outsourcing and convergence of R&D knowledge and IT - relate to one another. The relationships between the core categories were determined by the second part of selective coding process. A diagram of the four categories and distinctive relationships between them is presented.

- Section 5.2.4 - revisits a number of axial codes, which through the selective coding process of applying research questions, were given a lower level of prioritisation with respect to the nature of ISS in this specific research context (Section 5.2.1). The axial codes are broadly categorised into four contexts - strategic context, business context, R&D context and environmental context. It was anticipated that the relationship of the axial codes and their influence on the nature of ISS within the twelve cases would be revealed by a more detailed level of analysis in Stage Two (Section 5.3).

- Section 5.2.5 - develops a descriptive model based on the analysis of the data as a meta-case.

- Section 5.2.6 - concludes Stage One of data analysis. Critical reflection is reintroduced as a process for validating the research methodology in a complex research domain (Section 4.6.2.3). It also validates the need for further detailed analysis that is discussed in Section 5.3.

- Section 5.3 details Stage Two of the data analysis process, which seeks to explore the current nature of ISS both within cases and across cases and is detailed in the following subsections:

  - Section 5.3.1 - describes the analysis process for exploring the nature of ISS at the case level. Through exploring the nature of the core categories (which emerged from Stage One) at the individual case level, it was anticipated that the researcher would be able to identify the focus of each case as well as reflect on whether the descriptive model was appropriate for all twelve cases. Using the open codes, which were assigned to each case transcript in Stage One (Section 5.2.1), cases were individually examined exploring the nature of the core categories within each case setting. The twelve cases are classified into three high-level groups based on commonalities and differences in the nature and dimensionality of the four categories, which emerged from Stage One Data Analysis, within the individual case setting. The open codes, which were assigned to each case transcript in Stage One (Section 5.2.1) were revisited and a similar axial coding process, which was applied in Stage One, was now applied to the open codes at the case level. This process of axial coding at the case level resulted in a number of the contextual factors (Section 5.2.4), which were broadly identified in Stage One, becoming more defined within the individual case setting. At the conclusion of axial coding, axial codes specific to each case emerged. It was evident within the cases there were semantic relationships between the axial codes.
• Section 5.3.2 - compares semantic relationships both within and between cases. Comparing the cases enabled commonalities to be explored and reflected on. The commonalities increase the explanatory power of the categories that emerged from Stage One. Through the process of comparing and contrasting semantic relationships between codes within cases, their proximity to core categories and comparing semantic relationships across the cases, five firm types emerged—Up and Comings (Section 5.3.2.1), Ad Hoc (Section 5.3.2.2), Stalwarts (Section 5.3.2.3), Stars (Section 5.3.2.4) and Virtuals (Section 5.3.2.5).

• Section 5.3.3 - reflects on the five firm types and the emergence of a fifth core category of strategic alignment. Significantly, the nature of some semantic relationships, which distinguished the cases, within the groups could be abstracted to a higher level. Through drawing on the axial codes and semantic relationships and undergoing a final process of selective coding across all twelve cases, the selective code of strategic alignment emerged and was the empirical link between the five firm types. Reflecting on the emergence of strategic alignment in Stage Two of data analysis and not in Stage One, it is evident that many of open and axial codes associated with this core category were given different prioritisation in the higher-level analysis (Stage One) and were present but spread across the four core categories in Stage One. However, in the case setting (Stage Two), it was evident that the axial and open codes were assigned higher levels of priority. Stage Two helped to validate the outcome of Stage One and suggest that in fact the diagrams, which emerged from this process, were a good, high-level representation of the nature of ISS among the twelve cases.

• Section 5.3.4 - concludes Stage Two of data analysis.

The chapter concludes with a summary reflection of the major elements of the two-stage analysis process (Section 5.4).

5.2 Data Analysis - Stage One

This section describes in detail the first iteration of the data. The process is discussed firstly through the application of the coding to the data across the twelve cases (Section 5.2.1). The four core categories that emerged from coding the meta-case (Section 5.2.2) and the relationships between the core categories (Section 5.2.3) are discussed. Contextual elements that may potentially impact the nature of ISS are discussed in Section 5.2.4 and from this a descriptive model of the data analysis from Stage One is developed (Section 5.2.5). The section concludes by critically reflecting on the Stage One analysis (Section 5.2.6) and highlights the need for a more detailed analysis, which is presented in Section 5.3.

The primary purpose of Stage One of the data analysis was to obtain high-level insights as to the nature of the ISS phenomenon within the Australian biotechnology SME setting (Sections 4.6.2 and 4.6.2.3). This was to align with the research questions.
As was highlighted in Chapter 3, the biotechnology industry is a complex and dynamic research environment. A holistic case study would provide an avenue through which to broadly explore the research phenomenon and an opportunity to reflect on the research methodology, prior to analysing the phenomenon in more detail (Section 4.6.2.3). Pooling the open codes, which were assigned to the twelve case transcripts and effectively treating all the codes as a meta-case, enabled high-level conceptual insights into the two research questions to be obtained (Section 4.6.2.3).

At the conclusion of Stage One, the researcher engaged in critical reflection in order to evaluate the research methodology (Sections 4.2.1, 4.6.2.3 and 5.2.6). Analysing a meta-case and reflecting on current ISS conceptualisation would help to validate whether the research methodology adopted, was successful in revealing additional insights in a complex, dynamic and commercially sensitive research environment. Variations between the findings at the conclusion of Stage One compared with current conceptualisations would help validate the research methodology adopted, as well as reiterate the need for a second stage of analysis, which would explore any nuances that may emerge at the individual case level (Section 4.6.2.3).

### 5.2.1 Overview of Coding Process

Equipped with the twelve interview transcripts, coding was employed to systematically reduce the data into a more manageable form. Open coding was conducted on each of the twelve case transcripts in accordance with the process described in Section 4.6.2.3 (see also Section 4.6.1.1 for an overview of coding). The open codes assigned to each case are drawn upon again in Stage Two (Sections 5.3.1 and Sections 5.3.2). Once open coding had been conducted on each transcript, the open codes from all cases were then pooled in a master spreadsheet to form a meta-case. At this stage, some 500 open codes emerged.

The next step involved systematically organising the codes and applying the technique of constant comparison to arrive at axial codes (the process is described in detail in Section 4.6.2.3). Appendix F presents in table form the axial codes and their associated open codes. At the end of the axial coding stage, categories emerged:
Chapter Five - Data Analysis

- Role of IT
- Reputation Management
- Relationship Management
- Innovation Nurturing
- Portfolio Management
- Environmental Management
- Financial Management
- Outsourcing
- Organisational Set-up
- Product Diversification
- Efficiency
- Commercial Orientation
- Australian Limitations
- Regulatory Barriers
- Investment Community Limitations
- Nature of Biotech
- Dichotomy of Science and business
- Niche/ Novelty
- Internationalisation
- Convergence of R&D knowledge and IT

Selective coding was subsequently employed to identify central or core categories (Sections 4.6.1.1 and 4.6.2.3). Selective coding is "the process of selecting the central or core category, systematically relating it to other categories, validating those relationships, and filling in categories that need further refinement and development" (Strauss and Corbin, 1990: 119). All other core codes derived from that axial coding process mustbe related to the focal core code, either directly or indirectly.

At the conclusion of the axial coding phase, emerged 20 axial codes. Attempting to systematically relate the categories, in order to identify core categories, proved to be a complex and perplexing task. The result was a complex, convoluted web of relationships. The complexity and difficulty encountered can perhaps be partially attributed to different levels of abstraction amongst the axial codes as well as the complex nature of the research environment. The primary research question and aims were drawn upon to help guide selective coding (Section 4.6.2.3 and Clarke, 2004).

Research Question 1

What is the current nature of information systems strategy among Australian biotechnology KSMEs?

To ascertain the current nature of ISS within Australian biotechnology KSMEs, the axial codes were examined to see if any explicit references were made to an ISS guided by the definition previously provided (Section 2.3). None of the twelve cases researched had made an explicit reference to an IS strategy or plan. The researcher did note, however, that some cases alluded to strategic intent or direction in respect of their IT or IS. Cases D and H, for example, referred to the future expansion and possible relocation of their businesses, where their IT infrastructures required consideration. Case D suggested that they would be looking at setting-up their own systems rather than remaining in a shared infrastructure arrangement. Case H on the other hand indicated that the business would be looking for another company with which to set-up a similar shared IT infrastructure arrangement. Case K referred to the implementation of a bar-coding system to facilitate the tracking and integration of multiple data sources within the businesses.

Despite there being no explicit reference to an ISS, the examples and insights with respect to the strategic intent of IS within the businesses, may in fact suggest that the
nature of ISS is largely implicit within the Australian biotechnology SME context. However, the dilemma faced was if an implicit ISS did exist, what was its nature?

To explore the implicit nature of ISS within the Australian biotechnology setting, the definition of ISS previously identified in the literature review was used (Sections 2.3 and 4.6.2.3).

**Definition of Information Systems Strategy**

ISS emerges as the information systems (in which IT only forms a component (Zack, 1999)) an organisation needs to maximise its effectiveness and efficiency so it can achieve its objectives and enable it to be competitive (Levy et al., 1999).

In essence, this involved exploring the axial codes for any references of information production, flows and use, IT and human activity systems. The following axial codes appeared to have some relevance to ISS:

- Role of IT
- Reputation Management
- Relationship Management
- Innovation Nurturing
- Portfolio Management
- Environmental Management
- Financial Management
- Convergence of R&D Knowledge and IT
- Outsourcing

The categories not listed above were not disregarded, as the selective coding process seeks to relate all axial codes, directly or indirectly, back to the core categories (Section 4.6.2.3). However, under this analytical approach, the remaining axial codes had been given lower levels of prioritisation in the context of the research question being asked. Instead the axial codes were recorded in an analytical memo and would be revisited in a later stage of the analysis (Section 5.2.4).

The next stage of the coding process involved exploring in detail, the nature of the axial codes and whether there was any relationship with other axial codes. Through the process of constant comparison, the categories of relationship management, environment management, financial management, innovation nurturing, portfolio management and reputation management appeared to be different business activities. Consequently, a new, higher-level category of **business activities facilitation** emerged and the earlier categories were demoted. The decision to rename this category **business activity facilitation** was made on the basis of the context in which the axial codes were discussed. When references were made to the activities, it tended to be in relation to how IT or information was used to assist within the businesses' activities.

The table below summarises the core categories and their underlying axial codes (refer to Table 5-1).
Table 5-1  Core Categories and Axial Codes

<table>
<thead>
<tr>
<th>Category</th>
<th>Axial Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role of IT</td>
<td>Communication Tool</td>
</tr>
<tr>
<td></td>
<td>Information Facilitation Tool</td>
</tr>
<tr>
<td></td>
<td>Management Tool</td>
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<tr>
<td></td>
<td>Operational Efficiency Tool</td>
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<tr>
<td></td>
<td>Marketing Tool</td>
</tr>
<tr>
<td>Outsourcing</td>
<td>R&amp;D</td>
</tr>
<tr>
<td></td>
<td>IT</td>
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<tr>
<td></td>
<td>External Expertise</td>
</tr>
<tr>
<td>Convergence of R&amp;D Knowledge and IT</td>
<td>Relationship Management</td>
</tr>
<tr>
<td></td>
<td>Reputation Management</td>
</tr>
<tr>
<td>Business Activity Facilitation</td>
<td>Environment Management</td>
</tr>
<tr>
<td></td>
<td>Financial Management</td>
</tr>
<tr>
<td></td>
<td>Innovation Nurturing</td>
</tr>
<tr>
<td></td>
<td>Portfolio Management</td>
</tr>
</tbody>
</table>

Four core categories appeared to have relevance to the implicit nature of ISS within the Australian biotechnology KSME setting and will be discussed in detail in the next section (Section 5.2.2).

5.2.2  Core Categories

This section provides a detailed description of the four core categories, which emerged from the coding process described above (Section 5.2.1):
- Role of IT (Section 5.2.2.1);
- Business Activity Facilitation (Section 5.2.2.2);
- Outsourcing (Section 5.2.2.3); and
- Convergence of R&D Knowledge and IT (Section 5.2.2.4).

To follow are descriptions of each of the four core categories and the relationships within the core categories, as well as reference to potential relationships or permeations between the core categories. The purpose is to open for inspection the derivation of the core categories. In a subsequent section (Section 5.2.3), relationships between the core categories will be discussed.

5.2.2.1 Role of IT

This section describes the first core category role of IT. Information technology was considered by all cases as critical to the business and was predominantly used as a tool. In this section, the role of IT is described in terms of its many roles including

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33 As can be seen in the coding tables in Appendix F, the category of convergence of R&D knowledge and IT was abstracted to a higher level and did not have an axial codes beneath it.

34 In Section 6.3.3, the emergence of this core category is reflected upon as to whether the emergence of the role of IT was reflective of the nature of ISS in these businesses or merely emerged as a result of the interview framework.
being a communication tool, information facilitation tool, management tool, operational efficiency tool and marketing tool.

Several excerpts from the interview transcripts illustrated the central role IT played in the businesses

We are all technology (Case E).

We use computers all the time, obviously for writing, getting scientific data (Case B).

You just can't do without it [IT]. It would be impossible to do without it (Case J).

Case I perhaps best summarised the extent to which IT is used within the businesses

I guess the thing is all of our business is really conducted through computers. And we have a lot of funding in the US and Europe and a lot of our collaborative partners are overseas and we communicate with them by email and even with each other. We are separately located around the university campus. All our records are kept on computer. We do market research and competitive research using the Internet. We have linked up with various companies through the Internet. We have a database containing... what you would call... information relating to our technology, which is kept on a computer so all the knowledge, about a particular chemical that we are developing, is kept in a database so it can be accessed by everybody. That's also used to store all our intellectual property relating to the technology, they are really the main uses (Case I).

Analysis of the twelve cases provided some insight into the use of information technology, which has been categorised into, a communication tool, management tool, information facilitation tool, business efficiency tool and marketing tool. The Internet and email technologies were explicitly mentioned on a number of occasions as being critical and indispensable to the businesses. However, what this analysis revealed was the difficulty at times of detaching the role of technology from the context of the business activity in which it was discussed. Technology did underlie most business activities and took on a number of different roles in this capacity. The following provides some discussion around the various roles where IT is used as a tool. This section also alludes to other roles IT may have within the context.

**Communication Tool**

In this section, the role of IT as a communication tool will be discussed in terms of its use in facilitating internal communication, external communication and teleconferencing/videoconferencing.

The use of Internet-based communication technologies was widespread within the twelve cases. Email in particular appeared to play a significant role within all cases in the dissemination of information both internally and externally. All cases examined were in a collaborative partnership and often dealing with organisations and people overseas. Email was considered an effective form of communication. This technology enabled many businesses to operate efficiently and effectively when dealing with
businesses overseas. Three quotes emphasise the important role email played in enabling the cases to conduct business globally

[Email is] good in that while you are sleeping, work is being done on the other side of the world (Case D).

There is a lot done by email. Email has the advantage particularly for Northern Hemisphere and time zone differences. It is really one of its biggest advantages. We are dealing with the US and the end of their day is the beginning of our day (Case H).

We find it a really good system because of time delays with Europe and US. It is a good way to ensure that you keep up communication (Case I).

Clearly from the above three quotations, email enabled the businesses to effectively operate ‘around the clock’. On another level, it highlights the international nature of the environment in which the businesses operated and how IT assisted them to operate in this capacity (refer to Internationalisation - Section 5.2.4). It also highlights that despite being detached from core markets in the Northern Hemisphere, twelve cases were able to use this factor to their advantage.

**Internal communication**

Despite most cases being small offices, email was in fact a common method used for communicating internally, both to individuals and groups within the business. In fact, Case H remarked on the irony, particularly as this business is comprised of three people

We still use email quite a bit even though we are only in the office next door (Case H).

Similarly, Cases A and E also discussed the extent to which email was used to communicate internally within their respective businesses

Everybody here sends about 10 emails a day to each other or to someone within the company (Case A).

So internally memos fly thick and fast (Case E).

The above quotations highlight the extent to which email was used internally to communicate with and among staff members. It suggests that email as a form of communication was an accepted business practice within the cases. Email formed an integral part of the cases’ internal communication strategy. For example, Case D suggested forwarding of email among staff members was very common despite only being a company of three core people.

Case E in fact suggested that email provided a mechanism, as he described, for ‘lubricating the wheels of communication’ within his business

A headline will come through from one of these BioHubs. It will have the latest study on a particular drug in Botswana or something. You just click that and send it out to everyone and that will form a conversation point at the next chance you get to meet. It’s really just lubricating the wheels of
communication where they will see the same information and beyond that, the next time you physically meet, you will talk things through (Case E).

In essence, email was an informal, but effective tool for encouraging internal communication. The above quotation also revealed that Case E stayed abreast of developments in the industry and disseminated this information to other colleagues so that they also were kept informed. The above quotation also highlights that there was also a 'human element' to the communication process (refer to Relationship Management - Section 4.2.2.2), where an email was often followed up by face-to-face contact.

In one case (Case J) where their technology infrastructure was described as somewhat limited, email was the only mechanism the business had for sharing information and files with other colleagues in their widely distributed office environment. There were a number of issues associated with this use of IT, which will be discussed in a later section (Section 5.3.2.2).

**External Communication**

Email was also commonly used in communicating with individuals and organisations external to the business. Case A used email extensively to communicate with its due diligence consultants. It was a useful tool particularly for those businesses that had operations or worked with people overseas. Similarly, Case D considered email as an integral part of their 'virtual structure' as it enabled them to both coordinate and work with businesses overseas. For example, when Case D looked at contracting out the next stage of their clinical trials, the bidding process involved using email extensively. Case D also suggested that communication with its overseas contractors involved email, noting its dealings with Australian contracting parties had tended to be more through phone contact. This reiterates the importance relationships played within the businesses and industry but also suggests that there is a human element to this relationship (refer to Relationship Management - Section 5.2.2.2).

Email played a key role in how many of the cases conducted their business. Case C described

> We ended the conversation that I would send him some information on our business, various aspects of our business, by email. He would have a look at that and if it was of any interest, we would continue discussions. So it is an indispensable tool now days I think (Case C).

In the above quotation, Case C was referring to a phone call he had with a business in New Zealand immediately prior to the researcher arriving at his office. The fact that the two businesses had agreed to finish the conversation by emailing information suggested that it was an acceptable business practice. Furthermore, Case C's reference to email being 'indispensable' further emphasised the importance placed on this technology by this particular business.

Finally, email has become part of the businesses' strategy for building and maintaining relationships

> It is a good way to ensure that you keep up communication. I think in this kind of business, it really relies on relationships and relationship building and
in order to maintain the relationship, you have to keep in contact and let people know what is happening. We find email is a very good way to do that (Case I).

Case I's reference to relationship building and management, in this capacity, suggested it is considered a key business activity; this will be revisited in more detail in Section 5.2.2.2. The quotation suggests that email facilitated the relationship building and maintenance process. The process described by Case I also suggests there is a human component to relationship building, where email is merely a tool.

Despite email being commonplace within the businesses studied, more conventional business technologies, including the telephone and fax, were also used. A secure fax was selected as the transfer method of choice, particularly when a document required a signature (Case D). Similarly, Case J gave the example of the use of a fax machine for sending commercially sensitive data from a clinical trial site. All of Case J's clinical trial sites sent trial data via secured fax. However, this business set-up had resulted in duplicates and triplicates with double entry of the data. In fact, the potential for human error to occur because of double entry was of concern to Case J35. Case J was exploring other options for the secure transfer of clinical trial data, with a joint venture partner at the time of the interview. This provides insights into one of the many reasons that biotechnology businesses enter into collaborations (Section 5.2.2.2).

Case B however was in a unique situation where several of its suppliers and customers did not have access to technology such as the Internet

Your average flower seller, to my knowledge, has not picked up on the Internet, so you have got a wide variety of technology being used. And you are dealing with growers in Columbia and Ecuador, where we grow, that have varying degrees of electronic communication. So it is more fax and phone in that situation (Case B)

This suggests that the use of IT within the businesses appears influenced, and perhaps limited by the technological capability of the individuals/business with whom they conduct their business. Although an interesting point, this issue appeared to be unique to Case B's business.

Although email appeared to be commonly accepted as a method of communication, most businesses combined the use of email with other conventional methods including telephone and face-to-face contact. This suggests that communication has a 'human element', which technology cannot emulate or replace. The telephone was commonly used for contacts in Australia, often to the same extent as email usage

So we use the phone and we have met a lot of the people so the two go together (Case B).

In fact, Case B suggested there is a strong linkage between IT as a communication tool and relationship management. However, face-to-face contact was also consistently mentioned as being important, especially for building and maintaining relationships with investors. As Case H described

35 This issue re-emerges as an important axial code in Stage Two of data analysis (Section 5.3.2)
Particularly with the number of the people we deal with, you really want to get things done face-to-face and if you are not in front of them, you will tend to be dropped down the rank (Case H).

The excerpt describes the perspective of biotechnology businesses that need to maintain face-to-face relationships with collaborative partners or investors. As Case B described

Even though with all the communications in place, investors feel more comfortable investing capital in their next door rather than coming all the way out here (Case B).

The above quotation highlights the limitations of technology and the importance of the human element in relationship building.

**Teleconference/Videoconferencing**

Finally teleconferencing and videoconferencing were often used as a method of communication by the management side of the businesses. In Case K, the methods were also used to complement their R&D activities. Teleconferencing occurred three to four times a week in Case D to communicate with its business partners located in the US. For more important, formal meetings, videoconferencing was used and Case D would hire facilities nearby, which again emphasised the importance of the human element in the relationship building processes. Videoconferencing occurred on a weekly basis. Case D mentioned that videoconferencing was an expensive communication strategy and that they were evaluating whether it would be financially viable for the business to set-up their own videoconferencing facilities. The emphasis placed on more ‘face-to-face’ interaction, through the videoconferencing, re-emphasised the human element aspect of communication.

Case K was unique as their operations were spread across two locations, one in Australia and the other in the US. Videoconferencing was used extensively by both management and scientists in this business. Case K had in fact set up its own videoconferencing facilities using a VPN. There were a number of active ports in the building, with all labs having videoconferencing capacity. The participant in fact suggested that meetings between scientists could go for several hours. Furthermore, the meetings required supporting documentation, with 60 to 100 pages of PowerPoint slides. Case K referred to extensive use of videoconferences between their scientists and other locations. They found the use of e-mail limiting with substantial delays in sending PowerPoint files which can be up to 50 to 60 megabytes in size.

The use of teleconferencing and videoconferencing facilities again suggests there is ‘human element’ to communication, which technology can facilitate but not necessarily replace.

One of the key roles of IT in the context of the twelve cases was as a communication tool. The next section will describe how IT was used to facilitate access to information.
Information Facilitation Tool

This section presents a second role of IT, which is facilitating and gaining access to information. This section complements further discussion on the core category *business activity facilitation*. The Internet and email were consistently mentioned as key tools for facilitating access to information. The Internet provided the businesses with access to competitor websites, e-journals, newsgroups, competitor databases and patent databases. For example, Case C described the use of IT in this capacity:

"And the Internet is obviously used to determine what our competitors are doing (Case C)."

The above quote highlights that Case C analyses its competitors' activities (refer to Environment Management - Section 5.2.2.2) and the Internet was the primary tool used for accessing this information. The Internet acted as conduit to a variety of information sources which prior to its advent would have been difficult to access (Cases A, C and H). For example, the businesses were now able to access a variety of databases, for example competitor and patent databases. In the example of patent databases, the Internet facilitated the searching of patents in other countries.

The relationship between information facilitation, the role of IT and business activities was often at times difficult to separate. A more in-depth discussion will be provided in the next section *business activity facilitation* (Section 5.2.2.2).

Management Tool

A third role of IT in the context of the twelve businesses was as a management tool, which assisted management in a number of key tasks. Database applications were used within most cases to assist with the management of business contacts/clients, intellectual property and grants/funding. The applications ranged from off-the-shelf solutions to simple in-house developed database solutions.

The client/contact management was the most common management tool across the cases, storing data pertaining to key contacts and alliance partners. Several case businesses had purchased and were using an off-the-shelf software package called ACT!. Case H was in fact evaluating a free trial version of ACT!, at their marketing manager's request. The marketing manager had used ACT! with his previous employer- a large pharma. Other cases had developed their own software tools for managing contacts. Case D referred to the development of a 'simple Access database' to manage contacts. All of the databases were used by management, were located on the company's server and thus were accessible to other members of the management team. The emergence of this axial code highlighted the importance of relationship management as well as describing the role technology played in facilitating and managing this process.

Gathering information on patents was particularly important for managing the businesses patent and licence portfolio. The importance of IP management was referred to in all cases and the role of technology was mainly as an access to the information facilitation role i.e. providing access to patent databases around the world. Two case businesses explicitly referred to the use of IP management tools.
Case J referred to a software package, which automatically told them when the business' patents were due for renewal. Case D had developed an in-house database to manage their patents. Case I utilised an application used by their incubator, “they have packages I use to store information on our intellectual property”.

The final database application was to assist in the management of research grants. Case J referred to the vast amounts of reporting required in managing grants and used a database application to assist with these responsibilities. Similarly, Case L had in fact developed an in-house grant database using FileMaker Pro.

The use of IT in the three capacities described in this section provides some insight into the importance placed on IT in the businesses activities as well as the potential complexities and difficulties in managing the processes. The three key areas in which the role of IT as a management tool emerged are explored in the next section under the second core category of business activity facilitation (refer to Relationship Management, Portfolio Management and Financial Management - Section 5.2.2.2).

**Operational Efficiency Tool**

The term ‘operational efficiency’ is used in this context to represent the use of IT to assist with improving the efficiency of everyday business activities. IT was applied in two capacities, assisting with business activities such as accounting as well as facilitating R&D activities.

**Business Application**

From a business perspective all cases referred to the utilisation of Microsoft Office applications. The most commonly used applications were word processing, spreadsheets and, at times, database packages in addition to Internet and email. Several cases also mentioned the use of financial application packages

The most unusual piece is something we use for our financial management, which is called MBO or MBOC, or something? Otherwise we all use whatever comes with Microsoft (Case A).

Well the main things I use are word processing, spreadsheets- budgetary spreadsheets, email, Internet in terms of finding information, access to databases (Case J).

Generic use of Microsoft Office that is used by everyone (Case F).

A notable feature was the use of two distinct operating systems within the twelve businesses. PCs were used for business applications and Macs were often used for R&D purposes. The clear distinction between the two PC systems is indicative of the dichotomy between the two parts of the business, which will be discussed in more detail in Sections 5.2.4 and 5.3.2.4.
Research and Development

Although not mentioned by all cases, some businesses made explicit reference to R&D specific software applications. The most commonly mentioned R&D application was statistical packages (Case A, B, F, L). Case F referred to the business developing an in-house R&D application, which is used in the laboratories. Although Case F’s IT manager had not been involved in the initial development of this application, she was involved in ensuring the system was Y2K compliant a few years ago. Case L also mentioned that their business has modified the propriety software, which accompanies their equipment, and required anyone who works on machines to sign a confidentiality statement (refer to Portfolio Management - Section 5.2.2.2).

Marketing Tool

For all cases IT formed an integral part of their marketing strategy. This section describes the role of IT as a marketing tool within the case businesses. Although the level of sophistication of the websites varied between businesses, much emphasis was placed by all cases on their business website. The following quote describes some of the key uses of websites among the twelve businesses

[The website is] used for announcements and any announcements that are made are also emailed out to people. It also gives the background on the company (Case D).

The importance of a website was commonly mentioned in conjunction with the business’ reputation. Case C, for example, highlighted the importance of having a website. At the time of the interview, Case C was in the process of upgrading their website. The improvements being made to the website provide some insight on how Case C considered the website should be used, particularly as a communication tool

We now have several other products that I don’t necessarily manufacture here but I trade in, so the website will communicate that to anybody that logs on. But also it provides a fair bit of information on the application of the products we trade in and manufacture (Case C).

Case C also suggested that potential customers and/or suppliers accessed the business’ website prior to contacting the business. Therefore, Case C placed great emphasis on their website and as will be discussed in the next section, this highlights a link with the business’ credibility (refer to Reputation Management - Section 5.2.2.2)

The first thing that they do before they come back to you is they access your website before they bother to respond (Case C).

Similarly, Case E referred to the dilemma faced when constructing a website to market their business. Case E discussed the issue of ‘information content’ and ensuring the website content was appropriate to capture a number of audiences

Our original website was really very basic. Our recent one is not bad, but it is not as stellar as it could be. It is your shop front because that is what your potential customers look at first. Trying to cram it with as much juicy information that you can. You are dealing with about half a dozen different types of audiences. You are dealing with lay people, investors who want to
know Case E. And at the same time, big pharmaceutical companies and big biotechnology companies are going to look at it as well (Case E).

This thread will be picked up further in the next section (Section 5.2.2.2)

The category, *role of IT* provides some key insights into the use of IT within the twelve businesses. It is noticeable in the above discussion elements of the category *role of IT* are associated with a number of the business activities. The business activities and there relationships will be discussed in the next section.

### 5.2.2.2 Business Activity Facilitation

This section describes the second core category, which emerged from the coding process - *business activity facilitation*. The core category *business activity facilitation* is discussed in terms of its six axial codes of *reputation management*, *relationship management*, *environment management*, *portfolio management*, *financial management* and *innovation nurturing*. However, prior to discussing the nature of each business that emerged, a brief overview of the context of its relationship with the *role of IT* is provided.

In this research context, the role of IT was often mentioned in reference to key business activities and it was often difficult to detach the role of IT as a tool from the business activity context. The category *business activity facilitation* encapsulated six key business activities, which emerged from the selective coding, and their use of information, which may or may not include IT. In essence, the core category of *business activity facilitation* alluded to the access, flow and communication of information with reference to key business activities and therefore could be demonstrative of the importance of information to the businesses. The context in which the six key activities emerged was in reference to information or IT usage or both and how they assisted their business activities. Therefore, to more accurately describe the context in which the categories where discussed, the term *business activity facilitation* is used rather than merely describing them as business activities. Through this process, the interconnectedness of a number of activities also emerged.

The Internet and email were consistently mentioned as integral tools for facilitating access to information. The Internet provided access to a plethora of information ranging from business intelligence (*environment management*), scientific data (*innovation nurturing* and *environment management*) and IP related information (*portfolio management*). Personal relationships were also a mechanism for gaining access to particularly sensitive data (*relationship management*).

Management used the Internet to access information relating to the industry - including industry trends, stock markets and competitors (*financial management* and *environment management*). In fact, what emerged from the analysis process was that a considerable amount of a manager's time was spent on the Internet, searching particular websites. This may provide some insight into the strategic nature and the importance of environmental management. The most commonly cited websites visited were competitor websites, some university websites, regulatory bodies and patent bodies, particularly the US Patent Office (*environment management* and *portfolio management*). The Internet was frequently used as a source of gathering information.
relating to both business and scientific questions. The Internet was the first point of call for many businesses to research specific problems and offered solutions to many of their queries (Cases A, B, C, E and H).

Whenever we have a question we'll get the answer from the net 9 times out of 10 (Case A).

The use of the Internet to assist with finding answers to questions was perhaps particularly noticeable as well as critical to Case C's business operation. As a sole person operation, there were situations where the owner did not possess the skills or expertise himself. The Internet was an important source of information in helping him to address some questions.

But associated with that is also often you get something out of left field, where somebody asks you a really curly technical question and you obviously have to access the net to find the answers to some of these questions if you don't know them yourself. Sometimes one particular customer requires some really obscure technical assay to measure something you have never even thought of in the product because nobody else has asked you for it, but this one person has? Well, how do you measure something that you nothing about, well obviously the Internet is the way to go (Case C).

Email was not only used as a way of communicating, but many cases referred to the use of email as a help to their thinking processes, and to control knowledge flows. Case D found that using email to communicate with other team members, and the tracking changes function in word, was an effective way to construct documents. Similarly Case H referred to using email as a way to help draft documents.

And often it’s a good process, especially if it’s an issue that you are particularly hot on. Even just putting down in writing thinking about it for a day and then coming back to it, you are often not so hot about it (Case H).

Case B used email as a way of tracking what information was leaving the business as part of an approval system.

It is always copied to someone and there is an approval system of information going out at any time (Case B).

In the analysis, six common business activities emerged from the axial coding process. The next section will provide specific examples on the use of information, IT and human activity systems in the context of key business activities (Section 5.2.2).

The axial codes of relationship management and reputation management emerged as significant business activities and appeared to influence how the businesses attracted potential collaborators, investors and gained access to information. The researcher grappled as to whether the apparent significance and influence of the axial codes justified their elevation to core categories in their own right. The decision to keep relationship management and reputation management as axial codes under the core category of business activity facilitation was made through the researcher returning to the context in which the axial codes were discussed in the interview. This was predominantly as part of a business activity. The iterative process of moving back and forth between the analysis and the original data is the essence of constant comparison.
and the inductive theory building process (Section 4.4.3.5 and 4.6.1.3). At this stage, *relationship management* and *reputation management* were noted in an analytical memo as significant axial codes. This observation was then reconsidered in the context of analysis and interpretation (Section 6.3.5).

**Relationship Management**

This section describes the key activity of *relationship management* and is discussed in terms of internal and external relationships. Relationships played an important part in facilitating access to information, establishing research and business collaborations and influencing the case’s image and reputation management. Relationships formed a crucial role in establishing collaborative partnerships with other companies and research institutions. Informal relationships provided a mechanism for overcoming issues of commercial sensitivity and often the cost of accessing certain information sources. As described above, the *role of IT* in this capacity appeared significant in facilitating communication both internally and externally, particularly with colleagues overseas.

Several of Case J’s employees still held research or teaching positions at University D. Through this connection, Case J effectively had access to University D’s information sources, in particular access to their electronic journals. Similarly Cases G, H, L and I suggested that several of their staff had similar arrangements with other research institutions. The following quotes demonstrate how businesses use their connections

> So whatever electronic journals the University D subscribes to I get access to it. A lot of us have appointments at the University D so can access their electronic journals (Case J).

The above quotation suggests that this arrangement for accessing information is quite informal. The participant clarified this point stating that he had access to University D’s resources but inferred that other staff members would be in a position to do this due to their holding similar positions at the same research institution.

The nature of the biotechnology industry appeared to rely on ‘who you know’. Therefore relationship maintenance and relationship building were important business activities

> I think in this kind of business, it really relies on relationships and relationship building (Case I).

> It's all networks and its about people connecting through people they know (Case L).

It is clearly evident that in a business such as biotechnology, relationships are considered vital key.

The axial code of *relationship management* can be further decomposed into internal and external relationships.
Chapter Five - Data Analysis

Internal Relationships

Cases appeared to place importance on developing internal relationships through activities such as regular weekly meetings. Case A, for example, had a weekly meeting immediately before the researcher arrived at the premises to conduct the interview. Case E alluded to their business holding regular, disciplinary and interdisciplinary meetings and once a week having a meeting with all members of the business. There were also informal events such as monthly drinks:

And we have a booze-up once a month. Alcohol is a wonderful drug. People loosen up and tend to talk more freely (Case E).

This was one of the many team-building activities used within the businesses.

Several cases, which had been previously dispersed across different locations throughout a city, had recently moved to one central office location (Cases E, F and G). The impact this has had on the communication between scientists and management was noted on several occasions:

It has helped management moving closer to the science and the scientists (Case G).

There is a lot more two-way communication (Case G).

It is a real big impetus to people's enthusiasm and almost pride in the company (Case E).

The three quotes above allude to the communication divide between scientists and management. It also suggests that the physical location of the business can also be a significant influence on relationships within the business, in particularly overcoming the dichotomy between the science and management teams. This is discussed in more detail in Sections 5.2.4 and 5.3.2.4.

Case C had a unique business set-up, where as a sole operator, he did not have the opportunity of interacting with other employees to exchange ideas and thoughts. The participant in fact suggested that the set-up was quite challenging:

But often the hardest thing with what I am doing is you can't bounce ideas off other people which you can when you work in other organisations (Case C).

The above quotation highlights the importance of internal relationships within Case C. The quotation also provides an insight into the nature of the knowledge creation processes within this business context, relying on interaction with others outside of the business.

External Relationship

All cases were in collaboration including with research institutions, similar sized biotechnology businesses and large multinational companies. Case E described the nature of the various relationships.
Cold hard cash and future royalty stream from the sale of the drug that is the best kind of partnership you could have because it is black ink on the ledger (Case E).

You often get the opportunity to partner with like-sized companies. So companies of 20, 30 people who haven't got cash to spend but have a complementary technology (Case E).

The above quotations suggest that the more sought after relationships in the businesses are those where the partner invests in the business. It also highlights another relationship, where similar sized biotechnology companies collaborate in order to gain access to complementary technology.

Case L referred to a number of alliances with research institutions. The participant referred to the arrangements as 'research opportunities' whereby a university or research institution gains access to the business’ equipment and in return the business is permitted access to the IP that results from the research.

It is also means we get extra research done (Case L).

In essence, the approach adopted by Case L enabled the business to gain access to knowledge as well as providing a mechanism for increasing the efficiency of their R&D process and ultimately leading to cost savings.

Relationships were also used to gain access to key markets. For example, Case H had set-up relationships with a number of key veterinarians to facilitate the launch of their product on the North American market.

We have set-up contact with a number of key equine vets in North America who are ready to start trialling our horse product (Case H).

Alliance management was seen as a key managerial activity by all cases. Despite not having a specific person in the alliance manager position, largely due to limited resources (refer to Business Context - Section 5.2.4), all cases ensured that someone took on the responsibility for managing the alliance. The business development manager or CEO most commonly undertook the role of the alliance manager.

We don't really have enough resources to have anyone to be an alliance manager. We do as much as we can. Someone takes on the responsibility for the relationship and we keep that person involved in order to maintain that relationship and making sure that things are kept on track (Case I).

The above excerpt offers two insights into the businesses, firstly ensuring that someone was responsible for the relationship, emphasised the importance of collaborations. Secondly, the business development manager or CEO undertakes the role of alliance manager, which would suggest that alliance management is considered a high level or strategic business activity.

Employee contacts with external organisations and people played an important role in gaining access to information, financing and improving the business’ reputation. As previously discussed, several cases used their connections with universities to access
information. Case E, for example, referred to the co-CEO of the business having very influential contacts

With some high-level individual, so on the rich 200 list and the yachting fraternity (Case E).

Similarly, Case B explicitly stated that their business relied on their scientists’ personal networks to keep abreast of what was going on in the industry

At a technical level, we rely on scientists working in the field of having a network that has developed over many, many years... a little bit of going to scientific conferences, but mostly it is word and mouth, through people who know people, the human network (Case B).

The excerpt above from Case B again highlights the human element involved in both forming and building relationships.

It was common practice for the cases to attend forums such as conferences and trade fairs. This was alluded to in the previous quotation from Case B, however, in this business it was not a significant strategy. The primary reason for attending forums was to find out what was happening in the industry as well as using them as an opportunity to meet potential clients/customers. The following quotations highlight the reasons for attending conferences

Mainly to find out about the industry and for networking purposes (Case I).

We go to ones [conferences] where there are key people, clients who want to buy our products or clients who want to distribute our products, or collaboration partners (Case L).

So we usually try to set up as many one-on-one partnering sessions as we can (Case E).

The BIO conference was consistently mentioned by cases as a target conference and trade fair. For example Case E described the BIO conference

As a dating service for big pharma and small biotechs, it is a good one to go to (Case E).

The dilemma facing both agricultural and health biotechnology businesses is referred to as the ‘competitor-partner’ dilemma. Although the big pharmaceutical companies could be potential business partners, they could also be the competitors of the cases mentioned in the research

It very much depends on what you call competitors as well. In some ways the big Fort Dodges and the CSLs are competitors to the company to a degree but then they are also a potential partner as well. They’re usually more involved in taking products through to market (Case H).

So from that side they are a competitor but also a potential partner (Case H).

As alluded to in the discussion on the role of IT category, email and a business’ website were used extensively to assist with building and maintaining relationships.
Case C described the process of finding potential partners through the use of the Internet:

Through that process of using the Internet, we've managed to lock in 4 or 5 distributors around the world and there is probably another half a dozen of those which are close to being signed up and that is positive from our point of view (Case C).

Case E also described the dilemma faced by businesses with respect to creating a website aimed at attracting investors and collaborators:

It is actually quite a difficult task for someone like us, to put together a website that satisfies both lay investors and potential investors and potential collaborators who want to see the business that they might be getting into. It's a tough one the website (Case E).

The issue faced by Case E was in developing a website which would satisfy the information needs of both potential investors and collaborators.

This section has described the key business activities of relationship management, in terms of internal and external relationships. The next section will discuss the second business activity of reputation management, which appears to be closely linked with the first key business activity of relationship management.

**Reputation Management**

In this section, reputation management is discussed in terms of business credibility and scientific credibility.

**Business Credibility**

Business credibility plays an integral part in gaining access to finance and entering collaborative relationships. A business’ website was often cited with reference to its credibility. However business credibility largely stemmed from a case’s relationship with both external organisations and people.

The necessity of possessing a website was consistently mentioned as an important part of building and establishing business credibility. The website was often considered the first place a business, or the first point where a potential investor would investigate to obtain background information.

Case B suggested that the composition of the management team and board could also influence the perception of the business, referring to the business community being suspicious of scientists who run businesses.

The importance of the Internet in assisting business credibility was also consistently mentioned, with particular emphasis on possessing a website. Case H provided a good description of the relationship between a business’ website and its credibility:

The website is credibility. It is a big credibility thing. When our sales and marketing manager came on board, that was one of the big things that he wanted to get going. He is ex-CSL so he is used to having decent websites.
and promotional tools. He did a good job getting that up and running and that has been really good for us because we are able to put quite a few publications on there and direct people to there for people who want general information. So it's a good credibility thing but it is general information for people (Case H).

The excerpt above describes a clear link between the business’ website and their perceived credibility. The above quotation suggests that while a website may provide information, it also enhances the credibility of the business. Scientific credibility will now be explored.

**Scientific Credibility**

Science and technological credibility was also critical for attracting potential investors or collaborators. Traditional strategies involved the publishing of key data in peer-reviewed journals. For example Case A stated

> We have data published in peer-reviewed journals, which we can use as marketing material to give scientific credibility to the product (Case A).

Similarly, Case B referred to how publishing papers can increase the business’ credibility in the scientific community. Although Case B suggested that their business seldom publishes nowadays, it certainly helped to develop that business’ credibility in the scientific community.

> It [publishing] also gave you credibility in the scientific community. I don’t know how true that is I mean we did publish, very little but we did and I think we developed quite a bit of credibility in the scientific community (Case B).

Although publications played a major role in a business’ scientific credibility, the importance of patents has changed this perception. Most cases described the need for protecting their research through patents and although they did not discourage publishing papers, were cautious and had tight controls on what may or may not be published (*portfolio management*).

> The scientific community is changing. Patents are considered to be worth more than they used to be (Case B).

Several cases also exploited the fact they have several eminent scientists either sitting on the board of the business, or connected in some measure to the business and its research (Cases A, B, G).

> We have over different periods developed a scientific advisory board. We began by trying to put together eminent international scientists (Case B).

Similarly Case E and A referred to employing several key scientists, who “are internationally renowned in their own rights” (Case E).

Relationships with large multinational companies also help validate a business and its underlying technology. Case E referred to there being a lot of competition between biotechnology businesses to link with a major pharmaceutical company and how a relationship of that nature can raise the profile of the technology and the business.
Partnership with a big pharma, as I was mentioning before, is really a big deal as it validates us and validates our technology (Case E).

Case E described the key importance that the business placed on relationships with big phamas. It provides a linkage between the case's relationships in respect of the company's scientific and business credibility.

So our competitors are other biotechnology companies which are sniffing around the big pharmas trying to get partnerships basically. So we have to present ourselves as having better opportunities, better drug discovery paradigms or better technology. We have highlighted a computational platform which is better than other people's. We show our compounds and how well they work and compare them with current standard technologies like Gluvac and so forth. So you are always trying to trump your competitors (Case E).

The process of attracting potential major pharma alliance partners, described by Case E above, involved marketing the business' technology and demonstrating that it is superior to Case E's competitors.

This section has described the second business activity of relationship management within the core category business activity facilitation. The next section will discuss the third business activity of environment management.

Environment Management

Environment management is the process of examining and analysing external factors which may impact on the business. The emergence of this axial code suggests the businesses require strong awareness of their external environment. The axial code of environment management includes three activities:

- industry analysis;
- competitor analysis; and
- opportunity analysis.

Although the three activities are discussed as discrete activities in this section, there is often overlap between them.

Industry Analysis

Industry analysis is used to describe the process undertaken to stay abreast of developments in the industry. It entails forming an understanding of the industry and the potential impact that industry level factors may have on the business. For example, in the case of agricultural biotechnology businesses, GMO moratoriums appear to have a direct impact on where and or even whether a business could market and distribute a product within various countries. Case B closely monitored the European GMO moratorium and analysed how its influence may affect their business strategy.

We will go back if the moratorium lifts, which it may do. It is showing signs but there are still a couple of countries still opposed (Case B).

The Dutch flower market is one of Case B's main markets, therefore the outcome of the moratorium will impact Case B's marketing and distribution strategy. Similarly,
the recent downturn in biotechnology stocks, had influenced Case H’s recent financing round. This highlights the potential influence the biotechnology industry may have on a business’ finance strategies.

The main tool used for conducting industry analysis was predominantly the Internet combined with databases and newsgroups.

So we tend to particularly use the Internet to do searches on just the industry and what’s going on, what other products may be competitive products (Case H).

We obviously look at the websites and markets. Not actual databases (Case J).

Case B also described how the business now had greater access to information available in the market as well as having an employee ‘on the ground’

We get a lot more quality information now that we are in the market, so trade fairs are one... We get a lot of information from trade journals and in the flower industry there are published statistics. The biggest source is the Dutch flower market, they have a lot of stats. That is a major source of information—such as volumes, costs and again because we are in the business, we get a lot more information about growing costs and marketing costs and so forth about the industry (Case B).

Although much of the discussion around ‘industry analysis’ has been from a business perspective, the businesses also kept up-to-date with the latest R&D developments. For example, Case G referred to their scientists as well as their business development manager searching certain criteria on a competitor database, such as pharma licencing, to keep abreast of the latest developments in the field. The following excerpts suggest that these businesses placed some onus on their scientists to maintain an awareness of new developments in their specific area of research.

Our scientists are well-up to speed (Case G).

We also do a lot of literature reviews, journals, analysis of research data (Case A).

There are public access ones [databases] which I go to a lot, such as PubMed, which is all the literature on medicine and medicinal chemistry and I will be looking at papers all the time. Patent databases, you know PCT [Patent Cooperation Treaty] (Case E).

Membership and association with industry groups such as AusBiotech and those specifically related to their business, also provided a mechanism for the businesses to stay informed on major industry developments (Cases C, E, I and K).

This year we went to the big ones, BIO conferences and the AusBiotech, but we also go to industry specific conferences that relates to exactly what we are doing, so we can understand what best practice is and understand what stage other groups are at (Case I).

The above excerpt describes how Case I attends industry conferences to stay informed with respect to developments in the industry. The business also used this as an
opportunity to find details on their competitors' current endeavours, a type of environment management activity described in the next subsection.

**Competitor Analysis**

Competitor analysis involved businesses examining the environment to ascertain who their competitors were, what they were doing and the potential impact on their business. Although this activity may be considered a form of industry analysis, the specific focus placed on this process suggested it needed to be considered as a separate but related activity. The Internet was the most common tool used and facilitated access to competitor information, through websites, newsgroups and competitor databases (refer to Information Facilitation Tool - Section 5.2.2.1). The extent to which this process is performed within the twelve Australian biotechnology businesses is exemplified by the following quotation:

And also another thing is that I am straight into the websites of other competitors and potential competitors. I have my favourites list, which is all biotech companies - it is like this long [exaggerated hand gesture to emphasise size] (Case E).

The above excerpt from Case E highlights that reviewing a competitor's business activities occurs regularly, as the competitor websites have been bookmarked. Other examples of the use of the Internet to facilitate competitor analysis include:

- We do market research, competitor research using the Internet (Case I).
- We sometimes look up on competitor websites, but that is usually secondary. You would follow up to a piece of information you have seen on an electronic journal. Most electronic journals do email notifications. You get a one sentence about each story. There are a couple of sites that do that-you have just go to go to them and check. And databases are very useful (Case J).
- One [database] we have subscribed to is VentureWire which contains information about money companies have had access to. That sometimes discusses information about people working in the same area as us. There are also some updates that don't come out daily but come out weekly and monthly - R&D review and the AusBiotech Newsletter (Case I).
- There are a lot of gossip, not gossip, no newsgroup type things. You usually find out from that who is doing what or who has done what. So that is quite a useful set-up (Case E).

The above examples highlight the key role the Internet and IT played in facilitating access to information sources on competitors. The above examples also suggest that the process of competitor analysis involved synthesising information from a number of different sources.

In addition to electronic information sources, the businesses attended conferences and other forums to find out current details of other businesses' activities. For example, Case G stated that they attended conferences to look for potential collaborators and to find out ‘who our potential competitors are’.
Given the commercially sensitive nature of the industry several cases indicated that personal relationships were also essential for discovering details of their competitors' current projects (Cases B and H). Case H for example suggested that personal relationships often played a key role in finding out competitors current activities.

It's often hard to find out what companies like that are doing, because on the new side of things they tend to keep that quite tightly, in-house. So what it really comes down to here is trying to use personal contacts, just trying to get a foot in the door. Whereas universities and others, they are a bit more open about with their publications and about what is going on. It's a little bit easier to find out what is out there, but then you have go the next step and find out whether it is just a research project or how commercial is it (Case H).

In contrast to the other case businesses, Case D perceived it was easy to find information on other companies activities. As Case D discussed:

Most companies tend to publicise what they are doing; there are no real or very few secrets within the industry. They tend to blow their own trumpets for deals and publicity. Generally you can find out who has deals with who, what is generally harder to find out is the amount (Case D).

Although Case D would suggest that competitor activity information is relatively easy to obtain, the participant acknowledged that there is a certain level of secrecy surrounding some types of information such as the exact amount of a financial arrangement.

Some cases also paid subscriptions to 'competitor databases' (Case E). Although as a result of financial constraints, several cases explicitly stated that they did not subscribe to competitor database services (Case A and H) (Section 5.2.4).

Opportunity Analysis

The final axial code to emerge under environment management was opportunity analysis. Businesses tended to infer the presence of opportunities, through discussing ‘potential partnership’ or ‘potential investment’ opportunities. As a consequence, processes for analysing opportunities have tended to be encapsulated under other categories namely relationship management and financial management.

Case L referred to the nature of their relationships with research institutions as “some of it is a research opportunity” (Case L).

Similarly, Case C described using the Internet to look for potential opportunities. The following example highlights that the Internet was the primary tool used for searching for ‘leads’ but it is also through personal contacts that opportunities may arise:

You pick up potential leads but predominantly it is though the Internet and using networks, the networks one has established over the years (Case C).

Case A also conducted a ‘background check’ through literature reviews on drugs that they are thinking of licensing:

We do due-diligence on drugs we are thinking of licensing in, like looking for literature around those (Case A).
Case H and Case E made explicit reference to analysing for opportunities. For example Case H stated

The universities and others, we just keep an eye on them, some of those are on the competitor side but also looking for an opportunity (Case H).

The above quotation also highlights the interrelationship between the categories, competitor analysis and opportunity analysis. It is also reflective of the competitor-partner dilemma, which several businesses referred to in relation to big pharma (refer to Relationship Management - Section 5.2.2.2). Similarly, Case E highlighted by analysing other businesses’ patents, they were then able to turn them into their own ideas

You can steal ideas from people’s patents and turn them into your own very easily (Case E).

In fact, the process which Case E referred to ‘stealing idea’ is in fact the impetus behind Case C’s choice not to patent and is discussed in more detail under the section Portfolio Management.

Opportunity analysis was an evaluation process whereby the opportunity is assessed in terms of its viability. Again the Internet was drawn upon in the scoping stages

It has been particularly handy when we have had to do assessment of a new opportunity or as people come to us with an idea or technology that they have taken at a certain point and we then have to evaluate whether we want to take it on or whether it has got value to us. So we tend to particularly use the Internet there (Case H).

In the quotation below, Case H appeared to have a well-established process for assessing and evaluating an opportunity, exploring the market potentials, who the competitors and what are the potential risks

We also tend to do a sort of mini-business plan around a new business opportunity as well. Just at the moment the board has in its hands a R&D plan, well more R&D opportunities than a plan and to do that John 36 really went away and looked at all the key facets. It’s a lot smaller than a business plan. But really it is like a mini-business plan, it’s new opportunity and if we are going to take it on, we need to do this. What’s the market, who are the competitors, what’s the risk, so you do that process and we are involved. We also have a set of criteria that we look at when look at a new opportunity, which are pretty much the key elements of a business plan but are done in a matrix fashion. So we will go through that looking at a new opportunity (Case H).

As highlighted above, Case H had a formalised process for assessing the opportunities presented to their board. The description of the process as a ‘mini-business plan’ emphasises the importance the business places on such opportunities.

This section has described the third business activity of environment management within the core category of business activity facilitation. Environment Management

36 Pseudonym used
can be considered in terms of the three activities of competitor analysis, industry analysis and opportunity analysis. The next section will discuss the fourth business activity of portfolio management.

Portfolio Management

The section describes the activity of portfolio management, which encapsulates the administration and overall management of a business’ IP. This not only includes the management of the patents owned by the business but also any patents the business either licensed-in or out. The importance of protecting propriety know-how and processes is exemplified by a number of key practices and axial codes surrounding the management of IP.

The primary method employed to protect business know-how and technology was patenting. All cases, except Case C, owned several patents as a means of protecting their knowledge and technology. Case E presented an image of building a fortress around key areas, which appears to suggest the importance of protecting their IP.

We tend to be very focused on mapping our territory, bricks in the wall around our lead ideas that could lead to a compound in the future. The more bricks in the wall that surround your core IP, the safer and the more valuable it is in terms of its long term profitability (Case E).

The above excerpt described the link between the protection of IP and longer term financial rewards.

Commercial in-confidence agreements were a common mechanism for protecting business know-how. Case L, for example, checked to see whether the researcher would be required to sign a confidentiality agreement prior to the interview.

We are really strict on that. In fact, I checked to see if you needed to sign one [a confidentiality statement] (Case L).

The above example highlights the commercially sensitive nature of the business and one mechanism that the cases use to ensure their knowledge remains in-house. Case L, required anyone who worked for the business and any external contractors, to sign a confidentiality statement. All other cases referred to the requirement that any alliance partner must sign a non-disclosure agreement. The following quotations provide some examples of the use of confidentiality agreements.

We routinely have a confidentiality agreement (Case J).

All of the relationships we form with people because of the nature of the technology in its early form we always initiate a confidentiality disclosure agreement. As part of that you have to identify information that is confidential and mark as such (Case I).

Case C was distinct from the other cases in deliberately choosing not to patent. As a start-up business, Case C considered that they would not have the ability to defend themselves against any litigation. Therefore, it would be a risk to the business if they were faced with a litigation suit. Furthermore, Case C perceived that patents allowed competitors to obtain details on their business and research activities. However, Case
C also placed importance on protecting business’ critical knowledge but instead of patenting, considered ‘trade secrets’ as the most appropriate form of protection. The following quotation exemplifies Case C’s opinion on patenting

I am not necessarily a great believer in the patent process. As soon as you have put a patent out into the public domain, everybody knows exactly what you are doing and how you are doing it. And quite often I think it can work to your detriment. And as an organisation like this where you only a small, you start off small. If any body overseas picked up this patent they think ‘hang on a minute’ there is an element of this particular process breaching a patent. You find yourself in court. It might be a frivolous issue but you might find yourself trying to fight a multinational overseas. It just doesn’t make sense. But we are definitely are not in breach of any patents. Nonetheless, even if were capable of putting out a patent, I wouldn’t simply because I don’t believe it is the way to go personally, not at this point. A lot of people would disagree because they believe it gives you a lot of value for your business, If you have got a patent and that is true. But we have decided not to take that approach (Case C).

The above quotation clearly illustrates Case C’s objection to patenting. This does not suggest that Case C considers protecting their know-how has a lower priority than other cases, rather as a sole-person operation Case C chose other, more economical methods for protecting business know-how, namely trade secrets. Case B also used trade secrets explicitly in conjunction with patents to protect their business’ know-how as “it is a cheap way of protecting it”.

Discussion on IP often referred to the high cost of patenting. Cases sought patents in every country in which they intended to market their product. Two cases explicitly stated that the cost of patents influenced their marketing and distribution strategies

We tend to take them out in the United States, Europe and Japan and Australia. In the past we have had more countries, but now we always try to narrow it down to save cost (Case B).

The cost of getting patents through, you make a financial decision early on-cost-benefit wise. For example our [animal biotech] product, we decided not to go into Japan. But Japan is potentially a big market but it was going to cost 17 000 dollars just to apply. A market like that it would probably take a few years until an opportunity comes up (Case H).

The above quotations clearly demonstrate a link between patenting and marketing strategies. In Case H, the choice not to patent in Japan, although potentially a lucrative market for their product, was a financial decision and also highlights a potential linkage between environmental features and the business’ IP strategy. Similarly, Case B patented in a select number of countries to reduce costs.

In addition to owning patents, several cases also licensed-in technology. However, Case C, which had developed a totally in-house process, did not patent nor licence in any technology.

Case E appeared to have a proactive IP strategy. Not only did Case E licence-in patents, the business also licensed-out some of its non-core technology and was gaining revenue from that process. The CEO of Case E had a number of patents, which he brought with him when he started the business.
So we have done reasonably well from licensing out our non-core technology (Case E).

But we are sort of intellectual property aware, so we are also aware of knowhow. We had other funding partners in the past and you had to compartmentalise some of the information of one group from another, so in some cases you would share that with the parties involved. So yes, in some cases there is a very clear demarcation and in other cases it is impossible, because it is information in people's heads and it can get tricky and creates situations where people argue. So there are very tight rules on what we can publicise to the outside world and again the venture partner has to approve that, which if either one of us said no then we wouldn't (Case B).

As with other business activities, IT and in particular the Internet were important tools for gaining access to information relating to patents. For example, searching key patent databases in US and Europe (refer to Operational Efficiency Tools and Information Tools- Section 5.2.2.1)

We search through European database and also the US database (Case H).

You can get direct access on-line. And that can give you directions. But generally we rely on our patent attorneys to do most of our work. We do some informal searching to understand it. It is generally searching on the Internet or there is a chem. database, which we link into to find out what else is going on in the area and whether or not what we are coming up with has been done before (Case I).

Although not necessarily referred to as a strategy adopted by the cases in this research, Case E referred to the practice of patent blocking, where patents form barriers to entry for other businesses.

It is not a problem that has faced us, but it is one we have thought of doing on many occasions. It is cunning and evil stuff. You can try and anticipate someone is going to end up here but all of a sudden they could go that way [a different direction] and you have wasted sixty grand. But there are some clever organisations, that for example patented internal DNA standards and very cleverly. And everyone uses internal standards as it's the best way to standardise your information. And there is a patent out there and people can't use it without licensing the patent on internal standards. And they have done very well out of it and that is good for them (Case E).

In the above excerpt, Case E identified patent blocking as being a 'cunning and evil' strategy. This description may relate to other discussion on commercial research, where Case E alluded to commercial research being perceived as being money hungry. This is discussed further in Sections 5.2.4 and 5.3.2.4. The above quotation also acknowledges the risk associated with this strategy.

This section has described one of key business activities of portfolio management within the core category business activity facilitation. The next section will discuss the fifth business activity of financial management.
Financial Management

This section discusses the business activity of financial management, the process of attracting investors and raising capital. The development of biotechnology products is an expensive process and few of the businesses appear to have the capacity to take a product all the way to market. In the following quotation, Case E alluded to the amount of investment needed when they were looking at raising capital.

So they [Case E's Venture Capitalist] were raising somewhere between 8 and 10 million dollars. And that was the sort of level of support that we would need to really get the company going (Case E).

The level of support required by Case E was in the magnitude of between AUD$ 8 to 10 million illustrating the level of capital required to develop a biotechnology-based product.

Business image and reputation was previously highlighted as a key element for attracting investors (refer to Reputation Management - Section 5.2.2.2). As Case A suggested in order for the business to become a venture capital target

We needed to put some zest into the company (Case A).

The above quotation suggests the need for businesses to distinguish themselves from other biotechnology businesses in order to become an attractive investment option. A similar comment was also made in terms of attracting collaborative partners, particularly big pharma (refer to Relationship Management - Section 5.2.2.2).

Attracting financing was clearly an important concept. This is indicated by several comments made by the cases

You write a business plan and update it whenever you need money (Case A).

We tend to update it [business plan] pretty regularly because we are looking for venture capital (Case I).

The above quotations also highlight a strong relationship between the business plans and the business' financial strategy. Case I referred to an information memorandum, which puts forward an investment proposition on the level of shares in their business. Strategic planning practices were commonly linked to the business' financial management and investment activities.

The role of finding capital was primarily the role of the CEO, which highlights the high-level strategic nature of this activity

A big part of my job is trying to raise capital (Case H).

Emerging from the analysis was that a key approach to attracting investment within Australia was to go public. Case I alluded to this practice and indicated that it was necessary due to the limited venture capitalist pool in Australia. This is discussed in more detail in Section 5.2.4 as one the limitations of the Australian market. Two cases
referred to the issues involved in small businesses going public (Section 5.2.2.3). Case B particularly stated that their business had floated too early. As Case I stated

> What a lot of biotech companies in Australia tend to do is take an option of public listing to get venture capital. So they either undertake an IPO or back their company with an already listed company. And that happens more regularly in Australia than say it would overseas, for an early stage company (Case I).

One business stood out as having a different investment strategy compared to the other cases. Case C had not sought investor funding. The business had an intentional strategy of not seeking external funding. Case C stated

> And that is my objective to avoid having investor funding where possible because I want to maintain control of the business for as long as possible (Case C).

From Case C the importance of maintaining control was clearly a driver for not seeking external investors.

This section has discussed the fifth business activity of financial management and alluded to its connection to the business activities of relationship management and reputation management. The next section will discuss the final business activity of innovation nurturing.

**Innovation Nurturing**

The final business activity within the core category of business activity facilitation is innovation nurturing, which refers to the process that supports the R&D segment of the business. This category related to the processes that facilitated the effective provision of information to the scientists. In some cases, this involved a supportive technology infrastructure to help facilitate the process (Case E, G and K). Access to scientific information was important for the R&D area of the business (Case A, B, C, F, J and L). Scientific information came in a number of forms and the Internet offered the most common way to access this type of information. Case A referred to accessing research data and conducting literature reviews

> Not a database we have to pay for but we certainly look at our competitors and we also do a lot of literature reviews- journals, analysis of research data (Case A).

The above quotation highlights that despite resource constraints, businesses find strategies for undertaking literature reviews in order to support their R&D activities.

However, Case I did explicitly mention that the management team did not use scientific journals, the participant commented that the researchers, to whom they contract out their R&D, used such information sources

> The researchers working for us may use that, from the business side we don't use it but having said that we still could have access to it (Case I).
The above quotation suggests there may be an absence of *innovation nurturing* within businesses, which outsource their R&D operations\(^{37}\).

More recently, DNA sequences have been made publicly available over the Internet. Case G had adopted an opportunistic strategy and were using the publicly available sequences and applying their own proprietary knowledge to further their R&D.

In Case B, the process for accessing information was not only reliant on email and Internet, but also on the networks their scientists have built up over the years. Although other cases explicitly mentioned the importance of relationships, Case B distinctly mentioned the importance of gaining access to scientific information through their scientists' networks (refer to Reputation Management). Several businesses also noted the importance of having one distinct business location that was an aid in fostering innovation, rather than the business being spread over several separate sites (Case B, E, G-refer to Section 5.2.4).

However, Case E and K moved beyond just ensuring scientists had access to information and had set-up intranet and IT structures to ensure effective communication amongst their scientists. This is explored in more depth in Section 5.3.2.4.

This section has described in detail six business activities that form part of the core category *business activity facilitation* including *relationship management, reputation management, environment management, portfolio management* and *innovation nurturing*. The next section will describe the third core category of *outsourcing* (Section 5.2.2.3), which emerged from the coding process described earlier (Section 5.2.1).  

### 5.2.2.3 Outsourcing

This section describes the third core category of *outsourcing*. Outsourcing in the context of ISS in the twelve Australian biotechnology cases can be considered in three ways. Firstly, there were a group of cases in which outsourcing was a key part of their business strategy and model. Secondly, elements of the management of IT can be outsourced and finally, IS is used to facilitate outsourcing business activities.

**Virtual Business Model**

Cases D, H and I all had a similar business set-up consisting of a management team hub in a coordination role. All business processes were outsourced to various contractors both in Australia and overseas. The business set-up enabled the three cases to effectively operate as a ‘virtual’ company and enabled them to reduce their initial financial outlay. The two quotations below provide some insight into the reason for adopting this type of business approach.

*We were pretty much set-up to be a virtual company, well at least initially. It was just me to start with. And really the concept is that we manage R&D rather than actually do it ourselves necessarily (Case H).* 

\(^{37}\) Limited evidence could be found in Cases D, H and I with respect to this axial code.
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It means that we don’t have to have expensive manufacturing or extensive distribution channels or anything and pass it on to others. It works quite well from a risk perspective in particular and also means we don’t have to gear-up (Case H).

Case I operated in a similar manner and was supported by the research institution’s commercialisation arm.

So the way we work is we have people who are involved in the management team, both myself, my boss and financial director and then there is the R&D side, who are actually employed by the University. We also work with external providers like patent attorneys and lawyers and Incubator B provides some account support (Case I).

Central to this ‘virtual’ business structure was IT. IT formed the backbone of the business model, as highlighted by Case I.

IT has helped to support and facilitate this ‘virtual’ structure (Case D).

IT Management Outsourcing

The second way the core category outsourcing can be considered is with respect to the outsourcing of the management of IT. In Cases D, J and I, IT along with other business operations were outsourced. Cases D and H were in a sharing arrangement in respect of their IT and relied on an external company to help in its management. Case I’s IT was hosted and managed by its incubator. Case B had to relinquish its control and management of the business’ IT to their majority shareholder, which appears to be restrictive.

Traditionally we did it ourselves, we relied on people in-house who had IT knowledge and students and that is how it was done. But now, you can’t put any software onto the computer without it being authorised (Case B).

Several cases also outsourced the management of their IT infrastructure to an external company or to consultants (Cases J and L).

We have a mixed/split of on site and we also outsource. Another thing is, as part of this whole building we share with another company and all the hubs, they look after them all (Case L).

Some cases such as Case A, had internally managed their IT. However, there were some components that were outsourced to an external company. Case A for example outsourced both their website development and hosting to an external company.

We have one person who is the graduate from (University A) who handles all non-Mac affairs - software, hardware, firewall, and programming. We have the founder who programs on his Mac, which he will then have translated into the other language so he can run it on the Microsoft engine. We also use consultants from Company A to develop and host our website (Case A).

Cases E, F, G and K were businesses where their IT was managed and supported in-house. In some circumstances, these cases relied on external expertise for assistance, but all had a dedicated IT manager.
Facilitating Outsourcing

In another capacity, IT appeared to facilitate businesses being able to outsource or contract out some of their operations

Then we seek through email, questions to our due diligence consultants who all respond to us by email (Case A).

The majority you can work out but sometimes you need outside advice or expertise (Case C).

The primary use of IT in an outsourcing arrangement was in the capacity of a communication tool. For example, IT was used for coordinating contractors (Case D). Case D suggested that IT makes their contracting overseas possible. For example, three contractors submitted bids for the next stage of the business’ clinical trials. The bidding process used emails extensively. Case D stated that “it did not matter where the contractors were” (Case D) and this factor allowed them to contract to businesses or individuals overseas.

This section has discussed the emergence of a third core category of outsourcing. The final core category to emerge from the holistic case study was convergence of R&D knowledge and IT (Section 5.2.2.4).

5.2.2.4 Convergence of R&D Knowledge and IT

The final category, which emerged during the selective coding stage, was the convergence of R&D knowledge and IT. The core category of convergence of R&D knowledge and IT represents a combination of proprietary R&D knowledge and technology, which was used by several businesses to enhance their R&D programs. Case G had more recently commenced a drug discovery program including bioinformatics. The business applied and combined its in-house developed data, propriety understanding of key biological processes and the processing power of UNIX with publicly available genetic sequences to move their drug discovery forward. In Case K, the IT manager was developing a database tool, which would enable eight data sources to be linked via a database set-up. The intention of the database was to allow a genetic trait to be tracked over multiple data sources. Case K planned to eventually employ data mining tools. The business was also implementing a barcoding system to enable tracking and linking of data and objects throughout the business. For example, various samples from the one animal would be allocated the same bar code so it could be tracked enabling a particular genetic trait to be traced. Case E developed in-house a computational chemistry program. The CompProg developed by Case E had been demonstrated to be superior to other programs then available and its use was not confined to Case E’s business. Case E had a number of partnerships with other companies which would enable the companies to access Case E’s suite of computer programs.

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38 The emergence of this category was a dilemma to the researcher as it had similarities with other categories including efficiency and product diversification.
39 Pseudonym used.
We have to have some way for sifting through all those possibilities. The way we have done it is through computational chemistry (Case E).

The above quotation highlights the importance of this particular program in assisting in making Case E's R&D process more efficient (refer to Strategic Context - Section 5.2.4).

This section has provided an in-depth discussion of the four core categories of role of IT (Section 5.2.2.1), business activity facilitation (Section 5.2.2.2), outsourcing (Section 5.2.2.3), and convergence of R&D knowledge and IT (Section 5.2.2.4), which emerged through analysing the data from the twelve cases as a meta-case (Section 5.2.1). Relationships within the core categories were discussed and potential relationships between the core categories were alluded to throughout this section. The next section will expand on this discussion on the potential relationships between the core categories and highlight what are considered to be the distinct relationships (Section 5.2.3).

5.2.3 Exploring Relationships Between the Categories

Four core categories emerged from the first part of the coding:
- Role of IT;
- Business Activities Facilitation;
- Outsourcing Strategy; and
- Convergence of R&D Knowledge and IT.

These four core categories, their dimensionalities and potential relationships have been discussed extensively in the previous section (Section 5.2.2). The four core categories provide some insight into the implicit nature of ISS across the twelve biotechnology businesses. The process of selective coding not only seeks to identify core categories, but also whether any linkages exist between those core categories. (Sections 4.6.1.1 and 4.6.2.3).

In the previous sections relationships between axial codes within the core category were described. Furthermore, references to potential relationships between the core categories were also described. However, to explore in detail the relationship of the categories one to the other involved revisiting the open and axial codes, where evidence for any relationships between the categories was sought. Each category appeared to permeate the other three categories. In examining the nature of the relationship between role of IT with the three other categories (business activity facilitation, outsourcing and convergence of R&D knowledge and IT), it was possible to identify the nature of the relation was at times either:
- connecting;
- underpins;
- is a comment of;
- is an integral for;
- provides a mechanism for; or
- facilitates.
There were many levels and ways of examining the role of IT. Several distinguishing relationships between the category role of IT and the other three core categories include (refer to Figure 5-1).

**Figure 5-1 Central Core Category Role of IT in Relation to the Other Three Emergent Core Categories.**

- **Facilitator** - Primarily the role of IT within the businesses appeared to be one of facilitation. In this capacity, it demonstrates a strong relationship with the business activity facilitation. IT, particularly the Internet and email, were tools which provided access to information and enabled communication within the businesses.

  We are technology driven but we are mostly information driven. The technology just leads to the information (Case E).

- **Enabler** - Cases D, H and I identified that IT enabled their businesses to operate as 'virtual' businesses.

  IT has really enabled us to do this (Case H).

- **Driver** - Finally in several cases (Case E, G, K), IT was a driver behind their drug discovery programs. In Case E, IT was in fact a driver behind their R&D program.

  So having built around in-house discovery programs and then having applied the technology to that, we have a tool there that people with similar discovery programs themselves can utilise (and) that is something which we can offer at a profit (Case E).

Similarly, the categories of outsourcing, business activity facilitation, convergence of R&D knowledge and IT also permeated the other core categories, but the incidences of permeation were not as noticeable or were less when compared to the role of IT. However, distinctive relationships with the other three categories emerged. These relationships include:

- outsourcing business activities;
- in-sourcing strategy; and
- public available DNA data driver.
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- **Outsourcing business activities** - Each of the business in some capacity had outsourced various aspects of the businesses activities

  I use a variety of external organisations for a variety of different things. For example, some of the analytical methods that are required to establish certain aspects of quality, I can't do here. I just do not have the equipment nor the time to be able to do it. The easiest thing is to send a sample out to Company Y who does the test for 100-bucks (Case C).

- **In-sourcing strategy** - Evidence was found which appeared to refute the existence between an outsourcing Strategy and the convergence of R&D knowledge and IT. There were three instances that alluded to the business having a largely in-house strategy

  We don't do as much of the consultancy type stuff as other groups do. We internalised ours as part of the process. It is an expensive strategy but then again it adds to the overall strength of the teams. People often double, they will often have strengths in two areas (Case E).

  We built them the computers and all that kind of thing, and they in turn built a computational platform, that we have tested against other systems, which is second to none as well (Case E).

Similarly Case K, also has a predominantly in-house strategy, only seeking advice externally when it would take more than two hours of reading a book to fix the problem himself.

- **Publicly Available DNA Data Driver** - A minor reference was found between business activity facilitation and convergence of R&D knowledge and IT, whereby Case G's bioinformatics section was in fact a combination of IT and proprietary scientific knowledge combined with DNA sequences, all of which are currently publicly available.

  In this respect, role of IT emerged as a central core category. Through combining the relationship diagrams above, a descriptive model of these relationships was constructed, linking the factors that influence the implicit nature of ISS in Australian biotechnology KSMEs (Figure 5-2).
The diagram presents the core categories and the relationship between the four core categories, which appear to be distinctive in terms of ISS within the twelve cases.

This section has built on the discussion of the four core categories in Section 5.2.2 and sought to explore relationships between the core categories. The process of selective coding not only seeks to identify core categories, it also seeks to identify whether any linkages exist between the core categories. However, at this stage selective coding was still not complete. It was identified in Section 5.2.1, that there were a number of axial codes, which appeared to have a lower level of prioritisation with respect to ISS in Australian biotechnology KSMEs. The next section will revisit these axial codes and reflect on the relationship with the core categories (Section 5.2.4).

5.2.4 Describing the Context

One of the distinguishing features of case study research in exploring a contemporary phenomenon is its real life context (Yin, 1994; Scheepers and Scheepers, 2003). To this point, the analysis has focused specifically on revealing the nature of the phenomenon. The previous section of selective coding had only utilised 9 of the 20 categories, which emerged from the axial coding process (Section 5.2.1). The codes had been selected on the basis of their direct connection to the nature of ISS. The
remaining 11 categories, which appeared to have a lower level of prioritisation with respect to the nature of ISS, were recorded in the analytical note as described previously. These codes included:

- Organisational Set-up
- Product Diversification
- Efficiency
- Dichotomy of Science and business
- Niche/Novelty
- Internationalisation
- Commercial Orientation
- Australian Limitations
- Regulatory Barriers
- Investment Community Limitations
- Nature of Biotech

It is important that these aspects of the overall context are not ignored. Although the remaining 11 axial codes did not appear to have direct relevance at a higher level, the axial codes emerged from a broad question frame, which sought to explore ISS at various analytical levels, and thus from the participants’ perspective were relevant and important in their context. It was anticipated that these contextual features and their significance in the context of ISS within individual cases would emerge through a finer level of analysis (Sections 4.6.2.1, 4.6.2.2 and 5.3.1).

This section describes the process of both categorising the remaining axial codes, relating them to the core categories and the relationships described in the previous two sections (Sections 5.2.2 and 5.2.3). In Section 5.2.3.5, the four contexts discussed in this section are combined and integrated with the findings of the Section 5.2.2 and 5.2.3 to develop a descriptive model of Stage One of data analysis.

The axial codes could be broadly categorised into four contexts which may directly and indirectly have an influence on the nature of ISS with the twelve Australia biotechnology SME cases. The four contexts are:

- Strategic Context;
- Business Context;
- R&D Context; and
- Environmental Context.

This section will briefly describe the nature of the four contexts. It was anticipated that their relationships and influence in the nature of ISS within the twelve cases were likely to be revealed through analysis at the case level (Section 4.6.2.1, 4.6.2.2 and 5.3.1).

**Strategic Context**

From the outset, the businesses demonstrated strategic intent which was evident in that all cases had an explicit strategic/business plan. The broad categorisation of 'strategic context' is used to encapsulate the four business strategies, which emerged from the analysis including: niche/novelty, product diversification, efficiency and internationalisation.
Niche/Novelty

One of the key strategies, which all businesses strived to achieve, was finding their niche within the biotechnology sector or in developing a novel product. Novelty was considered a prerequisite of success in the biotechnology industry. The previous section highlighted the importance of patents to the businesses. Niche/novelty in this market provides considerable advantage to a biotechnology firm, for once the business has been granted a patent, it has exclusive rights to use of that knowledge and to develop the required technology. The experience of Case B best illustrates the impact and influence one business’ ownership of a particular patent can have on the industry and competitors. About 15 years ago, Case B were first to patent in a particular area. This had a dramatic impact on their competitor, Dutch Company A

It essentially meant that any competitors would find it that much harder to be involved in the area, therefore funding in the area declined for them [Dutch Company A]. Therefore that is why the company Dutch Company A was up for sale and was cheap (Case B).

Case B had exclusive rights by patent to the particular technology, which effectively blocked the R&D efforts of Case B’s competitors and enabled Case B to purchase Dutch Company A. This gave Case B a distinct competitive advantage

Our patents are still in place and they still have another 10 years on them so that gives us an edge there (Case B).

This suggests that novelty can be applied in a way to influence the industry, which is an exemplar of industry analysis.

Finding their business’ niche, in the international market place, was also a key strategy for Case C

All these companies that use this type of product overseas are generally looking for a disease free raw materials source if you like. So that is where we differentiate ourselves. On many, many occasions, I could have quite easily got product into various countries and matched the existing prices that are available. But I elected not to do that. My price is higher than those of competitors in many quarters. And I have elected not to try and compete with them because we are different (Case C).

The above example highlights the intentional strategy of Case C of finding a niche area for its product development rather than competing on price alone.

Efficiency

The second element of the strategic context is efficiency. Biotechnology product development is an expensive process (refer to Environment Context). To reduce the cost of developing a product, the cases sought to increase the efficiency of the product development process. This involved reducing the time to commercialise a product or focusing on products that were likely to obtain regulatory approval more easily (refer to Environment Context). Some examples include the development of a drug development process, CompProg (Case E), bioinformatics (Case G) and data source integration (Case J).
Internationalisation

As a result of operating within the international market place (refer to Environment Context) all businesses were involved in some form of overseas collaboration (refer to Relationship Management - Section 5.2.2.2). Case H, for example stated

We pretty much are an international company. I think anyone in biotech and anyone in biotech in Australia has to look at the world as its market place (Case H).

The above example highlights Case H’s perception that Australian businesses need to market themselves internationally. Furthermore, Case H also suggested that it is not only Australian biotechnology businesses that needed to look internationally but all biotechnology businesses due to the international nature of the marketplace. As Australia’s local market was considered limited, the twelve cases sought to market and distribute their product overseas. Case C described his business’ marketing strategy as

Predominantly overseas, that is where the benefits are. The reason being is that Australia is a small user of these types of materials in comparison to the rest of the world (Case C).

The most common method of gaining access to overseas markets was through collaborations, such as alliances or joint ventures (refer to Relationship Management - Section 5.2.2.2). For example, Case H had set-up an alliance with a software company in the US to distribute one of their products. Several cases had set-up an office or employed a person to work in the United States (Cases B and F).

Case B was unique in that it had bought a business to provide access to one of their biggest markets in Europe. The company purchased was Case B’s competitor, which had struggled and failed after Case B had been granted a key patent

And we bought them because they had some intellectual property and they were located in Europe and Europe is the biggest flower market in the world (Case B).

Product Diversification

Evident among all cases was the strategy of ‘product diversification’, which was one approach to managing and reducing risk. If a clinical trial fails for one product, the business has another product upon which they may rely, essentially ensuring that “not all their eggs are in the one basket”

Few diagnostic companies become multi-billion dollar companies nor do they attract much venture capital money with just diagnostics. So we decided to add drugs (Case A).

The above excerpt from Case A also highlights that a business with one product option does not make an attractive investment.

Product diversification can also take a number of forms such as discovering multiple applications for the one product. Case D worked in a joint venture with an overseas
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company to develop a veterinary drug from one of Case D’s human drugs. Case D stated

Often when drugs are a failure in humans, they can be still used in animals (Case D).

The drug in this instance could be produced at a low cost, which was particularly attractive in veterinary applications. Similarly, Case I had also looked for multiple uses for their product including medical, industrial and environmental applications.

This section has discussed at a high-level the nature of the strategic context. The next section will briefly discuss elements of the business context.

**Business Context**

The business context comprises those axial codes that emerged from the coding process and which were related specifically to business characteristics. A number of business activities as well as information were encapsulated within the core category *business activity facilitation* (Section 5.2.2.2).

**Organisational Set-up**

The axial code organisational set-up refers to business characteristics and their overall influence on business activities and can be broadly listed as the:

- Physical Structure;
- Management Team; and
- Small Business Constraints.

**Physical Structure**

Physical structure refers to the set-up of a business. Several cases referred to originally being set-up in a distributed setting but that they had recently moved their various business operations to a single location. The relocation of the business to one centre appeared to be related to business development. Case E and G both referred to being set-up originally in a distributed organisational manner.

As was highlighted in reference to *relationship management* (Section 5.2.2.2) both Case E and G alluded to the result that their more centralised structure had improved business communication and relationships, particularly between scientists and the management team.

**Distributed Structure**

Case K had a unique structure having part of its business located in the US with a link between the two offices. Similarly Case F had an office in the US, which was connected to the main business via VPN (Virtual Private Network). Case J referred to continuing with a decentralised structure, which was problematic when colleagues needed to share. Case B’s main shareholder was also located away from the main business activities, which became problematic from a business sense.
Virtual Business Model

Case D was located in a position where it shared its building and infrastructure with two other start-up companies. Case I was located in an incubator whilst Case H was provided with office space by its majority shareholder.

Management Team

The management team set-up is important to the businesses both for establishing relationships and also from a credibility perspective to assist in attracting investors (Section 5.2.2.2). There were variations in the management team structures but common to all businesses was the presence of a scientific advisory board in the management team.

In Case A, for example, the original founder had relinquished his position as the CEO of the business and taken the position of R&D Manager. Similarly, Case E's management team set-up was similar, where the founder was both the Chief Scientific Officer as well as sharing the 'co-CEO' role with the venture capital partner.

What actually happened is that they see huge value here in Case E, Jim\(^ {40} \) has become part of the management team indeed the CEO, co-CEO of the company (Case E)\(^ {41} \).

Cases F and B were public companies and thus had a management board. Case B in particular referred to the important role the board has played.

I think in a business sense the board had a major influence. We got a Chairman who was on the Board of Large Business A and had business experience. Scientifically, we have over different periods developed a scientific advisory board. We began by trying to put together eminent international scientists, that worked at different levels at different times (Case B).

Similarly, the above quotation provides insights into the strategy adopted by Case B for establishing its scientific advisory board while Cases D, H and I had persons with business management experience on their boards.

Small Business Constraints

Due to size and limited resources, several businesses made reference to the constraints and issues their business faced. The constraints included human resources, time and financial restrictions. However, business constraints were identified by several businesses as being an advantage, where the small number of employees in the business necessitated the need for employees to be multi-skilled.

Financial Constraints

Financial constraints were explicitly mentioned on a number of occasions. The cost of product development was considered in many instances to be prohibitive. Financial

\(^ {40} \) Pseudonym used
\(^ {41} \) Jim is the co-CEO and venture capitalist partner of Case E.
constraints also influenced a business' access to information (Case A). Limited financial resources influenced where a business decided to patent, and ultimately market and distribute product. Case H provided the example where financial constraints had resulted in a decision not to patent or ultimately market a product in Japan (refer to Portfolio Management).

**Time Constraints**

Time constraints were also mentioned as placing restrictions on business operations. For example, Case C referred to the use of external contractors when he does not have the equipment to undertake a certain course of action or when he does not have the time available for the work involved

> I just do not have the equipment nor the time to be able to do it (Case C).

**HR Constraints**

The constraints of being a small business were mentioned on several occasions in relation to the implications for HR. The businesses often did not have the skills or experience in-house and therefore looked outside the business confines (refer to Outsourcing) to access a particular skill.

Several cases referred to both the necessity and the ability to have employees who were multi-skilled. In Case A, this axial code was described through the willingness of employees to be able to focus on a number of operational tasks such as ‘stuffing envelopes’ and to use this factor as a strategy for overcoming this particular type of business constraint

> And the things with a small company you need to be willing to stuff envelopes as well as deal with investors (Case A).

Case E, however, identified that having multi-skilled employees was both a strength as well as a necessity. This is evident in the following quotation in which the use of the word ‘have to’ appears to imply that in small business it is a necessity for employees to be multi-skilled and the use of the phrase ‘multi-talented’ appeared to place focus on that skill being a positive attribute to the business.

> People often double-up, they will often have strengths in two areas. Even if we are not full bottle on one particular aspect can help out in another. Small companies like ours you have to be multi-talented (Case E).

This aspect also appears to have a relationship with the subsequent axial code of business flexibility.

**Business Flexibility**

Finally, flexibility was referred to explicitly as an advantage that small businesses have over large businesses. Through his own experience working for a large company, Case B referred to the differences that exist between large and small companies
Well I have worked for a big company - that there is big differences. That is one thing that is nice about here, it is very flexible and you have limited resources, you have got to find ways to get to the same end (Case B).

The above quotation infers that in order to be competitive, small businesses need to reach the same end point as their larger counterparts. It is the flexibility of a small business that enables it to achieve this end despite resource constraints. Flexibility in this context refers to the ability of a business to change its strategic focus, adapt or readily respond to environmental changes. The point is also emphasised by Case E, who highlighted that small businesses are able to change their strategic focus much more quickly than large businesses. Case E noted that

Bigger companies have cash, facilities, bulk, and people and in some senses that is equally their downside as well. The have bulk, and they are a dinosaur and it takes a long time to turn around. We can, at a drop of hat, decide for these next three months that this will be our key program. And we can make that decision in an afternoon as we have done so in the past (Case E).

We can ultimately get to the same point or a better point than those guys can and much more quickly because we they have this inertia because of this process (Case E).

The above examples indicate that while the advantages of large pharmaceutical businesses is that they have the necessary resources, they do not have because of their size, the flexibility to change their strategic focus as readily as small businesses.

R&D Context

The third context of R&D Context encapsulates the axial codes of commercial orientation and the dichotomy between science and business.

Commercial Orientation

The axial code of commercial orientation is the requirement that all R&D must be focused on commercial outcomes. Case E, for example, discussed the difference between academic and commercial research

Really academia is a wonderful thing but it is quite an introverted activity and it needs to be because you need to focus and so forth. Commercial research is very different. There has to be a product at the end of it otherwise you are dead (Case E).

The above excerpt emphasises the importance of commercial research focused on outcomes and acknowledging that the business' success or survival is very much dependent on whether a product results from the R&D. As Case G described their R&D activities are “science driven by business requirements”. Similarly, Case B described the interrelationship between their R&D plans, commercial plans and their business plans

So the R&D plans, which were always fairly well thought out, are then meshed with commercial plans and business plans (Case B).
Similarly, Case K also discussed the differences between academic work and commercial research, where in an academic environment, scientists often have the ‘freedom to pursue’ (Case K). As Case K articulated

In our environment, you have to focus on things which are useful (Case K).

The above excerpt from Case K highlights that commercial research cannot be esoteric and it is imperative that it is focused on a commercially realisable outcome.

**Dichotomy between Science and Business**

Prominent in most cases, was the divide between R&D and business operations. Differences in relation to science and business included cultural differences, knowledge differences and business set-up although threads of the dichotomy came across in all cases and will touched upon here. However, this axial code in fact emerged in three specific cases Case R, G and K, and is discussed in more depth in Section 5.3.2.4.

**Cultural Differences**

The management and science side of the businesses differ not only in the manner in which they operate but also in what motivates them. Case E in particular discussed this in detail (Section 5.2.4). However, Case B also indicated that the need for scientists to publish articles and findings to gain and maintain their credibility has changed

The argument used to be that scientists were motivated by publishing (Case B).

**Knowledge Differences**

Secondly, there were differences between business processes and the science process with respect to knowledge and the requirements of those knowledge categories. For the most part, the two categories appear to operate independently, with the CEO or R&D Manager acting as an intermediary between the two knowledge-categories (refer to Case E- Section 5.2.4).

The R&D knowledge category encapsulates knowledge relating to R&D activities. In some cases, such as Case E, the business was structured into four major groups, based around disciplinary areas, including medicinal chemistry, computational chemistry, structural biology and target validation. Each group operated with a certain level of autonomy and was headed by internationally renowned scientists. Specific information sources included scientific journals.

A second knowledge category was identified, which encapsulates business-related knowledge including aspects relating business planning, general management and financing etc. However, many of the knowledge sources within this category are

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42 This axial code emerges in Stage Two in the Group 2 cases and will be discussed in more detail here (Section 5.3.2.4)
directed at accessing knowledge about competitors and creating and formulating business plans.

Patent management, in particular, the writing of patents appeared to be one activity, which required input from both management and the R&D segments of the business. As Case E described, the CEO tended to write the patent but required input from patent attorneys. However, the CEO also required scientific inputs for chemistry patents. Chemistry patents required the involvement of the chemists, as the patent application must include an in-depth knowledge of the innovation being patented as well as the potential commercialisation area.

Chemistry patents are really quite intricate documents. You are trying to weave a web around a certain chemistry space. It is really quite a delicate web that you are trying to draw up in the claims and by far the best person to do that is our chemist. He understands the entire process (Case E).

The CEO tended to write more of the potential medical implications and commercialisation potential of the patent, which he described as the “fluffy stuff”.

**Business Set-up**

Structural differences are evident, where the R&D segment of the business, such as the laboratories, are located away from the management team. Cases E, F, G, and J all referred to being set-up in this manner at one point in their business' operational life. Case G referred to their scientists being detached from the management side of the business. This even went down to where there was a demarcation between Macintosh and PC use in the business (Cases A, B, E, F, G, J, K and L). For example, Case J described:

> The office people need more of what's available on PCs, like Access database, that just doesn't exist on a Mac... but then Macs have stuff that PCs don't and they are great for research purposes. Yes more for the R&D side. They have got packages with graphics that are so much better than anything on the PC (Case J).

The above quotation highlights the system differences and their distinct use within the businesses.

This section has discussed the R&D context drawing particularly on the differences between R&D and the business operations. The next section will discuss the broader environmental context in which the businesses operate.

**Environmental Context**

The final group of axial codes relate to the environmental context, encapsulates the axial codes that emerged from the coding process and which were external to but had the potential to impact upon the business. The impact of the environmental factors has been alluded to in various business activities and strategies adopted by the cases.
Nature of Biotech

Developing a biotechnology-based product is a risky and expensive process, where product development times ranged from twelve to fifteen years. The main impact this factor appeared to have on the businesses was on their ability to attract funding. For example

So if you are investor and you are seeding the future now, your horizon is never going to be 12 to 15 years because it is too long into the future (Case E).

Case E suggested that there are few investors that are prepared to invest long term in biotechnology products. As a result, there tends to be limited investment opportunities for biotechnology businesses in Australia. Case B suggested that the main problem is that investors are not realistic about the timeframe associated with developing a biotech-related product

Now I think a lot of people are unrealistic on how long these things take (Case B).

Several cases (Cases E and I) identified that they have actively sought to reduce the time to market through increasing the efficiency of their R&D process or through focusing on application areas, where regulatory approval times are shorter (refer to Efficiency and Regulatory Barriers).

Regulatory Barriers

The introduction of a new drug or product onto the market requires regulatory approval to be sought in every country where the product is intended to be marketed and/or distributed. Gaining regulatory approval was both a costly and time-consuming process. For example, Case H indicated that for their business there were number of opportunities in Europe and that they had progressed through a long process in seeking access to these potential opportunities

There are plenty of opportunities for us in Europe and we have been trying for a while, it just takes time (Case H).

The issue that businesses face is that the regulatory process is both a costly and laborious task. Case L described the process

Each [country] has different regulatory requirements, have their own regulations, have their own methods, their own way of measuring things. And we have to meet these requirements (Case L).

The cost of going through the regulatory process is prohibitive for many businesses and results in focusing their marketing and distribution strategies on the key markets in the USA and Europe. The GMO moratoriums in Europe and Tasmania were explicitly mentioned as directly impacting business operations (Case B).

Regulatory restrictions also influence the focus and priorities of a business’ product development strategy. Case I’s product has several applications, however, the business had chosen to focus more on developing the product’s potential industrial
applications for “medical applications have significant regulatory timeframes” (Case I). Similarly, Case E’s product development strategy was focused around cancer applications. For drugs that are aimed at curing or treating terminal diseases, such as cancer, “the bar is quite low for our molecule, because it is kill or cure with some of these diseases” (Case E). As a consequence, the regulatory approval process is much shorter compared with conventional drugs. This focus enables a business to move a product to market more quickly. The main advantage is that the business is then able to obtain return on its investment “that is why we really focused on cancer initially” (Case E). This highlights a relationship between the businesses product development strategy, as well as efficiency in their R&D development.

Australian Limitations

Australian Limitations refers to those characteristics, which were exclusive to the Australian marketplace. Four main concerns emerged including:

- tyranny of distance;
- small market;
- lack of critical mass; and
- nature of Australian investors

The ‘tyranny of distance’ was repeatedly mentioned as a hurdle for the twelve Australian biotechnology businesses. Australian businesses perceived themselves as isolated from their major markets in North America and Europe. Distance becomes a significant hurdle when a business seeks to access financing, alliance partners, customers and markets.

There is a mixture of the fact that you are a long way away trying to deal with them (Case H).

The tyranny of distance for Case L has proven a problem - “our main problem is distance” (Case L). Although Case I had not experienced this problem, the participant did identify it as being a potential issue in the future.

I think being separated from the market you are eventually going to sell to is an issue (Case I).

When the issue of ‘tyranny of distance’ is combined with other characteristics, such as the risk-averse nature of the Australian investment community and American investors seeking to invest at home, the combination forms a formidable barrier to Australian biotechnology businesses. Case E identified that it can be related to the level of control.

Not only do you have to be good but you have to be better because you are further away. Distance is inversely proportional to the cube root of control. The closer they are the harder they can kick the tyres and the more control over you they have (Case E).

The above excerpt from Case E also describes the issue of distance of being related to control.
The small size of the Australian business community also has a number of implications for the biotechnology businesses in terms of limited opportunities to access venture capital, a limited number of partnering opportunities and limited expertise.

One of the main issues is that we don't have an established pharmaceutical or biotechnology industry here. So there is not really a catchment for management expertise and for forming partnerships with those bigger companies. (Case I).

There are a number of perceptions. English speaking we can understand what you are taking about easily, long way away. Probably quite backward, probably just ignorant peasants, but it was the same in the United States. If you couldn't phone them up or if you weren't next door, it was some sort of barrier (Case B).

The final barrier consistently mentioned was the Australian investment community with reference to the limited number of investors (Case I) as well as their risk adverse nature. For example, Case I observed:

The Australian market is really not that large because there are not many people actively investing in the biotech arena. And once you know who they are, it's not a long list (Case I).

Two cases commented on the risk adverse mindset of the Australian investor, suggesting that they were willing to take risks in other areas but not in biotech innovation.

Australia is a very funny place in terms of taking risk. I think we don't mind putting money on horses for example but not on our own innovation. It is funny. So that was a problem (Case B).

It is certainly not like the US where there is a massive mindset where risk is good and valued (Case E).

Case E further explained the comment on the Australian investor mindset and their lack of willingness to take risks with respect to biotechnology products:

I think it is the time line that is the problem. I mean you dig the hole, you find the gold or you don't find the gold. It usually happens in 12 months or you put the money on the grey nag at 3:30 pm at Doncaster or something. By four o'clock you know the result. You know if you have succeeded or failed quickly. With Biotech, it takes a long, long time (Case E).

The more ambitious cases acknowledged the importance of educating investors in the biotechnology product development process.

Investors have been a much more difficult education process (Case E).

Albeit what you have in the future is massively profitable the pharmaceutical scheme even limited over here in Australia or in Europe is still massively profitable. What we have had to do is train investors that there is value chain and each point on the value chain, representing a milestone, has an incremental value (Case E).
Chapter Five - Data Analysis

The education of investors involved conceptualising the product development process as a value chain, where each milestone along the value chain represents an incremental increase in the value of returns.

The issue of limited investment opportunities in Australia required most cases to look overseas for investment and partnering options. Several businesses including Case I, E and B referred to pursuing overseas investment in the US, where all the money is, or where a lot of it is, they would still rather invest in their own country. They just think we can't do it and for all sorts of reasons (Case B).

Another key approach is Australian companies listing on the stock exchange, much earlier than in other countries in order to raise capital.

**Investment Community Limitations**

The nature of the investment community and the economic environment influenced the ability of the businesses to obtain financing and their overall financial strategy. Although in the above section some specifics with respect to investment limitations were discussed in respect of the Australian marketplace, the matter was also a broader issue for the biotechnology industry. As Case E described

> At the top of the list with daylight between that and the second one is financing (Case E).

The above quotation indicates that finance was considered one of the main challenges facing the businesses.

In recent years, biotechnology has acquired a negative image as a result of the recent downturn in the biotechnology market and stocks. This issue was raised in Cases B, E and H. As Case H described

> The market is really good at responding to negative news (Case H).

Case H referred to the direct influence that recent negative news had in relation to the biotechnology industry and its effect on their ability to raise capital

> I've seen cases where biotechs came out with a negative trial result and the market has just crashed. It didn't help us with our capital raising last year, which is partially due to the fact that there is a negative attitude towards biotech, the lack of returns but also because the stocks were so cheap on the stock exchange, people were still favouring putting money into public rather than private equity so that did affect us (Case H).

Many cases sought overseas investment. The Australian market was considered too small and it was perceived that there were more opportunities in North America and Europe. However, a commonly cited issue with US investors was they tended to invest at home and this was a problem for Australian businesses

> There tends to be an 'invest at home' mentality- in particular in the US (Case I).
The fact that we are not American... what is international to them is what is on the coast of Hawaii (Case H)

In the US, where all the money is, or where a lot of it is, they would still rather invest in their own country (Case B)

We have spoken to a few groups overseas in Europe, Germany, and also in the US but it tends to be, especially in the last couple of years, that people don't like to invest too far away from their comfort zone. There are a lot of US Venture Capital providers that just don't invest outside the US. People like to talk to the people they are giving money to and keep an eye on them (Case I)

The above quotations highlight the challenges facing Australian businesses that seek overseas investment and a number of the difficulties they face including that relating to control.

This section has categorised the remaining axial codes, which appeared to have a lower level of prioritisation in respect to ISS into four broad contexts. It was anticipated a finer level of analysis would reveal the relationship and importance of these contextual features on ISS at the case level. The next stage draws on the four broad contexts and the core categories to develop a high-level descriptive model of ISS across the twelve cases.

5.2.5 Development of a Descriptive Model

The four contexts discussed in Section 5.2.4 can be graphically represented in Figure 5-3. The dashed line of each of the contexts suggests that categories found in one context are not restricted to that context and in fact permeate and/or are related to axial codes in other contexts. For example the axial codes of Australian limitations, nature of biotech and regulatory barriers did not necessarily impact on ISS they can influence factors in the R&D, business context as well as the strategic context. Due to Australian market limitations (Environmental Context) such as a lack of venture capital and the tyranny of distance, several cases had sought to market internationally (Strategic context) through collaborations (relationship management).
Figure 5-3 A Graphical Representation of the Four Emergent Contexts
Utilising the context diagram above (refer to Figure 5-3), the four core categories were mapped onto the diagram above (refer to Figure 5-4). This was achieved by reflecting on the contextual axial codes, their nature and the relative association with the four emergent core categories. For example, the core category outsourcing tended to be discussed as a strategy and thus was considered to be closely associated with the context - strategic context. A descriptive model of the four contexts and the various influences of the core categories was constructed. ISS in the business context was influenced by business activity facilitation, the R&D context was influenced was by the convergence of R&D knowledge and IT and strategic context was influenced by the outsourcing strategy. The core category of role of IT, which had strong relationships with the three other core categories, was mapped in the diagram. This suggests that the role of IT in the business context is largely facilitatory, in the strategic context IT can be an enabler and R&D context can be a driver. The descriptive model is drawn upon in Stage Two, to ascertain whether it is a good representation of the focus of ISS within all the cases, some or none of the cases.

The descriptive model represents a high-level representation of ISS among the twelve cases and makes reference that there appears to be contextual factors that may be associated with ISS among these twelve cases. However, which contextual factors appear to play more of a role in the nature of ISS was not revealed through this high-level analysis process and pointed to the need for further, more detailed analysis.

**Figure 5-4** A High-Level Descriptive Model of ISS Among the Twelve Cases
5.2.6 Summary of Reflections of Stage One of Data Analysis

At the conclusion of Stage One, critical reflection was reintroduced as a process for validating the research methodology in a complex research domain (Sections 4.2.1 and 4.5.2.3). Through the process of reflection-in-action and on-action, the researcher reflected on the phenomenon. At the end of Stage One, some high-level conceptual insights concerning the two research questions emerged. These insights include:

- implicit nature of ISS (Section 5.2.1);
- central role of information technology (Section 5.2.3);
- the emergence of R&D context (Section 5.2.4); and
- permeable firm boundary (Sections 5.2.2.2 and 5.2.4).

These insights are discussed and interpreted in the next chapter (refer to Chapter 6). The divergence of these findings and the descriptive model (refer to Figure 5-4) from the heuristic tool presented in Section 2.14, suggested the heuristic tool had not influenced the preliminary findings.

In the research methodology chapter (Section 4.6.2), the limitation of a holistic case study approach was identified. This level of analysis would not reveal the particular focus or attributes of the individual case. At various stages throughout this process, some case-specific idiosyncrasies emerged. As the subtleties emerged, they were noted in an analytical memo as being able to be integrated into the second stage of data analysis. As was suggested rich and deeper insights required an examination of the descriptive model and its relationship to particular elements of individual cases.
5.3 Data Analysis - Stage Two

At the conclusion of Stage One, a descriptive model had emerged from the data that captured key high-level elements of the nature of ISS across the twelve Australian biotechnology KSMEs investigated and alluded to the potential role of contextual factors (Section 5.2.6). However, Stage One revealed only part of the story and did not reveal where individual cases fitted in relation to the core categories. Furthermore, it did not reveal how other factors may influence the position of the firm with respect to the core categories. In essence, this suggested that the previous stage of analysis failed to reveal how individual cases engaged in ISS, differences in ISS or factors that effect ISS within the individual case. The research strategy identified and articulated the need for a second stage of analysis for addressing this shortcoming (Sections 4.6.2 and 4.6.2.4).

One of the main reasons for selecting a case study approach is the explicit acknowledgement that context plays an important role in the nature of the phenomenon (Section 4.4.3.1). Stage Two provides a process through which to explore the peculiarities of each case and to investigate what role they may have on the nature of ISS within the particular case setting in order to address research question two:

Research Question 2

What factors need to be considered in a model for ISS in the Australian biotechnology KSME context?

Cases are of interest both for their uniqueness and their commonalities (Stake, 1995; Ayres et al., 2003) and the purpose of this stage of analysis was to explore, compare and contrast characteristics across the twelve cases.

This section discusses in detail Stage Two of data analysis, which seeks to explore the current nature of ISS both within cases and relationships between cases. Section 5.3.1 describes the analysis process for exploring the nature of ISS at the case level. Section 5.3.2 compares semantic relationships both within and between cases. Comparing the cases enabled commonalities to be explored and reflected on in particular their significance. Commonalities increase the explanatory power of the categories that emerged. Emergent from this process were five firm types. Section 5.3.3 reflects on the five firm types and the emergence of a fifth core category of strategic alignment and presents a descriptive model. Section 5.3.4 provides a summary reflection of Stage Two of data analysis.

5.3.1 Stage Two - Part A - Case Level Analysis

The first part of Stage Two involved investigating whether any differences were present in the nature of ISS among the twelve cases. To determine whether there were differences between cases, the open codes assigned to each case transcript were revisited (Section 4.6.2.4). The nuances within the open codes of the individual cases
were anticipated to provide an insight into the position of the firm in relation to the core categories. This was likely to occur in two ways:

1. nuance inflections in particular open codes, which in the process of abstraction to the core category level in Stage One, have not been examined in more detail. For example, outsourcing in Case H referred to all business activities including their R&D, whereas outsourcing in Case J referred to IT outsourcing; and

2. revealed through the relationship within the cases and between the open codes. For example, the codes outsourcing and virtual business model were closely associated.

By exploring the nature of the core categories at the individual case level, it was anticipated that the researcher would be able to identify the focus of each case as well as reflect on whether the descriptive model, (emergent from Stage One) was appropriate for all twelve cases (Section 4.6.2.4).

Using the open codes, which were assigned to each case transcript in Stage One (Section 5.2.1), each case was individually examined exploring the nature of the core categories within the individual case setting (Section 4.6.2.4). The dimensions of the categories within each case provided insight into the nature of ISS within the particular case setting. Summary tables for each case were constructed and Appendix F contains exemplar summary tables for Cases A (Group 1), E (Group 3) and H (Group 2), which are representative of the summary tables constructed for each of the twelve cases.

The process was repeated for all twelve cases, where it was evident that there was some variation in the cases in terms of the nature of the four categories, which emerged in Stage One (Section 5.2.2). In order to illustrate these differences and similarities, a matrix was constructed which enabled the researcher to identify the similarities and differences in respect of the four categories (refer to Table 5-2).

There was evidence to suggest, as one might suspect, that there was variation among the twelve cases with respect to the core categories, which emerged from Stage One. The twelve cases could be classified into three high-level groups based on commonalities and differences in the nature and dimensionality of the four categories, which emerged from Stage One Data Analysis, within the individual case setting. A distinguishing feature of each group was the role of IT with respect to each of the core categories. Common across all twelve cases was the role of IT as a facilitator in business activity facilitation. Although outsourcing was to some extent in all cases, in Group 2 cases all business activities appeared to be outsourced and common to these cases was open code ‘virtual’ which linked their business model to their outsourcing strategy. The core category convergence of R&D knowledge and IT appeared to be particular to Group 3 cases. There were also some variances in the nature of certain aspects of business activity facilitation. For example, the axial code innovation nurturing in Group 1 had a predominantly information access component flavour. In Group 2, the same core category revealed the presence of an information system, which integrated their R&D, nurturing their knowledge creation processes. However, in Group 3 there was a distinct absence of the axial code innovation nurturing.
Through differences in the conceptualisation of the Stage One core categories, it was evident that variation existed within the cases in respect of the nature of ISS. At this point, the researcher adopted reflection-in-action (Section 4.2.1) to critically evaluate whether the selection process may have influenced the emergence of these three groups. Utilising the descriptive table (Section 4.6.2.1 and Appendix E), the reflection process revealed the selection of participants appeared to have little influence on the emergence of these three groups. This suggested that there appeared to be other factors underlying these groupings, which would require further investigation.

Table 5-2 highlights the anticipated variation among the individual cases in relation to the Stage One core categories. However, the table does not show the semantic relationships within each core category i.e. there is no explanation of the factors of the position of each case. The next part of this analysis seeks to discover those factors between the cases that influence their positions.
Table 5-2  A Matrix Of Core Categories and their Emergence within Each Case

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Group 1

Group 2

Group 3

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Having shown that there are indeed differences, it was then necessary to examine in the detail the nature of the differences and answer the second research question:

**Research Question 2**
What factors need to be considered in a model for ISS in the Australian biotechnology KSME context?

The cases make different contributions to the core categories. At the case level, context becomes more apparent (Section 4.6.2 and 4.6.2.4). In order to capture the individual case experience, the researcher returned to and analysed each individual case transcript (Section 4.6.2.4).

The open codes, which were assigned to each case transcript in Stage One (refer to Section 5.2.1), were revisited and the axial coding process that was applied in Stage One was now applied to the open codes at the case level. The axial codes that emerged were compared and contrasted, in order to explore the semantic relationships both with and across the individual cases. This process of axial coding at the case level resulted in a number of contextual factors (Section 5.2.4), which were broadly identified in Stage One, becoming more defined within the individual case setting. The other noticeable feature was that many of the categories, which were identified in Stage One, were assigned different levels of priority such that the codes could be conceptualised as being re-positioned and/or re-orientated in the individual case.

Five exemplar-coding tables are provided in Appendix F and the axial codes that emerged are listed below.

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<td>- Role of IT</td>
<td>- Role of IT</td>
<td>- Role of IT</td>
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<tr>
<td>- Business Constraints</td>
<td>- Environmental Control</td>
<td>- R&amp;D IT applications</td>
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<tr>
<td>- External Expertise</td>
<td>- Environmental Barriers</td>
<td>- Physical Business Set-up</td>
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<tr>
<td>- Business Acumen</td>
<td>- Image/Credibility</td>
<td>- Lack of System Integration</td>
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<td>- Collaborations</td>
<td>- Business Set-up</td>
<td>- Lack of Centralised Control</td>
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<tr>
<td>- Image/Credibility</td>
<td>- Lack of IT Control</td>
<td>- Relationship Management</td>
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<tr>
<td>- Investor Attractiveness</td>
<td>- Relationship Management</td>
<td>- Reputation Management</td>
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<td>- Environment Management</td>
<td>- Small Business Advantage</td>
<td>- Environment Management</td>
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<td>- Portfolio Protection</td>
<td>- Financial Management</td>
<td>- Business Planning</td>
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<td>- Internationalisation</td>
<td>- Competitor Analysis</td>
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<td>- Business Planning</td>
<td>- Security Conscious</td>
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<td>- Financially-focused business</td>
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At the conclusion of the axial coding process, axial codes specific to each case emerged. It was evident that within the cases there were semantic relationships between axial codes. For example, in Case A, there was a clear link between the role of IT and image/credibility and between collaborations and business acumen. Similarly, in Case H a clear relationship existed between the axial codes outsourcing strategy and virtual business model. However, these axial codes did not provide a mechanism for exploring the similarities and differences between cases. This would require a further analysis, which is discussed in the next section (Section 5.3.2).

5.3.2 Stage Two - Part B - Cross-Case analysis

In this section, the semantic relationships both within and between cases are explored. Cases are of interest both for their uniqueness and their commonalities (Stake, 1995; Ayres et al., 2003). Comparing the cases enabled the commonalities to be explored and reflected on, in particular their significance. The commonalities increase the explanatory power of the core categories that emerged from Stage One. Cases were not only compared on the presence of the axial codes but the relationship between the axial codes within the case setting.

For example, the axial code outsourcing appeared to some extent in all cases. However, the nuance inflection attached to this code within the case provides insights.

In Case H the axial code outsourcing strategy had a clear link with the axial codes virtual business model and role of IT. As part of outsourcing axial code, an initial axial code of lack of strategic control emerged. Within Case J an initial axial code of IT outsourcing\(^4\) emerged. In some respects, this axial code could be considered closely associated with the outsourcing strategy in Case H. The emergence of the axial code lack of centralised control in Case J could also be potentially associated with Case H and the axial code lack of strategic control. Therefore, the researcher reflected on whether Case J, which had been tentatively grouped in Group I with Cases A and C (refer to Table 5-2), would be more appropriately aligned with Case H. However, in Case J, the relationship between the role of IT was merely as a facilitator.

\(^4\) Within the axial code of lack of centralised control
The relationship between the role of IT as an enabler of virtual business model, which appeared to be distinguishing relationship, in Case H with respect to the outsourcing, did not emerge in Case J. Therefore, although Case H and Case J were similar in terms of the presence of the axial codes outsourcing and lack of strategic control, the nature of other relationships, Case J was reposition closer to Case L. Case H was as a result realigned with Cases D and I, which also highlighted a close association between the axial codes virtual business model, outsourcing, lack of strategic control and the relationship of role of IT as an enabler.

Another example includes Case A and Case B, which shared the common axial code of business constraints. In Case B, the axial code business constraint was closely associated with the business set-up and lack of IT control. Being set-up as a public company had in some ways restricted many of Case B’s business activities including their IT infrastructure. Case A also had an axial code of small business constraints, however, this code was more closely associated with the axial codes of business acumen, role of IT, image/credibility, collaborations and investor attractiveness. What is evident from this example is that an axial code such as outsourcing, when it is detached from it context, can appear to be similar in nature. However, when an axial code is examined in context and with respect to its relationships with other codes, it often has a different nuance inflection, which can influence its interpretation. In addition, the above example also demonstrates it is not necessarily the emergence of an axial code which is significant but the semantic relationships, which exist between the axial codes and how these compare across the twelve cases.

The process described above was repeated for all twelve cases. Through this process, the initial groupings of Group 2 and Group 3, which were identified earlier (Section 5.3.1) based on a ‘quick and dirty’ categorisation of cases according to the emergence of core categories from Stage One, were strengthened. However, the more detailed analysis assisted in further describing and differentiating these cases from the others by illuminating key contextual features. The process also resulted in the disaggregation of Group 1 into three more appropriately aligned subgroups. In essence, what this suggested was that the group boundaries were impermeable; there were differences within the Group. The more detailed level of analysis revealed that there existed five business types within the twelve cases based on the nature and distinct relationships, which existed within the axial codes. The researcher also drew on a number of secondary sources pertinent to the businesses, to identify, discuss and enfold any descriptive characteristics that appear common with the firm types. The descriptive table was drawn on in this capacity to identify any relationships (Section 4.6.2.1 and Appendix E).
Table 5-3  Five Firm Types and Axial Codes

<table>
<thead>
<tr>
<th>Firm Type</th>
<th>Axial Codes (Distinct to the Firm Type)</th>
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| Up and Comings | • Role of IT  
|               | • Business Constraints  
|               | • Business Acumen                                                        |
| Stalwarts    | • Role of IT  
|               | • Business Set-up  
|               | • Lack of Control                                                        |
| Ad Hoc       | • Physical Business Set-up  
|               | • Lack of System Integration  
|               | • Lack of Centralised Control                                              |
| Virtuals     | • Role of IT  
|               | • Outsourcing Business Strategy  
|               | • Key Business Activities  
|               | • Virtual Business Model                                                   |
| Stars         | • Divide Between R&D and Business  
|               | • R&D and Business Orientation  
|               | • Value Added R&D Strategy  
|               | • In-House Development                                                     |

5.3.2.1 Firm Type: Up and Comings

Table 5-2 suggested Cases A and C were closely associated with the axial codes *business activity facilitation* and the *role of IT* as a facilitator. In addition, Cases A and C showed strong similarities in both the presence of the axial codes of *small business constraints*, *business acumen* and *role of IT*, and the relationships between those axial codes. Business constraints in Cases A and C referred to resource constraints

Again because the business is small I don't have the cash flow to be able to appoint companies like Consultancy A let's say for argument sake to go out and find the markets for me (Case C).

Case C indicated in the above quotation that due to resource constraints, he had to use the 'cheapest means' to find markets for his products, which involved the use of the Internet and email.

And basically I went through the process of identifying potential markets overseas through the net. Just by emailing some of these organisations and saying this is who I am and what I am doing, are you interested? (Case C).

Similarly Case A's marketing strategy involved seeking innovative marketing methods due to resource constraints. Case A looked at targeting key conferences to market their products

It was the cheapest way to access customers and to acquire our customers (Case A).
The axial code of *business acumen*, referred to the business’ ability to effectively use and apply their limited resources and still achieve strategic gains in relation to their business development. For example, Case A utilised the Internet to assist with both their *relationship management* and *reputation management*. Case A signed a collaborative deal with a two billion dollar Japanese pharmaceutical company through the clever use of the internet. What was unique about this collaboration process was that Case A never visited Japan nor did the pharmaceutical company come to Australia. Case A and Case B both referred to the “mind-numbingly slow” process of obtaining a contract with a Japanese company and described a generic process which over three years can involve 

Visits, expensive dinners, signing agreements, which might lead to a discussion and to a collaboration (Case A).

Case A was able to clench the deal in less than 10 months and “it was all done on the Internet”. There was a strong relationship between the axial codes *reputation management*, *relationship management*, *business acumen* and *role of IT*. In combination the axial codes underpinned a strategy for overcoming the constraints of a small business

It was just as well they didn’t come to us, we are an 8 person, dinky little company on the bottom of the world with stained carpet and a start-up environment. This large pharmaceutical company with a two billion dollar in revenue, that is 2 billion US, they probably wouldn’t have signed a deal with us if it had not been for the Internet because we appeared than we were at least in terms of bricks and mortar. It was because we asked the right questions, our intelligent responses impressed them, the names we were able to quote to them, true names of people we knew or could provide references on us or were our investors. All of that made us seem more of a substantial company (Case A).

The above example suggests that it is business acumen and the ability to apply technology strategically rather than access to specialised technology, which provided an advantage.

Cases A and C demonstrated the ability to use their IS in a strategic manner to meet their business needs. Both cases provided exemplars of the application of IT to effectively overcome the barriers of a traditional business start-up by using the Internet and email. Case A described a process in which they were able to sign an agreement with a Japanese company without ever visiting Japan nor meeting with the company. Similarly, Case C also used the Internet as the “main tool if you like for our marketing foray. And again because the business is small and I don’t have the cash flow”.

Case C was the only business in the twelve cases that had explored e-commerce as a way of doing business

But we thought that was a good way to just advertising that we are here in the event someone may come across our details in an e-commerce site (Case C).

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44 Case B stated Japanese investors “they are very cautious and take long time to decide” (100-101)
Case C had investigated the possibility of using e-commerce as a mechanism to sell its products and registered with an e-commerce website. Although at this stage, there had only been minor interest from this website.

This firm type demonstrates that it is not the possession of strategic IT but how IT is strategically used, which is important to these businesses.

This section has discussed and described the firm type - Up and Coming.

5.3.2.2 Firm Type: Ad Hocs

The second firm type entitled Ad Hocs encapsulated Case J and L, where the role of IT was that of facilitating business activities (refer to Table 5-2). The distinguishing feature of the two cases was the emergence from a business perspective of the axial code dysfunctional IS. Surprisingly, on the R&D side, the application of IT was to a large measure strategic. This may to some extent suggest a closer association with Group 2 cases (i.e. from Section 5.3.1- Cases E, K and G), which also appear to utilise R&D in a strategic manner. However, the lack of system integration from a business perspective resulted in these cases being considered as a separate type of business and revealed a lack of alignment between their business and IS needs.

The axial code dysfunctional IS in Case J referred to its distributed company, lack of system integration and a lack of centralised control. The axial code dysfunctional IS referred to an almost ad hoc IT set-up. Three axial codes appear to explain this:

1. Physical Business Set-up
2. Lack of Centralised Control
3. Lack of System Integration

Physical Business Set-up

Case J is a dispersed company spread across three offices in two cities.

Lack of Centralised Control

One of Case J’s main problems appeared to be a lack of centralised control of their IT resources. Case J described:

We have three different providers and three different type of access (Case J).

When the participant was questioned about the management of IT within the business, Case J suggested that it was managed on a “per office basis” (Case J). The participant made reference to “who ever was around” was be responsible for managing the business’ IT, “no one person has the specific job” (Case J).

Lack of System Integration

Case J also referred to the lack of system integration, where the two locations operated using PCs and the other location operated using the Macintosh system.
which “that in itself creates problems” (Case 159). Although Case J operated using the same Microsoft programs, integration problems occurred between the two operating systems. Another system integration problem occurred with the need to transfer files between offices.

We don't have any organised capacity of a wide area network (Case J).

Currently the only capacity the business has for transferring information between offices is through email.

The lack of system integration also became a problem with the R&D aspect of the business, where currently trial side data is sent by fax in paper format thus requiring the company to re-enter data in another system. The company is currently in collaboration with a Swedish company developing a secure website and database management tool to overcome this problem

So there's no double handling or triple handling of getting information on the systems where you need it to be (Case J).

In Case L, the emergence of the axial code dysfunctional IS was more implicit and emerged through Klein and Myers’ Principle of Suspicion (Sections 4.4 and 7.3.4). In Case L, the participant appeared to be suggesting to the researcher that his firm was a strategic business with respect to their IT

We have our logistics officer who is pretty well versed in hardware and computers (Case L).

Although Case L went on to state that their Logistics officer was not as well versed “in software we tend to outsource it” as he had originally suggested. The researcher had noticed a large number of paper files located in the office where the interview took place, and thought Case L may have been in the process of moving offices. However, a comment towards the conclusion of the interview suggests that this was not necessarily the case.

We go back to our old systems though for some of the time...just because we find software like MYOB is so restrictive that we can't do all what we want. So instead we pull it out and write it down (Case L).

The above quotation suggested that while the business had the technical knowledge, Case L did not have the business acumen to apply it in a manner that could assist with the business' needs.

Both Case J and L provided evidence of an ad hoc IS systems set-up, in which IT did not meet their business needs. In Case J, it was the difficulty of integrating various systems as well as different platforms, which resulted in an ad hoc IS. In respect of Case L it was the ad hoc systems set-up which resulted in the lack of flexibility of their business applications and resulted in the business returning to paper-based systems.

Whilst Cases J and L’s IS did not appear to meet their business needs, examples were provided from their R&D operations, where IT was being used more strategically.
example, Case J was currently in a joint venture with a Swedish company to develop an on-line secure website for inputting data from clinical trials. Similarly, Case L leased out its machinery to a University and through this arrangement, was able to get access to the R&D.

The Ad Hoc cases had an ISS, on an operational level however their IT did not meet the businesses' needs. Surprisingly, these cases provided examples where IT was being used in a more strategic capacity. The management of IT within the two cases relied on an employee with technical skills as well as an outsourcing arrangement.

This section has discussed and described the firm type - Ad Hoc.

5.3.2.3 Firm Type: Stalwarts

The focus of ISS in Cases B and F was on business activity facilitation and the role of IT appeared to be predominantly that of a facilitator (refer to Table 5.2). The two cases were initially placed in the Group 1 category (refer to Section 5.3.1 and Table 5.2). However, after analysis that is more detailed it was revealed that Cases B and F had limited similarities with both the Ad Hoc and Up and Comings cases, which also were initially categorised as Group 1 (refer to Section 5.3.1 and Table 5.2).

The distinguishing feature of Cases B and F was the occurrence of the axial code business constraints. Although a similar axial code of business constraints appeared in the Up and Comings, the nature of this axial code was slightly different in the context of Cases B and F. Business constraints in the context of the cases, referred to the restrictions associated with the cases being publicly-listed companies. Furthermore, as Case B's IT was now managed and controlled by their shareholder, the business alluded to restrictive nature of purchasing or making decisions around IT. Therefore the distinguishing feature of this firm type were the semantic relationships between the axial codes of business constraints, lack of control, business set-up and role of IT.

In reflecting on Cases B and F's structural characteristics, these two cases stood out in comparison to all the other case businesses on the basis of the longevity of their businesses (refer to Appendix E). When other structural characteristics were compared, it was found that Cases B and F were publicly-list companies and operated in the agricultural application sector. The structural similarities between Cases B and F when compared with the Up and Comings and Ad Hocs, justified their forming a separate firm type.

Cases B and F when examined differed from the other four cases in Group 1 on the basis of their age. Both businesses were established in the mid-1980s, whereas the remaining participant cases were less than five years old (refer to Appendix E).

I guess genetic engineering was new then and people thought that there were opportunities (Case B).

Similarly, the businesses commenced as spin-offs from research institutions headed by a scientist. Common to both cases was their early reliance on government funding.
Case B’s financing strategy appeared to be heavily dependent on government funding in the early stages of development of the company.

Originally we got our funding from government grants and that worked well for us (Case B).

However, as Case B identifies, its ability to access government funding became progressively more difficult.

I think after a while it became harder and harder to get funding, to get money from government grants and rightly or wrongly the governments think that you have had a go (Case B).

In order to increase funding, Case B and Case F underwent IPOs as a capital raising strategy. However, undergoing an IPO may have been detrimental to Cases B and F’s long-term sustainability. For example, Case B referred to the failure of the business’ public float and resulting in their being taken over by a shareholder. Where the two cases appear to differ is in the size of their businesses. Case B alluded to the company passing through a number of size cycles. Case F currently has 68 full-time employees. Case B has 17 employees, although the numbers have been as high as 50, ‘that is a reflection of finances really’ (Case B).

This happens through cycles, and we have been through many cycles of barely surviving (Case B).

From a management viewpoint, the interviewee in Case F found herself in the support role as the IT manager. The participant alluded to a lack of documentation on the old system used by that business and that the process for developing or purchasing IT was often slow.

Case B demonstrated a strong link between business set-up, lack of IT control and the restrictions placed on the business. To explore this linkage requires an understanding of the context in which it was mentioned. After Case B’s share market float failed a shareholder, Chem A, a publicly listed chemical company acquired the business and the board of management was changed.

Now when the float failed, we were essentially broke and the major holding was taken over by Chem A which is essentially a chemical company and the management of the board changed at that point (Case B).

Although the Case B appears to have improved its business experience with this new arrangement, Case B was forced to relinquish control of the company. The influence of the new arrangement was mentioned with reference to Case B’s commercialisation and IT management.

Now that is very conservative. Chem A is a public company it gets a lot of scrutiny, so you have to be realistic (Case B).

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45 Case F was placed in voluntary administration in early 2004- whether this is symptomatic of this strategy of undergoing IPO too early cannot be determined from the data.

46 This highlights the application of Klein and Myers’ (1999) principle of multiple interpretation.
However, the loss of control and the restrictions this has placed on the business is perhaps most evident with IT, which the major shareholder now controls.

They [the shareholder] control them very tightly. That slows it down. Traditionally we relied on people in-house who had IT knowledge and students and that is how it was done. But now, you can't put any software on without it being authorised (Case B).

In the interview Case B referred to the method of operation of Chem A. When an issue was raised was rather than it being directly addressing “they tend to let things accumulate a bit” (Case B). The participant referred to several occasions where there was a delay of days before an issue was remedied.

Our bias is that in the past we used to fix it ourselves (Case B).

The above quotation suggests that Case B preferred the original position where the business had control of and were able to rectify their own IT problems, rather than relying on Chem A.

In summary, while publicly listed companies are accountable for all company expenditure this arrangement can place restrictions on the use of IT in the business. In Case B, the lack of control over their business’ IT has led to the perception that this lack of control is a factor in retarding businesses’ operations and that in itself is considered a business constraint.

5.3.2.4 Firm Type: Stars

While all business alluded to some extent to the differences between the science and business aspects of their respective companies, the firm type Stars appeared to have well-established business processes and systems in place to orient and align their business and R&D operations. This firm type, consisting of Cases E, G and K, demonstrated an ability to integrate their R&D and business operations beyond what was described by other cases with IT being used to facilitate this integration. For example, as previously described in the innovation nurturing section (Section 5.2.2.2), Cases E, G and K went beyond ensuring that their scientists had access to the appropriate information. The cases had set-up intranets and cross-disciplinary meetings to facilitate communication between both their management team and their scientists.

Significantly, within these three cases the role of IT emerged as driver and the only cases in which the core category convergence of R&D knowledge and IT emerged in a strategic manner. Section 5.2.2.4 describes in detail the emergence of core category convergence of R&D knowledge and IT, which was unique to Cases E, G, and K and emerged during more a detailed level of analysis as the axial code value-added R&D strategy. Similarly, Sections 5.2.2.3 and 5.2.3 described in detail the in-sourcing strategy of the businesses, and the intended strategy of building their internal capacity and strength.

The axial codes R&D and business orientation and divide between R&D and business had emerged previously and were discussed in Section 5.2.4. In the Stars firm type the discussion on the divide between R&D and Business was much stronger and
somewhat different to the other cases. Therefore the discussion in Section 5.2.4 will be expanded below.

**Divide between R&D and Business**

Cases E, G and K discussed differences between their R&D and businesses operations explicitly in terms of cultural differences and business structure, as well as knowledge differences. The discussion was often associated with key comments on strategies for orienting, aligning and integrating these two dichotomous operations.

**Cultural Differences**

Cultural differences emerged between scientists and management in Case E and to a lesser extent Case K. Case E’s interviewee spoke broadly on the significant cultural differences between the scientific and management/business teams. For example, Case E’s CEO who is the company founder describes himself as being a “proper scientist at one point” (Case E). From his personal experience, as a scientist-turned-businessperson, he alluded to the cultural differences and barriers he experienced moving from academia to commercial research

Initially amongst scientists, I was really, really frowned upon for going over to the ‘dark side’ (Case E).

The imagery of the ‘dark side’ provides a perception of commercial research as being dedicated to profits rather than higher motives. The interviewee indicated that on his leaving the research institute, where he worked, prior to establishing the company, there was a lot of ill feeling towards him by his peers.

You see there were tears before bedtime when I left. We really had a falling out (Case E).

The scientific community appears to perceive that the primary motivation of commercial research is monetary return. While Case E CEO acknowledged that his motivation in moving to commercial research was to gain a better monetary return, he also suggested that the ability to follow through his research into an effective compound with its impact on human health was also a significant motivation

Part of the motivation is clearly that, but the other part is that you are actually making a compound which is going to have an impact on a human rather than doing some esoteric bit of research over here (Case E).

Finally, Case E made reference to the differences between academic and commercial research

Academia is a wonderful thing but it is quite an introverted activity and it needs to be because you need to focus and so forth. Commercial research is very different. There has to be a product at the end of it otherwise you are dead (Case E).

Similarly Case K also suggested differences between his previous role as a management consultant and how scientists operate in a business context. In particular, Case K referred to the somewhat introverted nature of scientists. The manner in which
scientists operate differs from that of business people and will be discussed in more
detail under “knowledge differences”.

**Business Structure**

Case E’s business structure appeared to both facilitate and orient R&D to the
business. For example in Case E’s management structure, the founder is also co-CEO
of the business as well as, the CSO.

From the business side of things, I am the interface with the scientists and
the Case E-VC CEO and financial director (Case E).

I mean I have a little knowledge, which is a dangerous thing, in each of the
areas so I try and pull them together in various meetings and deploy them in
a strategic sense (Case E).

The management team of Case E is also unique because the major investor, is a co-
CEO of the business. The arrangement is unusual when compared to other venture
capital arrangements as it has a more “hands on” rather than investment only
approach

Jim [CEO of Case E- Venture Capital] has become part of the management
team indeed the CEO, co-CEO of the company. We’ve formed the
management team of the company. They realised the value of their
investment through nurturing a smaller number, but being much more hands
on in term of how they have managed the process. They are actually quite
rare, the rest of them throw money in and wait (Case E).

Evident was the business was still divided into disciplinary areas, meeting often,
operating separately. However, there were also cross-disciplinary meetings

Chemistry will have their own meeting and only the chemists will be there,
apart from me occasionally. Protein chemists have their meeting and
screening chemists have their meeting. And there is one meeting we have on
Thursday that everyone attends (Case E).

The business had recently moved to a central location and referred to this as having
improved both informal communication and communication across groups.

Now we are in one place, it is easy to get to meetings, you bump into people
in the corridors, just across the floor and you are already talking to the people
who are doing the business for you (Case E).

Because of the proximity of all the groups, it has helped and facilitated
integration, which is good (Case E).

Similarly, Case G had recently moved to a location that brought both the scientists
and management team into the one building. Case G indicated that their more
centralised structure had improved business communication and intra-business
relationships particularly between scientists and the management team (refer to
Business Context – Section 5.2.4). Although Case K’s business was spread across two
locations, in Canberra and the US, the business used technology and particularly VPN
to enable it to operate effectively as one business. Case K discussed the extensive use
of videoconferencing within the business and also that all labs and several meeting rooms had videoconferencing facilities.

Knowledge Difference

Case E alluded to the differences in skills and knowledge between operating as a research scientist and as business manager. The participant referred to the steep learning curve he was required to undertake to operate effectively in the business market place.

When I first left the Research Institute B, I wrote my first business plan. The first venture capitalist I met said it was a fantastic NHMRC [National Health and Medical Research Council] grant but it was not a business plan. I had to learn what the hot buttons were for a business plan (Case E).

Case E referred to the need for him to be educated in the operations of the business market.

I have had to be deprogrammed and reprogrammed (Case E).

Knowledge differences in the businesses were also reflected in the information sources relied on by the businesses.

Case G in particular referred to the business' scientific advisory board, which was described as a 'type of consultant body' that provided the scientific direction for the business.

Case K referred to knowledge difference in terms of the business' knowledge-creating process. Case K stated that the process of scientists working together was completely different to his experience, coming as he had from a management consultancy background. Case K also noted that he was used to conducting presentations using the KISS (Keep It Simple Stupid) principle usually discussing three or four key points. However, when the scientists at Case K met, the discussion continued in general for from four to six hours, with presentations of between 60 to 70 slides involving large amounts of figures, flowcharts and maps of genes with a presentation file size of between 50 to 60 megabytes. Case K’s interviewee’s, role as an IT manager was to ensure that infrastructure was in place to facilitate and assist the scientists.

This section has discussed the uniqueness of the firm type -- Stars.

5.3.2.5 Firm Type: Virtuals

From the beginning Cases D, H and I, assigned the in-vivo code of 'virtual' were differentiated from the other cases on the basis of a distinct business model. Case D, H and I’s distinct business model involved outsourcing or contracting-out all of their key business processes. The Virtuals essentially consisted of a core management team of three people, who were responsible for coordinating and managing the various business activities. It is this linkage between the axial codes of role of IT, outsourcing business strategy and virtual business model, which is unique to these three cases.
The outsourcing strategy extended to the management of the business’ IT infrastructure. Case D operated in a shared arrangement with two other similar science-based businesses and relied on an external provider to support their system. Case H, which is co-located in a building with its major shareholder, also uses the shareholder’s IT infrastructure. Case I belongs to an incubator, which manages the business’ IT infrastructure. Both Cases D and H were dissatisfied with the service they were receiving from their providers.

We get IT support theoretically through Shareholder B. We've had a few hiccups lately with IT support so we are not in favour of it (Case H).

Case D also was dissatisfied with the service received referring to their system as going through “three incarnations”. As a consequence, Case D was exploring the possibility of engaging another service provider.

Associated with a ‘shared infrastructure’ arrangement is the outsourcing of the responsibility of IT management to the provider.

Well we are on the Incubator B’s system. So there are two fulltime IT people, and they make all those decisions (Case I).

The dilemma the researcher faced with this group of cases was their description as being virtual. The term ‘virtual’ and the type of business they appeared to be emulating is commonly portrayed in IS literature as a strategic business model in an e-commerce environment. However, when examining the case summaries and her previous reflective notes, it appeared that the current arrangement for IS in these businesses was stifling the very characteristic the businesses sought to achieve - flexibility. Both Case D and Case H reflected that their IT set-up was now becoming a problem particularly as both businesses were looking to expand and move to new locations.

But really it is something we haven’t had to think too much about. We may be moving from these offices, so it has suddenly become something that I have to think about. We have to find someone else we can do the same set-up (Case H).

The focus on business operations influences IT management and in the cases mentioned (Cases D, H and I) the absence of IT management (“leaving it to the experts”) was noticeable. The result of being part of an incubator was that the incubator controlled Case I’s IT management. The outsourcing of Case I’s IT management also revealed a lack of management knowledge concerning the IT set-up.

Several examples were given during the interview where management’s lack of knowledge of the IT arrangements was apparent.

I think the systems are leased but supported by Incubator B people (Case I).

The outsourcing or contracting out of R&D reflected a potential lack of understanding in respect of the business activities associated with innovation nurturing. For example, this business did not make use to any great extent of R&D information.
We don't really use that stuff... the researchers working for us may use it, from the business side we don't use it (Case I).

The above quotation highlights the absence or disconnection from its R&D operations within Case I.

This section has discussed the semantic relationships both within and between cases. On this basis, the twelve cases can be categorised into five firm types. The next section will reflect on the emergence of and explore potential empirical links between the five firm types.

### 5.3.3 Reflecting on the Five Types of Firms and the Emergence of Strategic Alignment

Through the process of comparing and contrasting semantic relationships between axial codes within the cases and comparing semantic relationships across the cases, five firm types emerged - Virtuals, Stars, Ad Hoc, Stalwarts and Up and Coming. The axial codes, that were distinct for each firm type (refer to Table 5-3), underwent a further coding process, “selective coding” within the firm types in order to reveal whether there was a core category.

The axial codes in Table 5-4 and the semantic relationships between those codes, (which led to formation of the five firm types), was passed through another analysis process. As a result of comparing and contrasting the axial codes, they were aggregated to a higher level to form a core category for the specific firm type (refer to Section 4.6.2.4). At the conclusion of this process, a core category for each firm type had emerged and is as follows:

- Strategic IT Application (Up and Comings);
- Business Constraints (Stalwarts);
- Dysfunction IS (Ad Hocs);
- Business Model IT alignment (Virtuals); and
- R&D and Business Orientation (Stars).
Table 5-4  Five Firm Type Core Category

<table>
<thead>
<tr>
<th>Axial Codes (Distinct to the Firm Type)</th>
<th>Core Category (Firm Type)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Up and Coming</strong></td>
<td></td>
</tr>
<tr>
<td>• Role of IT</td>
<td>Strategic IT Business Application</td>
</tr>
<tr>
<td>• Business Constraints</td>
<td></td>
</tr>
<tr>
<td>• Business Acumen</td>
<td></td>
</tr>
<tr>
<td><strong>Stalwarts</strong></td>
<td></td>
</tr>
<tr>
<td>• Role of IT</td>
<td>Business Constraints</td>
</tr>
<tr>
<td>• Business Set-up</td>
<td></td>
</tr>
<tr>
<td>• Lack of Control</td>
<td></td>
</tr>
<tr>
<td><strong>Ad Hoc</strong></td>
<td></td>
</tr>
<tr>
<td>• Physical Business Set-up</td>
<td>Dysfunctional IS</td>
</tr>
<tr>
<td>• Lack of System Integration</td>
<td></td>
</tr>
<tr>
<td>• Lack of Centralised Control</td>
<td></td>
</tr>
<tr>
<td><strong>Virtuals</strong></td>
<td></td>
</tr>
<tr>
<td>• Role of IT</td>
<td>Virtual Business Model IT Alignment</td>
</tr>
<tr>
<td>• Outsourcing Business Strategy</td>
<td></td>
</tr>
<tr>
<td>• Key Business Activities</td>
<td></td>
</tr>
<tr>
<td>• Virtual Business Model</td>
<td></td>
</tr>
<tr>
<td><strong>Stars</strong></td>
<td></td>
</tr>
<tr>
<td>• Divide Between R&amp;D and Business</td>
<td>R&amp;D and Business Orientation</td>
</tr>
<tr>
<td>• R&amp;D and Business Orientation</td>
<td></td>
</tr>
<tr>
<td>• Value Added R&amp;D Strategy</td>
<td></td>
</tr>
<tr>
<td>• In-House Development</td>
<td></td>
</tr>
</tbody>
</table>

The goal of cross-case analysis is to link empirical findings across cases (van der Blonk, 2003). Therefore to link the empirical findings across the twelve cases, the data was required to pass through a final stage of selective coding to ascertain whether a central core category existed across the five firm types (Section 4.6.2.4).

The selective process (refer to Table 5-4) revealed a central core category of strategic alignment, which was derived through the following manner:

- Strategic IT Business Application - refers to the application of operational IT for strategic purposes, which appears to be linked with the axial code of business acumen;
- Dysfunctional IS - refers to the lack of strategic alignment between business requirements and the IT infrastructure;
- Business Constraints - refers also to the lack of strategic alignment between the business needs and IT infrastructure, which appears to be related to the business' set-up as a public company;
- Virtual Business Model Alignment - refers to the alignment between the outsourcing business model and the business' IT arrangements.
- R&D and Business Orientation - refers to the commercial orientation and integrations of R&D activities with business operations as being essential for the business' commercial sustainability.
Table 5-5  Five Firm Type and the Formation of a Central Core Category

<table>
<thead>
<tr>
<th>Axial Codes</th>
<th>Core Category</th>
<th>Central Core Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Up and Comings</strong></td>
<td>Role of IT</td>
<td>Strategic IT Application</td>
</tr>
<tr>
<td></td>
<td>Business Constraints</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Business Acumen</td>
<td></td>
</tr>
<tr>
<td><strong>Stalwarts</strong></td>
<td>Role of IT</td>
<td>Business Constraints</td>
</tr>
<tr>
<td></td>
<td>Business Set-up</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Physical Business Set-up</td>
<td>Dysfunctional IS</td>
</tr>
<tr>
<td></td>
<td>Lack of System Integration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of Centralised Control</td>
<td></td>
</tr>
<tr>
<td><strong>Ad Hoc</strong></td>
<td>Role of IT</td>
<td>Virtual Business Model IT Alignment</td>
</tr>
<tr>
<td></td>
<td>Outsourcing Strategy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Virtual Business Model</td>
<td></td>
</tr>
<tr>
<td><strong>Virtuals</strong></td>
<td>Divide Between R&amp;D and Business</td>
<td>R&amp;D and Business Orientation</td>
</tr>
<tr>
<td></td>
<td>R&amp;D and Business Orientation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Value Added R&amp;D Strategy (Convergence of R&amp;D Knowledge and IT)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>In-House Development</td>
<td></td>
</tr>
<tr>
<td><strong>Stars</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The central core category of strategic alignment emerged from the abstraction of the five firm types and appeared to be the underlying empirical link between the various cases (van der Blonk, 2003). Through this process it was also evident that there was a close association of the codes lack of strategic control and management team with respect to strategic alignment. The code lack of strategic control emerged in several cases but in different forms. The lack of strategic IT control in the Virtuals appeared to be closely aligned with the business model in which all business activities including IT management and key decisions were outsourced. The Stalwarts lack of control was a result of the business structure. As a public company, the majority shareholder had control over business operations, which on two separate occasions was referred to as being restrictive. The Ad Hoc cases also relied on outsourcing some of their IT. The resultant factor appeared to be a mismatch between business and strategic IT alignment, which indicates a relationship with strategic alignment.

Management experience in various forms, was revealed in the twelve cases. In the Up and Coming, business acumen appeared to be central to the manner in which IT was applied for strategic business purposes. Although no explicit link could be found in terms of other cases, an interesting observation was that the Stars and Up and Coming, demonstrated in their management teams a good mix of business and R&D skills. The cases (Case A, E, G, K) employed a CEO from outside of the industry whilst the founder was involved as co-CEO, Chief Scientist or R&D manager. The association of these two axial codes with the central core category of strategic alignment will be interpreted and discussed in the next chapter.
The next stage involved reflecting on how the central core category *strategic alignment* related to the four core categories, which emerged at the end of Stage One (i.e. *role of IT*, *convergence of R&D knowledge and IT*, *business activity facilitation* and *outsourcing*). It was evident that the four core categories, emerged very readily from data analysis but in each category were insights that suggested a consistent underlying core category. The four core categories (*role of IT*, *convergence of R&D knowledge and IT*, *business activity facilitation* and *outsourcing*) contributed to the central core category of *strategic alignment* as well as emerging as axial codes within each of the firm types (Section 5.3.2 and Table 5-5).

In some cases, the core categories in Stage Two appeared to be the link between the central core category of *strategic alignment* and the four core categories from Stage One.

It was clear that the virtual business model *IT alignment* provided a clear link between the core categories of *outsourcing* and *strategic alignment*. Similarly, R&D and business alignment provided a link between *convergence R&D knowledge and IT* and *strategic alignment*, through the presence of these core categories as distinctive axial codes in Stage Two.

However, the link between the core categories *business activity facilitation* and *role of IT* was less obvious. Both of these core categories from Stage One emerged to varying degrees among the five firm types in Stage Two. On reflection, the categories of *dysfunctional IS* and *business constraints*, contributed to a similar type of strategic alignment or misalignment. There appeared to be a distinct lack of alignment between the company's business needs and IT infrastructure. Therefore, one possible relationship between *strategic alignment* and *business activity facilitation* is ‘Business and IT alignment’. Similarly ‘Strategic IT Application' referred to the use of operational-type technology for strategic purposes. Therefore, a potential linkage between the *role of IT* and *strategic alignment* is strategic operational versus strategic IT.

<table>
<thead>
<tr>
<th>Core Category (Stage One)</th>
<th>Relationship (Core Category - Stage Two)</th>
<th>Central Core Category (Stage Two)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outsourcing</td>
<td>Virtual Business Model IT Alignment</td>
<td><em>STRATEGIC ALIGNMENT</em></td>
</tr>
<tr>
<td>Convergence of R&amp;D Knowledge and IT</td>
<td>R&amp;D and Business Alignment</td>
<td></td>
</tr>
<tr>
<td>Role of IT</td>
<td>Operational vs. Strategic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Strategic IT Application</td>
<td></td>
</tr>
<tr>
<td>Business Facilitation</td>
<td>Business and IT Alignment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Dysfunctional IS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Business Constraints</td>
<td></td>
</tr>
</tbody>
</table>

In addition to the initial four categories that emerged from Stage One, the second stage of analysis resulted in the emergence of a fifth core category, *strategic alignment*. Not only was it apparent that the *role of IT* in respect of the three core categories *business activity facilitation*, *outsourcing* and *convergence of R&D*
knowledge and IT was important but at a finer grain of analysis, strategic alignment emerged as an important factor in the case setting. Reflecting on the emergence of strategic alignment in Stage Two of the data analysis and not in Stage One, it is evident that many of the open and axial codes associated with this core category were given different prioritisation in the higher-level analysis (Stage One) and were present across the four core categories. However, in the case setting (Stage Two), it was evident that these axial and open codes were assigned higher levels of priority. Therefore, Stage Two aided in the validation of the outcome of Stage One and suggested that the diagrams that emerged from this process were a useful, high-level representation of the nature of ISS amongst the twelve cases.

Figure 5-5 presents a revised version of the descriptive model presented in Stage One (refer to Figure 5-4) incorporating the fifth core category ‘Strategic Alignment’. The relationships between the existing core categories and strategic alignment emerged from the semantic relationships referred to previously (refer to Table 5-5).
Figure 5-5  Stage Two Data Analysis - Descriptive Model

Business Activity Facilitation

Convergence of R&D Knowledge and IT

Outsourcing

Role of IT

Key

- Strategic Alignment

A: driver
B: in-house strategy
C: outsourcing business activities-
D: facilitator
E: public available DNA data driver
F: strategic vs. operational alignment
G: business and IT application
H: virtual business model IT alignment
I: R&D and business alignment
J: enabler

The dashed lines between core categories in Figure 5-5 are only intended to aid with diagram clarity and do not imply anything about the nature of the relationship between the core categories.

5.3.4  Summary Reflection on Stage Two Data Analysis

Stage Two sought to explore how individual cases engage in ISS, the differences in ISS or factors that effect ISS in the individual cases. One of the main reasons for selecting a case study is the explicit acknowledgement that context plays an important role in the nature of the phenomenon. Stage Two provided a process through which to explore the peculiarities of each case and to investigate, what role these may have on the nature of ISS within the particular case setting in order to address research.
question two. Through exploring the nuances and relationships with other open codes in the core category at the case level, the dimensions of the core categories emerged. This process revealed at a case level, how these businesses were different. Finally, a comparison of the semantic relationships within and between cases, revealed the emergence of a central core category strategic alignment. Strategic alignment appeared pertinent to the emergence of the five types of businesses and resulted in the revision of the descriptive model.

5.4 Chapter Five Reflections

This chapter has provided an in-depth discussion of the analysis of the primary investigation data. A set of coding procedures was applied to the transcript data in a two-stage process, which revealed an array of concepts, themes and interrelationships. The two-stage analysis approach unites the strengths of a holistic case study and a cross case study approach as a mechanism for combining grounded theory techniques within a multiple case study design. The two-stage process provided a method through which to extract rich, detailed meaning about the emergent concepts, themes and interrelationships from the data.

Stage One sought to develop high-level conceptual insights across the twelve Australian biotechnology KSMEs through a holistic case study approach (Section 5.2). Each case was individually coded and the open codes from all twelve cases were then pooled and effectively coded as a single 'meta-case' (Section 5.2.1). Four core categories emerged the role of IT, business activity facilitation, outsourcing and convergence of R&D knowledge and IT. The four core categories were discussed in detail with reference made to relationships both within each of the core categories and possible relationships between the four core categories. A number of axial codes, which through the selective coding process of applying research questions, were given a lower level of prioritisation with respect to the nature of ISS in this specific research context (Section 5.2.1). The axial codes are broadly categorised into four contexts - strategic context, business context, R&D context and environmental context. It was anticipated that the relationship of the axial codes and their influence on the nature of ISS within the twelve cases was likely to be revealed by a more detailed level of analysis in Stage Two.

At the end of Stage One, a descriptive model was presented consisting of the four core categories and distinctive relationships that existed between the core categories (Section 5.2.5). Critical reflection was reintroduced as a process for validating the research methodology in a complex research domain (Section 5.2.6). A shortcoming of a holistic case study approach was it failed to identify how these core categories related to individual cases and whether there were similarities or differences between cases. Therefore, a second stage of analysis involving a more detailed level of examination was required.

Analysis from the familiarisation and pilot interview stages were critically reflected on to further refine the primary investigation strategy and procedures. As a result, the insights these two stages generated are discussed in the research methodology chapter.
Stage Two involved a more detailed level of analysis to explore ISS at the case level and drew out semantic relationships within and between cases (Section 5.3). Each case underwent a process of coding, utilising similar techniques as was applied to the meta-case in Stage One. Through the process of comparing and contrasting semantic relationships between axial codes within cases and comparing semantic relationships across the twelve cases, five firm types emerged - Up and Comings, Ad Hocs, Stalwarts, Stars and Virtuals. The axial codes distinct to each firm type underwent a further selective coding process to reveal whether there was a central core category across five firm types. Strategic alignment emerged as the empirical link. The four core categories, which emerged from Stage One, emerged very readily from data analysis but in each there were insights that suggested a consistent underlying central core category. The four core categories (role of IT, convergence of R&D knowledge and IT, business activity facilitation and outsourcing) all contributed to the central core category of strategic alignment. Strategic alignment also emerged from axial codes within each of the five firm types.

A discussion of the analysis for the twelve cases has been presented in this chapter. In the next chapter the findings are interpreted and discussed to formulate the development of a set of new models and frameworks to explore the ISS among knowledge-based SMEs.
CHAPTER SIX
INTERPRETATION & DISCUSSION
Chapter Six: Interpretation and Discussion

6.1 Introduction

This chapter provides an interpretation and discussion of the data analyses presented in Chapter 5. The chapter reveals key insights into the nature of ISS among twelve KSMEs in the Australian biotechnology industry. A two-stage data analysis process resulted in the emergence of five core categories where strategic alignment emerged as a central core category. This chapter is divided into six sections:

- Section 6.2 - critically reflects on the two-stage data analysis process discussed in Chapter 5 highlighting the key findings. As the data analysis occurred in stages, the purpose of this section is to briefly reflect on the findings prior to interpreting them.

- Section 6.3 - discusses the significance of the findings from Chapter 5 with respect to current IS literature. The findings highlight some potential implications at the substantive, methodological and theoretical levels. A fundamental problem in presenting an interpretation of a complex research domain is how to articulate an interpretation in which both the relationships within the core categories and the relationships between the core categories are both significant findings. However, a critical step in the interpretivist approach, which has been adopted here, is to interpret the interrelationships amongst the core categories. To address this, the interpretation will discuss the significance of each core category and make reference to the relationships with core categories. In addition, significant relationships between core categories are discussed. The first five subheadings (Section 6.3.1 to 6.3.5) are discussed in order of significance assigned to them by the researcher as they relate to ISS in the twelve biotechnology KSMEs. From the section ‘environment pressures’ onwards (Section 6.3.6), the significance appears to be less clearly defined.

- Section 6.4 - engages in an in-depth interpretation of the findings around the core category strategic alignment as it emerges from the analysis and initial interpretation of the findings (Section 6.3). In the researcher's opinion, it is the core category strategic alignment, out of the five core categories and their relationships, which is significant in understanding and conceptualising how the twelve biotechnology KSMEs engage in ISS. While Section 6.3 reveals some insights concerning all five categories, it is the core category strategic alignment, which is of the greatest significance for the cases and therefore our understanding of ISS. The Strategic Alignment ISS Framework for Australian Biotechnology KSMEs presented identifies the nature of ISS among the twelve KSMEs from an exploration of interrelationships between themes that emerged from the data. The nature of ISS could be described from the business' position within the four quadrants as either being - innovative, high potential, R&D-focused or operational efficiency. The section reflects on how this framework could be applied outside the specific research context and how it could contribute to furthering IS theory in relation to ISS in KSMEs. The section concludes through revisiting and answering the first two research questions.
Chapter Six: Interpretation and Discussion

- Sections 6.5 - seeks to answer the first part of the third research question. It was anticipated that the third research question would need to be answered in two parts because of its theoretical nature. The first part required discussion of a number of research challenges, which emerged from the interpretation including - reassessing strategic alignment, conceptualisation of IT as a tool or agent of change, firm boundary permeability, conceptualisation of SMEs and potential application of the socio-technical perspective.

- Section 6.6 - explores the second part of the third research question. The impetus for this research came from two observations that the RBV may be too restrictive in the biotechnology KSME context and that ISS theory and frameworks have drawn extensively on strategic management literature in which the RBV has dominated the discussion. This section revisits the starting point of this research to see what additional insight can be proffered through drawing both on the substantive findings and their interpretation as well as current literature around the area. It reflects on the applicability of the resource-based, relational and industry structure views in the context of the research findings and challenges. Discussion then proceeds to the relative merits of an integrated approach. It is posited that in exploratory studies of complex environments, an integrated perspective in the first instance appears to be most appropriate approach for progressing IS research. Once the phenomenon has been explored and the researcher has a better understanding of the environment, it may then be appropriate to consider adopting a specific management perspective, however researchers should not be restricted in the first instance.

- Section 6.7 - concludes the chapter with summary reflections of the elements that emerged.

6.2 Summary of Key Findings from Data Analysis

This section provides a brief summary of the key findings from the analysis process. As the findings were revealed through a two-stage data analysis process, it is important to reflect on the findings prior to interpreting them. In Section 6.3, the findings are interpreted in relation to current IS literature.

The data collected primarily through interviews with twelve cases (Section 4.5.3.4) was subjected to a two-stage analysis process (Sections 4.6 and Chapter 5). Emerging from the analysis process are some key findings with respect to the current nature of ISS among the twelve cases as well as some broader insights in relation to the research context. The descriptive model, which emerged at the end of Stage Two data analysis revealed five core categories with strategic alignment as the central core category (Section 5.3.2.6).

Implicit Information Systems Strategy

A key finding was that the twelve biotechnology businesses possess an implicit information systems strategy (ISS). Significantly, while none of the twelve cases had an explicit ISS, there was clearly strategic intent with respect to their IS (Section
5.2.1). The challenge for the researcher is to elicit the nature of the implicit ISS (Section 5.2.1).

**Strategic Alignment**

Emerging from the more detailed level of analysis is the core category *strategic alignment* (Section 5.3.2.6). *Strategic alignment* within this research context is focused particularly on alignment between R&D and business strategies. It is this characteristic which distinguishes the work of the businesses from conventional academic research (Section 5.2.4). However, the nature of strategic alignment is also multi-faceted and involves several types of alignment. Strategic alignment, in some cases, appears related to the lack of strategic control and management experience, two axial codes, which also emerges in relation to the core category *outsourcing*.

**Role of IT**

At the conclusion of Stage One of data analysis, the *role of IT* emerged to be a central core category, but was repositioned after the data was subjected to a more detailed level of analysis (Stage Two). Although the *role of IT*, as a communication and management tool, gives insight as to the uses of IT within the businesses, the significance of this core category is its relationship with the other core categories - *outsourcing, business activity facilitation* and *convergence of R&D knowledge and IT*, which emerged in Stage One. It appears where the role of IT goes beyond being facilitatory to being an enabler of an outsourcing business model (Case D, H, I) and a driver of part of R&D strategy in other cases (Cases E, G, K), that the *role of IT* is significant. Broadly, the twelve businesses can be placed into three groups based on this relationship between the *role of IT* and the three other Stage One categories (Section 5.3.1). However, at a more operational level, Group 1 cases, in which the role of IT is facilitatory, can be further disaggregated into three sub-groups. In fact across the twelve cases there are five distinct firm types in which case level factors became more influential and distinctive (Sections 5.3.2.1 to 5.3.2.5).

**Outsourcing**

*Outsourcing* emerges a core category from the data analysis and its significance varied across the twelve cases. *Outsourcing* is particularly significant in one type of business, the Virtuals (Section 5.3.2.5). Outsourcing enables Cases D, H and I to adopt a virtual business model to align with their strategy of risk minimisation and reducing the business' initial financial outlay. In this context, the *role of IT* goes beyond being a facilitator and is an enabler of this type of business model. Outsourcing IT is also significant in the context of the two cases classified as Ad Hocs, relying on external expertise to manage their IT infrastructure. Similarly, Cases B and F (Stalwarts) appear to outsource any decision-making with respect to their IT to their major shareholder due to their set-up as a publicly listed company. Although the Stars rely on external expertise in some circumstances, the cases have an intentional in-house strategy and to build up their internal capacity (Section 5.2.3). Cases A and C also outsource or rely on external expertise on an 'as need' basis to access skills and knowledge that the business did not possess internally.
**Business Activity Facilitation**

The analysis reveals some core business activities among the biotechnology businesses. The activities provide insight into the nature of the businesses and the overall business focus. Their strategic planning practices are commonly linked to the business' financial management and investment activities. *Relationship management* and *reputation management* are revealed as key business activities among the twelve cases (Section 5.2.2.2). The businesses also demonstrate a strong environmental awareness, whereby all twelve cases analysed their industry, competitors and as well as scanned for potential opportunities. In Section 5.2.2.2 it was noted that separating information and information technology from the businesses activities was often difficult.

**Convergence of R&D Knowledge and IT**

Although elements of this core category are present within all twelve cases, *convergence of R&D knowledge and IT* is significant in one particular firm type, the Stars (Cases E, G and K). In certain circumstances, the role of IT is a driver of this approach and forms a unique element of the businesses overall R&D strategy.

**Strategies of biotechnology firms**

All twelve cases have an explicit business plan. Primarily the function of the business plan is to attract finance and investment. Other types of strategies include internationalisation, niche/novelty, product diversification, efficiency and risk minimisation. The strategies are often either reactive to environmental pressures or were directed at building up the business enterprise (Section 5.2.4).

**Environmental Pressures**

The analysis reveals a number of environmental pressures encountered by the twelve cases. Elements specific to the Australian context include risk adverse investors, tyranny of distance and small marketplace. Factors more specific to the biotechnology industry emerge from the analysis, including: the nature of biotechnology, regulatory barriers and the investment community (Section 5.2.4).

**R&D Context**

In Stage One of analysis, an R&D context emerges, however, elements of this context become more significant at the case level. Specifically, the difference in how R&D and management teams operate was of particular note (Section 5.2.4).

**Organisational Factors**

There are a number of organisational factors, which emerge including physical structure, management team and business constraints (Section 5.2.4).
Focus of ISS

The focus of the businesses is associated the unique relationship between the role of IT and the other core categories which emerged in Stage One (i.e. business activity facilitation, outsourcing and convergence of R&D knowledge and IT). In Section 5.3.1, it emerged that the twelve cases could be distinguished in three groups based on whether the role of IT was a facilitator, enabler or driver in the context of business activity facilitation, outsourcing or convergence of R&D knowledge and IT respectively.

Five Firm Type

The nature and characteristics of the five core categories and the relationships between them result in the emergence of five types of biotechnology business - Up and Comings (Section 5.3.2.1), Ad Hoc (Section 5.3.2.2), Stalwarts (Section 5.3.2.3), Stars (Section 5.3.2.4) and Virtuals (Section 5.3.2.5). In addition, the role of IT and its relationship with respect to business activity facilitation, outsourcing and convergence of R&D knowledge and IT also appear to be significant in terms of the nature of ISS (this is evident at the reflection on the where the twelve cases could be categorised into three broad groups based on the similarities and differences in the relationship of the role of IT with the core categories- Section 5.3.1).

Descriptive Models

In summary, the descriptive model, which emerges at the end of Stage Two, highlights strategic alignment as a central core category across the twelve cases and also has interrelationships with the other core categories (Section 5.3.3). At a higher level of analysis, the role of IT played a central role. However, the more detailed level of analysis, which explored the nature of ISS at the case level, strategic alignment (which was captured in elements of the four categories which emerged at the end of Stage One), in fact emerges as the central core category.

This section has provided a high-level overview of the findings, which emerged from the two-stage analysis process presented in Chapter 5. The significance of the findings are discussed and interpreted in relation to current IS theory and presented in the next section (Section 6.3).

6.3 Interpreting the Findings

The previous section provided a brief summary of the key findings of this research (Section 6.3). In this section, the findings are now discussed and their significance interpreted with respect to current IS literature (refer to Chapter 2). The findings highlight potential implications at the substantive, methodological and theoretical

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48 The names assigned to these businesses imply some level of interpretation by researcher as to the overall nature of these businesses. However, their significance with respect to the nature of their ISS is unclear at this stage.
levels. This section also draws on some other insights gained from the interviews with industry representatives during the familiarisation stage. Through critical reflection on the earlier interviews, some of the findings from the primary investigation put these initial insights into perspective.

A fundamental problem in presenting an interpretation is how to articulate an interpretation in which both the relationships within the core categories and the relationship between the core categories are often the most significant findings. In this section, each core category is interpreted and its individual significance explored. However, a critical step in the interpretivist approach, which has been adopted here, is to interpret the interrelationships amongst these core categories. To address this, the interpretation will discuss the significance of each core category and make reference to relationships between core categories. In addition, significant relationships between core categories are discussed. The first five sections of Nature of ISS (Section 6.3.1), Emergence of Strategic Alignment (Section 6.3.2), Role of IT (Section 6.3.3), Outsourcing (Section 6.3.4) and Business Development and Product Development Focus (Section 6.3.5) are discussed in order of significance assigned to them by the researcher as they relate to ISS in the twelve biotechnology KSMEs. From the section the Section 6.3.5 Environment Pressures onwards, the significance appears to be less clearly defined.

6.3.1 Nature of ISS

The primary research question is ‘What is the current nature of ISS within Australian biotechnology KSMEs?’ The first significant finding with respect to the nature of ISS is that each of the twelve businesses has an ISS but it is implicit in nature. The literature purports that while SMEs generally do not have an explicit business or IS strategy, there are often implicit strategies (Levy and Powell, 2000). Each participant was able to articulate their IS plans with respect to their business’ future direction and how they sought to gain competitive advantage. However, unlike their business plans, the ISS was not a formalised document but was largely in the minds of the CEO/managers. This suggests ISS in the twelve cases is implicit, however, this does not suggest it is less strategic or not as well thought-out. Furthermore, the fact that R&D managers, in addition to IT managers and CEOs, are all able to articulate their business’ IT direction suggests that the ISS was communicated to other employees within the business. A methodological implication of this finding is that when researching ISS in the KSME domain, researchers need to be cognisant that an ISS may not necessarily be in the traditional format such as a formal plan or document. Therefore researchers will need to develop research strategies to elicit the nature of ISS.

Two observations from the analysis are worthy of note. Firstly, the twelve cases can be categorised into three broad groups, based on the relationship between the role of IT with respect to three other core categories of convergence of R&D knowledge and IT, business activity facilitation and outsourcing which emerged in Stage One. Therefore, if the role of IT with respect to the twelve cases is an appropriate way to consider the nature of their ISS, the cases can be grouped as to whether IT is an enabler, facilitator or a driver. The focus of their ISS appears largely dependent on the
role IT takes within the cases and how it is conceptualised. This suggests IT plays a central role in the cases.

A second observation is that a more detailed level of analysis revealed that twelve cases were more appropriately categorised into five firm types, based on distinct interrelationships between core categories and contextual elements of the case. The analysis revealed was that contextual elements played a role in the overall nature of ISS.

6.3.1.1 Implicit Nature of ISS

According to Mintzberg (1987), a strategy can be seen as a plan, pattern, position, or perspective. Strategy in this research is considered as a plot of a firm’s intentions according to a set of long-term goals. The rationale for including the recognition and understanding of strategies is that sometimes strategies emerge or are implicit (Mintzberg 1987). In such cases, it is important for firms to recognise and understand their emergent or implicit strategies.

There are some variations in respect of the definition of implicit and explicit strategy within the literature. Porter (1980: xiii), for example, states “every firm competing in an industry has a competitive strategy, whether explicit or implicit”. He defines explicit strategies as those developed through planning processes, and implicit strategies as those that evolve through functional areas of the firm, based on the agendas and incentives of individual departments. Clearly, Porter’s (1980) definition is more aligned with strategies in large organisations rather than the SME context. Mintzberg et al. (1995) discuss strategy in much the same way as Porter, but with different terminology (intended-explicit and emergent-implicit).

Within IS literature, it is acknowledged while SMEs generally do not have an explicit business or IS strategy, there are often implicit strategies (Levy and Powell, 2000). In this research investigation, each participant was able to articulate their IS plans with respect to their business’ future direction and how they sought to gain competitive advantage. However, unlike their business plans, the ISS was not a formalised document but was largely in the minds of the CEO/managers. This suggests ISS in the twelve cases is implicit.

As described in Section 5.2.1, none of the twelve cases made an explicit reference to an IS strategy or plan, however, there was clearly strategic intent, logic or direction in respect of these businesses’ IT and IS. While this type of strategy does not conform to an ISS in its traditional form or evolved through a formal strategic planning processes, it does not imply that there is no strategy.

Cases D and H referred to the future expansion and possible relocation of their businesses, where their IT infrastructures required consideration. Case D suggested that the business would be looking at setting-up their own systems rather than remaining in a shared infrastructure arrangement. Case H on the other hand indicated that the business would be looking for another company with which to set-up a similar shared IT infrastructure arrangement. Case K referred to the implementation of a bar-
coding system to facilitate the tracking and integration of multiple data sources within the businesses.

Several researchers emphasise the importance of intention in respect of strategy (Mintzberg et al. 1999). Whether the strategy is manifested through vision or through vague ideas of getting somewhere, the rationale behind operations deriving from intention is strategic in nature, regardless if it is explicitly expressed or not.

Noticeably, while the twelve cases could articulate a vision with respect to the ISS, there were some distinct differences. For most of the twelve cases, their ISS vision was focused on IT and IS. An example of a distinctive IT vision is where there is convergence between their business, R&D and IT visions. Case G had a clear vision of combining propriety R&D knowledge, computational power and publicly available DNA sequences. Case E's vision was clearly focused on developing its CompProg. Case K vision was to integrate multiple data sources and using data mining tools. Similarly, the Virtuals had a clear alignment between their business strategy of risk minimisation and IT vision.

Few cases focused on their vision in respect of information management. However, some notable discussion about information management occurred with Cases J, E and K. Case J discussed the business's current information management issue handling trial site data. The current process requires data to be sent from the trial site by fax in paper format thus requiring the company to re-enter data in another system. Case J is currently in collaboration with a Swedish company developing a secure website and database management tool to overcome this problem. Case K was developing a database tool, which would enable eight data sources to be linked via a database setup. The intention of the database was to allow a genetic trait to be tracked over multiple data sources. Case K planned to eventually employ data mining tools.

Those businesses in which their ISS vision was less clearly defined were the Ad Hocs (refer to Section 5.3.2.2).

There are also a number of issues associated with implicit strategies, which relate to how well implicit strategies are shared. Similar to issues associated with sharing or transferring implicit knowledge (refer to Section 2.14.4) there are inherent difficulties in how an implicit ISS is shared or communicated with other employees within the business. The fact that R&D managers, in addition to IT managers and CEOs, were all able to articulate their business' IT direction suggested that the ISS was communicated to other employees within the business. However, this was largely an informal process and interpreted to be ad hoc. Case E had formalised structures in place facilitating the effective communication of the businesses' ISS through weekly staff meetings.

A related issue is that of the stability of an implicit ISS as these businesses' ISS were not formally documented.

Future research may benefit from ascertain how well these businesses' ISS is shared with other employees with these businesses and how stable these strategies are in light of not being formally documented. A methodological implication of this finding is that when researching ISS in the KSME domain, researchers need to be cognisant that
an ISS may not necessarily be in the traditional format such as a formal plan or document. Therefore researchers will need to develop research strategies to elicit the nature of ISS.

6.3.2 Emergence of Strategic Alignment

The emergence of strategic alignment as the central core category is significant for a number of reasons. This core category falls across all five firm types and emerges from the abstraction of distinguishing semantic relationships, which existed within each of the five firm types (Section 5.3.3). The importance of alignment and orientation between the business and R&D strategies is noted by several cases and is interpreted to be significant in this particular business context (Section 5.2.4). However, the nature of strategic alignment as it emerges from the analysis is somewhat different from current conceptualisations of alignment (Section 2.4.1). Significantly, IS theory has only just begun to explore the concept of strategic alignment in the SME context (e.g. Hussin et al., 2002).

Strategic alignment emerges as a central core category. Its emergence at the second stage of analysis, in which the focus of analysis was on the individual case, emphasises the importance of this category with respect to ISS at the firm level. In addition, it suggests there are firm-level factors and idiosyncrasies, which influence the nature of strategic alignment. This is explored in more detail in Section 6.4.3. The researcher interprets that although businesses can have a similar focus with respect to their ISS (such as Group 1), how their ISS is implemented is influenced by the nature of strategic alignment. This is significant to interpreting how the three groups, which have relatively similar ISS focus (Section 5.3.2), can be disaggregated into five distinct types of firms. Strategic control and management experience appear to play an important role (Section 5.3.3) in determining the nature of the strategic alignment.

The findings of this research concur with current literature that highlights alignment as an important concept in ISS discussion. The alignment of IS and business strategies has been a particularly prominent debate within IS theory (Avison et al., 2004). The literature has advocated that the successful alignment between business and IS strategies creates significant business returns (Weiss and Anderson (2004) and Sections 2.4.1 and 2.16). However, where the findings of this research diverge from current IS literature is with respect to the nature of the alignment. IS literature focuses mainly on the alignment between IS and business strategies. The research reveals the alignment between a business' IT and business strategies forms only one part of the overall strategic alignment which occurs to varying degrees within the twelve cases. The nature and type of strategic alignment among the cases is multifaceted as well as central to explaining the emergence of five firm types among the twelve cases (Section 5.3.2).
Within the twelve cases there exits various types of alignment including:

- business and R&D (Section 6.3.2.1);
- business and IT (Section 6.3.2.2);
- R&D and IT (Section 6.3.2.3); and
- strategic and operational alignment (Section 6.3.2.4).

In Stage One of data analysis, the descriptive model in which a number of contexts were described, also pointed to a possible environment and business alignment (Section 5.2.5). Although environmental factors were evident through the emergence of environmental management strategies (such as industry analysis in Section 5.2.2.2), the significance of the environmental context is interpreted to have an indirect influence on the nature of ISS (Section 6.3.7). Environmental pressures influenced the type of business activities undertaken by the twelve cases (Section 6.3.2.5).

6.3.2.1 Business and R&D Alignment

The research findings suggest that business and R&D alignment is important to the success of biotechnology businesses. The business and R&D operations are quite distinct, particularly in terms of the business culture, business set-up and types of knowledge (Section 5.2.4). Both the business and R&D functions often operate independently. This is as evidenced by the Virtuals' ability to outsource their R&D function as well as in other cases, the scientists and their laboratories being physically separated from the management team (Section 5.3.2.5). It is the alignment between business and R&D strategies, which distinguishes commercial research endeavours from those of academia (Section 5.2.4). An R&D strategy in this business context needs to be directed towards commercially viable outcomes. Through exploring the various strategies (Section 5.2.4), it is evident that the strategies are largely concerned with product development or business development (Section 6.3.5). For example, the strategy of niche/novelty (through patents) ensures that a business has exclusive rights to develop a product, which also highlights another element of business and R&D alignment (Section 5.2.2.2).

6.3.2.2 Business and IT Alignment

The alignment of business and IT strategies is the focal point of most literature on the subject of strategic alignment (Section 2.4.1). Within the twelve cases IT is used for predominantly for operational purposes (Case B, D, F, H, I, J and L) and in others, IT is applied in a more strategic manner (Cases A, C, E, G and K).

More recently, several researchers have suggested there may be occasions where too tight fit between these two components could reduce a business' strategic flexibility (Avison et al., 2004). Similarly, Tallon and Kraemer (2003) suggest that the relationship between IS and business strategy is only valid up to a certain critical level of alignment.

Three cases categorised as Virtuals, suffer from over-alignment between their business and IT strategies. The Virtuals appear to support Tallon and Kraemer's (2003) proposition that reduced strategic flexibility can result from over-alignment.
These cases suffer from reduced strategic flexibility with respect their current IT infrastructure and management, stifling the cases’ ability to expand in the long term. Cases D, H and I are small start-up businesses that employ a virtual business model. In essence, the cases operate with a core management hub responsible for managing and coordinating various aspects of the business (Section 5.3.2.5). As evident from the analysis, the cases sought to minimise risk and initial capital outlay as well as exhibit flexibility through their business model set-up. The findings also indicates that by the cases outsourcing a number of their business functions, much of the strategic decision-making relating to their business function is outsourced in the process. This is particularly evident with respect to the management of their IT. The Virtuals’ current IT set-up is problematic and constraining as these businesses seek to expand and develop into more substantial businesses and is particularly noticeable in Cases D and H (Section 5.3.2.5). Case I had only been established within the last twelve months at the time of the interview. However, the similarities Case I exhibits with respect to Cases D and H in terms of outsourcing IT strategic decisions (in this situation to the business incubator), suggests this business may find itself in similar situation as Cases D and H in the future. Through aligning their IT management with their overall outsourcing strategy, the strategic flexibility that the three cases endeavour to achieve through a virtual business set-up in fact is limiting their businesses’ future expansions.

From a business risk perspective, the decision to outsource their IT and key decision-making to a third party, appears strategic and aligned with the Virtuals’ overall strategy. From an IS perspective, the decision to outsource results in a misalignment between their IT infrastructure and the future needs of the business. One interpretation is that the Virtuals have over-outsourced by outsourcing not only their IT management function but also any strategic decision-making in relation to their IT. It also highlights the importance of keeping strategic decision-making in-house and is significant in explaining whether outsourcing is considered a strategic phenomenon within this KSME context (this is discussed in more detail in Section 6.3.4).

6.3.2.3 R&D and IT Alignment

Another form of alignment is R&D strategy and IT alignment. However, this form of alignment does not emerge to the same extent that R&D - business alignment and business - IT alignment. The businesses that exhibit a strong R&D and IT alignment, are those in which their propriety R&D knowledge converges with the business’ IT resources and forms an important component of their overall R&D strategy. This is particularly evident in Cases E, G and K. Although CompProg is now a significant R&D strategy in Case E, their bioinformatics program was originally intended to improve the efficiency of the business’ R&D program. However, through a number of partnerships, this program has become a strategic asset.

Noticeably, Cases E, G and K also use their IT systems to facilitate their innovation nurturing process to a level of sophistication above what is observed in the other four firm types (i.e. Ad Hocs, Virtuals, Stars, Stalwarts and Section 5.2.2.2). These cases use technologies, such as videoconferencing facilities and intranets, to facilitate business and R&D processes as well as the interaction between the two distinctive components. Several of these technologies are considered by some researchers to be
types of knowledge management technology (Section 2.12.5.1). More significantly, the management teams in Cases E, G and K appear cognisant and sympathetic to the differing needs between the scientists and management team (Section 5.3.2.4). Although the role of IT is still as a facilitator, the Stars' IS set-up facilitates key knowledge and information facilitation processes associated with the R&D by increasing communication among scientists and improving access to information. This is consistent with the view that IT facilitates knowledge creation process. While IS research suggests that there is no doubt that IT assists process of R&D by increasing communication among scientists, improving access to information, revolutionising scientific instruments, through their impact on scientific publishing opportunities for collaboration and access to education and training (Roberts, 2000). Case E, G and K epitomise the use of IT to assist R&D processes.

The firm type Ad Hocs also highlight that in some selected circumstances the role of IT in their R&D strategy is quite strategic. Case L perceives its IT (used in R&D) as a strategic asset and use 'confidentiality statements' in order to protect their inventions. Although it is important to note there are only some elements of their R&D strategy in which the role of IT is strategic. The role of IT in the R&D strategies of the Ad Hocs is interpreted to be less strategic than the Stars. Significantly, in Cases J and L exhibit poor alignment between their business needs and IT infrastructure (Section 5.3.2.2). A potential relationship exists between their business’ management team, in which the original founder/scientists are still operating in the capacity as CEO, and the R&D focus of their ISS (Section 6.4.3). In the remaining cases, the role of IT is largely for gaining operational efficiencies (Cases A, B, C and F). For example Case C uses statistical packages as part of their R&D operations.

In the Virtuals, the alignment between R&D strategy and IT is less obvious. Cases D, H and I do not have internal R&D operations as these businesses outsourced various aspects of their R&D process. The role of IT in this capacity is facilitating the management of their R&D operations and to some extent 'enables' the businesses to adopt a virtual business model. It is interpreted that the R&D component of Cases D, H and I is in fact absent in the context of their ISS.

6.3.2.4 Operational versus Strategic

The two-stage analysis process revealed that Group 1 cases can be delineated into three sub-groups (Section 5.3.2). Despite Group 1 businesses all having a similar focus with respect role of IT, the delineation of Group 1 into three subgroups (i.e. Stalwarts, Up and Comings and Ad Hoc) suggests differences in the operational nature or contextual features may account for the variations.

The Up and Coming businesses highlight a situation where despite limited IT, IT can be applied in a strategic manner (Section 5.3.2.1).

Another example of operational versus strategic alignment is Case L. Although Case L perceives its current IT set-up is strategic, the evidence is somewhat to the contrary. A comment towards the conclusion of the interview suggests that Case L’s IT is not as strategic as the participant indicates.
We go back to our old systems though for some of the time...just because we find software like MYOB is so restrictive that we can't do all what we want. So instead we pull it out and write it down (Case L).

The researcher observed the number of paper files around the office in which the interview was taking place but had thought it was part of an office relocation.

6.3.2.5 Environment versus Business Alignment

Although not emerging as a significant research theme, there is an element of environment and business alignment. This form of alignment is expressed in terms of high-level business strategies (e.g. internationalisation) and business activities (e.g. environment management) to address environmental pressures (Section 5.2.4), however its role in ISS is less clearly defined. Although this type of alignment may not directly influence the nature of ISS such as its impact on the role of IT, it is interpreted as influencing ISS in an indirect way.

While the multifaceted nature of strategic alignment in itself is significant, its significance relates to it being a key factor in categorising the twelve cases into five firm types and is the empirical link. Furthermore, strategic alignment is central in explaining how a group of cases which have a similar focus in terms of their conceptualisation of IT, can have a different ISS at an operational level (e.g. Group 1 disaggregating into the three firm types of Ad Hoc, Up and Comings and Stalwarts).

Strategic alignment is an important concept within the twelve cases. However within this context, strategic alignment goes beyond aligning business and IS strategy (Section 2.4.1) and involves the alignment of R&D, IT and business strategies.

6.3.3 Role of IT - Its Central Role and Three Hats

The role of IT in itself is significant, as the use of technology is consistently mentioned among the twelve cases, as being important and central to their business (Section 5.2.2.1). However, it is the relationship between the role of IT and with the three other core categories of outsourcing, convergence of R&D knowledge and IT and business activity facilitation that emerged in Stage One, which is of significance.

Levy and Powell (2000) articulate that technology merely plays a backbone role and emphasise the role of information in the context of conceptualising ISS. To overcome issues on the limited use of IS currently in SMEs, Levy and Powell (2000) argue that it is more appropriate to focus on the information requirements rather than concentrating on IT requirements. Consequently, the role of IT in their model is largely implicit (Section 2.9). The findings of this research concur with the need to emphasise the importance of the role of information, particularly in the context of supporting the various business activities (Section 5.2.2.2). However, IT also emerges explicitly as a central core category in Stage One, although is repositioned as a result of a more detailed level of analysis in Stage Two (Section 5.3.3).

The researcher reflected at this stage as to whether the emergence of the role of IT is indicative of the nature of ISS in these businesses or merely emerges as a result of the
interview question frame. Although a section of the interview was focused on IT (Section 4.5.3.4), on a number of occasions, where discussion was focused on other aspects of the business, for example people or key processes, the dialogue often would come back to the role of IT. In the interview with Case H, when the discussion was around a particular staff member who had worked at a big pharma previously, the interview topic came back to this staff member wanting to establish a website “he is ex-CSL so he is used to having decent websites and promotional tools”. Similarly Case D, when discussing the next stage of the drug development process, the company suggested they would be looking overseas and the tendering process would be done by email. Several other cases had talked about their overseas operations and suggested email was central to this part of their business. Similarly, when conducting competitor analysis, IT was consistently mentioned “and the Internet is obviously used to determine what our competitors are doing” (Case C). These snippets suggest that the emergence of the central role of IT was due to the importance placed by the twelve businesses on IT and not merely a result of the interview question frame.

In the context of the twelve cases, IT has a more central role, one which enables a ‘virtual’ business model to be adopted (Cases D, H and I) and one in which IT is a driver behind a R&D program (Cases E, G and K). The central role IT plays may be a reflection of the fact that technology underlies much of the innovation in biotechnology. The central role of IT in these businesses may be significant with respect to outsourcing in terms of its strategic nature. This is discussed further in Section 6.3.4. The focus of these businesses’ ISS relates to how IT is used with the business and how IT is conceptualised as a facilitator, enabler or driver. In Section 5.2.3, three roles of IT are identified including:

- **facilitator** - where IT is used as tool and in the capacity of assisting business activities;
- **enabler** - which through the use of technology, potential strategies can be adopted; and
- **driver** - in which technology was a key development force behind their R&D strategy.

Chan (2000) suggests as an initiator (described in this research as a driver), IT acts as an agent of change. In the twelve cases, the most common role of IT is as a facilitator particularly in terms of facilitating the various business activities. Therefore, if the core category **role of IT** is considered to be of most significance in describing the nature of ISS within the twelve cases, then conceptualising IT as tool is appropriate in most situations within this research context. However, in some circumstances IT is a driver, therefore IT also needs to be conceptualised as an agent of change. Similarly, IT is an enabler and made it possible for several cases (Cases D, H and I) to adopt a virtual business model. This suggests than in some circumstances, it may be necessary to consider IT more than just a tool and expand its conceptualisation to include in some circumstances being an agent of change. Conceptualising IT as both a tool and an agent of change has potential methodological and theoretical implications. A more explicit conceptualisation of IT is required when developing an ISS for Australian biotechnology KSME context. How the **role of IT** is perceived within these businesses, influences the focus of a business’ ISS. It also raises the question as to whether IT is more appropriately conceived a tool or an agent of change. This is discussed in more detail in Section 6.5.2.
6.3.4 Outsourcing

The core category outsourcing is particularly significant in the Virtuals and underpinned their business model. In this respect, outsourcing influences the nature of their IS as IT enables the cases to outsource their business activities, including their IT management and all of their R&D functions. Cases D, H and I describe themselves as virtual businesses and appear to have outsourced all the strategic-decision making concerning the business' IT. It also suggests a potential relationship between business strategy, business model and the nature of IS.

Cases J and L (Ad Hocs) outsource the majority of their IT management and maintenance to a third party. This IT set-up is problematic as in both cases their IT is both dysfunctional and frustrating to the extent that Case L has reverted to using paper-based systems (Section 5.2.2.2). Therefore Case L's current IT set-up is not meeting their business needs.

In the cases classified as Stalwarts, IT and its strategic decision-making are outsourced to their majority shareholder due to being publicly-listed companies. This arrangement restricts the Stalwarts' business growth, in particular their IT infrastructure (Section 5.2.2.3).

In the Up and Comings and Stars firm types, outsourcing is used but in a selective manner. This approach is interpreted to be the most strategic outsourcing strategy adopted by the twelve cases. The Stars and Up and Comings draw on external expertise in areas in which they have limited knowledge or expertise (Section 5.2.2.1). The Stars, in particular, adopt an intentional in-sourcing strategy (Section 5.2.2.4.) For example, Case K describes where the IT manager enlists the help of an external consultant to assist with some technical problems, where it would take more than two hours of reading a book to fix.

Teng et al. (1995) link the outsourcing decision with the organisational strategy. They suggest that the strategic orientation of the organisation influences its outsourcing decision whether to in-source or outsource the IT function. Barthelemy and Geyer (2004) suggest cost motivations were strongly related to total IT outsourcing. A similar observation can be made with respect to the Virtuals, who emphasise one of the main advantages is cost reduction, risk minimisation and not having to outlay money. This is exemplified by Case H, who stated

It works quite well from a risk perspective in particular and also means we don't have to gear-up (Case H).

Significantly, Barthelemy and Geyer's (2004) research suggests that businesses from highly IT intensive industries should be less likely to outsource their entire IT department. Although this statement is made in reference to large organisations rather than small businesses - as SMEs often do not have separate IT departments, the central nature of IT in these businesses suggests this may have relevance to the biotechnology KSME context (Section 6.3.3). The paper suggests that in businesses that belong to IT intensive industries, IT is frequently a 'core competence' (Barthelemy and Geyer, 2004). As highlighted in Section 6.3.3, IT emerges as an important core category and is interpreted to be a result of technology underlying
biotechnology innovation. Selective IT outsourcing may be safely used to access expertise that is not available in-house even when IT is a 'core competence' (Barthelemy and Geyer, 2004). In this respect the selective outsourcing strategy adopted by the Stars and Up and Comings is interpreted to be strategic and most appropriate for this context. On the other hand, total IT outsourcing involves a loss of control over the entire IT activity. It is more the lack of strategic control associated with outsourcing than the strategy itself, which influences whether outsourcing is considered a strategic phenomenon.

Despite the relative advantages of small businesses outsourcing, a number of researchers have also highlighted several disadvantages with outsourcing, including:

- lack of control;
- loss of accountability;
- expenditure of resources on managing the transition from in-house to outsourcing; and
- getting both parties to understand what is to be delivered (Beaumont and Costa, 2002).

The research indicates that the lack of control is the primary disadvantage of outsourcing IT within this particular KSME context. The lack of control can result in strategic limitations being imposed onto the business. Case B’s IT is largely controlled by a majority shareholder, which has placed restrictions on their IT infrastructure. Despite the Virtuals’ reasons for adopting an outsourcing strategy are for strategic outcomes, outsourcing in these circumstances limits their future growth. Therefore, the researcher argues that it is not the loss of the core competence, which is the issue but the lack of strategic control over the outsourced functions and its limited integration with the business activities and future business plans.

In summary, this research suggests that outsourcing, when used effectively and appropriately managed, can be a strategic phenomenon. However, the key importance is that the strategic decisions in relation to the outsourced function are still kept within the control of the business. This finding is also relevant in discussing the issue of strategic alignment within these businesses and is drawn on in Sections 6.3.2 and 6.4.3 to inform this discussion.

The research interprets IT outsourcing an appropriate strategy in the small business context as long as strategic decisions surrounding IT are not outsourced in the process. The Ad Hoc cases outsource their IT, and this has resulted in a dysfunctional IT set-up (Section 5.3.2.2). The literature also suggests that SME tend to outsource in response to a crisis situation. The findings of this research indicate that the decision to outsource is a strategic phenomenon within these biotechnology businesses and not necessarily a response to a crisis situation (Section 2.16). One interpretation is that outsourcing is not appropriate in the SME context. Another interpretation is that 'selective outsourcing' can be of benefit to the SME context. As long as the strategic decisions regarding IT or the outsourced function are kept in-house, then outsourcing in a SME context can be used strategically.
6.3.5 Business Development and Product Development Focus

The six business activities associated with the core category business activity facilitation are each significant in their own right and provide some insight into how the twelve cases operate. Significantly, when participants made references to the business activities, it was often made to either how IT or information was used (Section 5.2.2.2). The role of IT in this capacity is largely as a tool. In conceptualising the six emergent businesses activities, it is important to take into account information and the role of IT in facilitating the business activities (Section 5.2.2.2).

The business activities relationship management and reputation management emerge as being particularly important to the twelve biotechnology businesses. As previously noted, the researcher faced a dilemma as to whether the relative importance of relationship management and reputation management justified the two activities forming their own core category (Section 5.2.2.2). The decision to include them under the core category business activity facilitation was made on the basis of the context in which they were discussed and their relationship with other business activities. This observation will assist with interpreting the findings.

Relationship building and management are important business activities for gaining access to markets, to assist with product development and gaining access to information. Reflecting on discussion with industry representatives in the familiarisation stage also reiterates the importance of relationships within the biotechnology industry in general.

The other is a more intangible part of business management, which is the networking, relationship management (Industry Association A).

It is a matter of building a relationship with them, developing a trust, developing a sense of capability, respect for the person (Research Institute A).

Research Institute A's description above describes an important component of these relationships, trust. Trust becomes important for enabling access to information and knowledge sharing both formally and more informally across the firm boundary. The strong dependence and high occurrence of collaborative partnerships within the biotechnology industry is highlighted both within the literature and the cases. Informal relationships in particular form a key role in gaining access to information (Section 5.2.2.2).

The research methodology chapter (Section 4.3.2) identifies the biotechnology industry as being a commercially sensitive field and it is often very difficult to get information about what is happening in the industry. As Industry Consultant A discussed:

There is no database with information you can access. This has been an extremely difficult role and part of the difficulty or challenge of my role is to making some sort of decision, assumption or analysis when you have only got half the information. And no one else has the other half of the information; it is not as though they're alone (Industry Association A).
Similarly, the twelve cases rely on their networks to gain access to information that is commercially sensitive (Section 5.2.2.2). Reflection on discussion with Industry Consultant A, during the familiarisation stage, also highlights the use of networking to gain access to commercially sensitive information.

But that kind of information is really difficult. How do we go around it because it is just not out there is knowing people in the industry and getting the industry's view on things. So being at conference, talking to people in the know. Talking to tech transfer and trade organisations. Passing information along (Industry Consultant A).

In summary, relationships enable the twelve cases to often overcome issues of commercial sensitivity and limited access to information.

Although it has been recognised within the literature that implementation of different reputation strategies may have a positive effect on the company, there are few managers who make a pragmatic and premeditated decision to invest in building a corporate reputation as one of the primary objectives during early stages of business development (Goldberg et al., 2003). Within the twelve cases, it is evident that the importance of building their reputation and image is recognised. The cases possess explicit strategies of how they sought to develop and build their reputation (Section 5.2.2.2). This is significant in the Stars and Up and Comings cases in which their business’ founding scientist had in fact relinquished their position as CEO and specifically recruited a person with business experience to manage the business. Case B highlights investors are often sceptical of scientists who run businesses. For example, Industry Consultancy A suggests the importance of the business credibility, prior to investing in a company.

First you look at the people, because when it is a start-up company, that is one of the most important factors, who is driving it (Industry Consultant A).

On reflection, the focus of the two business activities individually is on developing the enterprise. However, it is the interrelationships that exists between the various activities, which is interpreted to be of significance and also supports the interpretation that the twelve cases are largely focused on business development. The emergence of the interrelationship between credibility, relationships and financing is particularly significant (Section 5.2.2.2). The focus of the twelve cases" is predominantly on business development. For example, a business’ credibility can influence whether a venture capitalist will invest in a business. Similarly, the relationship a business has with another company such as a large pharmaceutical company both validates their technology and improves the business credibility. In addition, the emergence of the business activity opportunity analysis (under environment management) suggests that the businesses adopt a proactive approach by seeking future business development opportunities. Therefore, the focus of the twelve businesses at the time of this research is less on product selling and marketing and more on business and product development.

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49 This also validated the researcher's research strategy of spending a lot of time in the developing relationships with people in the industry prior to commencing data collection in order to develop trust and facilitate access to commercially sensitive information.
6.3.6 Emergence of a Knowledge Creation Context

In Stage One a broader R&D context emerged and its specificities were revealed in Stage Two. The emergence of the categories of commercial orientation of R&D, the dichotomy of science and business, and the significant role IT plays in several drug discovery programs, justified R&D being represented as its own context. R&D is considered a knowledge-creating process (Section 2.12.4) and often the locus of innovation in high-technology fields. The emergence of the R&D context and the need for it to be separate but still connected to other business activities is both unique and central to ISS in the twelve cases, for example alignment between R&D and business strategies emerged as central to these biotechnology businesses (Section 6.3.2). While on its own the R&D context is insignificant, how well it is integrated and aligns with other aspects of the business is important in terms of the nature of ISS among the twelve cases. An R&D context appears to be a unique characteristic of KSMEs and how R&D is incorporated and aligned in the business is an important consideration. In Section 2.12.3, a question was raised as to whether R&D knowledge may be worthy of investigation in Australian biotechnology KSMEs. The findings of the research although reveal a core category in which R&D knowledge forms a component, it is its convergence with IT (convergence R&D knowledge and IT) that is significant.

6.3.7 Environmental Pressures

The significance of the environmental pressures provides insight into why the twelve biotechnology cases behave in a certain way. For example, the regulatory barriers imposed by a GMO moratorium have prevented Case B marketing their product in Europe (Section 5.2.4). Similarly, Case H chose not to patent and potentially market a product in Japan due to the cost of going through the regulatory process. Limitations of the Australian marketplace also require the cases to adopt an internationalisation strategy predominantly through collaborative arrangements.

Substantively, the environmental pressures, which emerge from the analysis process, provide insight into some of the issues faced by businesses in Australia and in the biotechnology industry. Although the issues raised are specific to the biotechnology industry, they may also be relevant to other high-technology businesses and SMEs operating in Australia. A fruitful avenue of further investigation would be to ascertain where the environmental pressures are similar for all Australian businesses. Similarly, the strategies adopted by the twelve cases provide insight for other businesses that face similar environmental pressures.

6.3.8 The Importance of the Human Element

As highlighted in the literature review chapter, several researchers have suggested that IT has the potential to offer small businesses a number of advantages. For small businesses operating largely in a market dominated by large, multinational pharmaceutical companies, the literature purports that IT has the potential to level the playing field (Section 2.8). In the advent of technologies such as e-commerce, a
number of researchers have suggested that these technologies provide unique opportunities for small business (Al-Qirim, 2003). Numerous studies have highlighted the benefits of e-commerce for SMEs including global reach (Hughes et al., 1998), equalising the business environment (Whinston et al., 1997), cost savings and increased productivity (Burgess, 1998). The emergence of categories associated with Australian environment limitations such as ‘tyranny of distance’ was consistently mentioned as a barrier faced by the twelve cases, therefore IT potentially offered a mechanism to overcome such barriers.

Although it is widely acknowledged that IT assists small businesses and can be an advantage it does not necessarily overcome this issue of ‘tyranny of distance’ insomuch as this barrier appears both physical and psychological. Within the twelve cases, technology certainly assists in some respects in overcoming some business constraints. For example, Case A cleverly used its IT to assist with its business reputation, creating an illusion that the business was more substantial than it actually was (Section 5.3.2.1). Case D suggests that technology enabled its business to access skills and knowledge from overseas. However, the detachment of these Australian businesses from key markets in North America and Europe is considered a major hurdle by the cases (Section 5.2.4). As identified, in Section 5.2.2.2, financing emerge intimately linked to the business reputation as well as the relationships. US investors are identified as being reluctant to invest outside their home country. The tyranny of distance and being detached from its key markets is an issue faced by the twelve cases. A strategy of internationalisation is adopted. Although IS can definitely assist the businesses, what IS literature struggles to encapsulate is the human element which is interpreted as being essential in overcoming these more psychological-type barriers. The role of IT in this situation is predominantly as a facilitator or a tool. It is the many informal networks that the cases have that enables these businesses to access markets. A quote from one of the industry representatives reiterates this perspective.

That is the stuff that you cannot do using IT. That's professional advisor to client. You can impart information using IT, because it is a tool, you can send a report electronically, you can email results, you can fax results but you cannot replace the relationship between the client and the advisor. That's what I believe to be the fundamental reason why the agricultural e-commerce site fail, because they have tried to treat product as commodity but its not (Collaborative Partner A).

One key element of biotechnology KSMEs which current conceptualisations of ISS struggle to address are the roles relationships and reputation play within these businesses. Knowledge management theory has expanded and called for a socio-technical perspective in response to IS’s more technocratic view of knowledge (Section 2.12.5.1). Both formal and informal relationships both within and across the firm boundary provide access to information, which would be normally be difficult to access via traditional more formal methods. The use of teleconferencing and videoconferencing facilities again suggests there is a ‘human element’ to the interactions, which technology can only facilitate not replace (Section 5.2.2.1).

There are several implications including the current firm boundary, the socio-technical perspective and whether IT needs to be considered a tool or agent. In summary, IT can only facilitate this important networking process and in this capacity appears to be a tool. The way in which IT is applied strategically to develop
collaborations as evidenced by Case A, is highly dependent on the business acumen of the CEO, again the emphasising the human element of IS. This suggests merit in exploring the business skills of the management team.

6.3.9 Strategic Nature of Biotechnology KSMEs

A common conceptualisation within the literature is that SMEs are not strategic, seldom partake in strategic activities and tend to focus largely on operational efficiency particularly with respect to IT (Section 2.8). The significance of this conceptualisation is that it assumes that SMEs tend not be strategic and therefore have little opportunity to use their IS strategically. There is not enough managerial expertise to plan, organise and gain leverage from directing the use of IT resources (Blili and Raymond, 1993).

The findings of this research in fact highlight that all twelve cases have an explicit business plan and are continually going through regular planning processes. The business plans are largely focused on accessing finance. Significantly, the nature of the strategies often goes beyond gaining operational efficiencies. The strategies adopted by the cases are largely focused on business and product development.

As described in Section 5.2.4 the strategies included internationalisation, risk minimisation, market awareness, efficiency and in some instances align with those strategies adopted by larger organisations. The significance of this finding is that there appears merit in exploring the applicability of some strategic management theory developed from empirical research on large organisations in this particular KSME context.

In a recent paper, Qian and Li (2003) identified that biotechnology businesses exhibited with four strategic characteristics innovator position, market awareness, niche operation and internationalisation. The characteristics identified by Qian and Li (2003) are consistent with several business strategies that emerged from the findings of this research. However, it is the type of strategies adopted by the twelve cases that is of most significance. The strategies also assimilate to some of those used by larger businesses including creating barriers to entry.

Innovator Position

The findings indicate that the twelve cases tend not to be in a position to achieve cost leadership and thus appear to adopt an innovator position. This is observed through the emergent strategy of niche/novelty (Section 5.2.4 and 5.2.2.2). The businesses also draw on the flexibility of their set-up as another approach for maintaining an innovator position. Case E referred to the flexibility which small businesses posses

Bigger companies have cash, facilities, bulk, and people and in some senses that is equally their downside as well. They have bulk, and they are a dinosaur and it takes a long time to turn around. We can, at a drop of hat, decide for these next three months that this will be our key program. And we can make that decision in an afternoon as we have done so in the past.
We can ultimately get to the same point or a better point than those guys can and much more quickly because they have this inertia because of this process (Case E).

Similarly, Case B highlights one of the strengths of small businesses

Well I have worked for a big company - that there is big differences. That is one thing that is nice about here, it is very flexible and as you say you have limited resources, you have got to find ways to get to the same end (Case B).

The Virtuals’ current IT outsourcing set-up hinders their strategic flexibility (Section 6.3.4). Therefore, the ability of the businesses in the longer term to continue to adopt an innovator position may be stifled. This has potential implications for interpreting this particular firm type.

**Market Awareness**

A market awareness strategy in the cases is revealed through the category of reputation management. The Internet in particular is a crucial tool used in raising the profile of these businesses. Market awareness was important for accessing financing and investment. The cases tended to infer opportunities, through discussing ‘potential partners’ or ‘potential investment’ opportunities. It is anticipated that a product market awareness strategy is likely to become more relevant as the cases develop.

**Niche**

Innovator strategy and wide market awareness require considerable financial resources. However, size constraints often lead to resource shortages. Niche and novelty are critical to the success of a biotechnology business and IP has a key role within this business setting. This is exemplified by Case B’s experience, whereby the business was the first to company to be awarded a patent to isolate a blue in plants gene and it resulted in creating entry barriers for their competitors (Section 5.2.2.2).

**Internationalisation**

The final strategy posited by Qian and Li (2003) was that of internationalisation. The strategy of internationalisation in the context of the twelve cases is closely aligned with small market limitations, in particular in terms of financing and potential collaborative partners. Specifically in relation to the Australian context the market limitations include:

- tyranny of distance;
- small market;
- lack of critical mass; and
- nature of Australian investors.

In fact, Industry Association A describes the dilemma of the Australian marketplace and internationalisation being the major strategy adopted
The Australian market place is too small and it is never going to be the prime market for the products that are developed in biotech and the way the global chain for biotech operates is through alliances, collaborations and partnerships (Industry Association, A).

Therefore, the twelve biotechnology businesses look outside Australia for potential markets and partners (as described in Section 5.2.2.2 and 5.2.4). Multiple levels of analysis are considered even more necessary in a time of globalisation (Walsham, 2000; Trauth, 2001b). As the strategy of internationalisation is of particular relevance to the twelve businesses, examining the cases through multiple levels of analysis is warranted.

In addition, the research findings also highlight a number of additional business strategies- efficiency and product diversification.

**Efficiency**

Efficiency in this context relates to how to increase the efficiency of the R&D and turn it into a marketable product. The business focus is particularly on decreasing the time to market of their product. Despite Case E’s Comprog initially being a developed as way to increase the operational efficiency of their R&D, this has turned into a value adding strategy.

**Product Diversification (Risk Mitigation)**

As a strategy for mitigating risks associated with biotechnology product development, the twelve cases sought to diversify their R&D base and not concentrate on developing one product. In essence, this strategy involves either looking for a number of applications of the one product (Cases B, D and H) or engaging in research across a number of technology platforms (reflected in all cases).

While the above discussion highlights the strategic nature of the twelve cases, it is the type of strategies adopted that is of most significance. Some of the strategies adopted by the biotechnology KSMEs appear of a similar nature to strategies adopted by larger businesses including creating barriers to entry. From a theoretical significance perspective, the above discussion challenges current conceptualisation as to the strategic nature of SMEs. The strategy of internationalisation, for example, is generally considered the domain of larger multinational organisations and seldom associated with SMEs. Furthermore, the types of strategies adopted align with strategies often adopted by larger organisations. Thus there is merit in exploring the applicability of frameworks and models, developed from empirical research focused on large business, in this particular business context (Section 2.13.1).

**6.3.10 Heterogeneity of Small Business**

In recent years there has been a surge of interest and research on factors that make a small business successful. Although there has been much effort spent in distinguishing small businesses from their larger counterparts, much of the research to date has tended to treat small businesses as a single, homogenous group (Rutherford
et al., 2001). In one research paper it is suggested that SMEs with up to 250 employees can be treated as a homogenous grouping (Ghobadian and O'Regan, 2000). Some researchers propose that policy makers can formulate policies directed at SMEs in the knowledge that all firms employing fewer than 250 employees have broadly similar emphases on strategic planning, culture and leadership dimensions (Ghobadian and O'Regan, 2000). According to Poon (2002), many SME studies report on supposedly homogenous groups that in reality exhibit strong heterogeneity. This has led Poon (2002) to emphasise the importance of ensuring that SME samples are not just classified by number of employees, but also other factors, suggesting percentages of goods exported, management philosophy and background, roles played and the characteristics of the supply chain.

The findings of this research challenge the assumption that SMEs can be treated as a homogenous group. The research presents twelve businesses which display a range of dimensions of cultures and leadership. Significantly, the twelve cases exhibit a range of characteristics related to ISS, contrary to a 'one-size fits all' approach.

Significantly, the twelve biotechnology businesses investigated in this research, by their strategic nature and leadership qualities, are different from 'conventional SMEs'. They also differ from the KSMEs upon which Duhan et al. (2001) based their research. This was identified as a potential issue in the literature review and is now substantiated by the research findings. The KSMEs referred to by Duhan et al. (2001) are from a service-based sector whereas the biotechnology KSMEs, examined in this research, are from a science-sector with a focus largely on knowledge creation and business development. Cardinal et al. (2001) states that even in science-based industries, knowledge-based requirements vary. The stage of development of the knowledge base plays a critical role in determining the nature of product development routines (Cardinal et al., 2001). This suggests in science-based industries there could also be variation. Furthermore, there may be limitations in applying current ISS conceptualisations within this research as well suggesting a need for a revised conceptualisation of ISS in high-technology knowledge-based businesses.

At a methodological level, the findings also concur with Poon (2002) that it is necessary to ensure a cross-section of SMEs are encapsulated, which are not necessarily be determined by size. From a theoretical perspective, it suggests that researchers should be mindful about adopting SME-specific frameworks and reflecting on their applicability and appropriateness to their specific research context.

6.3.11 Reflecting on the Interpretation of Findings

In this section, the findings are discussed and interpreted by comparing current IS literature with key core categories and interrelationships that emerged during analysis. The findings highlight some potential implications at the substantive, methodological and theoretical levels. A number of research challenges have been posited and are revisited in more detail in Section 6.5. However, this section has only interpreted the findings with respect to current IS literature. The findings have not been interpreted with respect to the research questions. This is addressed in the next section (Section 6.4).
6.4 Revisiting the Research Questions: Nature of ISS and Strategic Alignment

Section 6.3 discussed the significance of the findings in terms of the data analysis and current IS literature. However, the researcher has neither interpreted the significance of the findings with respect to the research questions posed nor attempted to describe the current nature of ISS within the twelve Australian biotechnology KSMEs.

In this section, the researcher engages in an in-depth interpretation of the findings around the core category *strategic alignment* as it emerges from the analysis (Section 5.3.3) and initial interpretation of the findings (Section 6.3). In the researcher's opinion, it is the core category *strategic alignment*, out of the five core categories and their relationships, that is significant in understanding and conceptualising how the twelve biotechnology KSMEs engage in ISS. While Section 6.3 revealed some insights concerning all five categories, it is *strategic alignment* which is of the greatest significance for the cases and therefore the IS discipline's understanding of ISS. This section is divided into five parts:

- **Section 6.4.1** - discusses why the core category *strategic alignment* is interpreted by the researcher as being the finding of most significance with respect to the nature of ISS with the twelve cases.
- **Section 6.4.2** - develops an explanatory model of the interpreted significance of strategic alignment with respect to the twelve cases - *Strategic Alignment Framework for Australian Biotechnology KSMEs*.
- **Section 6.4.3** - draws on the explanatory model developed in Section 6.4.2 to explain factors which influence strategic alignment within the twelve cases.
- **Section 6.4.4** - extends the explanatory model in Section 6.4.2 and considers how it can be used to explain the nature of ISS among the twelve cases through the development of the *Strategic Alignment ISS Framework for Australian Biotechnology KSMEs*.
- **Section 6.4.5** - explores ways in which the *Strategic Alignment ISS Framework for Australian Biotechnology KSMEs* could be applied outside its research context.
- **Section 6.4.6** - revisits and answers the research questions.

### 6.4.1 Significance of Strategic Alignment

The five core categories and the relationships between each of the categories offer insight with respect to conceptualising ISS within the twelve businesses. The discussion presented in Section 6.3 highlighted some considerations concerning each of the core categories. For example, if the *role of IT* within the cases is of most significance in relation to understanding ISS within the twelve cases, the interpretation in the previous section suggests the following:

- **IT** would need be considered more explicitly than current ISS conceptualisations;
- **IT** would need to conceptualised both as a tool and an agent of change; and
the nature of ISS could be explained in terms of whether IT is enabler, facilitator or a driver (Sections 6.3.1 and 6.3.3).

Strategic alignment is identified as a significant research theme throughout the analysis and in the initial interpretation of the findings (Sections 5.3.3 and 6.3.2). The data from which strategic alignment emerged was collected through a broad question frame, which sought to explore the nature of ISS among the twelve cases through a multiple lens approach. Strategic alignment is interpreted to be the most significant core category as it displays the strongest interconnectedness both with the other four core categories as well as the five firm types. For example in Section 6.4.4, strategic alignment is used to interpret circumstances in which outsourcing can be considered a strategic activity. Furthermore, the axial code lack of control linked with the core category strategic alignment is also associated with the core category outsourcing. In this respect, strategic alignment underpins elements of core category outsourcing and therefore is considered to be of most significance to these businesses.

As it was described in Section 6.3.2, strategic alignment emerges from a more detailed analysis of the data. It resulted from a selective coding process, which sought to identify an empirical link between the five emergent firm types (i.e. Up and Comings, Ad Hocs, Stalwarts, Stars and Virtuals -Section 5.3.3). Therefore, strategic alignment out of all the core categories has the strongest association with the five firm types. Although there is merit in exploring the other core categories, the relationships between the other four core categories (i.e. role of IT, convergence of R&D knowledge and IT, outsourcing and business activity facilitation) with the five firm types are much weaker. For example, the core category outsourcing is significant in Cases D, H and I and less significant with respect to other businesses. Similarly, convergence of R&D knowledge and IT is only significant to a few cases and emerges through the analysis as being a distinctive characteristic. Therefore, although elements of other core categories and their relationships are drawn on throughout the interpretation, it is nature of strategic alignment, which forms the basis for understanding and conceptualising how the twelve Australian biotechnology KSMEs engage in ISS.

A strong case could be put forward that the core category role of IT is also significant with respect to the twelve cases. Technology underlies much of the innovation in the biotechnology industry and the role of IT emerges as a central core category in Stage One (Section 5.2.5). However, while the role of IT permeates the five firm types, it struggles to capture the semantic relationships between contextual factors, which contribute to the five firm types.

Furthermore, the significance of strategic alignment, in particular R&D and business alignment, is captured directly by the participant’s views. The alignment between the R&D and business strategies is interpreted as vital to the success of the twelve biotechnology businesses (refer Section 6.3.2.1). The R&D or knowledge creation components also add a level of complexity (Section 6.3.2).

In summary, strategic alignment is the finding of most significance with respect to understanding how the twelve KSMEs cases engage in ISS. The next section will build on this interpretation and develop an explanatory model of the significance of strategic alignment within the twelve cases.
6.4.2 Developing an Explanatory Model of Strategic Alignment

In light of the interpretation of the findings and their significance, it is appropriate to consider the potential utility of the two descriptive models that emerged at the end of Stage One and Stage Two of data analysis, as the basis for developing an explanatory model of strategic alignment and its importance with respect to ISS in KSMEs.

The Stage One descriptive model is considered to be an accurate, high-level representation of the twelve cases. As reflected upon at the end of Stage One, the descriptive model (refer to Figure 5-4) appears to be more closely aligned to an earlier model presented by Levy and Powell (2000), the ISS model for SMEs (Section 2.9). Table 6-1 provides a comparison between the model grounded in the data and Levy and Powell’s model (2000).

Table 6-1 Comparison of Stage One Descriptive Model

<table>
<thead>
<tr>
<th>Levy and Powell (2000) Model</th>
<th>Emergent Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Business Context</strong></td>
<td><strong>Environmental Context</strong></td>
</tr>
<tr>
<td>• Market</td>
<td>• International Market</td>
</tr>
<tr>
<td>• Relationships</td>
<td>• Competitor /Partners</td>
</tr>
<tr>
<td>• Customers /Suppliers</td>
<td>• Nature of Biotech</td>
</tr>
<tr>
<td><strong>Business Process</strong></td>
<td><strong>Business Context</strong></td>
</tr>
<tr>
<td>• Identification of Work Process</td>
<td>• Relationship Management</td>
</tr>
<tr>
<td><strong>Strategic Context</strong></td>
<td><strong>Strategic Context</strong></td>
</tr>
<tr>
<td>• Vision for change for the owner</td>
<td>• Niche /Novelty</td>
</tr>
<tr>
<td><strong>R&amp;D Context</strong></td>
<td><strong>R&amp;D Context</strong></td>
</tr>
<tr>
<td>• Commercial Orientation</td>
<td><strong>Convergence of R&amp;D Knowledge and IT</strong></td>
</tr>
<tr>
<td></td>
<td>• Dichotomy of science and business</td>
</tr>
</tbody>
</table>

Table 6-1 demonstrates that both models appear to encapsulate similar areas, although at times different naming conventions are adopted. For example, Levy and Powell’s (2000) model uses the term ‘business context’, whereas in the emergent model the term ‘environmental context’ is employed. However, these two contexts differ slightly in what they encapsulate. In the Levy and Powell (2000) model, business context addresses the market and relationships, whereas in the emergent model this context also includes the nuances of biotechnology context, including Australian limitations and the nature of biotech. Furthermore, Levy and Powell’s (2000) model demonstrates their business context as having a direct influence on the nature of ISS, whereas in the emergent model, the environment appears to have an indirect influence. As consequence, there is merit in researchers adopting Levy and Powell’s (2000) model as a starting point for exploring ISS in the SME context to provide high-level insights. However, there were specific characteristics that needed to be considered in the context of KSMEs, in particular the need to include an explicit knowledge-creating context (R&D context). Furthermore, it suggests that IT needs to be considered more explicitly in the biotechnology context, rather than just a backbone infrastructure. The

permeable boundaries and the dynamisms between contexts suggest that firm boundaries are not as stable or as rigid as implied in conventional IS theory. The model also does not encapsulate the theme of strategic alignment and the explicit role of IT. Therefore, the Stage Two descriptive model, in which strategic alignment is identified as a central core category, was considered.

Stage Two of data analysis saw the repositioning of core category of the *role of IT* and the emergence of a fifth core category, *strategic alignment*. Strategic alignment emerges as a central research theme and is interpreted as important concept in exploring ISS in the twelve KSMEs. While the descriptive model does highlight key relationships, it is difficult to ascertain the location of the five firm types on this framework or the nature of their ISS. The location of the core category *strategic alignment* to the centre of the diagram and elements of its relationships between the core categories are drawn upon to explain the nature of ISS within these twelve cases and forms the basis of the strategic alignment framework (refer to Figure 5-6).

In summary, while both descriptive models provide insights and will be drawn on to construct an explanatory model, the researcher needed to explore other options for developing a model of strategic alignment with the twelve cases.

6.4.2.1 Development of a Strategic Alignment Model for Differentiating Australian Biotechnology KSMEs

Although the two descriptive models, which emerged from the data analysis, provided some insights, the researcher returned to the literature, in particular to the literature on strategic alignment in the SME context (Section 2.4.1 and 2.8.1). The purpose of drawing on the literature was two fold. Firstly, it enabled the researcher to reflect on how the findings of this research inform current theory. Secondly, it could reveal how these findings develop new theory.

The researcher reflected upon whether SME-specific strategic alignment frameworks could be drawn upon in this research context to develop a model to explain and incorporate the specificities of the twelve cases.

In Section 2.8.1, an analytical framework called the focus-dominance model was presented. In the focus-dominance model in which SME alignment is defined by the level of customer dominance to capture both cost advantages and value-added benefits, as well as the function of fit between IS and the SME strategic context. The major limitation of the focus-dominance model was the customer dominance component of these models (Ballantine *et al.*, 1998; Levy *et al.*, 2001b; Levy *et al.*, 2002). On reflection, the customer-dominance focus appears to be of little relevance to the twelve biotechnology businesses. Few cases have a product on the market and of those that do, the product being marketed is not the primary focus of their business’ R&D strategy. The business activities of the twelve cases are largely focused on business and product development (Section 6.3.5). Business development involves commercialising their R&D, product development and seeking venture capital as opposed to seeking customers per se. The customer focus of the focus-dominance model (Ballantine *et al.*, 1998; Levy *et al.*, 2001b; Levy *et al.*, 2002) could be of more relevance to the cases once these biotechnology businesses have a product on the
market and begin to enter into the marketing and distribution phases (Section 3.3.5). However, due to the long product development time, the focus-dominance model in its current state is likely to be of little relevance for a number of years. Furthermore, the researcher would also urge caution in applying focus-dominance or similar models even once a biotechnology business is at the stage of marketing and distribution. It is the intention for a number of the businesses either to go into partnership with a large pharmaceutical company or to sell the product to another company, which may influence their SME dynamics. As Case H described:

We pass products on to other people to take to market (Case H).

Despite some limitations of the focus-dominance model, there is merit in exploring its adaptation to the biotechnology KSME context. In the model, performance is explained as a function of fit between the IS and strategy and the SME's strategic context. In the context of biotechnology KSMEs, a critical success factor in this industry is attributed to the fit between R&D and business strategies. The focus-dominance model uses the application of IS as either operational or strategic, which is emergent theme with respect to strategic alignment (Section 6.3.2.4).

Therefore drawing on the focus-dominance model and the descriptive models that emerge from the data analysis, the researcher developed a framework, which encapsulates the alignment between R&D, business and IT at both the operational and strategic levels. Similar to the focus-dominance model, the quadrants are drawn on to develop insights with respect to the nature of ISS among the twelve cases, according to their position on the framework.

The strong emergence of the research theme R&D and business alignment and its interpreted significance in the biotechnology business context, suggests this to be an appropriate focus for a framework in place of the customer focus of the focus-dominance model. The twelve cases are focused on business development and product strategies (Section 6.3.5). In addition, there needs to be consideration of the role of IT at both an operational and strategic level (Section 6.3.2.4). Considering the relationships between the core categories and the central core category, a framework is developed drawing on the focus-dominance model and the descriptive models from the data analysis. The decision to make the both axes referring to the role of IT, is a result of the central role IT played in these businesses (Section 6.3.3.) where it is evident that IT can be applied for operational efficiency and value-adding purposes.

Avison et al.'s (2004) study, for example, indicates that the case study's use of IT was dual focused, in which IT was used to seek operational efficiency but also as a mechanism for gaining competitive advantage emerged (Tallon et al., 2006; Avison et al., 2004). Similarly, Porter (1996) defines firm performance in terms of two strategic foci: operational effectiveness and strategic positioning.

Porter (1996) views operational effectiveness as businesses performing similar activities better than rivals while strategic positioning entails performing different activities or performing similar activities but in very different ways. In this research, operational efficiency is described as the use of IT in a capacity to support organisational and management processes and structures. The business strategies tend to be internally focused and the role of IT is to improve the manner in which internal
business processes are performed. Some cases demonstrated clearly defined strategies for obtaining operational efficiency, using IT to improve the quality, speed and in some instances increasing the flexibility of current business processes.

If the role of IT is strategic, the focus of the business is more akin to Porter’s (1996) strategic positioning or value adding perspective. In this instance, businesses may align their use of IT to achieve strategic positioning. These business strategies appear to focus on using IT on more externally-focused or market-based initiatives, however, these businesses may still be proficient at using IT to achieve operational efficiency.

Role of IT in Business Development

In this framework, the horizontal axis of the framework focuses on business development (refer to Figure 6-1), where the role of IT is operational focused or strategic focused. These dimension are described as follows:

Role of IT in Business Development - Operational

The Role of IT in Business Development - Operational dimension of the framework refers to role of IT and its alignment with the business’ development strategy of achieving operational efficiencies. The most commonly used applications were word processing, spreadsheets and, at times, database packages in addition to Internet and email. Several cases also mentioned the use of financial application packages. A notable feature was the use of two distinct operating systems within the twelve businesses. PCs were used for business applications and Macs were often used for R&D purposes.

Role of IT in Business Development - Strategic

The Role of IT in Business Development - Strategic dimension refers to using IT in a value-adding capacity assisting these businesses in developing the business enterprise. As described in Section 6.3.5, a number of key strategies were directed towards business development for example relationship management and reputation management. Some examples, where IT was used strategically include investigating e-commerce capabilities, using internet to enable a business to appear more substantial than it was, and effectively using email to establish relationships with other businesses. Businesses who sit in this dimension appear to use IT to achieve greater market reach or to identify entirely new market opportunities.

Role of IT in R&D Strategy

Similar logic was used in constructing the vertical axis.

Role of IT in R&D Strategy - Operational

The Role of IT in R&D Strategy - Operational dimension of the framework refers to the use of IT to achieve operational efficiencies in respect of R&D processes. As described in Section 5.2.4, a key strategy for biotechnology businesses was increasing the efficiency of their R&D
processes to reduce the time to market of their product. This commonly included the use of statistical applications to assist with the 'number crunching' processes. Some businesses developed in-house R&D applications (Case F). In this capacity, IT assists in increasing the efficiency of their R&D process, which supports their R&D strategy (Section 5.2.2.1).

Role of IT in R&D Strategy - Strategic

The Role of IT in R&D Strategy - Strategic dimension of the framework involves using IT to add value to their current R&D processes. The most significant was taking advantage of propriety R&D knowledge and applying the computational power of their IT to add value. Case L had modified the propriety software of their equipment and now regarded it to be a key strategic R&D tool. Case K was using data mining software to tap into their data sources. Case E developed in-house a computational chemistry program. The CompProg developed by Case E had been demonstrated to be superior to other programs then available and its use was not confined to Case E’s business. Case E had a number of partnerships with other companies which would enable the companies to access Case E’s suite of computer programs. Figure 6-1 presents the Strategic Alignment Framework for Australian Biotechnology KSMEs.

Figure 6-1 Strategic Alignment Framework for Australian Biotechnology KSMEs

The twelve cases can be mapped onto the framework (refer to Figure 6.1) with their position relative to the horizontal and vertical axes determined through drawing on the analysis and interpretation of participant discussions (Sections 5.3.2, 6.2 and 6.3).
Critical reflection is reintroduced at this stage to verify if the framework is a good representation of the interpretation. It was anticipated that as the central core category strategic alignment emerged from the abstraction of semantic relationships that were distinctive to the five firm types (Section 5.3.6.6), the location of the twelve cases and their proximity to one another should roughly correspond. In Figure 6-2, it is evident that the location of the twelve KSMEs largely corresponds to the five firm types. Therefore, the Strategic Alignment Framework for Australian Biotechnology KSMEs appears to be an accurate representation of the analysis. It is the researcher's opinion that different levels of maturation may explain the small differences between the locations of the cases within the five firm types.

**Stars**

The Stars are located in the strategic quadrant along both the ‘role of IT in R&D strategy’ and the ‘role of IT in business development’ axes. For example, Case E’s CompProg is used to increase the operational efficiency of their drug discovery programs. However, Case E has also marketed this product and has entered into a number of partnerships, resulting in CompProg being a key R&D area. The Stars also describe using their IT in business development. Reflecting on the overall business and R&D alignment within the three cases, the way in which IT was used to assist with such processes, for example improving communication as well as their centralised organisational (i.e. co-locating business and R&D operations) also supports these businesses being positioned in the top right-hand quadrant of the framework. Case G is positioned slightly away from Cases K and E as it had only started to venture into bioinformatics and in this respect their R&D strategy is interpreted to be not as developed as Cases K or E. It is for this reason Case G is not located more closely to Cases K or E.
Up and Comings

The Up and Coming cases utilise IT predominantly for operational efficiency in terms of their R&D strategy. The focus of Cases A and C is interpreted to be on business development. Although the Up and Comings are situated in a similar position along the 'role of IT in business development' axis as the Stars, the manner in which this position is achieved differs significantly.

As highlighted in Sections 5.3.2.1 and 6.3.2.4, Cases A and C do not possess strategic nor sophisticated IT. Instead the Up and Comings are able to apply their standard business technology in a strategic manner to assist with their business' development. For example, Case A's strategic use of the Internet and email resulted in a collaboration with a billion dollar Japanese pharmaceutical company (Section 5.3.2.1). Case C is located more towards the operational quadrant as its focus is still on the R&D strategy to some extent. However, Case C has demonstrated the use of IT in business development in a value-adding capacity. The Internet and email were valuable and exploited as marketing tools in Case C.

Virtuals

The decision to place the Virtuals in the operational efficiency quadrant was made on the basis of their distinct outsourcing strategy and showing little R&D and IT alignment. This is because the R&D operation of the Virtuals is outsourced and relies on contractors both in Australia and overseas (Section 6.3.2.3). In addition, while Case H suggests in the short-term, the role of IT in business development is for risk minimisation and reducing the business financial outlay (Section 5.3.25), as a long term strategy, this approach appears restrictive. As discussed in Section 6.3.4 in the long term, outsourcing is interpreted as having the effect of reducing the strategic flexibility of the Virtuals and stifling their future business development.

Cases D and H are similar in respect of their set-up. Case I has only recently been set-up. However, as the attributes of Case I are more closely aligned with Cases D and H, it is interpreted that Case I is likely to follow a similar path. The outsourcing or contracting out of their R&D reflects a lack of business activities, which made reference to their R&D. As described by the excerpt below:

We don't really use that stuff... the researchers working for us may use it, from the business side we don't use it (Case I).

Therefore, the Virtuals' strategic focus is largely on business development.

Stalwarts

The operational nature in which IT is used within the Stalwart both in terms of their R&D and business development necessitates. Cases B and F being located in the lowest left-hand quadrant. Although the Stalwarts are well-established businesses, the analysis did not elicit the role of IT beyond merely providing operational efficiencies in terms of their business development or R&D. Although their IT is managed in-house, both Case B and Case F are public companies and any key decisions in relation
to their IT tends to be controlled by their majority shareholder. Therefore IT control is effectively outside the control of both cases' management teams.

**Ad Hocs**

The Ad Hoc firm type represents the cases that displayed little alignment between their business and IT. At best, Cases J and L use their IT for operational efficiency. Even at times, Cases J and L struggle using IT for operational efficiency often resorting back to their paper-based system (Case L) or in the situation of Case J, using email to send files across their distributed organisational set-up. Surprisingly, these businesses provide glimpses of IT being used in a strategic capacity in terms of their R&D (Section 6.3.2.4).

**Figure 6-3 Strategic Alignment Framework - Mapping of Five Firm Types**

![Strategic Alignment Framework](image)

Figure 6-3 demonstrates how different configurations of strategic alignment - knowledge (R&D), business and IT can be used to differentiate the five firm types of Up and Comings, Ad Hocs, Stalwarts, Stars and Virtuals. The framework can be used to describe the emergence of five firm types in terms of their strategic alignment and how the different alignment configuration influences their position on the framework.

This section has developed an explanatory model adopting strategic alignment as a lens and considered how the twelve cases could be categorised into five firm types. The next section will explore factors, which affect strategic alignment within these businesses and their relative position on *Strategic Alignment Framework for Australian Biotechnology KSMEs.*
6.4.3 Factors Influencing Strategic Alignment

This section will briefly reflect on the potential factors that influence strategic alignment that emerged in the analysis and initial interpretation. The factors are interpreted to influence the relative position of the five firm types on the Strategic Alignment Framework for Australian Biotechnology KSMEs. Furthermore, if as this interpretation suggests, strategic alignment is a key factor in describing the nature of ISS among the twelve Australian biotechnology KSMEs, then these factors are also likely to impact on the nature of ISS among the cases.

In the analysis and interpretation (Sections 5.3.2.6 and 6.3.2), the core category strategic alignment in several cases is closely associated with the axial codes of lack of control and management experience. Significantly, the axial codes are also interpreted to be closely associated to the core category of outsourcing (Section 6.3.4), particularly IT outsourcing. Although the association between the axial codes is not evident across all twelve cases, some interesting observations can be made with respect to their association to the core category strategic alignment in several of the cases and their respective location on the framework. This involved revisiting the descriptive analysis (for additional insights see Section 4.6.2.1 and Appendix E).

Mapping the cases in which the two axial codes of lack of strategic control and management experience emerge onto the Strategic Alignment Framework for Australian Biotechnology KSMEs reveals some interesting observations. Firstly, it is noticeable that all cases in which lack of control emerges are located on the left half of the framework (Figure 6-4). On reflection, these are businesses in which their IT is largely outsourced. In this part of the framework, the role of IT in business development is largely used for operational efficiency purposes. This is interpreted to mean that lack of control influences whether IT is used strategically in business development within this particular research context. This reiterates an observation made in relation to outsourcing that the lack of strategic control in these businesses appears to stifle the future strategic development of the business through reducing their strategic flexibility (Section 6.3.4). In summary, the researcher interprets situations where there is a lack of strategic control with respect to IT stifling business development as well influencing the nature of strategic alignment. This interpretation also has implications with respect to whether outsourcing in an SME environment is a strategic phenomenon.
A similar observation can be made between the relationship strategic alignment and the management structure of these businesses, specifically their management team composition. The findings indicate that management experience influences alignment and is consistent with the emergence of the theme business acumen in Cases A and C (Section 5.3.2.1). The researcher went back and analysed the descriptive analysis section (Appendix E) to ascertain the experience and composition of the remaining management teams. The initial icebreaker questions provided a mechanism for the researcher to further explore the viability of this possible connection (Section 4.5.3.4 and Appendix D). Businesses located in the right hand (strategic) quadrants along the ‘role of IT in business development’ axis (horizontal axis), have a mixture of R&D and business skills and experience within their management teams. While businesses located in the left hand quadrant tend to have an emphasis on one type of skillset and experience among their management team, either mainly R&D-focused (Ad Hocs and Stalwarts) or business experienced (Virtuals). The mix of R&D and management skills within the cases located on the left-hand quadrant appears unbalanced and biased towards one business component (i.e. business or R&D).

A potential relationship exists between the management team composition, skills and the businesses' location on the Strategic Alignment Framework for Australian Biotechnology KSMEs. This indicates that businesses, which have a management team with a combination of R&D and business knowledge and experience, appear to be in a better position to develop their businesses and use IT strategically in terms of business development.
One explanation as to why it is desirable for the twelve cases to have a mixture of both R&D and business skills at the management level is that this set-up facilitates better orientation of R&D strategy with business strategy and vice versa as well as minimising the dichotomy, which commonly exists between these two areas (Section 5.2.4). Noticeably, in the cases in which the role of IT in business development is strategic (i.e. those cases situated in the right had quadrants along the horizontal axis of Figure 6-5), the original founder is still a member of the management team but had relinquished their position as CEO. The founders have generally taken on the positions of R&D manager or chief scientific officer (CSO) of the business (Case A, E, G, K). The advantage of this set-up is interpreted as follows:

- the tacit knowledge associated with the business still remains in the business (Thorburn, 2000);
- there is R&D representation at the strategic level in business;
- the original founder still has some control over or a say in the business;
- it goes some way in overcoming the dichotomy between knowledge and R&D and as Case G describes - “science driven by business requirements”; and
- a CEO with previous business experience is more likely to have contacts as well as knowledge about how the business sector operates.

The cases located in the operational quadrants have either a predominantly business or R&D-skilled management team. The Ad Hocs still have the original business founder leading their business. Interestingly, the Ad Hocs exhibit on some occasions strategic uses of IT with respect to their R&D but demonstrated poor alignment between their IT and business operations (Section 6.3.2). One interpretation is that due to the R&D focus of their management team, the strategic nature of the IT is focused on the R&D operations rather than business operations. An area of future research would include exploring the management team’s influence on the focus and nature on the use of their
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IT. This reminded the researcher, when reflecting on this observation, of a comment made by an industry representative during the familiarisation stage.

And so the type of issues that we are covering are process and systems such as licensing, capital raising and value creation, project management skills, international positioning, investor relations, presentation skills and investor pitching, biotech company management, IP strategies, drug development and regulation, competitive intelligence- access to it and what it all means, clinical trials. So really a long list of things- ranging from the very broad basics of business, as we are dealing with skill building a scientific community, which is not necessarily as business savvy as other sectors (Industry Consultant A).

The Virtuals are managed by a core management teams consisting of members with a business background (often largely big pharma or law). The strong business focus of the management teams may explain why their IT set-up is focused towards risk minimisation and reducing financial outlay and there is limited emphasis on their R&D strategy. This business-focus again may be symptomatic and the lack of R&D people involved in its management team.

The Stalwarts are an exception to this observation as these businesses’ management teams contain a balance of business and R&D skills. However, both Cases B and F referred to a time where the original founder led their business. During this period, these businesses went through a process of initial public offering and noted the financial strategy was over-reliant on government funding (Section 5.2.2.2 and 5.2.4). Case B commented that their IPO strategy has been being detrimental to the business and at one point the business was close to bankruptcy (Section 5.2.2.2 and 5.2.4).

The above discussion suggests that having either an overly R&D or business-focused management team is influential on strategic alignment, in particular with respect to their businesses development. Similarly, the lack of strategic control can also influence the nature of these businesses. The researcher reflected on current IS literature on strategic alignment with an SME context. Hussin et al. (2002) suggest that previous research indicates aligned firms have greater IT maturity, CEO knowledge of software is greater in aligned firms and however reported little support for a relationship between external IT expertise and IT alignment. Following is a brief discussion on the significance of these observed factors in relation to current IS theory.

IT Sophistication

There are varying degrees of IT sophistication displayed among the twelve cases (Appendix E - Case Vignettes). The degree of IT sophistication in these twelve cases appears to be largely related to resources and often the size of the business. For example, Case K was investing in IT equipment such as bar coding equipment and were intending to set-up data mining capabilities. Similarly, Case E had an intranet set-up as well as an established bioinformatics system. The findings also indicate that the degree of IT sophistication may not necessarily result in businesses having a

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51 It should be noted that while there appears to be a distinct lack of R&D skills in a management team, they still have a Scientific Advisory Board.
strategic IS nor that they necessarily use their IS strategically. Cases A and C gained strategic benefits from their IT, which of a relative limited sophistication. It is the merging their strategic use of IT with *business acumen* that is significant.

**CEO commitment to IT is positively related to IT alignment.**

In Hussin *et al.*'s (2002) study, CEO commitment is considered to positively relate to IT alignment. In the cases explored in this research, the level of IT knowledge and skill observed among the twelve cases differs from traditional IS research concerning SMEs and their use of IT. As Case B describes

> And I guess us scientists, we have been using computers since they were first available and there is a natural interest there so you tend to use it in your solution or in your problem solving. It is almost second nature (Case B).

This suggests that 'CEO commitment' may not necessarily be as influential within these twelve biotechnology businesses as indicated in current literature. However, once IT is adopted, how well it is implemented influences the performance of a business and relies on the education, experience and know-how of the owner/manager (Locke, 2004). Although the manager's background is generally regarded as being influential on the adoption of IT, this research suggest that a manager's background has influence on the nature of alignment in particular how IT is applied, particularly during the business development stages.

**External Expertise**

In their research, Hussin *et al.* (2002) suggests the use of external expertise may also influence the level of alignment. Furthermore, IT consultants and vendors were shown to have a significant influence on IT success in small firms (Thong *et al.*, 1996) and computing use in small firms (Igbaria *et al.*, 1997). In the small business context, many firms have neither an IT manager nor an IT department. Instead, IT expertise is sought from outside the firm from both consultants and vendors (Thong *et al.*, 1996). This indicates that external parties influence IT in small businesses.

Within these twelve cases, there are different levels of reliance on external expertise in relation to their IT. Case B highlights an element of trust associated with IT experts. This research suggests that the level of control and use of external expertise influences alignment. Thong's (1999) analysis indicates that IT success was more likely to occur when external IT experts worked as a team with senior management firms even if they had no formal 'power' through ownership over the firm (Ravarini *et al.*, 2001).

All cases rely on outsourcing/external expertise in some capacity with respect to their IT. However, it is the cases that use external expertise selectively and in a strategic manner that benefit from using external expertise. As previously concluded, to ensure alignment with the overall business, the management team still needed to be involved and not outsource key decisions to external consultants (Section 6.3.4)

In summary, strategic alignment plays a significant role in the context of these KSME. Factors such as management expertise and the lack of strategic control are interpreted
to influence nature of strategic alignment in the twelve cases and this is supported by
the literature. The lack of strategic control over IT, which often occurs in adopting an
outsourcing strategy, appears to restrict the utility of IT beyond being used in an
operational capacity in business development. Significantly, the two factors of
management experience and lack of strategic control appear to influence ability to use
IT strategically in business development. As these biotechnology businesses must
focus on commercial outcomes, it suggests that business development may influence
the competitive nature of these businesses.

In conclusion, the Strategic Alignment Framework for Australian Biotechnology
KSMEs can be drawn upon to explain how the lack of control and management experience
influence the strategic alignment within these twelve cases. As strategic alignment is interpreted to be a significant factor in determining the nature of ISS among the twelve KSMEs, it follows that the factors of lack of control and management experience are also likely to influence the nature of their ISS. In the section to follow, the researcher interprets the significance of the five firm types and strategic alignment and what this suggests about the nature of ISS among the twelve Australian biotechnology KSMEs.

6.4.4 An Interpretation of the Five Firm Types, Strategic Alignment and the Nature of ISS

In this section, the researcher will interpret the significance of the five firm types, the emergence of strategic alignment and what this suggests about the nature of ISS among the twelve cases. The position of the five firm types on the framework is used to describe the nature of ISS among the twelve cases. Interestingly, while the data analysis revealed the Virtuals and Stalwarts as distinct firm types, the interpretation of these businesses in terms of the nature of their strategic alignment suggests the two firm types have a similar ISS. This observation is made by the position of the Virtuals and Stalwarts within the same quadrant on the Strategic Alignment Framework for Australian Biotechnology KSMEs. Considering the nature of ISS within the twelve cases in terms of the overall alignment between R&D, IT and business strategies, the two cases are similar and thus are located in the same quadrant.

The five firm types (i.e. Stalwarts, Up and Comings, Ad Hocs, Virtuals and Stars) are based on the relationship of contextual factors with respect to strategic alignment. The descriptive names assigned to the five firm types by the researcher during analysis implicitly reveal some insights in terms of the researcher’s initial impression and interpretation of the businesses. The nature of ISS within the twelve Australian biotechnology KSMEs is discussed in terms of the characteristics exhibited by the businesses, which lie in each of the four quadrants. The characteristics are based on the interpreted significance of the position of these businesses on the framework (Section 6.4.), as well as the factors that influence their position of the framework.

This section discusses how the significance of the relative position of the five firm types on the Strategic Alignment Framework for Australian Biotechnology KSMEs The nature of their ISS is described as the alignment between three components: R&D (knowledge), business and IT.
Characteristics of Stars’ ISS

The cases categorised as Stars possess the most strategic ISS in comparison to the four other firm types. The researcher interprets that the Stars possess an innovative ISS. There are several reasons for this interpretation. Firstly, Cases E, G and K display a strong alignment between their R&D and business aspects of their business (Section 6.4.2), which is significant in the biotechnology business context, where a business’ R&D activities need to be directed towards commercial outcomes.

The Stars display a high-level of alignment and integration among their business, R&D and IT strategies (Section 6.4.2). Not only is IT applied to improve operational efficiency but it is also applied in a value-adding capacity within the business. The apparent success of the Stars may be supported by their relative growth compared with other cases, which are similar to the Stars in age but are still reasonably small in size (i.e. Up and Comings, Virtuals and Ad Hocs). This suggests organisational maturity models may be of relevance to exploring ISS in this context and suggests merit in pursuing a longitudinal study (Section 7.5).

In addition, the Stars exhibit a good mix of business and R&D knowledge within their management team. Achieving a balance between R&D and business skills in the management team occurred earlier on in the business development phase and was a deliberate strategy. This transition from an R&D-managed business (where the original founder operates in a CEO capacity) to a management team which has business expertise is vital during the business development stage. The importance of possessing a management team with business experience may relate to the fact that business leaders are more likely to have built up and established business relationships and networks as well as have a good understanding of key business concepts such as dealing with venture capitalists. This is supported by a comment the researcher remembers from the familiarisation stage from Research Institute A where the following comment was made:

I worked in Industry before I came here for many years, 12 years here and in the US so that has allowed me to build up a lot of contacts. And they have contacts as well and it just builds up that way. And that has proved good (Research Institute A).

However, businesses led by scientists, are in a less favourable position in this respect. Scientists-turned-CEOs are likely to have strong ties with research institutions and have established networks with scientists, which indeed offer insights into scientific developments. However, these leaders are likely to have had little opportunity to build up and establish business contacts (Section 6.4.3), and have a limited understanding of business operations. Therefore, a management team with members from both business and scientific backgrounds ensures the business has broader access to both scientific and business skills and contacts. This implies that there is better alignment between the business and R&D operations at the strategic level.

Commercially-focused R&D is considered a critical success factor within these biotechnology businesses. Case E provides an exemplar, where the CEO, who is also the CSO and founder, acts as a facilitator between the R&D knowledge and business knowledge sources. As the CEO/CSO describes himself
From the business side of things, I am the interface with scientists, and Case E-VC and financial director... that is where the business aspects get run (Case E).

The CEO acts more in a business capacity but also sits in on all meetings within the various groups

I mean I have a little knowledge, which can be a dangerous thing, in each of the areas so I try and pull them together in various meeting and deploy them in a strategic sense (Case E).

This characteristic is absent from the four other firm types. In addition, the business set-up and the use of intranets to facilitate and lubricate ‘the wheels of communication’ also appear influential.

In conclusion, the Stars are interpreted to have an innovative ISS. The nature of their ISS is interpreted as innovative due to the strong alignment of the three elements of the businesses - R&D, IT and business strategies at both the operational and strategic levels.

**Characteristics of the Up and Comings’ ISS**

The firm types called the Up and Comings are also strategic with respect to their ISS. The focus of these businesses is primarily on business development (Section 6.3.5 and 6.4.2). Similar to the Stars, Case A has a CEO, who had come from business background. The original founder, while still on the management team, has taken on the role as R&D manager. This arrangement is interpreted to be the most appropriate management structure for a biotechnology KSME for several reasons as described in Section 6.4.3.

The Up and Comings’ IS is applied in a strategic capacity in terms of business development, however, there is little evidence of it being applied other than in an operational efficiency capacity with respect to their R&D. If strategic alignment is key factor to determining the characteristics of the Up and Coming businesses, this suggests the potential for these businesses to move into the innovative quadrant, in which the Stars are located. The nature of the axial codes of management team and lack of control are similar in both the Stars and Up and Comings. As the nature of the factors which affect strategic alignment appear to be similar in the Stars and Up Comings, suggested there were other differences between the two firm types that account for their different locations on the framework.

The Stars appear to be larger, possess more resources (i.e. employees) and are further along the product development path. This observation suggests that levels of maturation may impact the nature of ISS within these businesses. The stage of development of the knowledge base is considered by some researchers to play a critical role in determining the nature of product development routines (Cardinal et al., 2001). It is interpreted that the strategic focus may be a key determinant as to whether an Up and Coming will eventually move to the same quadrant as the Stars. For example, the Stars are further along the product development stage, whereas the Up and Coming cases are still in the business development stage. Therefore, a fruitful area of future research would be to explore whether organisational maturity, in
particular the stage of product development, is a determinant or influence on the nature of ISS (Section 7.5).

The organisational maturity of the businesses has led to the Up and Comings to be interpreted to have an ISS, which can be described as ‘high potential’. Cases A and C possess the right characteristics to move into the same quadrant as the Stars (i.e. management team and strategic control of their IT), but it is the strategic focus in terms of their level of maturation in product development and business development which is preventing them from moving into the same quadrant as the Stars. Whether the Up and Coming cases move into the innovative quadrant would be an interesting follow-up study.

**Characteristics of Ad Hocs’ ISS**

The Ad Hocs limited set-up and their R&D-dominant management team has resulted in the nature of Cases J and L’s ISS being interpreted as R&D-focused. There are two interpretations, firstly the businesses are still in the early R&D stages and have only just set-up the business. Another interpretation may relate to the focus of their management team, which is largely from a scientific background rather than a business background. Ad Hoc cases may eventually turn into Stalwarts. This connection is made through several comments by the Stalwart business Case B, in which the participant alludes to their previous management set-up, in which their original founder was still leading the firm during business development stage (Section 6.4.3). Case B suggests the fact that their business was led by a scientist may have been problematic.

**Characteristics of the Virtuals’ ISS**

Although the Virtuals’ business model is aligned with a strategy of risk minimisation in the short term, in the long term the strategy may stifle the business development and ability to meet their long term objectives (Sections 6.3.2.2 and 6.3.4). Although Case I is not as mature as the other two cases, it possesses the qualities of a virtual business structure and outsource strategic decisions with respect to its IT. Therefore it is interpreted that Case I has the potential to follow a similar path as Cases D and H. The strategic inflexibility that a virtual business model set-up induces, suggests the role of IT in business development is no more than increasing operational efficiencies. The Virtuals’ current IT outsourcing set-up is stifling their strategic flexibility. Therefore, the ability for Cases D, H and I to move to the innovator quadrant may also be stifled (Section 6.3.2.2).

Interestingly, Case G was previously set-up as a ‘virtual company’. However, through the appointment of key management staff, the business has transformed and is now positioned as a Star. A quote from their website also highlights this point:

> New management appointments have resulted in Case G transformation from a virtual biotechnology company with largely outsourced research activities to an in-house, state-of-the-art operation focused on identifying and validating high value drug targets, and building a future drug discovery capability (from Case G website).
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This suggests a change in strategic focus induced by the management team may be an influencing factor behind this move from one quadrant to another. In this respect, this observation suggests management experience has an influential role in transforming Virtual into a Star (i.e. the role of IT in business development and R&D strategy moving from being of operational efficiency nature to a strategic nature). It supports an earlier interpretation that management experience influences the nature of ISS (Section 6.4.3). As part of the process of moving from a Virtual to a Star, the businesses appear to move towards a more centralised structure. This is interpreted as being important in overcoming the dichotomy between science and business and contributes to the overall R&D and business alignment.

In summary, while these businesses adopt a virtual business model and IT is an enabler of this strategy, the nature of these businesses' ISS is interpreted to be no more than achieving operational efficiency.

Characteristics of Stalwarts

Finally, the Stalwarts' organisational current set-up as a publicly-listed company has restricted their business growth. The restrictiveness of this set-up is related to the lack of control, with respect key IT decisions. The restrictions placed on their IT has resulted in Cases B and F's IT currently being of an operational nature.

Interestingly in both cases the R&D founder managed these businesses during the period both businesses went through an IPO (i.e. during business development). Case B refers to their apparent lack of business experience, led to the business adopting an IPO strategy too early. It suggests that undergoing an IPO too early in the business development phase can be detrimental to a business' ISS.

In this respect, the Virtuals' and the Stalwarts' ISS are interpreted to be of a similar nature, despite having vastly different business set-up. This highlights the potential for two businesses which appear to have different ISS focus (i.e. Virtuals being Groups 3 and Stalwarts as part of Group 1), how the business' IT is operationalised can result in these two distinct firm types having a similar ISS.

Figure 6-6 maps the five firm types in terms of the strategic alignment and role of IT and utilises the above interpretation to describe the nature of their respective ISS. The nature of their ISS is interpreted as the degree of alignment between the factors R&D, business and IT strategies both at the strategic and operational levels.
There are four ways to describe the nature of ISS among the five firm types:
- Innovative;
- High Potential;
- R&D-focused; and
- Operational Efficiency.

**Innovative**

Businesses described as having an innovative ISS exhibit the following characteristics:

- have a balance of R&D and business skills/experience at the management level;
- the original founder may have taken on a role as a CSO or R&D manager and in this capacity acts a conduit between the business and R&D operations and helping with this alignment at a strategic level;
- tend to adopt a largely in-house strategy; and
- have a centralised business set-up.

In this capacity, technology is utilised in a strategic capacity in business development as well as in their R&D strategy.

**High Potential**

Businesses described as having a high potential ISS exhibit the following characteristics:

- are focused on business development in particular establishing relationships and collaborations, investment and potential research opportunities;
- tend to use their IT strategically to assist with business development;
• have a management team, which has a mixture of R&D knowledge and business skills. For example, the original founder is likely to have moved to the position of R&D manager or CSO.

In this capacity, IT is utilised in a strategic capacity in terms of business development but largely for operational efficiency with respect to their R&D strategy.

**R&D-focused**

Businesses described as having an R&D-focused ISS exhibit the following characteristics:

- may be a recent spin-off firm from a research institution or university;
- the original founder is likely to still be heading up the business. The lack of business skills at the management level should be viewed cautiously;
- their IT may be strategic in terms of meeting their R&D strategy needs, however their IT often appears to fail to meet their business needs at times resorting to paper-based or manual systems; and
- the business set-up is likely to be distributed across a number of sites and their IT is generally outsourced.

In this capacity, IT is utilised for operational efficiency purposes in terms of business development but can be used in a strategic manner with respect to their R&D strategy.

**Operational Efficiency**

Businesses described as having a operational efficiency ISS exhibit the following characteristics:

- may adopt an outsourcing strategy with respect to the IT;
- tend to lack of strategic control over their IT, often the result of a majority shareholder;
- are likely to have an overemphasis on either R&D or business skills at the management level; and
- may have undergone an IPO too early during the business development stage.

Cases located in the operational efficiency quadrant are those businesses in which the role of IT in both business development and R&D strategy is merely for operational efficiency gains.

This interpretation is based on analysis of data that was collect at a particular point in time, however, there appears to be potential for these businesses to follow trajectories. Levy *et al.* (2002) discuss the potential trajectories followed by the businesses in their investigation. In this research, some business types appear to exhibit distinct characteristics, which may enable them move from one quadrant to another. For example, an Up and Coming could potentially become a Star. Similarly, an Ad Hoc business may become a Stalwart or in the situation with Case G, a Virtual becomes a Star. The journey from one quadrant to another may be a matter of organisational maturity or, as in the situation of Case G, a management-induced change in strategic
focus. These observations again highlight merit in conducting a longitudinal study to investigate potential trajectory paths. The stage of development of the knowledge base is considered to play a critical role in determining the nature of product development routines (Cardinal et al., 2001) and may in fact influence their position on the framework. A question which also arises is how alignment is sustained over the long term? To explore this question, longitudinal research methods could be employed to identify common strategic management and planning practices among organisations successful in achieving and maintaining a high degree of alignment. A longitudinal study could also offer an explanation as to why certain configurations or characteristics are not strategic in the Australian biotechnology KSME context.

To summarise, the Strategic Alignment ISS Framework for Australian Biotechnology KSMEs is presented here as an explanatory tool for describing the current nature of ISS within the twelve KSMEs in terms of the central research theme of strategic alignment. The framework is a useful lens through which to explain the emergence of the five firm types and the nature of their ISS. The next section briefly reflects on potential ways the Strategic Alignment ISS Framework for Australian Biotechnology KSMEs could be applied outside this research context.

### 6.4.5 Considerations for Applying the Framework

The Strategic Alignment ISS Framework for Australian Biotechnology KSMEs in its current form is useful as an explanatory model for describing the nature of ISS among the twelve cases. Through discussing the case's location on the matrix, the nature of ISS can be described as either being: innovative, high potential, R&D-focused or operational efficiency. More broadly, the nature of ISS is largely the result of the strategic alignment of three factors: business, R&D and IT, with the overall alignment between the R&D and business strategies as driving the strategic focus of the twelve cases.

The researcher reflected on how the framework could be applied outside this specific research context and contribute to furthering IS theory in relation to ISS in KSMEs.

R&D is considered a type of ‘knowledge creation’ (Section 2.12.4). In reflecting on this, it appears within KSMEs it is necessary for the overall knowledge-creation and business development to be aligned. Therefore one possible way of abstracting this framework could be to modify the axis ‘Role of IT in R&D’ to ‘Role of IT in Knowledge Creation’. Similarly, the quadrant labelled ‘R&D-focused’ could be modified to knowledge-creation focused. Figure 6-7 reflects how the Strategic Alignment ISS Framework for Australian Biotechnology KSMEs could be applied to other KSME contexts. The framework is likely to be better suited to other R&D or knowledge-creating SME contexts, in industries such as nanotechnology, where their business' initial focus is on product and enterprise development rather than customer focused.
In applying the framework outside this research context, researchers should use the description of each dimension, provided in Section 6.4.2.1, to plot a firm onto the framework. The nature of a business’ ISS corresponds to one of the four quadrant descriptions depending on its location on the framework. Mapping businesses onto the framework may assist researchers in determining the nature of ISS from the descriptions provided in Section 6.4.4. A fruitful area of future research would be determining whether quadrant labels accurately reflect the ISS in other KSME contexts as well as its broader applicability to other SME-types (refer to Section 7.5).

6.4.6 Reflecting on the Interpreted Significance of Strategic Alignment and Nature of ISS

To summarise, Section 6.4 has presented the core category strategic alignment as being the most significant finding with respect to explaining the nature of ISS among the twelve cases. This section will conclude by briefly answering the first two research questions:

<table>
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<th>Research Question 1</th>
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<td>What is the current nature of ISS within Australian biotechnology KSMEs?</td>
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The current nature of ISS within Australian biotechnology KSMEs is largely implicit. However, the nature of the implicit ISS relates to the nature of a business’ strategic alignment. The nature of ISS among the twelve biotechnology KSMEs can be described as the alignment between three components R&D (knowledge), business development and IT at both the operational and strategic levels. The Strategic Alignment ISS Framework for Australian Biotechnology KSMEs is presented as an
Chapter Six: Interpretation and Discussion

explanatory model for describing the relationship between strategic alignment and the current nature of ISS within the twelve cases. Depending on a business’ relative position on the Strategic Alignment ISS Framework for Australian Biotechnology KSMEs, the nature of their ISS can either be classified as

- Innovative;
- High Potential;
- R&D-focused; or
- Operational Efficiency (Section 6.4.4).

**Research Question 2**

What factors need to be considered in a model for ISS in the Australian biotechnology KSME context?

At a high-level, four broad contexts are identified as potentially influencing the nature of ISS among the twelve cases: strategic context, R&D context, business context and environmental context (Section 5.2.4). However, the environmental context has an indirect influence on the nature of ISS (Sections 6.3.2.5 and 6.3.6).

Strategic alignment is the factor that most influences ISS among the twelve cases (Section 6.3.2). The R&D and business strategy alignment is considered important in this context. Within the biotechnology context, R&D must be directed towards commercially viable outcomes. A significant factor influencing the nature of ISS is strategic alignment. Management experience and strategic control over IT appear to be particularly influential in the business development phase and can potentially impact a business’ future development (Section 6.4.3).

By mapping a business’ strategic alignment onto Strategic Alignment ISS Framework for Australian Biotechnology KSMEs, the nature of its ISS can be described. Therefore the Strategic Alignment ISS Framework for Australian Biotechnology KSMEs and a more abstract version Strategic Alignment ISS Framework for KSMEs (Section 6.4.5) offers a tool for other IS researchers as well as practitioners to determine the nature of ISS among knowledge-based businesses.

The next section discusses the implications the interpretation of strategic alignment (Section 6.4) and the research challenges (Section 6) have for current approaches to ISS.

6.5 Implications of the Interpretation for Approaches to ISS

In the previous section strategic alignment is interpreted as being of most significance in both understanding and conceptualising how Australian biotechnology KSMEs engage in ISS. In Sections 6.3 and 6.4, a number of theoretical challenges were identified. This section discusses some theoretical implications of this interpretation to ISS theory. In the process, this section in part answers the third research question:
Chapter Six: Interpretation and Discussion

Moving from the conduct of the research to the findings, it is important to consider what the substantive theory proposed in this thesis has to offer the IS discipline. The previous section addressed the current issue of IS within a particular KSME context, the Australian biotechnology industry, and revealed some specific insights about the nature of ISS within the twelve cases. The analysis provides some answers to the research questions at a substantive level, however, it is important to consider its implications for the IS community in general. The previous sections (Section 6.3 and 6.4) allude to potential theoretical and methodological implications of the findings. This section picks up the threads of these discussions and draws on them to answer the third research question. As anticipated in the research methodology chapter, the third research question needs to be answered in two parts due to its theoretical nature (Section 4.7). The first part involves discussing a number of research challenges, both theoretical and methodological, which arose from interpreting the findings and reflecting on their potential implications for IS theory. The second part involves taking the research challenges and in conjunction with the findings and current IS literature discusses the appropriateness of theory underlying ISS conceptualisation.

Five theoretical challenges emerge from this research including:

- reassessing alignment (Section 6.5.1);
- the conceptualisation of IT (Section 6.5.2);
- the nature of the firm boundary (Section 6.5.3);
- the conceptualisation of small businesses (Section 6.5.4); and
- relevancy of the socio-technical perspective (Section 6.5.5).

In Section 6.5.6, the researcher also reflects on how the theoretical challenges may also influence knowledge management theory, which has also been referenced in the research (Section 2.12).

6.5.1 Reassessing Strategic Alignment

Strategic alignment is interpreted as being the most significant research theme for understanding and conceptualising ISS among the twelve KSMBs. From a theoretical perspective, the emergence of alignment as a central factor that influences the nature of ISS not only suggests the concept is also relevant to discussion of ISS in the SME context, it also suggests strategic alignment should continue to be included in discussion on ISS. Strategic alignment, in the context of KSMBs, helps to explain how the distinctive R&D component is integrated into the business.

The concept of strategic alignment in these high-technology knowledge businesses is somewhat complicated by the R&D factor, or a knowledge-creating context. A consequence of this R&D factor is that IS theory needs to develop a more complex conceptualisation of strategic alignment than is currently described in the literature. IS theory needs to consider how the R&D context should be incorporated into its...
discussion. This research context suggests that the alignment between the knowledge-context and business strategies is most significant to the twelve cases to ensure R&D strategies are directed to commercial outcomes. The Strategic Alignment ISS Framework for Australian Biotechnology KSMEs offers a way forward for the IS discipline for exploring ISS in KSMEs. Through various alignment configurations between R&D, IT and business components of these businesses, the Strategic Alignment ISS Framework for Australian Biotechnology KSMEs provides a mechanism for explaining the nature of ISS among the twelve KSMEs.

The findings also raise a number of issues with respect to strategic alignment and the potential of reduced strategic flexibility, an issue first posited by Tallon and Kraemer (2003). While strategic alignment is important for conceptualising ISS in this KSME context, this appears to be valid only up to a point (Tallon and Kraemer, 2003). As described, the potential for some businesses to over-align their business and IT strategies may result in a reduced strategic flexibility. However, business flexibility is often quoted as one of the key advantages SMEs have over large businesses (Section 2.7). In this research context, the reduction in strategic flexibility is attributed to the lack of control over key business decisions in relation to their IT and its future development. The Virtuals’ IT set-up is in some respects limiting their ability to expand (Sections 6.3.2 and 6.3.4). Reduced strategic flexibility is a result of an over-alignment between business and IT strategies; however, this could be potentially an issue for other forms of alignment (i.e. business and R&D, R&D and IT). A potential avenue is to explore the nature of strategic alignment in other high-technology businesses and whether this knowledge and business alignment is still important in these respective contexts.

6.5.2 Agent or Tool - Conceptualisation of IT

Throughout the analysis and interpretation process, the researcher iteratively considered how IT should be conceptualised within this research context. The dilemma concerns whether IT should be conceptualised as an agent of change or a tool. The emergence of the core category role of IT and the various roles that IT has in a number of circumstances provided an impetus for exploring the conceptualisation of IT within the literature further. As described in Section 6.3.3, it was the role of IT with respect to other core categories in Stage One could be used to differentiate the twelve firms.

For the most part, IT can be conceptualised as a tool, as the role of IT is largely that of facilitation (Section 6.3.3). However, in the instances where the role of IT is either as a driver or enabler, IT may also need to be considered as an agent of change.

Kling (1987: 311) describes the ‘tool’ view of information technology as: “a computing resource (that) is best conceptualised as a particular piece of equipment, application or technique which provides specifiable information processing capabilities”. He argues that such a view conceives of information technology independent of the social or organisational arrangements within which it is developed and used (Orlikowski and Iacono, 2001). More recently, researchers have begun to explore the ‘enabling’ role of information technology, which place managers in the role of causal agent, triggering the “magic bullet” of information technology to
transform organisations (Robey and Boudreau, 1999). In summary, these researchers have argued for a more complex relationship between IT and organisations, advancing concepts such as emergent and reciprocal causality, and promoting interpretive research method (Robey and Boudreau, 1999). Chan (2000) suggests that information technology can take on any these roles dependent on the organisational environment and how the IT is applied. Chan (2000) concludes by stating although IT plays an important role in today’s workplace, it is neither the only cause of progress or the singular facilitator of change.

The dilemma as to whether IT needs to be conceptualised, as either as a tool or agent of change, suggests actor network theory or a socio-technical perspective are potential avenues through which to explore ISS in KSMEs and the role of IT. The relative merits of the socio-technical perspective are discussed in the Section 6.5.5. Actor network theory is considered appealing to IS researchers wishing to account for agency but also to take “technology seriously” (Rose and Jones, 2004). Under actor network theory, agency is not restricted to humans but attributed to machines and to material more generally. Technology and humans are so “mangled” together it is impossible to separate them clearly (Pickering, 1995 cited in Rose and Jones, 2004).

6.5.3 Nature of the Firm Boundary

The dominance of the organisational perspective was highlighted in the literature review and research methodology chapters as a potential limiting factor in current IS theory development (Sections 2.13.1 and 4.2.3). While current ISS theory could explain competitive advantage at a firm level, it struggles to explain the dynamisms that may occur across firm boundaries, particular with respect to knowledge and information sharing. The strong dependence and high occurrence of strategic alliances within the biotechnology industry, highlighted both within the literature (Section 2.13) and the twelve cases (and their use of informal relationships to gain access to information particularly commercially sensitive information (Section 6.3.5)), suggested the need to reconsider the nature of the firm boundary. Merali (2002) identified that when processes, expertise and people are shared, firm boundaries become indistinct. This raises the question as to whether a new conceptualisation of the firm is needed in IS theory or whether there is a need to consider the firm boundary more permeable than current thinking within the literature, particularly in a knowledge-based environment?

The permeability of the firm boundary is often considered most pertinent to knowledge-based firms. Some researchers characterise knowledge businesses by weak hierarchies, dense lateral connections, low departmental walls, and openness to the environment (Achrol and Kotler, 1999). These traits are illustrated in innovative firms in the biotechnology industry (Achrol and Kotler, 1999). Firm boundaries are permeable to firm-based knowledge and expertise, including management practices (anonymous, 2003). In strategic alliances and joint ventures, firm boundaries become permeable (Inkpen and Beamish, 1997). This permeability provides firms with a “window on their partners' broad capabilities” (Hamel et al., 1989: 134).

More recently, researchers have sought to extend the KBV conceptualising the firm boundary as a semi-permeable membrane through which knowledge flows at different
The permeability of the firm boundary is dependent on the type of knowledge (Birkinshaw and Fey, 2005) with codified, observable and system-independent knowledge being able to freely across firm boundaries as well as within the firm (Winter, 1987; Kogut and Zander, 1992). The permeability is also dependent on the nature of the relationships that these businesses have with its external actors. As Birkinshaw and Fey (2005) note every firm has ongoing exchange relationships with customers, suppliers and many other actors. The way in which the relationships are structured will have a considerable impact on the ease with which knowledge flows into and out of the firm. For example, a one-off transaction with a customer will allow little inflow or outflow of knowledge, whereas a long-term partnership will by design encourage each party to learn from the other (Birkinshaw and Fey, 2005). Sharing information requires a level of confidence and trust between the parties involved including a willingness to share information (Roberts, 2000, refer also to Section 2.12.5.1). In the context of the twelve cases, it is particularly the informal networks that these businesses have established which appeared to be the most influential in gaining access to information, particularly commercially sensitive information.

Although the KBV has adopted this permeable boundary concept, the RBV which underlies much ISS theory (Sections 2.6, 2.11 and 2.13.1), has not been so accommodating. The notion of a semi-permeable firm boundary was evident in both the formal and implicit knowledge and information flows, which occurred within the twelve cases. All cases are in formal collaborative arrangements such as strategic alliances or joint ventures and rely heavily on informal networks to gain access to information. However, the twelve cases exhibit varying levels of permeability.

The three cases demonstrating the highest level of permeability are those businesses described in the analysis as Virtuals. Virtual businesses represent a new form of organisational structure designed to enhance competitiveness and strategic flexibility through the extensive use of subcontracting, business partnering and information technologies (Fitzpatrick and Burke, 2003). The ability of virtual firms to freely exchange information, resources, technologies and ideas across organisational boundaries is where many of the strategic advantages (Fitzpatrick and Burke, 2003). The result is a “company without walls” (Galbraith 1995) that acts as a “collaborative network of people” working together, regardless of location or who “owns” them (DeSanctis and Monge, 1999). The literature suggests that a virtual business offers the flexibility that the organisational design will require if full advantage is to be taken of the emerging opportunities (Walters and Buchanan, 2001). Although the literature tends to advocate that a virtual business set-up gives a business its flexibility, in this research context it appeared difficult to implement. The next section will discuss that the virtual business model in fact reduces strategic flexibility (Section 6.5.2, also refer to previous discussion in Sections 6.3.2.2 and 6.3.4).

At the other end of the spectrum, the three cases referred to as Stars, have a number of strategic partnerships but tend to adopt a largely in-house strategy. Despite, these firms’ boundaries only being partially permeable to the environment, they demonstrate permeability between various teams within the firm. In addition the use of email to communicate with various team members, Case E and Case K allude to uses of IT to facilitate cross-group facilitation. For example, Case E had a firm
boundary characteristics which includes its permeability. Merali (2002) refers to a boundary agent, an individual engaged in the enactment of boundary relationships. How these agents operate and connect internal and external sources and user of intelligence is central to knowledge management in dynamic environments. The analysis touches on the role of the alliance manager within the businesses. While in the context, the role of the alliance manager is not explored extensively, their role as a potential ‘boundary agent’ may be suggest a fruitful area of future research (Section 7.5).

In summary, IS theory considers the firm boundary as an impermeable layer. The researcher suggests that the RBV, in its current form, reiterates this view as its focal point is on the firm level (Section 2.5) and offers limited opportunities to explore outside it (Section 2.13.1). However, in an industry such as biotechnology, in which collaborative arrangements are so prevalent and informal networks and relationships are so influential conceptualising the firm boundary as an impermeable layer is limiting. Considering the firm boundary as a semi-permeable membrane provides an avenue through which to explore the synergy and dynamism, which occur in collaborative arrangements such as joint ventures. The implication of this challenge for ISS theory is to provide a more open view of the current conceptualisation of the firm boundary and the need to focus on the human elements in ISS, specifically (Section 6.5.5) and the potential need to extend the RBV.

6.5.4 Conceptualisation of SMEs

The findings also challenged a number of perceptions, which IS and management literature currently have with respect to SMEs. This particularly relates to the common conceptualisation that SMEs have an operational focus. For example, Hagmann and McCahon (1993) suggest that the experience of strategic IS planning in SMEs is usually focused on improving operational processes rather than achieving strategies. The nature of the environment in which these biotechnology businesses operate is such that the high cost and risk of biotechnology research development necessitates a more strategic approach to business than is described in conventional SME literature (Sections 2.7 and 2.13.1). For example, the twelve cases have explicit business plans to enable them to attract financing or investment partners. Secondly, these biotechnology businesses differ from traditional SMEs in the way they use their IT. These businesses appear comfortable with the use of technology, which may be a result of scientists using technology for a number of years in their everyday work (Section 6.4.3). Finally, this research has suggested that SMEs should not be treated as a homogenous group and therefore it may be necessary to adapt and even in some cases reconsider concepts even within specific SME contexts (Section 6.3.10).

Knowledge-Based SMEs

Significantly, the twelve biotechnology KSMEs explored in this research, by their strategic nature and leadership qualities, appear different from ‘conventional SMEs’ (Section 2.7) Biotechnology KSME also appear to differ from the KSMEs upon which Duhan et al. (2001) base their research (Section 2.10 and 2.11). This was identified as a potential issue in the literature review and now appears to be
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intranet. Case K uses VPN and videoconference facilities to enable the business and scientists within the company to overcome geographical boundaries.

Despite the permeability of the firm boundary, permeability is not necessarily reflected in the IT infrastructure set-up of the cases such as dedicated networks between collaborative partners. Instead, IT supports, facilitates and contributes to permeability of the firm boundary. Email is the most common way of facilitating information and knowledge flow across the firm boundary between collaborative partners, and was particularly useful for overseas operations. However, none of the cases have set-up a permanent link with their collaborative partners, choosing to exchange information using email, telephone/videoconference or face-to-face and in some cases, secure fax. In Case K, the participant stated that they had chosen to control their own IT, because often the other party’s network could not be guaranteed to be as secure as their own. This suggested an issue was trust between partners as well as the need to protect their own assets.

Consequently, in terms of the permeability of the boundary, the role of technology is merely to facilitate the communication across the firm boundary. All firms refer to the use of confidentiality agreements, signed by all parties involved in the collaborative arrangement. However, IT is also embedded in the business processes, which involves information exchange. For example using the carbon copy function in email provides an audit trail of what information is formally leaving the business

Individuals can communicate with individuals in the party. It is always copied to one person and there is an approval system of information going out at any time, and that is one person (Case B).

The nature of ISS and its relation to a permeable boundary suggests the need to consider social/human aspects of ISS, in particular, the important role informal relationships can play in breaking down or by-passing the restrictions of the firm boundary. The nature of the firm boundary appears to be particularly relevant in the exchange of information and knowledge and suggests the potential for exploring a socio-technical perspective in this research context (Section 6.5.5).

In Section 2.12.4, a question was raised as to whether knowledge flow/transfer may be significant in the context of ISS in Australian biotechnology KSMEs. This research suggests exploring the nature of knowledge transfer might be significant particularly in the context of the firm boundary. The relationship between trust, knowledge flow and the firm boundary would appear to warrant further investigation within this research context (Section 7.5).

The emergence of boundary permeability in the literature has also given rise to the concept of boundary management. For example, Merali (2002) suggests that a clear understanding of the boundary phenomenology and its role in intra and inter-organisational knowledge processes is essential for effective strategies in the dynamic competitive environment. Technology facilitates the cross-boundary process and integrating information sources. Merali (2002) suggest that boundary management is critical in evolving, managing and dissolving synergistic relationships. The management of a firm’s own intellectual capital, including its protection, and the leveraging of inter-organisational resources depends on the effective management of
6.5.6 Potential Implications for Knowledge Management Theory

This section so far has focused on the significance the substantive findings have in relation to IS theory. The findings of this research and the current challenges identified may also be of relevance to knowledge management theory, which has been referenced in this research (Section 2.12).

Firstly, within the context of the twelve biotechnology KSMEs, a number of knowledge processes appear embedded in major business processes. Therefore, the researcher would advise other researchers to be cautious about separating a business' knowledge from its respective business processes in this context. Section 2.12.4 describe the nature of knowledge through knowledge creation, storage, transfer and application. Although elements of each of four knowledge management components can be found throughout this research context, as a method of entering the field it appears appropriate not to emphasise one particular component. For example, knowledge transfer (Section 2.12.4) may be a significant when discussing ISS, KSMEs and the firm boundary. Similarly, the emergence of a knowledge-creation context, such as R&D, suggests exploring ISS in KSME through a knowledge creation lens could be beneficial (Section 6.3.6). Furthermore, knowledge application through IP may also be important discussion (Section 6.6.1.3).

Secondly, the role of IT with respect to knowledge processes appeared to be mainly that of facilitation. The exception to this was with respect to several cases, where proprietary R&D knowledge, such as a particular biological process, is combined with the processing power of IT. In this respect, the findings largely support the socio-technical perspective as an appropriate lens through which to explore IT in a knowledge management context. Under this perspective, technology is designed to enhance or augment human skills rather than merely replicate them (Herndon, 1997) and thus the focus should is not entirely on the technology. In this respect, if knowledge management is considered an appropriate lens through which to explore ISS in KSMEs, a socio-technical may offer some additional insights.

Thirdly, two distinct knowledge types emerged from the businesses were: R&D knowledge and business knowledge. Both types of knowledge, each can provide the basis for a competitive advantage (VonKortzfleisch and Al-Laham, 2000). As R&D must be directed to commercial outcomes, it would be interesting to explore these various knowledge types, their interaction and how they may provide the basis of competitive advantage. Section 2.12.3 highlighted there may be merit in exploring KSMEs through R&D knowledge and IP and this research would also suggest there is merit in exploring ISS though R&D knowledge or IP analytical lens.

Fourthly, some initial work by the researcher also highlights the potential for extending the KBV and the findings of this research suggest merit in exploring this possibility. Knowledge and knowledge processes within these businesses clearly extend beyond the firm boundary both formally and informally. Furthermore, the discussion on portfolio management highlights the influence a patent can have on industry structure through creating barriers to entry for other businesses (Section 6.6.1.3) and in some cases, biotechnology business in fact controls certain aspects of the industry (Section 6.6.1.3). Therefore, from a knowledge perspective, it suggests the potential application of the industry structure view. The literature review posed the
substantiated by the research findings (Section 2.13.1). The KSMEs referred to by Duhan et al. (2001) originate from a service-based sector whereas biotechnology KSMEs in this research are from a science-sector and the focus of these businesses is largely on knowledge creation. In fact Cardinal et al. (2001) state that in even in science-based industries, knowledge-based requirements vary across science-based industries. This suggests in science-based industries there could also be variation among businesses. While the variation between the businesses investigated in this research and those discussed in Duhan et al.’s (2001) paper account for some differences between the findings of this research and current ISS conceptualisation, it is not interpreted to be main reason for the difference in findings. The research suggests both limitations in applying current ISS conceptualisations within this research context as well suggesting a need for revised conceptualisation of ISS in high-technology knowledge-based businesses.

6.5.5 Socio-technical Perspective

The relative merits of the socio-technical perspective have been explored within knowledge management theory (Section 2.12.5.1). The role IT plays, both as a tool and an agent of change, as well incorporating the importance that relationships also highlighted merit in exploring ISS among KSMEs from a socio-technical perspective. The importance of the human factor in this research context revealed itself in a several forms (Sections 6.3.5, 6.3.8 and 6.4.3).

A socio-technical perspective emphasises the interrelatedness and functioning of the socio-cultural, organisational and technological subsystems of the organisation, and the relation of the organisation as a whole to the environment in which it operates. This approach has become very popular in the knowledge management literature and in this respect appears to be relevant to KSMEs.

Organisations need to create a fit between their technological and social systems in order to sustain competitive advantage (Bhatt, 2001). Pan and Scarborough (2003) suggest a socio-technical perspective is required in knowledge management to encapsulate a more holistic view that recognises the interplay between social and technical factors. The socio-technical systems approach is a combination of social, technical and organisation needs (Herndon, 1997). A similar approach may be appropriate in the case of ISS but it must be extended also beyond the firm boundaries. Under this perspective technology is designed to enhance or augment human skills rather than merely replicate them (Herndon, 1997). This suggests a socio-technical perspective may also be a fruitful way of conceptualising and studying ISS among KSMEs, in particular where the emphasis is on knowledge creation. In Section 2.12.5.1, a number of theoretical challenges were raised in respect of knowledge and IT, in particular issues relating to IT being unable to capture tacit knowledge. At the conclusion of this section, a theoretical challenge is raised as to whether a socio-technical perspective is an appropriate way of conceptualising ISS and knowledge management in these KSMEs. Exploring ISS in KSMEs through a socio-technical perspective would be an interesting area for future research.
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This discussion will first focus on the RBV (Section 6.6.1), which currently underpins the majority of ISS frameworks, models and tools (Sections 2.6 and 2.13.1) and will reflect on the appropriateness of the core competence approach, which was originally posited as an appropriate analytical lens through which to explore ISS in KSMEs (Duhan et al., 2001, and Section 2.11). The discussion will broaden to include two other dominant strategic management perspectives (Section 2.5): the relational view (Section 6.6.2) and industry structure view (Section 6.6.3). The relative strengths and weaknesses of each perspective in relation to this research context are identified, and their ability to address the research challenges emerging from the research context (Section 6.5) are discussed. As no single strategic management theory appears to either explain or address the research challenges raised, the integrated perspective highlighted in Section 2.14 is reintroduced in Section 6.6.4. Reflecting on the adapted business model employed, as a heuristic tool with which to enter the field, the tool also assists IS theory in conceptualising ISS by providing a broad conceptual framework (Section 6.6.5). The section concludes with the broader implications of the utilisation of strategic management theory in ISS theory (Section 6.6.6).

6.6.1 Reflecting on the Resource-Based View

Previously, Duhan et al. (2001) identified that KSMEs have difficulties in applying current ISS approaches and suggested potential merit in the core competence approach, a derivative of the RBV, as an alternative for developing an ISS in the KSME context (Section 2.11). Conceptualising ISS within the twelve Australian biotechnology KSMEs through a core competence approach offers several advantages. Firstly, the core competence approach focuses on those activities or processes which are fundamental to the business. In this respect, it ensures that the ISS is focused on only those processes or activities, which are necessary. Core competence approach provide insight into why outsourcing is often not strategic in this biotechnology KSME context (Section 6.3.4).

The core competence approach in the Australian biotechnology KSME context also places emphasis on the knowledge resources. However, due to the embedded nature of knowledge and knowledge process within the businesses the focus is likely to be artificial (Section 6.5.6). As discussed later in this section, Wade and Hulland (2004) highlight one of the major limitations of applying the RBV is that IS resources (in this case of knowledge resources) rarely act alone to create sustained competitive advantage, instead they form part of a complex chain of assets and capabilities. Therefore by detaching knowledge resources from the processes in which they are embedded would be misleading.

The core competencies approach is restricted to the firm level and struggles to explain interfirm activities and collaborations. All cases are in some form of collaboration and the business activities that emerged are not necessarily restricted to the firm level (Sections 5.2.2.2 and 6.3.5). Furthermore, analysis of the twelve Australian biotechnology KSMEs highlights a wide spectrum of business models. Biotechnology business models range from those cases, which have an intentional in-house strategy and thus build up their competencies in-house, to those businesses, which have a purely outsourcing business model and in essence outsource their competencies.
question as to whether knowledge management practices in SMEs required extension beyond the KBV (Section 2.12.5.2). This research suggests there is merit in exploring extension and reconceptualisations of KBV beyond the firm level.

In summary, through interpreting the findings and their significance and through engaging with current IS literature, a number of research challenges are highlighted. Although the research challenges are discussed in relation to ISS theory specifically, the challenges also have broader application to IS, management and knowledge management theory. Equipped with these research challenges, the next section seeks to explore the impact the findings may have on the appropriateness of current conceptualisation in ISS theory.

### 6.6 Implications of the interpretation for utilisation of strategic management in ISS theory

This section explores the second aspect of the third research question.

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<th>Research Question 3:</th>
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<td>What are the potential implications for the IS discipline's conceptualisation of ISS and KSMEs?</td>
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The impetus for this research came not only from an observation that IS research did not appear to have a good understanding of the dynamics of KSMEs and how they engage in ISS, but also from an observation that current ISS frameworks, models and theory have developed predominantly from a single strategic management perspective the RBV (Sections 2.6 and 2.13.1). This was posed as a potential limitation of applying current ISS models in a biotechnology KSME context (Section 2.13).

Significantly, while strategic management theory has recognised the limitations of applying one perspective in isolation and has to begun to explore new ways of reconceptualising competitive advantage (e.g. strategic entrepreneurship and the business concept model - Section 2.14), IS research has continued to apply RBV-derived tools, with limited critical examination of its appropriateness (Wade and Hulland, 2004).

To answer the third research question, the researcher reflected on the substantive findings and their interpretation (Section 6.3 and 6.4), the research challenges identified (Section 6.5) as well as current IS and strategic management literature to determine what additional insight could be proffered in terms of suitability and appropriateness of ISS theory continually drawing on strategic management theory, particularly when investigating complex, dynamic business environments such as the biotechnology industry.

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52 A question was raised in the literature review as to whether there may be potential limitations in applying RBV-derived tools within this particular research context (Section 2.13).
6.6.2 Reflecting on the Relational View

In Section 2.13, the question was raised as to whether the relational view needed to be considered with respect ISS in Australian biotechnology KSMEs. The relational view was also significant within this context, highlighted by the importance of relationships and their management (Sections 6.3.5 and 6.3.8). Both formal and informal relationships were essential for knowledge creation and information flow among these businesses. In addition, the relationships a business has with other organisations or international scientists clearly are considered to influence the business' reputation and in some cases, influence the potential value of the company (Section 5.2.2.2 and 6.3.5). The relational view offers a perspective through which to explore these potential sources of competitive advantage. In addition, the relational view appears to be particularly good at addressing the challenge of firm permeability as many of these relationships and activities span the boundary of the firm. However, the relational view struggles to address the challenges of strategic alignment other than emphasising the potential importance of the relationships between the business and R&D parts of these businesses to ensure R&D and business alignment is maintained. Although the relational view also has relevance to these businesses, it struggles to encapsulate the full range of ISS-related activities.

6.6.3 Reflecting on the Industry Structure View

Sourcing industry structure advantage is often viewed as inappropriate in the SME context. SMEs tend to be viewed as operationally focused and lack resources and therefore unlikely to make an impact on the industry structure. Section 2.13 raised the question in respect of IP in the context of biotechnology KSMEs and whether the industry structure view may be of relevance. There is evidence to suggest these businesses, through their IP, can in fact influence the industry structure. Case B discusses the impact upon being granted a patent had on their competitors (Section 5.2.2.2), where a competitor's research program was hindered and resulted in the competitor's demise. Case E also refers to an intended strategy of patent blocking which aims to create barriers to entry is an example that falls within the industry structure domain. Although Case E had not encountered the problem of patent blocking, "it is one we have thought of doing on many occasions. It is cunning and evil stuff". The participant alluded to patent blocking being quite a risky and expensive exercise, where "you can try and anticipate someone is going to end-up here but all of a sudden and they could go that way [gestures pointing in a different direction] and you have wasted 60 grand". The participant also named a company, which was quite successful at it. Interestingly an ABC Four Corners' program (aired on the Australian Broadcasting Corporation on the 11th August, 2003) demonstrated the control one Australian biotechnology SME has over the industry due to its patent portfolio. The patent relates to methods for detecting genetic variation. The company's patents cover access to over 95 per cent of all organisms. It is claimed that almost every laboratory worldwide that is testing for inherited diseases would be infringing patent rights. The company is now currently seeking royalties on their patent from both private companies and some public institutions. The example highlights the central role patents (explicit knowledge) play in the context of the biotechnology industry. It demonstrates the influence patents owned and managed by
Chapter Six: Interpretation and Discussion

Therefore those cases which lie at either extreme may only find limited benefit from a core competence approach (Clarke, 2004).

The researcher reflected on whether the limitations are restricted to the core competencies approach or whether the limitations are also inherit in the RBV. In this respect, if these limitations are also found to be associated with the RBV, this has broader implications for IS theory in continuing to develop tools and frameworks based on the RBV, particularly in complex, dynamic business environments.

At the time of conducting this research, there had been limited critical examination of the RBV within the IS community (Section 2.13.1). It had been suggested that the RBV has been used in the IS field on a number of occasions, but there had been limited research that comprehensively evaluated its strengths and weaknesses (Wade and Hulland, 2004). It is only recently that a critical examination of the RBV in the IS discipline has been undertaken (Wade and Hulland, 2004). Wade and Hulland (2004) suggest that the theory as it currently stands, it is not ideally suited to studying IS, a point which has been previously posited by the researcher (Clarke and Turner, 2001a; Clarke and Turner, 2001b; Clarke and Turner, 2003c; Clarke and Turner, 2003a; Clarke, 2005).

Wade and Hulland’s (2004) criticism of the RBV focuses on the fact that IS resources rarely contribute to sustained competitive advantage but instead they form part of a complex chain of assets and capabilities. It is this aspect of the core competence approach, which is restrictive with respect to knowledge sources. It is suggested that while the RBV role of resource complementarity is referenced to, it is not well established in the literature (Wade and Hulland, 2004). Wade and Hulland (2004) argue that the refinement of this element is necessary for the RBV to be of use to IS researchers. Furthermore, they highlight there is a disproportionate focus on within-firm IS resources and firm performance or competitive advantage primarily on inside-out resources (Wade and Hulland, 2004). Greater attention needs to be paid to all types not just those internally focused (Wade and Hulland, 2004). Interestingly, the authors suggest that the strategic IT provides an area to demonstrate the deficiencies the RBV literature (Wade and Hulland, 2004). In their paper, Wade and Hulland (2004) also suggest that organisational factors and environmental factors which can affect the relationship between IS resources and performance. This research suggest that these variables would include firm permeability, IT as a tool and an agent of change, socio-technical perspective and strategic alignment.

Wade and Hulland’s (2004) argument with respect to the appropriateness of the RBV focuses on the limited discussion on capabilities. The researcher would also argue that the limitation of the RBV is its overemphasis on the firm level. Australian biotechnology KSMEs can potentially source their strategic advantage from multiple perspectives. Although the RBV and core competencies approach both have merit in explaining certain aspects of Australian biotechnology KSMEs, they cannot explain the full range of strategies employed by the twelve cases. Therefore, the researcher proceeded to reflect on the suitability of two other strategic management theories, relational and industry structure views (Section 2.5).
necessary for all levels of analysis to be considered when investigating complex, dynamic business environments.

6.6.4 Reflecting on the Integrated Perspective

At the end of literature review, the adapted business model was presented in this thesis as a heuristic tool, which integrated dominant strategic management perspectives and levels of analysis. In Section 2.14.1.1, the question was raised whether the business concept model warranted further investigation with respect to ISS in Australian KSMEs. It is now appropriate to reflect on the heuristic tool both as a methodological and analytical tool. The integrated perspective may provide a broad conceptual framework for exploring sources of competitive advantage in the Australian biotechnology context and ISS and at the same time address some of the research challenges identified in Section 6.5.

An advantage of an integrated perspective is that the limitation of one approach is often the strength of another. This section begins by discussing the application of the adapted business model, which was adopted in this research as heuristic tool (Section 2.14) and then reflects more broadly on the utility of the concepts, which underpin this approach.

Adapted Business Model

An adapted business concept model was presented in this research as a heuristic tool to enable the researcher to enter the field (Section 2.14). In light of the substantive findings of this research and their interpreted significance, the adapted business model is evaluated on its relative merits both as a methodological as well as an analytical tool.

Methodological Tool

As a methodological tool for investigating a complex, dynamic business environment, the adapted business model concept offers a number of advantages. Through utilising the adapted business model to minimise the potential for the analytical focus to be constrained by the firm boundary, a number of elements and characteristics outside the firm boundary were elicited. The variation between the heuristic tool and the emergent models also demonstrated that the model had not influenced the analysis and interpretation. Therefore in conjunction with critical reflection (Section 4.2.1), the heuristic tool provides researchers with a mechanism for exploring ISS within a complex, dynamic business environment.

Analytical Tool

The adapted business model concept is also reflected on and evaluated in terms of its ability as an analytical tool to describe ISS specifically for Australian biotechnology KSMEs. At a high-level, the adapted business model concept appears useful. The integrated framework does not enforce rigid artificial firm boundaries on the data unlike other perspectives enabling the dynamisms between boundaries, referred to in
a single KSME, can have over the industry itself (Clarke, 2005). In this respect, the importance of patents to the twelve cases and the potential influence they can have on the industry structure suggest merit in adopting an industry view in this specific KSME context.

As highlighted in Section 2.11, Duhan et al. (2001) identify a limitation of the value chain analysis in the KSME context is that the value chain is less clear in KSMEs. However, in science-based industries, such as the biotechnology, the flow of knowledge is typically viewed as sequential through the value chain (Cardinal et al., 2000; Porter, 1985). Product and process knowledge, which are codified at the research and development stage, flow sequentially through the remaining value chain activities with little need for cross-stage collaboration (Cardinal and Lei, 2000). The stage of development of the knowledge base plays a critical role in determining the nature of product development routines (Cardinal et al., 2001). This is further reiterated by a comment by Case E, which also views product development as a value chain process with each point representing a milestone. Case E suggests a key strategy for attracting investors is to educate them in the product value chain

What we have had to do is train investors that there is value chain and each point on the value chain, representing a milestone, has an incremental value (Case E).

The above excerpt clearly highlights the importance of an industry structure view, particularly in discussion of product development.

With respect to addressing the research challenges, the industry view could potentially encapsulate some elements of strategic alignment, i.e. the alignment between business and the environment as well as how SMEs are conceptualised, namely their ability to impact the industry structure. The industry structure view appears to struggle with other concepts such as the conceptualisation of IT and firm permeability other than the potential relationships biotechnology businesses may have with large pharmaceutical companies, may influence the industry structure. However, evidence for this connection was not revealed during this research.

In summary, this section has reflected on the applicability and relevancy of three dominant strategic management perspectives to the Australian biotechnology KSME context. It has evaluated the relative strengths and limitations of the three perspectives with respect to describing ISS in the twelve Australian biotechnology KSMEs as well as their ability to address the research challenges identified in Section 6.5. The inability of one perspective to describe the variety of competitive advantages sought by these businesses and address the research challenges, which have been identified in Section 6.5, both highlights the need for an analytical focus to be considered beyond the RBV (Section 2.13) and suggested there may be potential merit in further investigating an integrated approach in this research context (Section 2.14). As described earlier, Walsham (2000) urges IS researchers to cover all levels of analysis from the individual to the societal in their research agenda, and study particular individuals, groups, organisations, or societies in detail, and in context. Examining multiple levels is more necessary in a time of globalisation (Walsham, 2000). Considering the importance of internationalisation to these businesses, it appears
that only strategic activities lead to strategic opportunities and most fail to incorporate operational activities. This raises the question "Are such assumptions appropriate in an SME setting in particular where SMEs, due to resource constraints, find management doing operational work?". This research suggests merit in investigating this further and leaves open a possibility for future research (Section 7.5).

A final shortcoming was the practicality of applying the adapted business model concept. At times the researcher grappled with applying the tool finding some components ambiguous and not intuitive. For example, the researcher struggled with categorising certain elements into knowledge structure and governance.

Despite these limitations, the adapted business model revealed some interesting characteristics about the nature of IT and IS within this setting. IT is commonly is used as a tool to support value creation strategies and assisting in strategic-decision-making processes, for example as communication tool or research tool. The heuristic tool enables the identification and categorisation of IT in this manner.

The analysis of the adapted business model does reveal some interesting insights and areas to contemplate when looking at ISS in KSMEs. The principle of the business model is appealing as it attempts to unify a number of analytical perspectives. However, having a knowledge-centric business model for KSMEs appears to be overly constraining. The model is good at identifying various knowledge aspects of the business. The integration of scientific and business knowledge sits well with the strategy of biotechnology firms to be commercially focused (Section 6.3.2.1). Furthermore, it highlights a potential problem with all strategic management tools in that only strategic activities led to strategic opportunities too constraining for KSMEs setting. This KSME environment presents an area where operational activities may in fact led to strategic opportunities.

More recently, other IS researchers have discussed the relative merit of the business model concept in IS (Hedman and Kalling, 2003). Hedman and Kalling (2003) develop a model which takes into account resources, activities, products and markets. They suggest that the business model concept as a foundation offers a way forward to addressing challenges that underlie current strategic management concepts (Hedman and Kalling, 2003).

6.6.4.1 Reflection on the Relationship Between Business Model and Strategic Alignment ISS Framework.

At this stage, it is also important to reflect on the relationships between the explanatory models and descriptive models as they emerge from the analysis and interpretation (refer to Figures 5-4, 5-5 and 6-6) as well as the adapted business model presented as a heuristic tool.

The adopted business model was presented in Chapter 2 after the review of the literature identified that biotechnology businesses could source competitive advantage at a number of levels. It was suggested that it may be necessary to view ISS through multiple lenses. However, ISS theory until now has tended to adopt one lens, which focuses on the firm level (Section 2.13.1)
Section 5.2.4 to be encapsulated. In this sense, conceptualising the business as a reference point offered one approach that goes some way to addressing the issue of firm permeability.

The adapted business model concept emphasises the knowledge component of these firms, which is likely to be the result of the adaptive step of Amit and Zott's (2001) original model (Section 2.14.1.1). In this respect, the tool is useful for eliciting and making explicit the knowledge component of these businesses, which were largely embedded in business activities (Section 6.5.6). During the analysis process, knowledge was certainly mentioned, however, it did not come out as a dominant theme and were encapsulated within other categories. From this perspective, the heuristic tool as an analysis lens is useful for focusing the attention onto the 'knowledge' aspect of these businesses, however, in using the adapted business model for this purpose, it is important to ensure it did not focus on knowledge to the detriment of other factors, which emerged from the analysis as being important to this research context.

The researcher also found practical limitations in applying the adapted business model concept. At times the researcher found the adapted business model constraining, as it appeared to force value creation strategies to become knowledge-centric. In order for strategies to align with the heuristic tool, they must become knowledge focused value creation strategies. The researcher was conscious that this was fitting the data to the model rather than allowing the model to emerge from the data. Rather than proceeding with manipulating the data in this manner, this aspect was noted as a limitation of the adapted business model approach. At this stage, it is important to reflect that the knowledge-focused component was part of the adaptation of Amit and Zott's (2001) original model and this adaptation appears to have overcompensated the influence knowledge has in this context. However, reflecting on the original model upon which the adapted business model was based (Amit and Zott, 2001) transaction costs as a focus still appears inappropriate.

There were some characteristics of the biotechnology business, which could not be captured or were in fact misrepresented by the adapted business model. The role of the external environment, its relationship with business strategies and dynamism between these factors could not be captured appropriately. During the analysis stage, it was suggested that several of these value creation strategies appeared to be a reaction to the environment. This was further articulated with the observation of the environment and business alignment, which appeared to have an indirect influence on the nature of ISS (Sections 5.2.4 and 6.3.2.5). The adapted business model was quite static and could not be adapted to demonstrate the relationships, connectivity and influences of these factors. Therefore many of these contextual subtleties were lost, when applying the adapted business model to the data.

An implicit assumption of this model is that strategic level activities lead to value creation opportunities. Therefore the focus is largely on strategic activities. From data analysis, there are several examples where operational activities within the firm led to value creating opportunities (Section 6.3.2.4). Case A, for example, through a series of email communications with a company in Japan, was able to secure an agreement with the firm. The adapted business model could not elicit these types of strategies. On reflection, a common perception among strategic management tools in general is
conceptualising how the twelve biotechnology KSMEs engage in ISS. The *Strategic Alignment ISS Framework for Australian Biotechnology KSMEs* was presented and used to identify the nature of ISS among twelve KSMEs through an exploration of interrelationships between themes that emerged from the data. The framework was developed initially to demonstrate how strategic alignment resulted in five distinct firm types among the twelve cases and appeared central to the nature of their ISS. Depending on a business’ relative position on the *Strategic Alignment ISS Framework for Australian Biotechnology KSMEs*, the nature of their ISS can either be classified as:

- innovative;
- high potential;
- operational efficiency; or
- R&D-focused (Section 6.4.4).

The research findings also raise some theoretical challenges to current conceptualisation of ISS specifically in relation to strategic alignment, conceptualisation of IT as a tool or agent of change, firm boundary permeability, conceptualisation of SMEs and socio-technical perspective (Section 6.5).

The research reflects on the utilisation of strategic management theory in ISS theory (Section 6.6). Traditional strategic management theory, upon which ISS theory has been based, has adopted analytical lens which focus on only small components of the empirical world (i.e. the RBV - the firm, the relational view- the interrelationships, industry view- industry structure). Each analytical perspective has helped to progress the discipline’s understanding forward. However, researchers adopting a single management perspective, have the potential to miss observations. A potential risk for IS theory, as it begins to delve into complex, dynamic business environments is that if it continues to rely on a single strategic management perspective as a tool in which to enter the field, it too it at risk of missing observations. For the ISS field to progress, particularly in exploratory studies of complex, dynamic business environment, an integrated perspective in the first instance is considered most appropriate. Once the area is explored and the researcher has a better understanding of the environment, it may then be appropriate to consider a narrower lens.
The Strategic Alignment ISS Framework for Australian Biotechnology KSMEs (Figure 6-6) and the descriptive models (Figures 5-4 and 5-5), which describe ISS behaviour, have developed from a multi-lens approach. However, ISS theory behaviour may not itself be multi-lens. However, the RBV alone could not explain the full range of strategies adopted. Therefore adopting the RBV would be limiting in this context when exploring how the twelve KSMEs engage in ISS. In essence this research validates the business model concept, and its central tenet of integrating perspectives as a broad analytical framework for entering a complex, dynamic business environment. However, the adapted business concept model (Section 2.14) and the descriptive and explanatory models are tangential and it should not be interpreted that one is a subset of the other. What this suggests is that when looking at these businesses, multiple lenses are necessary and ISS in this environment is an output of the multiple lens approach. It also suggests the need to tailor a multiple lens approach to the specific ISS domain.

6.6.5 Summary Reflection on Strategic Management Theory Relevance

To conclude, the researcher suggests traditional strategic management theory, from which ISS theory has largely drawn, has adopted analytical lenses which focus on only small components of the empirical world. Each analytical perspective helps to progress the IS discipline’s understanding. However, through these narrowed lenses, the potential exists for researchers to miss observations. A potential risk for IS theory, as it begins to delve into more complex, dynamic business environments, is that if it continues to rely on a single strategic management perspective as a tool in which to enter the field, it too runs the risk of missing observations. It is suggested that in exploratory studies of complex environments, an integrated perspective in the first instance appears the most appropriate approach for progressing IS research. Once the phenomenon has been explored and the researcher has a better understanding of the environment, it may then be appropriate to consider adopting a specific management perspective, however researchers should not be restricted in the first instance.

6.7 Chapter Six Reflections

This chapter has interpreted and discussed the analysis of the data combining the principles of grounded theory and through a two-stage analysis approach. Prior to interpreting, the researcher reflected on the findings (Section 6.2).

The chapter then continued to discuss the findings and interpret their significance with respect to current IS literature. The findings highlight potential implications at the substantive, methodological and theoretical levels (Section 6.3).

The chapter proceeded to engage in an in-depth interpretation of the findings around the core category strategic alignment (Section 6.4). In the researcher’s opinion, it is the core category strategic alignment, out of the five core categories and their relationships, which is assessed as being significant in understanding and
7.1 Introduction

This thesis will conclude by revisiting the research questions and briefly summarising the major findings. The chapter discusses the contributions this research makes to the IS discipline as well as implications for KSMEs. Included in the chapter is a section detailing the limitations of this research and suggested areas for future investigation.

7.2 Summary of the Findings

A review of IS and related organisational theory indicates there is limited Australian case study research into ISS in SMEs. Absent from current IS theory is an essential body of theory addressing KSMEs, particularly in the Australian context and how this type of business engages in ISS. In the new knowledge economy, there is likely to be a growth in the number of knowledge-based. Furthermore, potential limitations of current ISS theory applied to the KSME context were identified. Therefore, to address the research problems identified the following research questions were formulated (Sections 1.4.1 and 2.11):

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<th>Research Questions</th>
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<td>1. What is the current nature of ISS within Australian biotechnology KSMEs?</td>
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<tr>
<td>2. What factors need to be considered in an ISS model for Australian biotechnology KSMEs?</td>
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<tr>
<td>3. What are the potential implications for the IS discipline's conceptualisation of ISS and KSMEs?</td>
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**Research Question 1: What is the current nature of ISS within Australian biotechnology KSMEs?**

The first significant finding with respect to the nature of ISS in the twelve Australian biotechnology KSMEs is that it is implicit in nature. Despite not having an explicit, formalised ISS in the traditional form such as a plan, all twelve cases were able to describe a level of strategic intent in relation to their IS. However, the nature of their strategic intent with respect to their IS, IT set-up and management varied across the twelve cases.

The focus of the ISS appears largely based on the business' conceptualisation of IT (Sections 6.3.1 and 6.3.3). The role of IT in the twelve cases is more explicit than current ISS conceptualisations and is attributed to the central role technology plays in biotechnology. The focus of the ISS appears to relate to whether the role of IT is to facilitate business activities, R&D and business strategies; whether IT is an enabler of business strategies (outsourcing) or whether in fact IT is driver of an R&D strategy (convergence of R&D knowledge and IT). All cases provide evidence to suggest the role of IT is one of facilitation, where IT is considered a tool for facilitating business development (Section 6.3.1 and 6.3.3). In some businesses, IT enabled the adoption of a distinctive outsourcing business model. Similarly, there is the potential for two cases
to have different foci, but the details of practical implementation may result in the nature of their ISS being similar (Section 6.3.3 and 6.5.3).

While businesses can have similar ISS focus, at an operational level their IT use and set-up can differ. This appears to be largely influenced by the nature of strategic alignment. Strategic alignment is significant in explaining how businesses can be categorised into three broad groups based on their focus but at an operational level, there are in fact five firm types (Section 5.3.2).

The current nature of ISS within Australian biotechnology KSMEs is largely implicit. The essence of this implicit ISS is interpreted as being related to strategic alignment. The nature of ISS among the twelve cases can be considered in terms of the alignment between the R&D (knowledge), business development and IT both at a strategic and operational level. The Strategic Alignment ISS Framework for Australian Biotechnology KSMEs is presented as an explanatory model for describing the relationship between strategic alignment and the nature of ISS within the twelve cases (refer to Figure 6-6). Depending on a business’ relative position on the Strategic Alignment ISS Framework for Australian Biotechnology KSMEs, the nature of their ISS can either be classified as:

- innovative;
- high potential;
- operational efficiency; or
- R&D-focused (section 6.4.4).

The interpretation also highlighted potential trajectories that businesses may take based on their relative position on the Strategic Alignment ISS Framework for Australian Biotechnology KSMEs. The level of maturation may influence their position on the framework. In its current form, the framework is useful as an analytical framework for describing the nature of ISS among the twelve cases. The researcher reflected on methods by which this framework could be applied outside this specific research context and how it might contribute to furthering IS theory in relation to ISS in KSMEs. The Strategic Alignment ISS Framework for KSMEs (Section 6.4.5) is presented as a possible framework for furthering current ISS theory. However, it also highlights the need for further research (Section 7.5).

**Research Question 2: What factors need to be considered in ISS model for Australian biotechnology KSMEs?**

At a high-level, four broad contexts were identified as containing factors that might influence the nature of ISS including - strategic context, R&D context, business context and environmental context (Section 5.2.4). The environmental context was interpreted to have an indirect influence on the nature of ISS (Section 6.3.2.5 and 6.3.7). The factors emerging in these four contexts contributed to the nature of ISS to varying degrees within each case.

Strategic alignment is interpreted among all the core categories to be the most significant and influential factor with respect to the nature of ISS among the twelve cases (Section 6.4). R&D and business strategy alignment is considered important in
this context, as a biotechnology business’ R&D must be directed towards commercially viable outcomes (Sections 6.3.2.1 and 6.4.1). A significant factor influencing the nature of strategic alignment appears to be related to the management experience and strategic control (Section 6.4.3). Management team composition and strategic control over IT appear to be particularly influential in the business development phase and can potentially impact on a business’ development. Furthermore, strategic alignment can be used to discuss the strategic nature of outsourcing with the twelve cases.

A number of other significant findings emerged including environmental pressures that may influence these types of firms (Section 6.3.7), the importance of the human element (Section 6.3.8), the strategic nature of the biotechnology businesses (Section 6.3.9) and the heterogeneity of SMEs (Section 6.3.10).

A third research question, focused more theoretically, was posited based upon the observation that current ISS theory has predominantly developed from the RBV. At the time of this research, there has been little critical examination of the RBV’s application within the IS discipline (Duhan et al., 2001; Wade and Hulland, 2004, and Section 2.13.1). Furthermore, the potential limitations of using RBV-derived approaches were raised to explain sources of competitive advantage in the biotechnology KSME context (Section 2.11 and 2.13).

Research Question 3: What are the potential implications for the IS discipline’s conceptualisation of ISS and KSMEs?

Throughout the interpretation, a number of challenges were highlighted including that:

- strategic alignment needs to be reconceptualised in terms of its complexity and relevancy to the SME context (Section 6.5.1);
- IT may need to be conceptualised both as a tool and an agent of change suggesting the potential applicability of actor network theory (Section 6.5.2);
- the firm boundary needs to be considered more permeable (Section 6.5.3);
- SMEs need to be reconsidered in terms of their strategic nature and ability to engage in strategic activities (Section 6.5.4); and
- the socio-technical perspective may also proffer additional insights with respect to the varying roles of IT and the importance of relationships (Section 6.5.5).

More broadly, reflecting upon the appropriateness of three dominant strategic management theory perspectives in this research context and the inability of one perspective to either address the research challenges or explain sources of competitive advantage within this research context, suggests the need for integrating perspectives (Section 6.6). This research proposes that for ISS theory to progress and to remain relevant in the new business environment; it is essential that its view of the empirical world is not narrowed by one particular lens. An integrated perspective, such as the business model concept, is suggested as a way forward for ISS theory development (Sections 6.6.4 and 6.6.5).
7.3 Contribution to Theory and Practice

This thesis makes a contribution to the IS discipline at three levels, the substantive, methodological and theoretical levels. Given that the substantive theory presented in this thesis represents the distilled experiences of practitioners in a KSME context, the thesis makes several recommendations to KSME managers as well as more broadly to the Australian biotechnology industry.

7.3.1 Substantive Level Contributions

At a substantive level the thesis provides an in-depth study of twelve KSMEs within the Australian biotechnology industry representing a cross section of two significant application sectors from four Australian states and territories (Sections 3.6 and 4.5.3.1). Micro, small and medium-sized businesses were explored. Research into high-technology Australian SMEs and the biotechnology industry is limited in the context of current IS research. The science of biotechnology has essentially emerged from both the convergence and advancements in bioscience knowledge and technology, which suggests IS as a discipline has the potential to offer something to this area. However, IS discipline is only now beginning to explore the area of biotechnology.

In the scoping stages of this research, it became apparent that there were challenges in conducting research in the area of biotechnology. Chapter 3 provides a detailed description of the biotechnology landscape to facilitate other IS researchers entering the field. It also highlighted a number of potential challenges associated with conducting research in the biotechnology industry.

7.3.2 Methodological Level Contributions

At a methodological level, this research makes several contributions:

- Firstly, the thesis presents an innovative approach for applying the principles of critical reflection to pre-data collection phases. Critical reflection is presented as a process to assist with research methodology selection and in planning its deployment. Although the notion of researchers being explicit about the derivation of their chosen research method is not new, what is novel is applying the principles of critical reflection at the pre-analysis stage as an approach to achieving this method (Section 4.2.1).

- Secondly, the thesis develops a strategy for investigating commercially sensitive research topics. By drawing on a number of papers written in the fields of sociology and psychology on ‘sensitive topics’, the thesis applies the insights generated to the domain of ‘commercially sensitive’ IS research where several broad research design issues were identified (Section 4.2.2). One major determinant of success of sensitive research appears to be the relationship between the researcher and the participant. Considerable effort is required on the part of the researcher to build and establish a relationship of
trust with the participants before commencing data collection (Section 4.5.3.3).

- Thirdly, the thesis suggests an approach for investigating the phenomenon beyond the firm boundary. A heuristic tool, which combines several levels of analysis, is drawn upon to develop a question frame, and applied in this research to minimise the potential for the investigation to be restricted to the firm boundary (Sections 2.14 and 4.2.3).

- Finally, the thesis develops an approach for incorporating grounded theory data analysis techniques within a multiple case study framework. A methodological limitation of applying grounded theory techniques within an interpretive multiple case study design is its limited ability to draw out semantic relationships across cases. Grounded theory techniques merely provide an approach for reducing and systematically handling and conceptualising the data, however, they do not provide a method for comparing or integrating data across multiple cases. The two-stage analysis approach combines the strengths of a holistic case study approach and a cross case approach (as an approach for overcoming the limitation of adopting one individual approach). Through the selective use of grounded theory techniques, the two-stage analysis provided the researcher with a method to extract rich, detailed meaning about the emergent concepts, themes and interrelationships (Section 4.6.2). In addition, critical reflection was reintroduced as a process for validating the research methodology in a complex, commercially sensitive research domain.

This research also provides practical examples of how to apply the principles suggested by Klein and Myers (1999) for conducting and evaluating interpretive field studies with the research process in a complex and dynamic business environment. The reflection process in Section 7.3.4 discusses how each of the seven principles were applied in this research context, so other researchers can apply and adapt these strategies to their particular research context.

### 7.3.3 Theoretical Level Contributions

At the theoretical level, the research presents a set of models that identify the nature of ISS among KSMEs. A heuristic tool, based on an adaptation of Amit and Zott's business concept model is presented in the literature review chapter as a tool for entering the field, as well as being a broad conceptual framework which integrates the main strategic management perspectives (Section 2.14). The Strategic Alignment ISS Framework for Australian Biotechnology KSMEs identifies the nature of ISS among the twelve biotechnology KSMEs and was developed through exploring the interrelationships between research themes that emerged from the data (Section 6.4.2). The analysis of the data revealed that alignment between R&D and business strategies was particularly important in this business context. The framework was developed initially to highlight how the nature of strategic alignment could be used to categorise the twelve cases into the five firm types. The data analysis revealed in some cases relationships between the nature of their alignment, lack of strategic IT control and the management experience. The nature of ISS among the twelve cases
can be described as innovative, high potential, R&D-focused or operational efficiency.

The research findings also raise some challenges in relation to current ideas of ISS. Specifically, the challenges relate to strategic alignment, conceptualisation of IT as a tool and an agent of change, firm boundary permeability, concept of SMEs and the application of the socio-technical perspective. These research challenges also offer some insights for knowledge management theory, which has been referenced in this research (Sections 2.12 and 6.5).

The thesis provides an insight into the utilisation of strategic management theory in ISS theory. Traditionally, strategic management theory, on which ISS theory has been based, has adopted analytical lenses, which focus on small components of the empirical world (i.e. the RBV - the firm, the relational view - the interrelationships, industry view - industry structure). Each of these analytical perspectives helps to progress the discipline’s understanding forward. However, through researchers adopting a narrowed lens, there is the potential to miss observations. Therefore, a potential risk for IS theory, as it begins to delve into complex, dynamic business environments, is that if it continues to rely on a single strategic management perspective as a tool in which to enter the field, it too runs the risk of missing observations. In exploratory studies of complex, dynamic business environments, an integrated perspective in the first instance is most appropriate. Once the phenomenon has been explored and the researcher has a better understanding of the environment, it may then be relevant to consider adopting a specific management perspective, however researchers should not be restricted in the first instance. The business model concept appears to be an appropriate broad conceptual framework that assists IS researchers in integrating various perspectives (Section 6.6).

7.3.4 Reflecting On the Application of Klein and Myers’ Principles

In the research methodology chapter, Klein and Myers (1999) seven principles of conducting and evaluating interpretative field studies were discussed and drawn upon in the development of the research strategy (Section 4.4.3). Applying and reflecting on these seven principles, assists other interpretive researchers in addressing some of the limitations or common criticisms associated with this type of research. This research provides a practical example of the application of the principles proposed by Klein and Myers (1999) to assist with the research process in a complex and dynamic business environment. This section briefly reflects on the application of the seven principles within the research.

Principle of Hermeneutic Circle

The Principle of the Hermeneutic Circle was primarily applied through data collection and analysis process. Grounded theory is primarily hermeneutic (Parker and Roffey, 1997). The interview transcripts were subjected to line-by-line open and axial coding from which a number of categories emerged (Section 4.6.2.3). The process of selective coding involves core categories being derived, relationships between
categories established and then the original data revisited to find exemplars. The process of iterating between various levels of analysis is a prime example of the hermeneutic circle in action. The researcher also alluded to the invaluable role of transcribing the interview tapes played in the initial stages of the research. Not only did the transcription assist the researcher in becoming familiar with the data, the process of immersion (reading and rereading the data) also facilitated the exposure of new meanings in the text.

Secondly, the two-stage data analysis process enabled a high-level version of the Principle of the Hermeneutic Circle to be applied (Section 4.6.2). The dilemma of multiple case study research in general is that the researcher must develop an interpretation of the data that reflects the individual case's experience as well as applying that interpretation across all the accounts that constitute the data set (Ayres et al., 2003). The two-stage data analysis process involved a holistic case study and the development of the descriptive model, then exploring the individual case and finally refining the descriptive model. This process provided an approach for iterating between the interdependent meaning of the parts (individual cases) and the whole formed by those parts (high-level overview model).

The Principle of Contextualisation

Case study research, by its very nature, seeks to study social practices in the field of the activity in which they take place (Doolin, 1996). The phenomenon under study is investigated within its 'real life' context (Doolin, 1996). Therefore the adoption of a case study approach ensured that the Principle of Contextualisation was at the very heart of the research design (Section 4.4.3.1). For each case, a vignette was constructed to provide the reader with background on the businesses involved in the research (Section 4.6.2.1 and Appendix E). The question frame also sought to contextualise the phenomenon from the cases perspective (Section 4.5.3.4). Individual interviews often gave insight into the organisational context that motivated the discussion.

Understanding the research context of biotechnology at a broader level was also important. Biotechnology, by its very nature, is complex and consists of a number of technologies. As a researcher and a reader, familiarity and sensitivity with the various facets of biotechnology is important for both investigating the field but also for understanding and being attuned to its idiosyncrasies (Section 4.4.1 and 4.4.2). Understanding the broader context of biotechnology was important for establishing the credibility of the researcher (Section 4.2.3, 4.4.1 and 4.4.2) and allowing her to be attuned to any biotechnology-specific references that emerged during the interview conversation, as well as understand and prepare for the impact the biotechnology context may have on the research design (Chapter 3). Chapter 3 in this thesis is dedicated to the provision of a high-level overview of biotechnology research context and the potential challenges it imposes.

Principle of Interaction Between the Researcher and Subjects

Interaction between the participant and the researcher needed to be explicitly addressed in this research. The commercially sensitive nature of the research topic and
context and the potential impact this may have on not only gaining access to participants but also the type information which the participants may divulge required the interaction between the researcher and subjects to be a conscious and carefully constructed process. As articulated in Section 4.5.3.3 the process involved a series of steps, building trust and rapport with participants and establishing the credibility of the researcher. Overcoming potential power relationships that may (or may perceived to) exist between the participant and researcher is one example in which the interaction needed to be evaluated. Furthermore, the data collection process has been described extensively in this research to make explicit to the reader, the interaction between the researcher and the participants (Section 4.5).

**Principle of Abstraction and Generalisation**

In this research, concepts were generated from the data using grounded theory techniques, and these concepts were subsequently used for abstraction at a higher level. Lee (1999) remarks that the grounded theory genre of research is itself directly concerned with abstraction and generalisation.

The themes that emerged are presented as substantive theory of the current nature of ISS in twelve Australian biotechnology KSMEs. Existing theories and literature are used both as a sensitising tool, in line with Glaser’s (1978) recommendations on theoretical sensitivity, and also as a means of comparing emergent theory with current (and sometimes competing) interpretations - using comparative analysis to generate theory (Strauss 1987). The emergent theory is also related to literature in IS and other substantive areas as a means of building that theory and to make it more generally applicable (refer to Chapter 6).

The criterion of transferability was proposed by Lincoln and Guba (1985) as an alternative to generalisation in the quantitative sense. In essence, transferability implies that researchers need to make their research process explicit and present their research in a sufficiently detailed account so that the reader can transfer it to other contexts (Lincoln and Guba, 1985). In this investigation, the researcher used critical reflection as a mechanism to explicate the research process (Section 4.2.1). Furthermore, in preceding chapters, an in-depth discussion detailing the process of data collection, analysis and interpretation is included (refer to Chapters 4, 5 and 6).

There is a paucity of detail within current IS and management literature to guide researchers on how to be explicit about research design choices or conducting research on a commercially sensitive topic (Section 4.2.2). The researcher had to design and develop her own approach to address these issues, drawing from other research disciplines including sociology and psychology. Through describing in general terms, the principles that guided her research design supported by the appropriate literature, the thesis highlights how the design applied in the principles in practice. The researcher produced two papers which provide some considerations for other researchers facing similar methodological challenges (for more information refer to Clarke and Turner, 2002a; Clarke and Turner, 2003b).

While this research only provides a snapshot, through theoretical sampling, broad ranges of businesses that fall under the category of ‘Australian biotechnology KSME’ were examined. Participant selection involved micro, small and medium businesses,
representing both agriculture and the human health application sectors in various states (Section 4.5.3.1). Analytical generalisation is considered possible by the strategic choice of informants relevant to the study and not by statistically drawn samples (Stenbacka, 2001). The data analysis process involved a comparison of each case to ascertain if there was any association with structural characteristics (Sections 5.3.1 and 5.3.2). Potential linkages were found, which the researcher draws on to assist with the interpretation and discussion as well as pointing to areas for further research.

**Principle of Dialogical Reasoning**

The Principle of Dialogical Reasoning requires the researcher to ensure that the fundamental philosophical assumptions of the research are transparent to the reader. Not only did this research emphasise the importance of declaring one's philosophical assumptions (Section 4.3), but proposed the application of critical reflection in the pre-data collection phase as a process through which a researcher could articulate those assumptions (Section 4.2.1). Critical reflection was posited as an approach for assisting a researcher to articulate his or her assumptions as well as making explicit other factors that influence the methodology choice. In summary, this research adopted a subjective ontology and interpretivist epistemology. How the philosophical stance affected the overall research design is discussed in Chapter 4. The Principle of Dialogical Reasoning is further applied in the data interpretation stage, where the findings are discussed with current literature both in IS and other fields as a method of strengthening the theory presented in the thesis (Section 2.16, 4.7 and Chapter 6).

**Principle of Multiple Interpretations**

This Principle of Multiple Interpretations requires the researcher to document multiple viewpoints, be alert for contradictions, and to revise their understanding accordingly (Klein and Myers 1999). By virtue of the research design, several views of the interaction are elicited. The joint and individual views are then overlaid and interpreted by the researcher. Through a multiple case study design, several interpretations of the phenomenon could be obtained from various viewpoints (Section 4.4.3.1). These multiple viewpoints lead to conflicting interpretations, which the researcher has endeavoured to represent honestly and, where appropriate, to suggest possible reasons for the conflicting views. In addition, industry representative viewpoints, gathered during the familiarisation stage, were also enfolded into the interpretation to provide a different viewpoint (from an interfirm and industry level). A strategy of not taking everything the participants said at 'face value' was also adopted (refer to the Principle of Suspicion and Section 4.4.3.4).

The articulation of the process by which research design was constructed, data collected and analysed and the methodology of deriving findings, enables the reader to develop and draw their own conclusions (Sections 4.5.3 4.6 and Chapter 5). Through access to the original data, readers can judge the accuracy of the researcher's claims and view how distinctions were drawn. This is accomplished by providing the reader with enough surrounding text that they can draw some conclusions of their own as they assess the findings and conclusions of the researcher (refer to Chapter 5).
In this research, care was taken in ensuring sensitivity to the Principle of Multiple Interpretation when presenting the findings by ensuring that both the participants' and researchers voices are heard. By the inclusion of the participants' own words wherever possible, the researcher is not only presenting her own construction on the situation but also that of the participant. This process is of particular importance in respect of the participant's own construction of the answers and the interaction with the interviewer. For example, the firm type, the Virtuals was actually derived from an in-vivo code assigned during the analysis.

**Principle of Suspicion**

Klein and Myers (1999) final principle is concerned with the discovery of 'false preconceptions' and not taking the informant's perspectives at face value. Critical reflection became an invaluable tool through which the researcher reflected on the participants' perspective. Through critical reflection, the researcher questioned whether the Ad Hocs, who considered themselves to be 'strategic' were actually acted strategically with respect to their IT (Sections 5.3.2.2 and 6.3.2.4). This example highlighted the researcher's suspicion and provided impetus for further analysis, exploration and reflection.

In summary, the principles proposed by Klein and Myers (1999) have been incorporated and integrated throughout this research as an approach for conducting interpretive research in a rigorous fashion. Through reflecting on how these principles have been applied in this research, offers other interpretivist researchers practical exemplars on deployment of the principles when investigating a complex, challenging research domain.

### 7.3.5 Recommendations for KSMEs

Given that the substantive theory presented in this thesis represents the distilled experiences of practitioners in a KSME context, it seems appropriate to ask how that theory might be disseminated in a meaningful manner to practitioners.

Firstly, KSME managers need to be cognisant of the central role relationships play in the biotechnology industry. Relationships form an important role in breaking down, physical, organisational and internal barriers. At a formal level, collaborations and alliances offer the potential for businesses to access international markets (Sections 5.2.2.2 and 6.3.5). Relationships with other businesses and well-known scientists/business leaders play an important function in establishing the business credibility and providing access to financing (Sections 5.2.2.2 and 6.3.5). On an informal basis, the networks that both scientists and key management teams have established can often provide access to information about the industry often bypassing organisational barriers to access sensitive information (Sections 5.2.2.2, 6.3.5 and 6.5.3). Due to salient role relationships play, KSME managers need be aware that their firm boundaries are not as resilient as they may think (Section 6.5.3). Similarly, KSME managers should be aware that their business contacts might potentially
provide a ‘foot in a door’ in some instances and thus need to ensure business relationships are maintained.

Strategic alignment appears to be of particular significance in a knowledge-based context. Ensuring strategic alignment between the R&D and business strategies and activities is important to ensure a business’ R&D activities are focused towards commercially viable outcomes. The composition of the management team and strategic control over IT appear to be particularly influential in the business development phase and can potentially impact on a business’ development (Section 6.4.3). Ensuring an appropriate mix of business and R&D experience at the management level appears significant. During the business development phase, it may be prudent for the founding scientist to step aside from his or her role as CEO and take on a role such as R&D manager or Chief Scientific Officer, looking to recruit a person with more business experience to the position of CEO. The advantage of this arrangement is that tacit knowledge stays in-house and ensures R&D representation at the strategic level. Furthermore, it may also encourage alignment between the business and R&D operations at the strategic level (Section 6.4.4). The business community is suspicious of scientists running businesses and credibility was identified as being particularly important for gaining access to finance (Section 5.2.2.2). Finally, a CEO with business experience is likely to have well-established business contacts as well as business acumen, which appear important during the business development stage.

A ‘selective’ outsourcing strategy is considered the most appropriate outsourcing strategy for the KSME context, particularly in high-technology fields (Section 6.3.4). Other outsourcing strategies can often result in strategic control, of the outsourced function/s, also being outsourced in the process. The result of a business not having strategic control over its outsourced function/s is that the function/s develop inconsistently and independently of the business’ longer term plans and thus has the potential to stifle future growth. This is evident in respect to IT in several cases that outsourced their IT management. KSMEs should also be wary of applying a virtual business model in a knowledge-base context. Despite outsourcing being a strategic option in the short term, as an approach for reducing risk and minimising initial outlay, it appears to inhibits the growth of the business in the longer term (Section 6.2.2.1).

Finally, KSME managers need to be aware that technology itself does not necessary provide a strategic advantage. It is the manner in which the technology is applied within the business that appears to be of greatest significance in providing advantage. IT’s strategic application appears to be largely dependent on the skills of the management team (Section 6.3.2.4). The Internet in particular can be used in a strategic manner and in some cases enabled a business to appear more substantial to others than it was in reality (Section 5.3.2.1).
7.3.6 Recommendations for the Australian Biotechnology Industry

More broadly, the findings of this research provide a number of suggestions for the Australian biotechnology industry.

Firstly, the industry needs to encourage relationship building both within Australia and overseas. Some potential strategies could include initiating networking forums and opportunities. Such forums are likely to benefit businesses headed-up by scientists or academics, such as a recent start-up business. While scientists generally have well-established networks within the scientific community, they are less likely to have established business networks. These contacts appear to be particularly useful through the business development phase. While technology can assist in facilitating communication, it cannot overcome the physical barrier that exists between Australia and the biotechnology global market and relationships appear to play a key role in overcoming the issue of distance.

Secondly, R&D businesses headed by scientists are likely to have limited business skills at the management level (Section 6.4.3). Business skill workshops and training courses, specifically designed for the biotechnology industry, would be beneficial to this type of business. The possession of business skills is particularly important during the business development phase.

Thirdly, there appears to be an assumption that Australian businesses must seek financing and markets overseas. However, Australia is in a position to provide world-renowned research at low cost. It is also one of only a few English-speaking countries in the Asia-Pacific market. Cases A and B have successfully established collaborations with businesses in Japan. Australia has the potential to establish and promote itself as a regional hub or gateway to the Asia-Pacific for European and North American firms. As Case E described

There are plenty of opportunities on our own patch in Asia (Case E).

While Australian firms can apply and search for niche markets, these approaches need the reinforcement of government policies to attract and sustain investment (Clarke, 2003a).

7.4 Limitations of Research Approach

Inherent in all research methods are a set of strengths and weaknesses. As part of the process of reflecting on the theoretical limitations of the research method (Section 4.3.1), it is important to recognise and demonstrate how these limitations have been addressed within this investigation.

Criticisms concerning interpretivist case study research tend to centre on bias, limited generalisation (Galliers, 1992), apparent lack of rigor and relevancy (Darke et al., 1998; Klein and Myers, 1999), lack of control of variables and different
interpretations by individual researchers/stakeholders (Galliers, 1992). Other limitations also include dependency on the skill of the researcher, access to case sites and being a time consuming process. Limitations of this research can be broadly categorised into the scope of the research and the limitations of a multiple case study design.

Scope of Research

Due to the exploratory nature of the research, this investigation has limited examination to a small number of biotechnology KSMEs within selected Australian states. The aim of the research was to gain insight into a cross section of KSMEs from prominent biotechnology application sectors. The human health and agriculture application sectors account for a significant proportion of Australia’s core biotechnology businesses and businesses from the micro, small and medium ABS SME classification were incorporated in this research (Section 4.5.3.1). Interviews with twelve KSMEs enabled sufficient data to be gathered to develop models of the nature of ISS among the selected businesses. While descriptive analysis was employed predominantly to ensure that participant selection had not influenced the emergence of the five firm types, it was also drawn upon to highlight potential relationships that could be drawn between the five firm types that emerged and their structural characteristics (Sections 5.3.1 and 5.3.2). No particular industry comparisons were made among the KSMEs included in this research. This could form a part of future research endeavours (Section 7.5). It is envisaged that this research provides a foundation for subsequent research into ISS in KSMEs, which may focus on particular types of KSMEs or aspects of a KSME business.

The second limitation with regard to the scope of this research is that it provides a snapshot of current activities. A longitudinal study may have provided some insight on how the nature of the cases ISS develops or changes over a period of time (Section 7.5). In general, each KSME was interviewed once, with occasional follow-up telephone calls made to clarify particular points of the interview.

Limitation of Multiple Case Study Design

There exists a range of limitations intrinsic to a case study research approach. The research methodology chapter has discussed in detail how this research has addressed issues relating to rigor, reliability and generalisability.

The scope of this research may also influence the case study design. As this research was undertaken as a requirement for the fulfilment of a doctoral thesis, the amount of time and resources available was finite. The amount of funding allocated to the data collection was also a limitation to the study. With the vast amount of data collected, the time to analyse and interpret the data potentially could be indefinite. Fortunately the temporal boundaries of the research is predeterminent and bound by the rules and guidelines set by the research institution overseeing this research (Section 4.2.1).

The lack of generality and research bias are possibly the greatest limitations of this research. Data collection and analysis can be influenced by the researcher’s interpretation of the events, interviews and documents collected (Galliers, 1992). The researcher’s background and experiences can also affect the process of interpretation.
of the data (Yin, 1994). Analysis of qualitative data is a time consuming process especially when there is only one researcher. The sheer volume of data collected can make the analysis of the data a tedious event (Darke et al., 1996).

**Generalisability**

Although the methods used in this research may lack some degree of generalisability, incorporating twelve cases studies increases the level of generality.

The use of case study research has been criticised for its perceived lack of generality. The intention of using case studies is not to derive inferences about a large population but to generalise back to theory. The case studies presented in this research are a very small snapshot of a specific type of KSME. The question arises how applicable is this research to other KSMEs in Australia and beyond. It is important to reiterate that the nature of this research is exploratory and therefore the intention is not generalisation but the enabling of rich, in-depth insights into ISS in KSMEs. It also identified that the IS discipline had a limited understanding of KSMEs, how they operate or engage in ISS (Section 2.10 and 2.11). In addition to the twelve KSMEs being representative of micro, small and medium-sized enterprises, they were also representative of a range of:

- public and private companies;
- different stages of product development;
- two major application sectors; and
- located in four states/territories in Australia.

The researcher therefore is of the opinion that the findings from this research can be generalised to the wider group of SMEs. In addition, as part of the interpretive process, the researcher returned to the literature to highlight where her research complemented existing literature (Section 4.4.3). Furthermore, the previous chapter highlighted differences in the findings of this research and current conceptualisations in ISS theory to generalise back to theory (Sections 6.3, 6.4, 6.5 and 6.6).

**Biases**

Biases are an unavoidable aspect of interpretive case study research. Although the researcher may not be able to prevent bias, awareness of its presence enables it to be taken into consideration and/or its impact addressed (Hall and Callery, 2001; Fade, 2003). The approach adopted in this research is largely focused on exposing potential biases and to demonstrate how they have been taken into account. The researcher was particularly conscious of the need for not influencing the participant and his or her response. This required careful research design construction. Critical reflection has been instrumental in this research as a means of exposing any potential bias (Section 4.2.1).

The critics of case study research often focus on the skill limitations of the researcher. The nature of case studies is that they rely on the sensitivity and integrity of the investigator. The researcher is the primary data-gathering instrument. In this researcher critical reflection was an invaluable process for making the researcher aware of her bias as well as demonstrating how her biases were taken into account in
the research design (Sections 4.2.1). The familiarisation and pilot interview work conducted in Canada, helped to highlight some assumptions prior to commencing the primary investigation stage (Sections 4.4.1, 4.4.2, 4.5.1 and 4.5.2).

The participants’ reaction to the interview, interview process and research can develop biases. Factors such as the length of the interview, the emotional status of the participant, the type of questions and the interview setting can all contribute to possible research biases. Pilot interviews and critical reflection were important mechanisms for minimising bias (Section 4.4.3 and 4.5.2). Through personal and pilot participant reflection, the researcher sought to minimise potential personal biases.

**Rigour and Reliability**

Research methodology requires the researcher to instil rigour and validity in all stages of the study. The adoption and subsequent reflection on the application of Klein and Myers’ (1999) principles in this research offered one method of demonstrating how rigour and reliability have formed a critical component of this research approach. In addition, rigour and reliability were instilled into this research through the provision of a detailed account of the research process and its outcomes. Reliability is obtained by the researcher ensuring that the whole process is visible, including preparation, data gathering and analysis (Stenbacka, 2001). The processes by which the research outcomes have been formulated and an outline of how these outcomes were gathered are aids in ensuring rigour in this research. Through the application of the principles of critical reflection throughout the research process, the decisions and actions of the researcher are transparent to the reader (Section 4.2.1).

At the completion of data collection, member checks were performed on participants, to ensure that the views of each participant had been accurately captured. The participants were requested to check the transcripts for errors or misrepresentations (Section 4.5.3.4). This procedure ensured that a level of validity was maintained throughout the research, with each of the case study participants. Some aspects of this research were published in an industry journal, demonstrative of both its credibility and relevance to the Australian biotechnology community (Clarke, 2003a).

To increase rigour and validity within this research, KSMEs from four states in Australia were interviewed, across two application sectors (Section 4.4.3.1). This was undertaken to ensure that the emergent themes gathered in the data analysis were not localised to a particular geographical area or application sector. Finally key elements of this research have been peer reviewed by independent academics in two continents. The researcher has launched major elements of this thesis in publications and conferences both in Europe and Australia.

As described the limitations of this research approach may be addressed by future research. Potential areas of future research are discussed in the following section.
Chapter Seven: Conclusion and Reflection

7.5 Future Research

It is envisaged that future work will expand upon this exploratory research to investigate in detail the components of this thesis. Suggested future work may involve extending the investigation to include a wider scope of SMEs differentiated by a broader range of industry sectors, including other knowledge-based sectors (Section 6.5.4). No particular industry comparisons were made among the KSMEs included in this research. This could form part of future research endeavours. It is envisaged that this research will provide a foundation for subsequent research on ISS in KSMEs, which may focus on particular types of KSMEs or aspects of a KSME business.

Further exploration of apparent factors that affect the nature of KSMEs would be of interest. The duration of this research was finite. Each interview only provided a snapshot of the business' position on ISS. The ability to investigate if and how businesses change their ISS, particularly as they evolve over time, would provide another worthwhile dimension to this research (Sections 6.4.4 and 7.4).

As this research was only a snapshot of time, it would be interesting to assess the applicability of the Strategic Alignment ISS Framework for Australian Biotechnology KSMEs as cases develop or to assess the appropriateness of the focus-dominance model (Sections 2.9 and 6.4.2). The Strategic Alignment ISS Framework for Australian Biotechnology KSMEs offers a tool for other IS researchers as well as practitioners to determine the nature of a business’ ISS through mapping its strategic alignment in terms of the role of IT in business development and R&D. Assessing whether the framework is applicable to other KSMEs would be an interesting area of future research (Sections 6.4.4 and 6.4.5). It is envisaged that the framework is likely to be of most relevance to other R&D and high-technology industries, where the focus is on product development. Yet another question about alignment stems from a consideration of whether different alignment models are necessary for organisations with different types of organisational structures.

Another area which warrants further investigation is whether organisational maturity, in particular the stage of product development or level of maturation of the underlying science, is a determinant of the nature of ISS. This has been previously alluded to in several places throughout this research (Sections 6.4.4). The potential for organisational maturity to influence the nature of ISS led to the Up and Coming businesses being interpreted as having an ISS described as ‘high potential’. The Up and Comings businesses appeared to possess the right characteristics to move into the ‘innovative’ quadrant, with respect to factors which may influence their alignment i.e. management team and strategic control of IT, however their levels of maturation differed. Whether the Up and Comings eventually move into the ‘innovative’ quadrant has the potential for an interesting follow-up study (Sections 6.4.4).

This research highlights the further merit of exploring strategic alignment in the SME context. Although the importance of strategic alignment in the SME context has only recently been acknowledged, it appears to be a central tenet in describing ISS in this specific KSME context (Section 6.3.2, 6.4 and 6.5.4). Furthermore, strategic alignment appears to be multi-faceted and extends beyond IT and business strategy alignment. It would be interesting to determine if in other knowledge-based industries,
a knowledge context exists and whether that context influences strategic alignment to the extent, it is described in this research context. Given the exploratory nature of this research it is acknowledged that there may well be other factors that impact on the nature of ISS within KSMEs. An investigation for additional attributes might form the basis for future research. Further research is also required to explore the relative success of the various types of ISS.

There may also be potential for businesses to move from one quadrant to another in the Strategic Alignment ISS Framework for Australian Biotechnology KSMEs. A second question that arises is how alignment is sustained over the long term (Section 6.4.4). To explore this question, it is suggested that longitudinal research methods could be employed to identify common strategic management and planning practices among businesses successful in achieving and maintaining a high degree of alignment (Section 6.4.4 and 6.5.1).

The research highlighted potential issues in treating SMEs as a homogenous group and suggested that treating KSMEs is this manner could be problematic. This research has uncovered the need to distinguish between service-based knowledge industries, upon which Duhan et al.'s (2001) core competence approach is predicated and the science-based, R&D, knowledge-creation businesses covered in this investigation. The researcher has alluded to the different foci of these businesses and variations in their product time scale. Cardinal et al. (2001) states that knowledge-based requirements vary across science-based industries. This suggests that in science-based industries there may be a variation in the SME context, which could have potential implications for ISS. A uniform model for science-based industries may fail to capture this important distinction. Therefore the researcher proposes taking a more detailed view of science-based industries by considering as important the level of maturation of the underlying science (Section 6.3.10, 6.4.4, 6.5.4 and 6.6.3).

The investigation also highlighted a number of research challenges with respect to the conceptualisation of the firm boundary. It suggested that there is merit, particularly in a knowledge-based context, of viewing the firm boundary as being permeable. Exploring the relationship between trust, knowledge flow and the firm boundary would appear to warrant further investigation within this research context. Future research would benefit from exploring this concept, along with the role of boundary agents (Section 6.5.3).

The research alluded to the potential application of actor theory network in this particular research context, where IT can be conceptualised both as a tool and an agent of change. It would be interesting to see what additional insight may be proffered through actor network theory (Section 6.5.2). Similarly, the important role of the human element within this research highlighted the potential application of a socio-technical perspective, which recently has become popular in knowledge management theory, to explain the role of IT in knowledge-intensive contexts. Therefore, viewing ISS through a socio-technical perspective may offer additional insights (Section 6.5.5).

A number of potential issues arose with adopting one analytical strategic management perspective, and the potential to miss important observations as a result of a narrowed lens, were discussed (Section 6.6.5). The business model concept, which has been
developed in the strategic management discourse, was initially posited in this research as a broad conceptual framework, through which to explore ISS (Section 6.6.4). Other IS researchers such as Hedman and Kalling (2003) have more recently identified merit in applying the business model concept to the IS context. Although the adapted business model was not considered entirely appropriate with respect to this research context, its central tenet of integrating the various strategic management perspectives was still considered relevant for broad discussion relating to sources of competitive advantage and ISS (Section 6.6.4).

Finally, this research did not develop specific tools and techniques for examining the current conceptualisation. It has provided recommendations on the conceptualisations that may be more appropriate in this context. Therefore future research might include exploring and developing specific tools and techniques for discussing ISS in a dynamic, complex knowledge-intensive context.

These are some of the potential areas for future research in this continuously evolving but important research area. Despite the exploratory nature of this research and the challenges raised, it is anticipated that it will make a valuable contribution as a base for future research.

### 7.6 Concluding Reflections

In conclusion this research aims to broaden the knowledge, understanding and theory in respect of ISS in KSMEs. The thesis has provided a number of substantive, methodological and theoretical contributions to the IS discipline. The researcher anticipates that aspects of this research will be helpful for those SMEs and practitioners that are actively considering the strategic use of IS within their respective contexts.

Although the volume of IS and SME research continues to grow, there still remains in Australia a limited amount of substantive IS theory that demonstrates a high-level of rigour and validity concerning ISS among SMEs, in particular KSMEs.

This thesis aims to provide a foundation for future works in this most important research area as we enter the ‘knowledge and biotechnology economies’ (Drucker, 1995; Rifkin, 1999). It is hoped that this research will encourage other researchers to continue advancing the knowledge and understanding surrounding ISS and KSMEs.
CHAPTER EIGHT

REFERENCES
References


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References


References


References


References


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References


References


References


References


References


References


References


References


References


References


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Appendices

Appendix A - Familiarisation Stage – Interviews with Key Industry Representatives

The following section provides a brief overview of the five industry representatives interviewed as part of the familiarisation stage (Sections 4.4.1 and 4.5.1):

- Industry Consultant A
- Incubator A
- Industry Association A
- Research Institute A
- Collaborative Partner A

Industry Consultant A

Industry Consultant A specialises in assisting with technology and commercial development for companies in the area of bioscience. The company employs seven consultants and specialises in areas such as scientific and commercial assessment, licensing, competitive intelligence and market analysis, business planning new company development, seed finance and technology management. Based in Melbourne, the company works with biotechnology business clients all over Australia. The interview was conducted with a senior consultant.

Incubator A

Incubator A is located in Melbourne and assists start-up companies in the biotechnology and IT sectors. The incubator has Federal Government funding of AUD $4.6 million over four years. The incubator offers shared office services; access to equipment; assistance with business activities such as finance and business development. The incubator is currently incubating eight start-up businesses. The interview was conducted with the deputy director.

Industry Association A

Industry Association A was established in February 2001 after the Victorian Government commissioned a management consulting company to develop a report on the Victorian biotechnology industry. The industry report concluded that although Victoria had a well-developed research and development base, its greatest threat was limited expertise in order to commercialise the research. Industry Association A is composed of representatives from research institutions, biotechnology companies and service providers. Industry Association A plays a role in providing networking opportunities as well as running biotechnology specific training courses, lobbying the government etc. The interview was with the executive director of Industry Association A.
Appendices

Research Institute A

Research Institute A is a large national research institute. The interview was conducted with the program director of a specific program area within Research Institute A's biotechnology program. The program area has close association with the pharmaceutical industry. The specific program comprises of a team of 12 scientists. The research program offers research to industry both on a collaborative or contract basis. In parallel, the program area has been exploring its own R&D in this area, which it is soon to look at commercialising their R&D in the future through forming a spin-off company.

Collaborative Partner A

Collaborative Partner A is a large private agricultural research company. The company provides a range of independent research, development and related scientific and technical services to private and corporate clients. In recent years, it has explored the area of biotechnology with several private and corporate clients. The company is based in Tasmania, in which there is GM moratorium, which has hindered the businesses development in this area. The interview was conducted with the senior manager of Collaborative Partner A.
Appendices

Analysis of Key Industry Interviews

The interviews with key industry representatives were recorded and subsequently were transcribed. A high-level coding process was used to reduce the data. Coding occurred at the paragraph/theme level. Table A-1 provides an excerpt from Industry Consultant A.

Table A-1  Excerpt From Initial Coding Table from Industry Consultant A

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Quotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk minimisation</td>
<td>Need to diversify product</td>
<td>We try to do what is known as technology minimisation product pool because if you are a one-product company in biotechnology it is highly risky as you have got all those clinical trials to get through, let’s say it’s a drug, to get it out there and if that fails, your company has nothing. So we try to put a few projects together, so it could be a drug and device together or it could be a number of drugs together</td>
</tr>
<tr>
<td>Management Experience</td>
<td>Academic tend to have limited management/ business nous</td>
<td>Usually when you are working with someone from a university or institute you are usually working with the academic without the commercial know how and that is where we come into play</td>
</tr>
<tr>
<td>Reputation-Connection</td>
<td>Reputation and connection with the business</td>
<td>First you look at the people, because when it is a start-up company, that is one of the most important factors - who is driving it</td>
</tr>
<tr>
<td>Management Skills</td>
<td>Academics often have limited business skills and narrow focus</td>
<td>Especially if you start with the academic who has done research in this for 10-15 years, are very narrowly focused, you are broadening their focus and it is working out how much you can broaden it</td>
</tr>
</tbody>
</table>
Appendix B - Canadian Pilot Interviews Stage

Dedicated Biotechnology Companies

Biotech A - is a publicly traded biopharmaceutical company based in the Toronto. The interview was with the business development manager, who has been with the company for several years but had also previously worked for big pharma.

Biotech B - is also a public traded biotechnology company specialising in clinical proteomics bases in Ottawa. The interview was conducted with the CEO of the company.

Biotech C - is a private biotechnology company, which is a spin-off company located in Ottawa. The interview was conducted with vice president innovation and regulatory affairs.

Biotech D - is a biopharmaceutical company based in Montreal. The interview was conducted with the business development manager.

Financing

Finance A - is a seed-stage financing company based in Toronto providing early stage investment based. The interview with Finance A was with their business development manager.

Service Providers

Supplier A - is a private firm which supplies contract experimentation services to biotechnology firms. The interview was with the CEO.

Incubator A - is located in the Quebec province and was launched in mid 2001. The interview was with the CEO.

Academia

Institution A - is research institution located throughout Canada conducting research in areas such as agriculture, biopharmaceutical, plant biotechnology and bioinformatics. An interview was conducted with the Vice-President of Research at Institution.
Figure A-1 Selection of Participants Involved in the Canadian Human Health Biotechnology Sector

(Adapted from Rautinainen, 2001).
Analysis of Canadian Pilot Interviews

A high-level analysis was conducted on the six discussion points. Emerging from these discussions around key strategies around financing, patenting, technology, alliance/merges, government support, planning and commercialisation.

Table A-1 High-level Analysis of Canadian Pilot Interviews

<table>
<thead>
<tr>
<th>Discussion Point</th>
<th>Key Discussion</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financing</td>
<td>Overcoming lack of specialised knowledge</td>
<td>Biotech C had described their technology using buzzwords such as nanotechnology and semi-conductor to gain the attention of VC and other potential investors. Biotech Band C look to the US as they have specialised VC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Going public to raise capital</td>
<td>Three firms interviewed had gone public to raise capital.</td>
</tr>
<tr>
<td></td>
<td>Attracting investment</td>
<td>Biotech C established a shadow board consisting of high profile people who did not want to the liability associated with being a board. A creative but unintentional strategy for getting financing as several board members wanted to invest in the next round of financing as they saw the potential of the technology. Biotech firms demonstrate their attractiveness for demonstrating their diligence, through proof of concept (Finance A), IP ownership (biotech A and C), business plan (biotech A, C, D) and having high profile people associated with company (Biotech A). Biotech B, C perceived linkages with highly regarded research institutions also contributed to their credibility. The use of external providers also provided a certain level of external validation (Biotech C). Biotech C suggested that some firms also have press releases to stating that they have a memorandum of understanding with another company/big pharma. This may encourage investors and increase stock prices.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Using government incentives to attract investment</td>
<td>Biotech C and D were able to market their eligibility to tax credits to access to investment. Biotech C development with a federal government department meant that R&amp;D credits matching of research investment. Biotech D located in Quebec had also used incentives to attract investment.</td>
</tr>
<tr>
<td>US Market</td>
<td></td>
<td>All biotech firms have travelled to the US seeking financing.</td>
</tr>
<tr>
<td>Discussion Point</td>
<td>Key Discussion</td>
<td>Example</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Patenting</strong></td>
<td>Attract alliances and investors by demonstrating diligence</td>
<td>Biotech A and C suggested that patents give a company credibility. Finance A for encouraging investment start-ups need to have patents.</td>
</tr>
<tr>
<td>Patent Management Strategy</td>
<td>Employ someone with science/law background (Biotech A, B, D)</td>
<td>Biotech C, the interviewee was responsible and had extensive experience in managing patents at previous institution.</td>
</tr>
<tr>
<td>Acquire companies to access technology</td>
<td>Use of patent lawyers (Biotech A, B, C,D)</td>
<td></td>
</tr>
<tr>
<td>Niche licensing of IP</td>
<td>Patent databases/searches(biotech A, B, C, D) and pipeline databases to see potential alliance partners and freedom to operate</td>
<td>Biotech D has tended to acquire the company rather than licence. Biotech A merger with pharmaceutical company gave the company access to more technology</td>
</tr>
<tr>
<td>Patent US, the at home and EU</td>
<td>Biotech C suggested the company would only niche licence- licensing to a boutique area, so they retained a control of the innovation</td>
<td></td>
</tr>
<tr>
<td>Exploit loopholes</td>
<td>All firms looked first to the US establishing first to file and then look at Canada, Europe to ensure that they establish first to file.</td>
<td>Biotech C took advantage of loopholes and first to file to extend the time before the business has to commit money to ensure whether their innovation worth pursuing or whether the patent applications needs to modified.</td>
</tr>
<tr>
<td><strong>Technology</strong></td>
<td>Standard business tool but utilised for - Communication purposes - Competitor Analysis</td>
<td>Biotech A saw email being crucial for keeping in contact with people in Europe especially with time differences. Assisted with management of alliances and their other offices (Biotech D)</td>
</tr>
<tr>
<td></td>
<td>- Patent Management</td>
<td>Biotech D suggested competitor database subscriptions are expensive but necessary.</td>
</tr>
<tr>
<td></td>
<td>Outsourcing of technology management</td>
<td>Supplier A and Biotech D accessed pipeline databases to analyse potential competitors and alliance partners.</td>
</tr>
<tr>
<td></td>
<td>Patent databases/searches (biotech A, B, C, D). Pipeline Databases to see potential alliance partners and freedom to operate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Biotech D and A employed external company to keep overheads down. AusBiotech C and B were still in research institutions premises, their technology managed by this institution.</td>
<td></td>
</tr>
<tr>
<td>Discussion Point</td>
<td>Key Discussion</td>
<td>Example</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Alliance/Mergers</strong></td>
<td>Attracting the attention of big pharma</td>
<td>Biotech A did not compete but sought to work with big pharma as they had better marketing resources. Biotech A business manager previous work for big pharma and therefore understood how they worked.</td>
</tr>
<tr>
<td></td>
<td>• Employ person with previous experience and connections with big pharma</td>
<td>Biotech C wanting recruit someone from US who understood boardroom tactics of big pharma in US. Biotech A, C, D suggested that need to attract partners need to demonstrate diligence proof of concept (Finance A, Biotech C).</td>
</tr>
<tr>
<td></td>
<td>• US Recruitment</td>
<td>Biotech D had a champion within the other company, a scientist who understood Biotech D’s technology and was able to push their case as he was 3rd from the top in the partner company. Supplier A suggests that biotech firms need to outsource when a certain area is not a core competency. This is the capacity in which Supplier A tended to deal with biotech firms.</td>
</tr>
<tr>
<td></td>
<td>Need to demonstrate diligence and reputation</td>
<td>Biotech A referred to big pharma having better marketing resources.</td>
</tr>
<tr>
<td></td>
<td>Seek a champion in the organisation</td>
<td>Biotech A and B saw that it limits the overheads incurred by company</td>
</tr>
<tr>
<td></td>
<td>Outsource a core competency</td>
<td>Biotech A and B alliances with enabled them to operate as virtual organisation through alliances with research institutions</td>
</tr>
<tr>
<td></td>
<td>Reasons for entering into alliances</td>
<td>Biotech C and B referred to the need for a person to manage the relationship to ensure the communication remains open. Biotech C although not currently in a alliance, would be look at recruiting someone into this position</td>
</tr>
<tr>
<td></td>
<td>• Access to better resources</td>
<td>Biotech A saw this as one of the main reasons for the merger with a pharmaceutical company.</td>
</tr>
<tr>
<td></td>
<td>• Limited overheads</td>
<td>Biotech C, D and looked mainly at US. Biotech D bad experience with an alliance in Europe attributed to distance reason why looking for US solution.</td>
</tr>
<tr>
<td></td>
<td>• Operate as virtual organisations</td>
<td>Employ someone with experience in boardroom tactics and understood the US market (Biotech C)</td>
</tr>
<tr>
<td></td>
<td>Alliance Manager</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Merger minimise risk and increase equity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oriented to US mainly</td>
<td></td>
</tr>
<tr>
<td>Discussion Point</td>
<td>Key Discussion</td>
<td>Example</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Government</strong></td>
<td>Quebec strategy based on clustering Tax credits (national and provincial)</td>
<td>Biotech A and D, Finance A and incubator A offers attractive tax incentives not only to invest but also attract researchers in the region. Quebec has attractive offer tax credits which have encouraged big pharma looking to establish in Canada to base their headquarters in Quebec (Biotech D). Incubator A had been able to attract several large companies to this facility (Provincial) Biotech C technology is of national interest and is likely to be developed in conjunction with a government department. Therefore investors are also able eligible for attractive tax credits (National). Quebec which has the highest income tax in Canada offers a tax free holiday for 3 years to international researchers who relocate to the province (Biotech D, Incubator A).</td>
</tr>
<tr>
<td></td>
<td>Tax incentives for international researchers</td>
<td></td>
</tr>
<tr>
<td><strong>Planning</strong></td>
<td>Use mentoring service To demonstrate diligence</td>
<td>Incubator A offered business planning services for businesses within their facility to help them establish. Research Institute A also had such a program as part of its technology transfer, both Biotech C and B had used this service. Biotech C suggested that it was necessary to show diligence Finance A helped business to develop a business plan to make them more attractive to investors.</td>
</tr>
<tr>
<td><strong>Commercialisation</strong></td>
<td>Big Pharma oriented alliances Outsource non-key areas Go to the US Fast track commercialisation</td>
<td>Biotech A saw that not to compete biotech did not compete with big pharma but relied on them for later stage developments. Biotech C, D outsourced many areas to external providers Biotech C saw that they can commercialise their product in -house through external providers, it is not risky as in alliances as they still have control. Biotech C and A sought commercialisation outside of US Biotech C's innovation had application that was of national interest, the product would be fast tracked through the approval process.</td>
</tr>
</tbody>
</table>
Critical Reflection on Canadian Pilot Interviews and Implications for Primary Data Collection

Table A-2 Critical Reflection on Canadian Pilot Interviews

<table>
<thead>
<tr>
<th>Issue</th>
<th>Reflection</th>
<th>Implication for Primary Data Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Limited Knowledge of Biotechnology</strong></td>
<td>- Researcher lacked knowledge specifically in the areas of drug discovery processes and biotechnology techniques.</td>
<td>- Before embarking on data collection in Australia, two areas needed to be researched (and have been included in the literature review Chapter 3).</td>
</tr>
<tr>
<td></td>
<td>- Noted researcher spent time, during the interview, trying to recall what particular terms meant.</td>
<td>- The researcher needed to be well-versed in the area to the point where it became second nature and could engage comfortably in conversation.</td>
</tr>
<tr>
<td></td>
<td>- Her limited knowledge interrupted her thoughts and compromised her ability to formulate follow-up questions during the interview.</td>
<td></td>
</tr>
</tbody>
</table>
| **Challenging and Questioning the Researcher’s Misconceptions and Assumptions** | Australia’s Biotechnology Industry  
- From reading government and industry reports, the researcher had an overall impression that “Australian biotechnology businesses are not as successful as their international counterparts”.  
- Biotech A challenged the researcher’s assumption - stating the fact businesses were commercialising overseas was important as it is a global marketplace.  
- The researcher reflected her impression was a government perspective, from reading a number of government commissioned reports than a reflection on the success of individual firms. | - Pilot interviews provided an opportunity to step-back, reflect and re-orient herself.  
- Gain an outside-in perspective of the Australian industry.  
- Of the Australian biotechnology industry and put Australia in context with its international environment.  
- Background research essential part of rapport processes. |
| **Biotechnology Business are Resource Rich** | - Biotechnology business, compared to traditional SMEs, appeared resource rich due to their multi-million dollar R&D expenditure.  
- High cost and long development time and the fact that most of their effort appeared to be focused on obtaining venture capital dispelled this myth.  
- High proportion of volunteers at BIO were in fact employees from small biotechnology firms as their companies could not afford the BIO 2002 registration fee (approx $2500 US per person). |                                                                                                       |
<p>| <strong>Industry Structure and Dynamics</strong>        | - Researcher’s initial impressions were that big pharma and biotechnology firms                                                                                       |                                                                                                       |</p>
<table>
<thead>
<tr>
<th>Issue</th>
<th>Reflection</th>
<th>Implication for Primary Data Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotechnology</td>
<td>• Biotech A, C, D in fact indicated that they were seeking partnerships with big pharma to commercialise their products rather than being in competition.</td>
<td></td>
</tr>
<tr>
<td>Losing the forest for the trees</td>
<td>• Investigators are at risk of losing perspective and sight of bigger picture. • Pilot interviews enabled the researcher to take a step back from the primary industry context.</td>
<td></td>
</tr>
<tr>
<td>Controversy Over Biotechnology</td>
<td>• Various experiences reiterated the controversial nature of biotechnology. • Until this point, the researcher had tried to remained detached from the controversy • High level security at BIO o past BIO conferences have been at centre of anti-globalisation and environmental protests; o first BIO conference since September 11 - threat of bioterrorism; o as volunteer, underwent a number of security checks; o protests throughout the conference including in some sessions; and o one speaker at the conference had a death threat made against her. • Physical location of several firms were undisclosed to prevent firms being targets of protests - used post office box addresses instead.</td>
<td>• This confirmed the sensitive and controversial nature of the area and further reiterated the need to address the sensitivities in the research design.</td>
</tr>
<tr>
<td>Question Framework</td>
<td>• Question framework too broad. • Enabled general insight about the industry to be obtained but data too general to answer the research questions.</td>
<td>• Question frame needed to be refocused to help provide insight into help answer the research questions.</td>
</tr>
</tbody>
</table>
| Interview Style | • Utilised a semi-structured question frame. • BIO 2002 formed a key conversation topic as well as acting as an icebreaker. • Although interview were not tape recorded, the process of note-taking was very draining on the investigator. Difficult to balance note-taking and interview flow. • The use of euphemisms appeared to be appropriate for eliciting sensitive information. | • Semi-structured interview format would be retained. • Interview time frame needed to be restricted to between 30 mins - 1 hour. • Where permitted a tape recorder would be used so flow interaction could be maintained. • Question wording worked well.
<table>
<thead>
<tr>
<th>Issue</th>
<th>Reflection</th>
<th>Implication for Primary Data Collection</th>
</tr>
</thead>
</table>
| Impressions | - The fact the trip was self-funded and not associated with a government or association participants appeared to be more willing and freer with disclosing information.  
- The Researcher's science degree also acted as a mechanism for breaking down barriers between the researcher and participant. The researcher to some extent was also considered a 'scientist' giving the impression:  
  o familiarity of terminology;  
  o understanding scientific process; and  
  o empathic to issues facing the scientific community.  
- Researcher's background similar to many participants - scientific to business domain. | - Need to be explicit about the nature of research.  
- Need to promote that this was a PhD research and not funded by any government or organisation.  
- Need to promote the researcher's scientific background. |
Appendices

Appendix C - Participant Documentation

This appendix details key documents sent to participants in this research investigation including:

- email to potential participants requesting their participation;
- information sheet for interview participants (required by the University of Tasmania, Ethics Committee);
- consent form signed by interview participants (required by the University of Tasmania, Ethics Committee); and
- email to participants post-interview.

Email to Potential Participants Requesting their Participation

Subject Line: PhD Research Project on Aus Biotech Firms- Possibility of meeting?

Dear <Contact Name>,

I am a PhD student from the University of Tasmania, looking at how Australian biotechnology businesses currently use their information systems.

I would be interested to learn more about how your business utilised its IT and I am writing to seek your company's participation in my research project. I am planning to visit Melbourne in mid-June (tentative date 8th-17th June) and was wondering whether it would be possible to meet with yourself or someone from <Company Name>.

My intention for this research is to provide some best practices for Australian biotechnology companies. I would be happy to discuss my research further with you and get your feedback on how the outcomes of this research could be tailored to be useful to your business. All discussion will be STRICTLY confidential and if needed, I can sign a confidentiality statement.

Please find attached an information sheet and a brief summary of my background would be very appreciative of any assistance you may be able to provide.

Thank you

Regards

Jayne Clarke

Jayne Clarke (BSc, BIS (hons))
School of Information Systems
University of Tasmania
Private Bag 87
Hobart TAS 7001
Australia
Ph + 61 3 6226 6215
Fax + 61 3 6226 6200
Email: jayne.clarke@postoffice.utas.edu.au
Information Sheet for Interview Participants

INFORMATION SYSTEMS STRATEGY AND AUSTRALIAN BIOTECHNOLOGY BUSINESSES STUDY

INFORMATION SHEET FOR INTERVIEW PARTICIPANTS

Researchers: Jayne Clarke (PhD Candidate)  
Dr Paul Turner (Senior Research Fellow and Supervisor)

The purpose of this research project is to explore how small-to-medium sized Australian biotechnology firms use and manage their information systems (IS) (including the technology, knowledge, people and business processes), to enable them to successfully compete in the international market place. The project is being undertaken to fulfil the requirements for a PhD in the Information Systems discipline.

The part of this research you have been asked to participate in will involve an in-depth interview. The aim of the interview is to explore the issues and management of information systems in the context of the Australian biotechnology industry. Initially, you may be asked to provide some background on the firm, such as the type of research it is conducting and then the interview will focus on issues related to the management of information systems within the Australian context. It is anticipated that the interview will be between 45 mins - 1 hour in duration. Only with your consent will the interview be recorded. The tape recorder can be turned off at any point in the interview. You will be provided with a copy of the transcript to allow you to edit out, add or clarify any points before analysis of the interview commences.

All information discussed with the researcher will remain totally confidential. No other person(s), parties, institutions or government bodies will have access to this information discussed, interview notes or tapes. All data, including transcribed copies of the interviews and any notes, will be kept in secured premises for a period of 5 years at the School of Information Systems, University of Tasmania.

A summarised report on the overall findings and recommendation from this research will be made available to you. The main results and findings from this research may be used in publication. However, no individual person(s) or firm will be named or will be able to be identified by the information published.

Please note that participation in this research project is entirely voluntary, you can choose not to answer a question and can withdraw at any time without prejudice. If you have any questions about the study, please contact

- Jayne Clarke ph (03) 6226 6215 email: j.clarke@postoffice.utas.edu.au
- Dr Paul Turner ph (03) 6226 6240 email: paul.turner@utas.edu.au
This research project has received ethical approval from the University Human Research Ethics Committee. If you have any concerns of an ethical nature or complaints about the manner in which the project is conducted, please contact the Chair or Executive Officer of The Southern Tasmania Social Sciences Human Research Ethics Committee.

- Southern Tasmania Social Sciences HREC Chair: Dr Margaret Otlowski (6226 7569)
- Executive Officer: Amanda McAully (6226 2763)

You will be provided with a copy of the information sheet and the statement of informed consent to keep.

Thank you for your participation in this study.
Consent Form signed by Interview Participants

STATEMENT OF INFORMED CONSENT
for the research project entitled

Information Systems Strategy and the Australian Biotechnology Industry

I have read and understood the 'Information Sheet' for this study. The nature and possible effects of the study have been explained to me. I understand that this part of the study involves an in-depth interview which is anticipated to take between 45 mins - 1 hour. I understand that all research data will be treated as confidential. Any questions that I have asked have been answered to my satisfaction. I agree that research data gathered for the study may be published provided that I cannot be identified as a participant. I agree to participate in this investigation and understand that I may withdraw at any time without prejudice.

Name of participant

..........................................................

Signature of participant............................. Date.. ..................................

Investigator

I have explained this project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

Name of investigator

..........................................................

Signature of investigator ......................... Date.. ..............................

Page 446
Subject Line: Thank you for your participation
Attachment: Interview Transcript

Dear <Contact Name>,

I am writing to thank you for your assistance with my research investigation and participating in an interview. Please find attached a copy of the interview transcript. This is both for your reference as well as for you to edit out, add or clarify any points before analysis of the interview commences.

I plan to be in contact in the coming months to provide you with some initial feedback on my research investigation. If you have any further questions about this research, please do not hesitate to contact me.

Thank you again for your participation.

Kind regards

Jayne

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University of Tasmania
Private Bag 87
Hobart TAS 7001
Australia
Ph + 61 3 6226 6215
Fax + 61 3 6226 6200
Email: jayne.clarke@postoffice.utas.edu.au
Appendices

Appendix D - Interview Frame

Primary Data Collection Interview Frame

The section lists potential points of discussion to guide the interview process in the primary investigation. Adopting a semi-structured interview frame provided the researcher with flexibility to adapt the questions and interview as dictated by the field conditions. It enabled the researcher to explore in-depth key concepts raised by the participant during the interview.

Business Background - The first part of the interview aimed to establish rapport between the researcher and the participant by talking about something familiar to the participant (Clarke and Turner, 2003b) to gain a better understanding of the business and the environment in which the case operates. When looking to develop an ISS, an understanding of the business environment is critical (Levy et al., 1999). Grover and Davenport (2001) also suggest that it is important to understand the knowledge processes and the context in which the processes is embedded.

Potential Discussion Points -

- Could you give me some background on yourself and the company?
  - History?
  - Structure?
  - Number of employees?
- What stage of development is research currently at?
- Can you describe the nature of the environment in which you operate?
- What do you consider some of the challenges your business faces?
- How do you try to address these challenges?
- Could you described the process you go through to set your business goals?
- By what means does your company determine its success in the marketplace?

Information Technology - The second part aimed to explore the usage, management and planning of IT within the businesses. Traditionally, IT within SMEs has been utilised in an administrative support role but it has moved towards playing a more central part of business strategies (Bergeron and Raymond, 1992; Pollard and Hayne, 1998). IT enables knowledge management practices by facilitating and storage of knowledge, making knowledge accessible and swiftly circulating relevant knowledge to the appropriate individuals (Ryan and Prybutok, 2001).

Potential Discussion Points -

- Could you give an overview of your IT infrastructure?
- How is IT managed in your business?
- In what capacity does your business use IT?
- What kind of processes do you go through when looking at purchasing new IT?
- Who tends to make the key decisions with respect to IT?
- Can you describe the process for making decisions regarding IT?
Knowledge Management - The third section aims to explore knowledge management process and the nature knowledge within the biotechnology company. Within knowledge-based firms, knowledge management is key for competition (Robertson and O'Malley-Hammersley, 2000). To develop an IS which encapsulates knowledge management, it is important to understand the nature and types of organisational knowledge (Alavi and Leidner, 2001). To use knowledge strategically, it is important to understand the multi-dimensional nature of organisational knowledge and analyse the different role of each dimension plays on competitive advantage (Narasimha, 2002).

Potential Discussion Points -

- Could you briefly describe the R&D process?
- Does your company hold any patents?
  - Type?
  - How is IP managed?
  - Do they publish?
- Is the company currently involved in licensing agreements?
- IS your company currently sharing R&D knowledge and skills with other companies?
- What processes do you have in place for managing information and knowledge?
- What would you consider your business’ main information sources?

Collaborations - The final section aimed to explore the nature of interorganisational relationships, both in alliance type arrangement (relational view) and with customer and suppliers (industry-structure level). The aim of this section is to investigate collaborations within the context of the business. Interfirm relationships are also an essential part of the biotechnology industry. Due to the prohibitive cost of R&D, patent blocks and the related financing and investment issues, strategic alliances, joint ventures and mergers are rife in the industry. These interfirm relationships enable companies to overcome barriers to entry through access to IP, capital and international markets. Powell et al. (1996) found that in the biotechnology industry innovation was the result of networks, not individual firms.

Potential Discussion Points -

- Do you have external relationships?
- Nature of the relationships?
- Purpose of these relationships?
- What types of things are exchanged (i.e. knowledge, people, patents)?
- How are these collaborations managed?

Concluding Comments

Thank the participant for their assistance

- Is there any else you would like to add?
- Do you have any questions about this research?
- As far as this research is concerned, what would you find beneficial.
Appendix E - Primary Case Vignettes

Case A

Case A is a Victorian-based human health biotechnology business specialising in neurological disorders. Established in 1999, the business was initially formed to develop and market screening software. A neurologist, who specialised in cognitive behaviour but who also had an interest in programming, founded the business.

In January 2000, Case A secured funding, which enabled the development of the neurological software. The business is backed by an Australian venture capitalist, a consortium of private investors as well as receiving some assistance from Federal Start-up Grants. The business is looking to float on the Australian Stock Exchange (ASX) in the future.

The diagnostic division has an extensive collaborative clinical trial program with Australian and international neuroscientists, clinicians and sports physicians to validate the scientific applications of products. Case A is a unique biotechnology business as it already has a product on the market, which means that it has income.

More recently, the business has formed a therapeutics division aimed at utilising Case A’s in-house expertise in the preclinical and early clinical evaluation of neurological-based therapies. Case A has now licensed in and is developing a series of three lead compounds for the early treatment of a number of neurological degenerative diseases. These compounds are licensed from both companies and research institutions in Japan, US and Israel. Case A’s therapeutic division seeks to identify early stage research, and develop these through to preclinical and early clinical phases. The business is seeking to outsource or find a development partner for the final phases.

The business currently has eight employees. While many of the employees have come from academia, all have since left their academic positions to take up full-time positions with Case A. Case A also has a scientific advisory board, which includes representatives from research, clinical practice and academia.

The participant, who is the CEO, has been with the business since 2000, previously working in both drug development and medical tools. The CEO who is from a medical background and fully certified psychiatrist, holds an MBA from a US university. He has also worked for a venture capitalist and has previously established a couple of biopharmaceutical companies.

Information Systems

Within Case A, all employees have access to a computer. The business operations run predominantly on PCs. The business utilises the Microsoft Office suite in its business operations, predominantly word processing and spreadsheet applications. The business had purchased an accounting package. However, the R&D operations generally run on Macintosh computers.
The business employs a recent graduate to manage the business' network including the hardware, software, firewall, programming and website. The IT is backed-up on a regular basis and stored off-site.

The business uses email and the Internet extensively. The business also has a website which is used predominantly as a marketing tool.

Case B

Case B is an agricultural-based Victoria biotechnology business specialising in horticulture and forestry applications. The business was established in 1985 and founded by a scientist who was working for a Victorian university. Through the application of biotechnology techniques, the case has developed several novel varieties of cut flowers.

In 1991, Case B’s scientists isolated a key gene and an initial patent application was lodged. Case B in fact had beaten Japanese researchers, working in the same area, in lodging a patent by just three days. Furthermore, a Dutch business, which had been working in a similar field lost the support of its investors when Case B’s patent was granted. Case B was able to takeover their Dutch competitor providing, which enabled them to enter the European market.

Since its start-up in 1985, the business has been through a series of financing. In 2000, Case B was close to bankruptcy, when a Victorian-based chemical company Chem A became a majority shareholder.

Currently, Case B’s market is predominantly in the US and Japan. Due to the EU’s GM moratorium, Case B is unable to sell its products in Europe. However, one of the business’ non-commercial viable flowers was approved before the moratorium and is currently sold in the UK. Similarly, a moratorium in Tasmania prevents the business selling within the state.

Case B has an agreement with two prominent international flower breeders. This agreement allows access to a range of commercial flower varieties and as well as the expertise of the conventional breeders. The business also has research joint venture with a Japanese business.

The business currently has 17 employees. Employee numbers have been as high as 50, the numbers fluctuating over the years. The interview was conducted with the R&D manager.

Information Systems

When Case B was taken over by its majority shareholder, the IT infrastructure became controlled, managed and supported by Chem A. In effect, the business is connected to Chem A’s network but has its own separate part of the system network. The shareholder tightly controls the system with any software installation requiring approval. Security has become a priority of the Chem A and Case B since their system
was infiltrated. In the past, the business used to manage their IT in-house relying on people who had some IT knowledge as well as recent IT graduates.

Case B uses standard software supported by the Chem A. This includes the Microsoft Office suite, mainly word processing and spreadsheet packages. The business also uses the Internet and email extensively. The business has a website predominantly used as a marketing tool, providing information on its products.

The business does have a mixture of manual and electronic IS, using a combination of electronic and faxed invoices. The growers of their product are located in South America, where there is limited access to the Internet. The business receives fax invoices from these areas, which are then manually keyed into their system.

Case C

Case C is a privately owned biotech business located in Victoria. Although registered in 2001, the business did not start operations until mid-2002. Case C conducts research, manufactures and supplies a variety of animal derived proteins, sera and related products for application within biotechnology, pharmaceutical and research applications. Its application includes immunoassays, cell culture, molecular biology and other applications.

Case C is a sole operation. The business is spread across two locations. The manufacturing plant where product research, development and manufacture occurs. The business section of the business is generally conducted from a home office. The managing director previously worked in the area for nearly 20 years and developed his own propriety research and manufacturing process. The business has had access to Federal Start-Up funding to establish a proof of concept. More recently, Case C has been involved in one of AusTrade's business development programs. The business intentionally does not have any investors. The business does have several collaborations including a Victorian university and several distributors.

One of the advantages Case C is that its raw material is guaranteed to be free from animal diseases such as foot and mouth and mad cow disease, which are found in other places of the world. Currently, Case C exports internationally predominantly to South America, North America, Europe and Middle East and Asia as Australia is a small market.

Information Systems

As the business is a sole operation, its physical IT infrastructure is limited. The owner has a laptop, which allows him to easily to move between his home office and the manufacturing facility. A dedicated computer, in the laboratory, is used for quality control. On the whole, the business uses predominantly the Microsoft Office suite. Case C does run one or two specialised quality control programs. The back-up procedures are not automated, but involve manual back-up on a regular basis. The back-up is then held offsite.
Email and the Internet are used extensively by the owner. At one stage, the business had looked at e-commerce sites as a possible way of selling their product. Due to the specialised nature of their product, it was not considered an appropriate media for selling the product. The business has a website. At the time of the interview, the website was very basic containing limited information on the products and the business. The owner stated “the website itself at the moment is fairly basic and rudimentary and not very professional in my opinion”. During the interview, the owner discussed that the website was in the process of being updated. The updated website contains more comprehensive information on the business profile, its products and its product applications.

Case D

Case D is a human health biotechnology business based in Victoria. Case D’s target areas are in metabolic diseases such as obesity, diabetes and osteoporosis. The business was spun out from a Melbourne university in 1998. The business has one drug in Phase II clinical trials and three compounds in development. The business has also looked at veterinary applications of its key drugs.

The business current shares its premises with two other small biotech firms. It operates as a virtual structure contracting research organisations, in all aspects of drug development formulation, manufacturing, preclinical studies and clinical studies, concentrated mostly in North America and Europe. For example, toxicology UK, manufacturing USA, and clinical trial Australia initially. The business operations consists of a management team of three people, who are responsible for the coordination and management of contractors. A feasibility study with the Australian biotech manufacturing business was recently conducted for the manufacture and distribution of its key drug.

In August 2003 the business received a Federal Start-Up grant for the use in the conduct of Phase II B clinical trials.

The business has a number of patents in the US, Australia and New Zealand and is currently awaiting examination in Canada and Japan. The interview was conducted with the CEO of the business.

Information Systems

Case D operates under a ‘virtual business’ structure and relies heavily on their IT. Each business executive has their own laptops and they store everything on their laptops. Case D shares IT infrastructure with two other biotechnology start-up companies located in the building. Case D’s management team are dissatisfied with their current IT services and have recently changed IT providers. In the future, the business will be moving to another location and in the process will purchase their own dedicated server. The business currently hires video conferencing facilities but is evaluating the feasibility of purchasing their own equipment.

In general, the business utilises the Microsoft Office suite, using word processing and spreadsheet applications. The business has also developed an in-house database for
managing their IP and clients using Microsoft Access. The business uses email and the Internet extensively. Case D also has a website used for marketing purpose and making announcements. These announcements are also sent to people who have signed up to the business’ mailing lists.

Case E

Case E is a private Victorian-based drug discovery business focused on human health applications. It was established four years ago by the business’ CEO, who has previously worked in research institutions both in Australia and overseas. A Pooled Development Fund (PDF) provided the initial funding for the business and has remained a majority shareholder. The CEO of the PDF also acts as a co-CEO with Case E and sits on its management board. Case E’s board consists of the CEO (who is founder and chief scientific officer), CEO (PDF) and the finance manager.

Case E employs over 30 staff members of which 20 hold a PhD degree. The CEO is the principal inventor of a number of patents held by the business and holds exclusive worldwide royalty-free licence to commercially exploit the technology he developed whilst working at his previous employer.

Case E is structured into a number of disciplinary groups, which includes medicinal chemistry, structural biology, computation chemistry and target validation. The focus of Case E is on therapeutic areas of immune disease and cancer. The business recently completed successful in vitro testing and is commencing human trials in the next 6 to 12 months. The computational chemistry group had developed an in-house computer program, CompProg, which aids with drug discovery research. The business is currently negotiating with several companies to allow them to incorporate CompProg into their own drug discovery program.

The business has a number of collaborations. Case E’s primary R&D collaborations are with three famous well-known cancer institutes located in Melbourne, Brisbane and New York. The interview was conducted with the CEO and founder of the business.

Information Systems

Case E has developed a propriety software program, which forms part of their drug discovery program. This was developed in-house by their computational chemists. This technology is soon to be adopted by other businesses in their drug discovery programs under a collaborative agreement.

Case E has a series of three networks including a Linux cluster, a computational chemists intranet and the business’ network. One person is hired to manage all three networks. The IT technician also has a role as part of the java programming team, which were involved with development of the propriety software. All instrumentation is linked to the network.

The business does not use external consultants, except a computational chemist, who also does much of the database work within the business.
The business utilises mainly word processing, spreadsheet, powerpoint and sometimes database packages. The business has also developed a number of in-house databases. Email is used extensively within the business and the business intranet is used for communicating information, for example- minutes of meetings or presentations. Case E has a website, containing overviews of the business structure, strategy, people and the technology with also attention to news stories.

Case F

Case F is a biotechnology business based in South Australia and is currently engaged in both human health and animal therapeutics. Formed in the early 1980s, the business was a university spin-off. The business also has an office based in the US. At the time of the interview, the business had just moved to a new office location, where both the management, R&D and manufacturing were now located in the one facility. Previously these areas were located separately around the city. The business currently employs 68 direct and contract employees. The business has both a management board and scientific advisory board, consisting of both academicians and business people both from Victoria, South Australia and the US.

The human therapeutics area is divided into protein pharmaceutical and cell therapy. The protein pharmaceutical division works in recombinant proteins as well as offering contract services. The cell therapy division is targeted at the treatment of neurodegenerative disease and gene based disorders. The business hopes to have one of its human products in human clinical trials by 2005.

Case F has one product on the market in the area of animal therapeutics. The cash flow from these sales is used to fund longer term R&D projects in human therapeutics area.

Over the years, Case F has received several start-up grants. In the late 1980s, the business listed on the ASX. The business plans to list on the NASDAQ in the future.

The business holds several patents, mainly directed at the North American market. It is also involved in a number of licensing arrangements and collaborations with research institutions both in Australia and in the US. Case F has a product licensing, development and commercialisation agreement with a major biotech with the UK.

The interview was conducted with the IT manager.

Information Systems

Until recently, the IT infrastructure was spread over two locations. The business currently runs on a mixture of Apple and PCs. Apple is generally used for scientific applications. PCs tend to be used more in management and administration roles. The business generally uses generic Microsoft Office programs, except the email system, which runs on Lotus Notes. Some statistical packages tend to be used by the scientists. An in-house program was developed for use in the labs. In fact, the IT manager was responsible for ensuring its Y2K compatibility.
Appendices

The US office is connected to the main office in Australia via VPN. Email access and server access are supported from the Australian end.

The business has a central server for storing information. It also has an intranet, which utilises Lotus Notes intranet facility for the storage of certain policy documents - HR type forms (e.g., leave forms). All employees have access to email and the Internet but not everyone has a workstation.

The website is predominantly an information and marketing tool. It provides information to potential investors, product information and overview of the business as well as access to news/press releases and reports pertaining to the business.

The business uses a number of security procedures including firewalls, VPN and auditing of security. The systems is backed up automatically and stored off-site.

Case G

Case G is a genomics business based in South Australia. Established in 1999, the business is listed on the Australian stock exchange. The business was a spin-off from key research conducted at a research institute in South Australia. While the business has its own research facilities, the business has research agreements with a number of research institutions in South Australia and Melbourne.

The business’ main focus is on the discovery of genes associated with epilepsy and breast cancer. Its epilepsy research program has 26 patent applications in various phases. The business also recently received a substantial Federal Government grant to start its own drug research program.

The business has only recently moved to its current location. The research and management are situated at different locations across Adelaide. The business currently has a number of research and product development partnerships both in Australia and internationally.

There was a high-level of security with Case G, the researcher was required to send a copy of her questions to the participants beforehand. Furthermore, the participant did not wish to be tape recorded. There were also a number of questions, the business did not want to answer. One of these included the number of employees, where the participants would only specify a range of less than 50 employees.

The interview was conducted with both the IP manager and Head of Bioinformatics.

Information Systems

Case G utilises a mixture of Apple, PCs and Unix. Apple is predominantly used for scientific applications, UNIX is used by the bioinformatics department and PCs tend to be used for business operations. Case G has an intranet and central server which is automatically backed-up. The business predominantly uses Microsoft applications and
a specialised accounting package. The business has also developed a couple of in-house databases to help manage their IP and their technology.

The business' research facility manager is also the IT manager, however the business relies on IT consultants. Furthermore some staff members have a good knowledge of their computer systems, such as the Head of the Bioinformatics section. Not all scientists have a dedicated computer but all have access to a terminal.

Case H

Case H is a South Australia biotechnology business, which was established in 1999. The business was formed to commercialise several unique biotechnologies for agricultural and veterinary applications, which were developed from a national research program. Unlike other biotech firms, Case H is focused more on product development. The business aims to take an innovation past its basic research stage through to product development then is to outsource it at the final stage of marketing.

There are currently three full time employees, who work in the positions of CEO, R&D manager and sales and marketing manager. The business also has two part time employees and employs consultants/contractors on an as needs basis.

Unusually, the business already has two products on the market, with its most recent product launch occurring two months before the interview. Therefore unlike many biotechnology companies, Case H has cash revenue. Additional business financing has also come from angel investment. The business was also awarded government funding in 2000.

The business markets predominantly to the US market, with Europe and Australia also being good-sized markets. The business is in a number of collaborations, including licensing and distribution agreements with companies in Australia and in the US.

Case H shares office facilities with its majority shareholder. This also includes their IT infrastructure. The business has a number of informal joint venture such as with US software business to help developed one of its products.

Information System

The business shares the network with its majority shareholder. This arrangement was part of the deal when Case K was being set-up. Effectively Case H has its own secure part on the network, which links the management team with their lab. The shareholder also provides much of the technical support.

Each of the management employees has a laptop, allowing them the flexibility to work from home. The software used by the shareholder tends to be standard with the system provided. In particular, Case H uses word processing and spreadsheet. The R&D manager required access to statistical packages. The sales and marketing manager was also investigating the purchase of a client management database
package. The business also uses the Internet and email extensively. Case H’s website contains information as well as access to their publications.

Case I

Case I is a NSW based biotechnology business with a technology which has a number of application areas including human health, marine and industrial applications. The business is a spin-off from a NSW university, and is currently housed and being incubated by the university’s commercialisation arm. Case I was formed in 1999 to commercialise research that inhibits bacterial growth. University researchers identified a number of these compounds that occur in seaweeds.

The university’s commercialisation arm holds 50 per cent equity in the business. The business has 3 full-time employees and another 10 university researchers are contracted to work 50 per cent of their time on Case I.

Case I does not have a product on the market, it is currently at the stage of initiating some of the registration processes. The business estimates to have a product on the market within the next two years.

Most of the business’ funding is from overseas and similarly their collaborative partners are generally US or European based. The business received a Federal Government grant in the early stages to develop proof of concept.

Information Systems

As Case I is still located and being incubated by the commercialisation arm of the University, the IT infrastructure is leased from and supported by the incubator. The incubator has two full time IT technicians who support the systems. Decisions regarding IT tend to be made by the incubator IT staff. However, Case I makes a decision on IT requirements specifically for their business, and incubator IT staff buy it and support it.

The business runs PCs utilising the Microsoft Office applications, predominantly word processing and spreadsheet applications. The business also uses an accounting package, which is again leased from the incubator. The business does run a couple of databases to hold information relating to its technology and an IP database. Contracted university researchers also have access to their own specific software packages, but this is provided by the university. The Internet and email are used extensively by the business. In particular many of their collaboration partners are overseas, so email is often the main form of communication. The business has set-up a website, although this is again hosted and managed by the incubator. It is a basic information page.

Case J

Case J is a human health biotechnology business based in the Australian Capital Territory (ACT) and NSW. The business’ focus is on the treatment of autoimmune and respiratory disease. Founded in 1999, the business was originally formed to develop novel research into the treatment of rheumatoid arthritis and multiple
sclerosis. Currently, the compound is being tested for efficacy and clinical trials in patients are due to commence in 2004. More recently, the business has licensed-in technology and is developing a product for the treatment of respiratory diseases such as cystic fibrosis.

The business has 21 full-time staff members, who are spread across three locations. These locations include a research facility at an ACT university, a clinical trial group located in Canberra as well as its corporate/manufacturing office located in Sydney. The business currently licenses and collaborates with universities in NSW, Victoria and ACT. Currently, Case J's toxicology testing is contracted out to UK and France, and their manufacturing is contracted out to India.

The interview was conducted with the medical director of the business, who is also a company director and co-founded the business.

**Information Systems**

Despite the business being spread across three locations, the business has no integrated network connecting the three locations. In the Canberra office, employees are able to transfer information in an intranet arrangement, but do not have the capacity to share over wider area network. Documents are generally sent via email.

IT is managed on a per office basis. The Canberra office uses an IT consultant on an 'as needs' basis. All three locations have different Internet service providers. The business runs two platforms, Canberra office and Sydney office both run on PCs, whereas the university runs on Macs. The business has had problems going between the two formats.

Business executives have their own laptop. The main software application used tends to be word processing, spreadsheets, Internet and email. The business is currently in collaboration with a Swedish business to develop a secure website to support the transfer of clinical data. Currently, the method involves transferring data using a secured fax, which often results in data being entered twice or three times into the system.

**Case K**

Case K is a private biotechnology business established in June 2001. The business is spread across two locations, one in ACT and the other in the US. The Australian office has about 20 people, with the total business size being less than 50 FTE. The focus of the business is on the development of human therapeutics. All staff members are from a scientific background especially in the area of genetics, and this includes people holding management positions. Many of the staff still have ties with or hold honorary teaching/research positions at the university.

Located on an on-campus business incubator, the business' facilities were under tight security with many areas off-limits to the researcher.

The business' expertise lies in metabolic syndromes and cardiovascular diseases (including diabetes, obesity) neurological diseases and respiratory diseases. At the
core of Case K’s platform is a broad suite of proprietary, disease-specific animal models.

Limited information was disclosed on the Case’s relationships with other businesses and the nature of its collaborations. Case K does have relationships other companies in California, France and Germany.

The interview was conducted with the IT manager of Case K, who has a PhD in physics and previously worked in management consulting.

Information Systems

Case K is spread across two locations. The participant is the IT manager for the Australian side and there was another person in charge of the IT in the US. There is a VPN connection between the Australian and US offices. The network has also been set-up so can log employees can log on to either the Australian network or US network. The business has its own videoconferencing facilities between the two locations. The incubator utilises a broadband connection whereas the US office only has smaller bandwidth, which causes a bottleneck.

The IT is based on Microsoft technology, utilising the operating systems and Office applications. The business has also its own financial package. The participant has also developed in-house databases. Each of the instruments also comes with its own proprietary software.

Case K is soon to be implementing a bar coding system whereby every sample is bar-coded to allow for the collation and manipulation data from a number of sources. It also enables an audit trail.

Although the business does have an IT manager, an external consultant is brought in when there is a problem which IT manager can fix or would take more than two hours of reading a book to fix himself.

Case L

Case L is a private biotechnology based in Sydney, NSW, whose product has applications in environmental, pharmaceutical and food and beverage industries. Formed in 1999, the business was established to capitalise on research its two founders, a microbiologist and a opto-electronics engineer, had been developing at a NSW university. Their techniques were shown to be invaluable during the Sydney water crisis and became the impetus behind forming the business. The business was then spun out from the university. Case L now pays a licensing fee and royalties to the university. Case L’s products detect the presence of micro-organisms such as cryptosporidium and giardia in samples.

The business was initially located in a incubator, although in the last two years has moved to its own premises. It does share lab facilities with another biotechnology business located in the same building. The business has 11 full time employees and 2 part time employees. The business also has a number of distribution partners. Case’s
L products have approval and are sold in 18 countries, in particularly USA, UK and Japan.

Initially the business received some Federal R&D start-up funding, but more recently has relied on VC and private investment.

The interview was conducted with the quality control manager\(^{53}\).

**Information Systems**

The logistics manager is largely responsible for the day-to-day management and purchasing of Case L’s hardware. The computers are leased and software is largely outsourced. Currently, most of Case L’s staff use laptops.

The business’ IT infrastructure consists of a mix of PCs and Macs. The PCs are used in the business operation side and Apples are connected to all the scientific instrumentation. The business, with which they share lab space with, also manages the Internet access.

Case L predominantly runs Microsoft Office applications, in particular word processing, spreadsheet and email. The business also uses MYOB accounting package. Recently, the business purchased an off-the-shelf client database. A number of in-house databases, used to manage contacts and grants, have been developed using FileMaker Pro. The cytometer also runs specialised software, which has been heavily customised.

The logistics manager runs back-ups of the server once a week. The business has recently purchased a second, removable hard drive so it can be kept off site.

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\(^{53}\) The interview was supposed to be with the CEO and founder, however, he was required to be interstate at the last moment, for the week the interview was scheduled.
Table A-3  Descriptive Characteristics of the Twelve Australian Biotechnology Cases

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<td>Collaborations</td>
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<td>Yes</td>
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</tbody>
</table>

Ag = Agriculture
## Appendix F - Coding Tables

### Stage One Data Analysis - Meta-case

<table>
<thead>
<tr>
<th>Open Codes</th>
<th>Initial Codes</th>
<th>Axial Codes</th>
<th>Axial Codes</th>
<th>Core category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitate communication, internal communication, internal relationship communication tool, irony of communication techniques, not a human contact replacement, improved internal communication, 'lubricates the wheels', informal communication, high internal email use, extensive email use, file sharing, encouraging tool, email transfers, lack of WAN capacity</td>
<td>Internal</td>
<td>Internal</td>
<td>Communication Tool</td>
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<tr>
<td>external communication, relationship builder, email communication, language issues, cc'ing, marketing tool, dilemma of information overload, audience communication issues, communicates to investors, communicates to partners, importance of websites, face-to-face vs technology, 24 hour operations, relationship building/maintenance tool, increased productivity, B2B communication, facilitate international business, accepted business communication tool, limited by technology capability of partner</td>
<td>External</td>
<td>External</td>
<td>Communication Tool</td>
<td></td>
</tr>
<tr>
<td>Human contact, management communication, scientists communication, $$$, 'human element' in technology</td>
<td>Teleconferencing</td>
<td>Teleconferencing</td>
<td>Teleconferencing</td>
<td>Information Facilitation Tool</td>
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<tr>
<td>Information access, literature searches, Internet searches, partner's IT compatibility dependence, manual process, biohub information sources, newsgroups to keep up-to-date, stay abreast information access- financial constraints, search tool, key role of Internet, Internet conduit to a plethora of information, information filtering, information overload</td>
<td>Information Facilitation Tool</td>
<td>Information Facilitation Tool</td>
<td>Information Facilitation Tool</td>
<td>Information Facilitation Tool</td>
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<tr>
<td>Central role of IT, competitor analysis tool, patent management assistance, client management, contact management tool, funding management tool, clinical trial data base, patent management database, technology (Scientific) management tool, in-house developed management tools</td>
<td>Business</td>
<td>Business</td>
<td>Business</td>
<td>Operational Efficiency</td>
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<tr>
<td>Business applications, business process facilitation, everyday business tool,</td>
<td>Business</td>
<td>Business</td>
<td>Business</td>
<td>Operational Efficiency</td>
</tr>
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</table>
### Open Codes

- Accounting process, Microsoft suite, PC dominated, lack of security systems, doesn't fit business application, paper-based systems, resort to manual systems, system inflexibility, manual process system integration, system mismatch, dissatisfaction with system, lack of expandability, manual system, double handling, human error, time wastage, IT problem accumulation
- R&D Application, scientist happy using computers, Mac dominated, stats packages, data source integration (efficiency), trial data inefficiency, double-handling, commercial sensitive data, secure data handling tool
- Marketing strategy, information communication tool, key role, substantiate the business, shop front, communication dilemma, credibility-website relationship, getting the information mix right, e-commerce potential
- Internal relationships building process, centralised business set-up, improved internal communication, informal relationships, establishing internal scientists business relationships, overcome internal barriers, two-way communication, lack of people to bounce ideas, idea generation
- Relationship establishment, finger on the pulse, nature of the business based on relationships, academia relationship, intellectual collaborations, alliance management, JV, reputation dependent, Internet-key in relationship building, resource access, relationship maintenance, access to research, relationship management (managerial level), CEO activity, conference hopping, human networks (science), information access, science networks, business networks, knowledge exchange relationships, improved information quality, external expertise (Informal), relationship approval, approval systems, electronic communication, increased information access, alliance competition, international relationship building, big pharma deals, competitor-partner dilemma, partnering forums, financial focused, resource access, access to expertise, 'Who you know', high-level investors, 'yachting fraternity connections, know people in high places, 'dating services', relationship management, information access, market access, partner credibility, overcome time distances, alliance management, Information access to commercial sensitive, old ties, where the people are, location driven, access to external expertise
- Image projection, referees, creating impressions via Internet, illusion of a

### Core category
- Application
- R&D Application
- Marketing Tool
- Internal
- Relationship Management
- Business Activity Facilitation
- Business Credibility
- Reputation
<table>
<thead>
<tr>
<th>Open Codes</th>
<th>Initial Codes</th>
<th>Axial Codes</th>
<th>Axial Codes</th>
<th>Core category</th>
</tr>
</thead>
<tbody>
<tr>
<td>substantial company, cheap marketing strategies, peer validation, severed ties, business community suspicious of scientist running businesses, change management structure, business transformation, commercially serious', commercial-sawy appointments, company restructuring, business credibility, big pharma validation, trump competitors, investor attraction, potential investors/collaborators attraction, website- shopfront, business credibility, marketing tool, biotechnology reputation, market infiltration, 'who you know'-credibility, credibility gap, website credibility, investor focus, business credibility-financing relationship, website build business credibility,</td>
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<td>Management</td>
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<td>scientific credibility, patents- scientific credible, scientific advisory committee, eminent scientists, big pharma relationship- technology validation, internationally renowned, peer reviewed validation, publish or patent?, product marketing,</td>
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<td>Industry analysis, industry scanning, website monitoring, journal scanning, 'eye on stocks', on the ground access industry awareness, close to the action, industry association access</td>
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<td>Industry Analysis</td>
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<td>Competitor analysis, competitor website scanning, internet searching, competitor database subscription, patent searching, information synthesis, 'grapevine', website surfing, management level activity, 'eye on the ball; company filing information scanning, competitor database searches, contract-in, licence-in, commercially sensitive information access</td>
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<td>Moratorium monitoring, potential market opportunity, political barriers, market penetration eye on market, environment scanning, potential partnering opportunities, potential investment opportunities, opportunity evaluation, opportunity-risk evaluation</td>
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<td>Opportunity Analysis</td>
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<td>Commercial sensitivity knowledge, tight knowledge controls, patenting-marketing strategy link, proactive management of knowledge, knowledge controls, information compartmentalisation, IP awareness, publishing restrictions, information sharing policy, knowledge protection, partner approval, publishing patent dilemma, publish or perish, embargo on publishing, patent not published, motivating scientists, know-how- cheap protection strategy, changing nature of scientific community, cost driven patent strategy, privacy protection, trust, security obsession, idea generating,</td>
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<td>Portfolio Management</td>
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<td>Open Codes</td>
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<td>---------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
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<td>background information, external IP expertise, competitor R&amp;D, market</td>
<td>聚焦背景信息，外部IP专业知识，竞争对手R&amp;D，市场活动的活动，专利的复杂性，时间的消耗，费用和时</td>
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<td>Financial Management</td>
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<td>focused, patent complexity, time consuming, expense and time-consuming</td>
<td>process, specialised knowledge, 'map territory', fortress building, asset</td>
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<td>protection, revenue raiser (licensing out), non-core competencies strategy,</td>
<td>专利阻塞,“狡猾和邪恶”,窃取想法的机会,监控机会,专利数据库管理,营销-分销策略，与发明者的合作，保密协议，专利管理工具，隐含的</td>
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<td>patent blocking, 'cunning and evil', steal ideas for opportunities, keep</td>
<td>知识保留(IP所有者)，创建进入壁垒，市场优势，市场规划，常规战略过程，业务计划-通过动</td>
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<td>动，日本投资者的性质，资本筹集，改变业务策略，员工人数波动，资源影响，政府资金依赖，不合理的</td>
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<td>collaborate with inventor, confidentiality agreements, patent management</td>
<td>期望，金融波动，风险资本目标，失败，美国投资者问题，IT不是一个解决方案，后院融资，IPO减少灵活性，业务失败归因于IPO，</td>
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<td>Product diversification, investor attractiveness, investor focused,</td>
<td>多样性，投资者吸引力，投资者关注，战略规划，战略规划过程，业务计划-通过动，日本投资者的性质，资本筹集，改变业务策略，</td>
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<td>strategic planning, regular strategic process, business plan- going</td>
<td>投资者的性质，资本筹集，改变业务策略，员工人数波动，资源影响，政府资金依赖，不合理的期望，金融波动，</td>
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<td>through the motion, nature of Japanese investors, capital raising, change</td>
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<td>flexibility, business failure attributed to IPO, wary of IPO strategy, IPO</td>
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<td>管理，金融导向的业务规划，未来的IPO战略，价值链，投资者教育，金融导向的业务规划，与投资者沟通，投资</td>
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<td>In-house development, skill-set building, scientific subscription,</td>
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<td>innovation facilitation, facilitate knowledge access, facilitate knowledge</td>
<td>内部发展，技能集建设，科学订阅，创新促进，促进知识传播，促进知识流，访问研究数据，克服资源约束，DNA数据</td>
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<td>flow, access to research data, overcoming resource constraints, DNA data</td>
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<td>Innovation Nurturing</td>
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<tr>
<td>In-house IT management, internalisation expensive strategy, internal</td>
<td>内部IT管理，内部化，昂贵策略，内部策略，多技能，建立内部能力，增强业务，有限的内部能力，非核心活动，R&amp;D内部化</td>
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<td>In-Sourcing</td>
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<td>strategy, multi-skilling, build up internal capacity, strengthening the</td>
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<td>In-Sourcing</td>
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<td>business, limited internal capacity, non-core activity, R&amp;D in-sourcing</td>
<td>内部IT管理，内部化，昂贵策略，内部策略，多技能，建立内部能力，增强业务，有限的内部能力，非核心活动，R&amp;D内部化</td>
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<td>Business focused project development, manage R&amp;D, IT facilitates model,</td>
<td>业务聚焦项目开发，管理R&amp;D，IT促进模型，虚拟业务模式，业务风险最小化策略，访问关键专业知识，成本</td>
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<td>'virtual business model', business risk minimisation strategy, access to key</td>
<td>业务聚焦项目开发，管理R&amp;D，IT促进模型，虚拟业务模式，业务风险最小化策略，访问关键专业知识，成本</td>
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<td>Business Model</td>
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<td>expertise, outlay reduction,</td>
<td>业务聚焦项目开发，管理R&amp;D，IT促进模型，虚拟业务模式，业务风险最小化策略，访问关键专业知识，成本</td>
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| *虚拟能力模式*，*业务风险最小化策略*，*访问关键专业知识*，*成本削减*，*
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<th>Open Codes</th>
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<th>Axial Codes</th>
<th>Axial Codes</th>
<th>Core category</th>
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<td>business focused project development, manage R&amp;D, access to R&amp;D expertise, 'overseas R&amp;D access', best R&amp;D skills, contract R&amp;D, university R&amp;D, coordinate R&amp;D</td>
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<td>Outsource IT, dissatisfaction with provider, lack of IT plan, IT managed, issues with provider, IT management, 3 different providers, lack of communication, office-based IT management, outside IT management</td>
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<td>IT expertise, due diligence, external objectivity, key knowledge, IT security-trust in external consultants, IT vendor dissatisfaction, lack of IT control, outlay minimisation, IT enabler, shared facilities shareholder, future IT constraints, marketing and distribution outsourcing, consultant dependence, trust in experts</td>
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<td>Bio-informatics, in-house development, product diversification strategy, R&amp;D efficiency, partnering opportunities, product development efficiency strategy regulatory process advantage, R&amp;D applications, propriety knowledge exploitation, data mining, IT core role in R&amp;D, IT driven R&amp;D strategy, publicly availability of DNA</td>
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<td>Convergence of R&amp;D Knowledge and IT</td>
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<td>Niche product development nature of the business, market domination, competitor buy-out, barrier to entry for competitors, freedom to operate, business niche, novel product, first to market advantage</td>
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<td></td>
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<td>Speed regulatory process, making R&amp;D more efficient strategy, time to market, reduction strategy, less resource intensive product development strategies, regulatory process exploitation</td>
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<td>International market access, overseas market focused, JVs, international market penetration, Asian market potential, potential overseas opportunities, internationalisation, North American focused, European market, international market place, globalisation, collaborations access to markets</td>
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<td>Multiple products, multiple application, 'not all eggs in the one basket', product risk mitigation strategy</td>
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<td>Management Set-up, Distributed structure, decentralised set-up, centralised system, management hub, business incubator, virtual business model, unit-based offices, shareholder controlled IT, public company issues, shareholder tight control, shareholder dependent</td>
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<td>Physical Set-up</td>
<td>Organisational Set-up</td>
<td>Business Context</td>
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</table>

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<table>
<thead>
<tr>
<th>Open Codes</th>
<th>Initial Codes</th>
<th>Axial Codes</th>
<th>Axial Codes</th>
<th>Core category</th>
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<td>Business experience, founder-R&amp;D manager, in-source business skills,</td>
<td>intended strategy, business management team, R&amp;D focused manager, ties with</td>
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<td>management, R&amp;D management team, public company set-up, co-CEO structure,</td>
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<td>recruitment, tacit knowledge (original founder)</td>
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<td>'Cheapness', information access constraints, patent and marketing strategy</td>
<td>Financial Constraints</td>
<td>Small Business Constraints</td>
<td></td>
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<tr>
<td>constraints, cheap-focused business strategies</td>
<td></td>
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<tr>
<td>Strategic planning restrained, external expertise use</td>
<td>Time Constraints</td>
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<tr>
<td>Lack of internal skills, lack of internal expertise</td>
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<td>HR Constraints</td>
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<tr>
<td>CEO-founder role, multiple roles of staff members, operational vs. strategic</td>
<td>Multi-Skilled/ Resourcefulness</td>
<td></td>
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<tr>
<td>activities, non-discrete business functions, multi-skilled-staff member,</td>
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<tr>
<td>multiple hats</td>
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<tr>
<td>Big vs. small company, flexibility, resourcefulness, same endpoint, 'virtual</td>
<td>Business flexibility</td>
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<tr>
<td>business model', loss of IT control, restricted business plans, public</td>
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<tr>
<td>company conservative business plans, public scrutiny, virtual business</td>
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<td>flexibility, large business inertia, 'dinosaurs', business development vs. IT</td>
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<tr>
<td>constraints</td>
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<tr>
<td>Strategic planning, R&amp;D experiences, clinical trial planning, R&amp;D-background</td>
<td>Commercial Orientation</td>
<td>R&amp;D Context</td>
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<tr>
<td>commercialisable outcome, science driven by business requirements, R&amp;D and</td>
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<tr>
<td>business plan alignment, useful R&amp;D, business success dependence on</td>
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<tr>
<td>commercial success, difference between academic/commercial research,</td>
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<tr>
<td>commercial orientation, useful/practical applications, product development</td>
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<tr>
<td>focused</td>
<td></td>
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<tr>
<td>'Dark side', negative perception, proper scientist, risk taking, motivation</td>
<td>Cultural</td>
<td>Dichotomy</td>
<td>Business and Science</td>
<td></td>
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<tr>
<td>greed, esoteric, introverted vs. commercial, product focused, lack of</td>
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<tr>
<td>risk taking mentality, scientists motivated by peer acceptance, business</td>
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<tr>
<td>motivated by money, tension between academic and commercial research</td>
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<tr>
<td>Business knowledge learning curve, CEO-intermediary, different knowledge</td>
<td>Knowledge Differences</td>
<td></td>
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<tr>
<td>sources, scientific journals, business activity and science activity</td>
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<tr>
<td>differences, patent- conquer the divide, business plan vs. grant planning,</td>
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<tr>
<td>programmed and reprogrammed, business advisory, reprogramming the scientists</td>
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<tr>
<td>Open Codes</td>
<td>Initial Codes</td>
<td>Axial Codes</td>
<td>Axial Codes</td>
<td>Core category</td>
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<tr>
<td>---------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>----------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Functional group integration, management organiser decentralised vs. centralised, management team structure, communication tool, coordination issues, interaction facilitation, disciplinary structures, intranet, founder CEO, management sharing, patent-owner CEO, multi-talented, flexibility, separation of labs and management team, MAC vs. PC, investor oriented, business dichotomy, lack of compatibility,</td>
<td>Business Set-up</td>
<td></td>
<td>Nature of Biotech</td>
<td>Environmental Context</td>
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<tr>
<td>Commercially unattractive, long lead time, unrealistic expectations, expensive process, long process, drug target focus, profit margin focused, high process, time scale</td>
<td></td>
<td></td>
<td>Tyranny of Distance</td>
<td>Regulatory Barriers</td>
</tr>
<tr>
<td>Moratorium, moratorium-scale back operations, regulatory barriers to entry, prohibitive cost of regulatory process, regulatory restrictions on product development, political barrier</td>
<td></td>
<td></td>
<td>Small Market</td>
<td></td>
</tr>
<tr>
<td>Tyranny of distance, detachment from N. America, dislocated from main markets, distance lack of control</td>
<td></td>
<td></td>
<td>Australian Limitation</td>
<td></td>
</tr>
<tr>
<td>Australian small market, access to market, small business community, limited opportunities, limiting partnering opportunities, limited businesses, Lack of critical mass</td>
<td></td>
<td></td>
<td>Nature of Australian Investors</td>
<td></td>
</tr>
<tr>
<td>Risk averse investors, issue with investors, Australian financing issue, lack of risk taking, limited Australia investment; investor education, investor mindset, investment barriers, perceptions of Australia, educating the investor, Australian investors risk adversity, Australian financing issues, value chain, inadequate government investment,</td>
<td></td>
<td></td>
<td>Investment Community Limitations</td>
<td></td>
</tr>
<tr>
<td>Nature of investors, financial cycle, biotech boom time, over reliance on govt funding, funding issue, govt expectations, unrealistic expectation of finding investors, Australian VC, IPO strategy to detriment, risk averse investors, US key investment market, Japanese investment, cautious investors, market slowdown, economic environmental influences, market reactivity, overseas investment, perceptions of Australia, financing a key issue (interred), US investors homebodies</td>
<td></td>
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</tbody>
</table>
Stage Two Data Analysis - Coding Tables

In Stage Two of data analysis (Section 5.3.1), the open codes assigned to each case transcript were individually examined. The core category *role of IT* has been examined in terms of the three distinct relationships, which emerged from the analysis process, being the *role of IT* as either:

- facilitator;
- enabler; and
- driver.

As these appeared to be distinct relationships and *role of IT* emerged as a central core category.
## Case A

<table>
<thead>
<tr>
<th>Core Categories</th>
<th>Open Codes (examples)</th>
<th>Exemplar Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Role of IT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>facilitator</td>
<td>✓ Facilitate</td>
<td>I would say that we use [the Internet] extensively... whenever we have a question we'll get the answer from the net 9 times out of 10.</td>
</tr>
<tr>
<td></td>
<td>communication,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>information</td>
<td></td>
</tr>
<tr>
<td></td>
<td>access, literature</td>
<td></td>
</tr>
<tr>
<td></td>
<td>searches, Internet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>searches, internal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>communication,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>external communication,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>business application</td>
<td></td>
</tr>
<tr>
<td>enabler</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>driver</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Business Activity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Facilitation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reputation</td>
<td>✓ Image projection,</td>
<td>They probably wouldn't have signed a deal with us if it had not been for the Internet because we appeared more than we at least in terms of bricks and mortar</td>
</tr>
<tr>
<td>Management</td>
<td>refers, scientific</td>
<td></td>
</tr>
<tr>
<td></td>
<td>credibility, creating</td>
<td></td>
</tr>
<tr>
<td></td>
<td>impressions via</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Internet, illusion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of company</td>
<td></td>
</tr>
<tr>
<td>Relationship</td>
<td>✓ Academic</td>
<td>We did a deal with a two billion dollar Japanese pharmaceutical company... it was all done on the Internet</td>
</tr>
<tr>
<td>Management</td>
<td>relationships, JV,</td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>✓ Industry</td>
<td>We certainly look at our competitors and we also do a lot of literature review, journals, analysis of research data</td>
</tr>
<tr>
<td>Management</td>
<td>awareness, competitor</td>
<td></td>
</tr>
<tr>
<td>Innovation</td>
<td>✓ Information</td>
<td>We ensure our scientists have access to appropriate journals and attend conferences</td>
</tr>
<tr>
<td>Nurturing</td>
<td>sources</td>
<td></td>
</tr>
<tr>
<td>Portfolio</td>
<td>✓ Knowledge controls,</td>
<td>We have been non-disclosure agreements which people are asked to</td>
</tr>
<tr>
<td>Management</td>
<td>Company boundary</td>
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<td></td>
<td>awareness, IP</td>
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<td></td>
<td>management, tacit</td>
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<tr>
<td></td>
<td>knowledge (original</td>
<td></td>
</tr>
<tr>
<td></td>
<td>founder)</td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td>✓ Product</td>
<td>Wanted to be a venture capital target we needed to put some zest into the company</td>
</tr>
<tr>
<td>Management</td>
<td>diversification,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>investor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>attractiveness,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>change business</td>
<td></td>
</tr>
<tr>
<td></td>
<td>strategy</td>
<td></td>
</tr>
<tr>
<td><strong>Outsourcing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&amp;D</td>
<td></td>
<td>Founder-still in management team</td>
</tr>
<tr>
<td>IT</td>
<td></td>
<td>We use consultants from ----, they host our website</td>
</tr>
<tr>
<td>External Expertise</td>
<td>✓ External</td>
<td>We seek through email, questions to diligence consultant who all respond to us by email</td>
</tr>
<tr>
<td></td>
<td>expertise</td>
<td></td>
</tr>
<tr>
<td>Core Categories</td>
<td>Open Codes (examples)</td>
<td>Exemplar Quote</td>
</tr>
<tr>
<td>--------------------------</td>
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<td>----------------</td>
</tr>
<tr>
<td>Convergence of R&amp;D Knowledge and IT</td>
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</tbody>
</table>
### Appendices

#### Case E

<table>
<thead>
<tr>
<th>Core Categories</th>
<th>E</th>
<th>Open Codes</th>
<th>Exemplar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Role of IT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>facilitator</td>
<td>✓</td>
<td>Tool, communication tool, management organiser</td>
<td>It's [the Internet] completely indispensable in our business anyway. We are technology driven but we are mostly information driven. The technology just leads to the information</td>
</tr>
<tr>
<td>enabler</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>driver</td>
<td>✓</td>
<td>R&amp;D driver</td>
<td>Having built around in-house discovery programs and then having applied the technology to that, we have a tool that people with similar discovery programs themselves that is something which we can offer at a profit</td>
</tr>
<tr>
<td><strong>Business Activity Facilitation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reputation Management</td>
<td>✓</td>
<td>Scientific credibility, big pharma validation, scientific validation, investor attraction, internationally renowned, website-shop front, business credibility</td>
<td>It is actually quite a difficult task for someone like us, to put together a website that satisfies both lay investors and potential investors and potential collaborators who want to see the business that they might be getting into. It's a tough one the website.</td>
</tr>
<tr>
<td>Relationship Management</td>
<td>✓</td>
<td>Personal contacts, personal networks, 'who you know', 'yachting fraternity' connections, competitor-partner dilemma</td>
<td>With some high-level individuals so on the rich 200 list and the yachting fraternity</td>
</tr>
<tr>
<td>Environment Management</td>
<td>✓</td>
<td>Competitor analysis, competitor database subscriptions, grapevine, 'eye on the ball'</td>
<td>And also another thing is that I am straight into the websites of other competitors and potential competitors</td>
</tr>
<tr>
<td>Innovation Nurturing</td>
<td>✓</td>
<td>In-house development, scientific subscriptions, access to right information, interdisciplinary interaction</td>
<td>We have subscriptions to probably a dozen scientific journals, some of them are general like <em>Nature</em>, some of them are specific topics like the <em>Journal of Medicinal Chemistry</em>, <em>Journal of Computational Chemistry</em>, you can access those papers on the Internet</td>
</tr>
<tr>
<td>Portfolio Management</td>
<td>✓</td>
<td>Map territory, external IP expertise, patent complexity, fortress building asset protection revenue raiser, patent blocking</td>
<td>If you can immerse yourself in as much information around a topic, the professionals can structure things properly but you can feed them the right way to go</td>
</tr>
</tbody>
</table>
### Appendices

<table>
<thead>
<tr>
<th>Core Categories</th>
<th>E</th>
<th>Open Codes</th>
<th>Exemplar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial Management</strong></td>
<td>✓</td>
<td>Future IPO strategy, Australian financing issues, investor education, value chain, financial oriented business planning</td>
<td>What we have had to do is train investors that there is value chain and each point on the value chain, representing a milestone, has an incremental value</td>
</tr>
<tr>
<td><strong>Outsourcing</strong></td>
<td></td>
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</tr>
<tr>
<td><strong>R&amp;D</strong></td>
<td></td>
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</tr>
<tr>
<td><strong>IT</strong></td>
<td>✓</td>
<td>In-house IT management, Internationalisation, multi-skilling, build-up internal capacity</td>
<td>We don’t do as much of the consultancy type stuff as other groups do. We internalised ours as part of the process. It is an expensive strategy but then again it adds to the overall strength of the teams.</td>
</tr>
<tr>
<td><strong>Convergence of R&amp;D, Knowledge and IT</strong></td>
<td>✓</td>
<td>Bio-information, in-house development, product development, efficiency, R&amp;D application</td>
<td>We have to have some way for sifting through all those possibilities. The way we have done it is through computational chemistry</td>
</tr>
</tbody>
</table>
## Case H

<table>
<thead>
<tr>
<th>Core Category</th>
<th>Open Codes (examples)</th>
<th>Exemplar Quote</th>
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</thead>
<tbody>
<tr>
<td><strong>Role of IT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>facilitator</td>
<td>✓ Tool, communication tool, information access, management tool, work processes</td>
<td>It is really so much easier to get access to information now. It has its advantages and disadvantages, sometimes you just get too much information</td>
</tr>
<tr>
<td>enabler</td>
<td>✓ Flexibility, &quot;virtualness&quot;, outlay minimisation, IT enables</td>
<td>We were pretty much set-up to be a virtual company</td>
</tr>
<tr>
<td>driver</td>
<td>✗</td>
<td>IT has really enabled us to do this</td>
</tr>
<tr>
<td><strong>Business Activity</strong></td>
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<td></td>
</tr>
<tr>
<td>Facilitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reputation Management</td>
<td>✓ Credibility, website credibility, credibility gap, market infiltration, &quot;who you know&quot;, scientific credibility, information communication, information access</td>
<td>The website is credibility. It is a big credibility thing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>So it's a credibility thing but it is general information for people</td>
</tr>
<tr>
<td>Relationship Management</td>
<td>✓ &quot;who you know&quot;, alliance management, partner scanning, information sharing, overcoming time-differences</td>
<td>So--- looks up other publications through various databases to search out our potential partners and find out what other people are up to, competitors and suppliers</td>
</tr>
<tr>
<td>Environment Management</td>
<td>✓ Opportunity analysis, market analysis, environment scanning, industry analysis</td>
<td>So we tend to particularly use the Internet there to do a search on just the industry and what's going on, what other products may be competitive products</td>
</tr>
<tr>
<td>Innovation Nurturing</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>Portfolio Management</td>
<td>✓ Outsourced patenting, future patent responsibility, non-core priority</td>
<td>I haven't done a lot of that, again we use &lt;Shareholder&gt; for some of the kind of service. But it hasn't been a big thing up until now</td>
</tr>
<tr>
<td>Financial Management</td>
<td>✓ Capital raising, venture finding</td>
<td>It is a big part of my job trying to raise capital</td>
</tr>
<tr>
<td><strong>Outsourcing Strategy</strong></td>
<td>✓ Business-focused project</td>
<td>We manage R&amp;D rather than actually do it ourselves</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Core Category</th>
<th>Open Codes (examples)</th>
<th>Exemplar Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT</td>
<td>✓</td>
<td>We use the &lt;Shareholder&gt; network. Partly it was a deal we set-up with &lt;Shareholder&gt; early on, which has just means that we haven't had to set-up our own system</td>
</tr>
<tr>
<td>External Expertise</td>
<td>✓</td>
<td>&lt;Shareholder&gt; tends to manage our IP. They have a good in-house process where they come up with a patent, write it. There is a lot of in-house discussions and review of the literature and they come up with something that has a reasonable chance of getting through</td>
</tr>
<tr>
<td>Convergence of R&amp;D: Knowledge and IT</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
## Case A

<table>
<thead>
<tr>
<th>Open Codes</th>
<th>Initial Axial Codes</th>
<th>Axial Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilitate communication, internal communication, relationship builder</td>
<td>Communication Tool</td>
<td>Role of IT</td>
</tr>
<tr>
<td>Information access, literature searches, Internet searches</td>
<td>Information Facilitation Tool</td>
<td></td>
</tr>
<tr>
<td>&quot;critical tool&quot;</td>
<td>Management Tool</td>
<td></td>
</tr>
<tr>
<td>Business application, the usual stuff</td>
<td>Operational Efficiency</td>
<td></td>
</tr>
<tr>
<td>R&amp;D, application, product delivery</td>
<td>R&amp;D IT Application</td>
<td></td>
</tr>
<tr>
<td>Financial Contestants</td>
<td>Small Business Constraints</td>
<td>Business Constraints</td>
</tr>
<tr>
<td>- Information access, financial management, 'cheapness',</td>
<td>Australian Environment Limitations</td>
<td></td>
</tr>
<tr>
<td>HR Constraints</td>
<td>Lack of HR resources</td>
<td></td>
</tr>
<tr>
<td>Time Constraints</td>
<td>Strategic planning restrained,</td>
<td></td>
</tr>
<tr>
<td>tyranny of distance, cost of R&amp;D,</td>
<td>Australian Environment Limitations</td>
<td></td>
</tr>
<tr>
<td>IT expertise, due diligence, external objectivity, key knowledge, IT security-trust in external consultants, limited internal capability, non-core activity</td>
<td>External Expertise</td>
<td></td>
</tr>
<tr>
<td>CEO, operational vs. strategic activities, non-discrete business functions, multi-skilled-staff member, multiple hats</td>
<td>Multi-Skilled</td>
<td>Business Acumen</td>
</tr>
<tr>
<td>Mgt experience, founder-R&amp;D manager, in-source business skills, intended strategy, management skills, management skill recruitment</td>
<td>Management Background</td>
<td></td>
</tr>
<tr>
<td>Finger on the pulse, academic relationship, intellectual collaborations, CSO-alliance management (scientific focused), venture partnering, network maintenance</td>
<td>Relationship Management</td>
<td>Collaborations</td>
</tr>
<tr>
<td>JV, reputation, patent vs. publishing, Internet-key in relationship building, resource access, relationship maintenance</td>
<td>Relationship Establishment</td>
<td></td>
</tr>
<tr>
<td>Image projection, referees, scientific credibility, creating impressions via Internet, illusion of a substantial company, cheap marketing strategies, peer validation, competitor analysis</td>
<td>Image/Credibility</td>
<td></td>
</tr>
<tr>
<td>Business attractiveness, investor focused, strategic planning, regular strategic process, business planning going through the motion, nature of Japanese investors, capital raising, change business strategy, product diversification</td>
<td>Investor Attractiveness</td>
<td></td>
</tr>
<tr>
<td>Competitor analysis, competitor website scanning, industry analysis, environmental analysis</td>
<td>Environment Management</td>
<td></td>
</tr>
<tr>
<td>Company boundary awareness, knowledge controls patent scanning,</td>
<td>Portfolio protection</td>
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<tr>
<td>Open Codes</td>
<td>Initial Axial Codes</td>
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<tr>
<td>protection, niche/novelty, IP management, commercial orientation, tacit knowledge (original founder)</td>
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## Appendices

### Case B

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<tr>
<th>Open Codes</th>
<th>Initial Axial Codes</th>
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<tbody>
<tr>
<td>Internal relationships, not a human contact replacement, email communication, language issues, cc'ing</td>
<td>Communication Tool</td>
<td>Role of IT</td>
</tr>
<tr>
<td>Information Access, partner's IT compatibility, dependence, manual process</td>
<td>Information Facilitation Tool</td>
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<tr>
<td>Business Application</td>
<td>Operational Efficiency</td>
<td></td>
</tr>
<tr>
<td>R&amp;D Application, scientist happy using computers, mac vs PC compatibility</td>
<td>R&amp;D IT application</td>
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</tr>
<tr>
<td>Risk averse investors, Investment, Regulatory barriers, nature of investors, tyranny of distance, moratorium, moratorium-scale back operations, commercially unattractive Niche/Novelty, IP ownership, Internationalisation, barriers to entry, belief in commercial opportunity, first to market advantage, patent advantage, licence-in technology, Market leaders, IP ownership, commercial opportunity, market domination, novel product, freedom to operate, creating barriers to entry, product diversification, market edge</td>
<td>Environmental Barriers</td>
<td>Environmental Control</td>
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<tr>
<td>Moratorium monitoring, potential market opportunity, political barriers, market penetration</td>
<td>Regulatory Barriers</td>
<td>Environmental Barriers</td>
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<tr>
<td>Long lead time, unrealistic expectations</td>
<td>Nature of Biotech</td>
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<tr>
<td>Patents- scientific validation, business credibility, severed ties, business community suspicious of scientist running businesses, change management structure, business transformation, scientific advisory, eminent scientists, 'commercially serious' and commercial appointments, company restructuring, outside perceptions of Australia</td>
<td>Image/Credibility</td>
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<tr>
<td>Business development vs IT constraints, expertise access, product focused, commercially-seriousness</td>
<td>Business Development</td>
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<tr>
<td>Management Set-up, Distributed business, dislocation, loss of control, restricted business plans, public company conservative business plans, public scrutiny</td>
<td>Public Company Barriers</td>
<td>Business Set-up</td>
</tr>
<tr>
<td>Shareholder controlled IT, lack of ownership, public company issues, 'security obsessive', shareholder tight control restriction on IT, big vis small company, trust in experts, IT problem accumulation, constraints</td>
<td>Lack of IT Control</td>
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<tr>
<th>Open Codes</th>
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<th>Axial Codes</th>
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<tbody>
<tr>
<td>Scientific relationship, human networks (science), information access, science networks, business networks, knowledge exchange relationships, information quality, access to external expertise, relationship approval, approval systems, electronic communication, information access, information quality</td>
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<td>Relationship Management</td>
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<tr>
<td>Big vs small company, flexibility, limited resources, resourcefulness, same endpoint</td>
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<td>Small Business advantage</td>
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<tr>
<td>Financial cycle, biotech boom time, over reliance on govt funding, funding issue, govt expectations, unrealistic expectations of investors, issue of finding investors, Australian VC, IPO-strategy to detriment, risk averse investors, US-key investment market, Japanese investment, cautious investors</td>
<td>Finance</td>
<td>Financial Management</td>
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<tr>
<td>Government funding, funding cycles, unrealistic expectations, venture capitalist target, risk adversity, float failure, US investor issues, IT not a solution, backyard financing, Employee number fluctuations, resource-influences,</td>
<td>Funding Strategy</td>
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<tr>
<td>Australian small market, issue with investors, market slowdown, financial oriented, international market access, overseas market focused, overseas venture partnering, intentional</td>
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<td>Internationalisation</td>
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<tr>
<td>Commercial R&amp;D, R&amp;D-business plan alignment, strategic planning, public company necessity</td>
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<td>Business Planning</td>
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<tr>
<td>Competitor analysis- commercial sensitive, competitor scanning, quality information improved in marketplace, marketing information, reliance on scientific network, information quality, access to information</td>
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<td>Competitor Analysis</td>
</tr>
<tr>
<td>Commercial sensitivity, tight knowledge controls, information compartmentalisation, IP awareness, publishing restrictions, information sharing policy, knowledge protection, partner approval, publishing patent dilemma, publish or perish, embargo on publishing motivating scientists, know-how- cheap protection strategy, changing nature of scientific community, cost driven patent strategy, privacy protection, trust, security obsession,</td>
<td></td>
<td>Security Conscious</td>
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## Appendices

**Case E**

<table>
<thead>
<tr>
<th>Open Codes</th>
<th>Initial Axial Codes</th>
<th>Axial Codes</th>
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<tbody>
<tr>
<td>'dark side', negative perception, proper scientist vs commercial scientist, different motivation, greed, esoteric, introverted vs commercial, product focused, lack of risk taking mentality</td>
<td>Cultural Differences</td>
<td>Divide between R&amp;D and Business</td>
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<tr>
<td>Functional group integration, management organiser decentralised vs centralised, management team structure, communication tool, coordination issues, interaction facilitation, disciplinary structures, intranet, founder CEO, management sharing, patent-owner CEO, multi-talented, flexibility, multiple hats</td>
<td>Business Structure Differences</td>
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<tr>
<td>International relationship building, internal relationships building process, centralised business set-up, communication</td>
<td>Internal Relationships</td>
<td>R&amp;D and Business Orientation</td>
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<tr>
<td>Internal communication, 'lubricates the wheels', informal communication, high internal email use, marketing tool, dilemma of information overload, audience communication issues, communicates to investors, communicates to partners, importance of websites, intranet</td>
<td>Communication tool</td>
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<tr>
<td>In-house development, skill-set building, scientific subscription, interdisciplinary interaction</td>
<td>Innovation Nurturing</td>
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<tr>
<td>Business knowledge learning curve, tacit knowledge, reprogramming the scientist, commercialisable outcomes, useful/practical application</td>
<td>Knowledge Orientation</td>
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<tr>
<td>Bio-informatics, in-house development, product diversification, partnering opportunities, efficiency, multiple application, Efficiency Strategy- regulatory process advantage, R&amp;D applications, product development efficiency strategy</td>
<td>Knowledge R&amp;D and IT convergence</td>
<td>Value Added R&amp;D Strategy</td>
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<td>Expensive process, long process, drug target focus, profit</td>
<td>Biotech</td>
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<tr>
<td>Information Access, biohub information sources, newsgroups to keep up-to-date</td>
<td>Information Facilitation Tool</td>
<td>Role of IT</td>
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<tr>
<td>Central role of IT, competitor analysis tool</td>
<td>Management Tool</td>
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<tr>
<td>future IPO strategy, Australian financing issue, lack of risk taking, long-lead times, value chain, inadequate government investment, investor education, investor mindset, limited Australia investment, financial oriented business planning, distance lack of control</td>
<td>Financial Limitations</td>
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<tr>
<td>Personal contacts, personal networks,</td>
<td>External</td>
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<tr>
<td>alliance competition, big pharma deals, competitor-partner, partnering forums, financial focused, resource access, access to expertise, 'Who you know', high-level investors, 'yachting fraternity connections, know people in high places, 'dating services'</td>
<td>Active Portfolio Management</td>
<td>Managing corporate knowledge</td>
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<tr>
<td>Idea generating, background information, external IP expertise, competitor R&amp;D, market focused, patent complexity, time consuming, expense, specialised knowledge</td>
<td>Knowledge Protection</td>
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<tr>
<td>'map territory', fortress building, asset protection, Revenue raiser (licensing out), non-core competencies, patent blocking, Steal ideas for opportunities, keep eye on opportunities</td>
<td>Knowledge Exploitations</td>
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<tr>
<td>Eminent scientist, big pharma relationship validation, internationally renowned, Scientific credibility, big pharma validation, scientific validation, trump competitors, eminent scientists, investor attraction, potential investors/collaborators attraction, Website shopfront, business credibility</td>
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<td>Reputation Management</td>
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<tr>
<td>International market penetration, Asia market potential, potential overseas opportunities</td>
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<td>Internationalisation</td>
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<tr>
<td>Competitor analysis, Internet searching, competitor database subscription, patent searching, information synthesis, communication, information tool, opportunity analysis, Competitor Analysis lots of gossip, 'grapevine', website surfing, managers role, 'eye on the ball';</td>
<td></td>
<td>Competitor Analysis</td>
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<tr>
<td>In-house IT management, internalisation expensive internal strategy, multi-skilling, build up internal capacity, strengthening the business, non-core activity,</td>
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<td>In-House Development</td>
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<td>face-to-face vs face-to-face technology, relationship operations</td>
<td>Communication Tool</td>
<td>Role of IT</td>
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<td>building/maintenance tool</td>
<td>Information Facilitation Tool</td>
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<td>information access</td>
<td>Management Tool</td>
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<td>financial constraints</td>
<td>Operational Efficiency</td>
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<td>patent management assistance, client management</td>
<td>Business Set-up</td>
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<td>business applications</td>
<td>Virtual Business Model</td>
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<td>'management hub', external expertise, business incubator, business management team, 'virtual business model', 'virtualness', risk minimisation, Management flexibility, management oriented, shareholder facilities, shared IT, shareholder responsibility, outsourcing patent management</td>
<td>Product Development Strategy</td>
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<tr>
<td>Product marketing, R&amp;D in-sourcing, product development focused, take to market, value-adding, product diversification, efficiency, internationalisation, North American focused, European market, niche/novelty</td>
<td>IT Outsource</td>
<td>Outsourcing Strategy</td>
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<tr>
<td>IT vendor dissatisfaction, outlay minimisation, IT enabler, shared facilities shareholder, system limitations</td>
<td>Lack of Strategic Control</td>
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<tr>
<td>lack of control on IT, future IT constraints, shareholder managed IT, IT expansion issues</td>
<td>R&amp;D Outsourcing</td>
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<tr>
<td>business focused project development, manage R&amp;D, access to R&amp;D expertise, coordinate R&amp;D</td>
<td>External Expertise</td>
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<td>marketing and distribution outsourcing, consultant dependence</td>
<td>Collaborations</td>
<td>Relationship Management</td>
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<td>relationship management, information access, market access, partner-competitor dilemma, partner credibility, overcome time distances</td>
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<td>Reputation Management</td>
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<tr>
<td>marketing tool, credibility, communication, biotechnology reputation, market infiltration, 'who you know'-credibility, scientific credibility, credibility gap, website credibility, investor focus, market outsourcing, alliance management</td>
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<td>Financial Management</td>
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<td>investment savvy, Australian investors</td>
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<td>Environment Management</td>
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<td>risk adversity, capital raising management level activity</td>
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<td>Portfolio Management</td>
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<td>competitor analysis, opportunity analysis, eye on market, environment scanning, industry analysis, market analysis</td>
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<td>Barriers to Entry</td>
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<td>patent d/base mgt, marketing-distribution strategy</td>
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### Case J

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<tr>
<th>Open Codes</th>
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<tr>
<td>Extensive email use, internal communication, file sharing</td>
<td>Communication Tool</td>
<td>Role of IT</td>
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<td>Information Access, search tool</td>
<td>Information Facilitation Tool</td>
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<tr>
<td>Funding management tool, clinical trial data base, patent management database</td>
<td>Management Tool</td>
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<td>Business Application, R&amp;D efficiency</td>
<td>Operational Efficiency</td>
<td>R&amp;D IT Applications</td>
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<td>R&amp;D Application, data source integration (efficiency), trial data</td>
<td>Operational Efficiency</td>
<td>R&amp;D IT Applications</td>
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<td>inefficiency, double-handling, commercial sensitive data, secure data</td>
<td>Collaboration</td>
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<td>handling tool</td>
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<td>Decentralised business, R&amp;D management team, uni-based offices</td>
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<td>Mac vs. PC, business dichotomy, manual process system integration,</td>
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<td>system mismatch, dissatisfaction with system, lack of expandability, email</td>
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<td>transfers, lack of WAN capacity, lack of security, manual system, double</td>
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<td>handling, human error, lack of compatibility, time wastage.</td>
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<td>Outsource IT, outlay minimisation, outside IT management</td>
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<td>dissatisfaction with provider, lack of IT plan, IT managed, issues with</td>
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<td>provider, IT management, 3 different providers, lack of communication,</td>
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<td>office-based IT management</td>
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<td>Information access to commercial sensitive, academic relationships,</td>
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<td>&quot;who you know&quot;, collaboration for, relationship, old ties, where the</td>
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<td>Management</td>
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<td>people are, location driven</td>
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<td>Science credibility, website credibility, impressions</td>
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<td>Industry scanning, website monitoring, journal scanning, company filing</td>
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<td>information, competitor database searches</td>
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<td>agreements, patent management tools</td>
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<td>Strategic planning, R&amp;D experiences, clinical trial planning, R&amp;D</td>
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<td>Management tool, business efficiency, budget management, financially</td>
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<td>oriented business plan</td>
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