Exploring Open Innovation in the Biotechnology Industry: A Qualitative Study

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Declaration

I, Hitu Sood, declare that the PhD thesis entitled *Exploring Open Innovation in the Biotechnology Industry: A Qualitative Study* is no more than 100,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work.

Signature: Hitu Sood

Date: July 30, 2019

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Abstract

Open Innovation (OI) is a new paradigm in innovation suitable for organisations characterised by Research and Development (R&D), and for organisations that are global and operating in high-technology industries. Although exceedingly relevant to Australian businesses due to the location challenge faced by Australia, to date OI is only sparsely researched in the Australian context. The majority of research published on OI is in the European or American context. This qualitative case study therefore, investigated OI in the Victorian Biotechnology Industry, which meets the characteristics of organisations suitable for OI. The aim of this research is to understand the micro-foundations of OI and its implications from individual managers' perspective in Biotechnology organisations; and to explore how organisations and individuals can manage these implications. The results of this study show how the implications of OI can be managed at an individual level and also at, the organisational level without heavy investment or major changes.

Applying the lens of Knowledge Based Theory of the firm, this research examines the perspectives of various stakeholders on OI in the Biotechnology industry. This research explored individual managers' interpretation of the OI phenomenon based on their overall experience of OI in their organisations. The interpretivist paradigm enabled an understanding into the reality of the phenomenon as seen by the practitioners of OI. It allowed the Researcher to search for patterns of meaning while describing meanings that the managers assigned to OI; their view of the implications of being open for innovation, and examining how OI was managed in their organisations. The data for this study was collected based on the considerations of theoretical saturation which was achieved from eight Biotechnology organisations in the state of Victoria in Australia. A total of twenty interviews were conducted with ten participants from the eight Biotechnology organisations. In addition, for triangulation, six interviews with five participants from: a Contract Research Organisation (CRO), a premier Australian Research Institute (RI), and an Industry Body (IB) for the Biotechnology industry were conducted. By including a variety of stakeholders from the industry this research is able to present a holistic picture of OI in the Victorian Biotechnology industry. Although a small sample, saturation of information was reached from the rich data that emanated from the semi-structured interviews, analysis of documents collected, and from information posted on websites. The data set was so rich that issues of validity and reliability were easily justified from the analysed data.

Literature on OI has suggested that one of the implications of OI is that it requires considerable changes in the policies, processes and systems of organisations. The findings of this research suggest that the nature of the Biotechnology industry is such that it is knowledge intensive, participates in R&D, is technology based, and adopts OI without much effort in change management. OI was viewed as ingrained in the nature of scientific work and not an entirely novel phenomenon within the Biotechnology industry in Victoria. The Biotechnology firms investigated did not have to incorporate any major changes to realise OI, nor required implementing any specific systems, processes or procedures for the management of OI. Consequently, the changes experienced by individuals in these organisations for

OI were minimal. The findings of this research, vary from earlier studies on OI in the American and European context that suggest that there are considerable implications due to the 'not-invented-here' syndrome. This research instead suggests that there are other implications that need more attention. For the Biotechnology organisations in this research OI promoted greater learning, improved staff morale and more team work. OI also required individuals to balance diverse stakeholder demands, learn better time management and communication, be more open to change as well as overcome ego, fear and distrust while attempting to form external partnerships. Additionally, these research findings suggest that entrepreneurial thinking, team work and cross-disciplinary knowledge are major enablers for OI in organisations.

The findings on the implications of OI in terms of the benefits and challenges highlight the dichotomy of saving time and money due to OI while also facing the challenge of risking time and money when working with external partners. To realise the benefits of OI these organisations had to harness the advantages of opposing forces such as: revealing and being open, efficiency and innovation, hierarchy and networks, teamwork and individual accountability, maintaining cost control and ensuring quality, as well as a centralised vision with decentralised autonomy. For individuals in the Biotechnology organisations this meant dealing with these paradoxes. The findings highlight that at an individual level OI can lead to a struggle to manage timelines and resource constraints while striving for quality; learning to balance between disclosure and discretion when interacting with external partners; retrieving internal knowledge while gaining new knowledge; working collaboratively internally and externally while being individually responsible.

The findings of this study suggest that OI increasingly requires knowledge exchange while contending with dualities and paradox at both individual and organisational level. Importantly this research highlights that Organisational Fluidity and Agility enables balancing and managing these dualities and paradox. The characteristics of Organisational Fluidity and Agility such as: porous boundaries, fluidity in processes and systems, resource mobility and temporary project teams are useful for OI as determined from the Biotechnology organisations. As these organisations were also Small to Medium Enterprises (SMEs) that are generally known to be responsive and flexible, it is deemed that the overall agility and fluidity of these organisations further provided on-going support for OI.

This research confirms that OI was facilitated in these Biotechnology SMEs due to their Organisational Fluidity and Agility at an individual and organisational level. At the individual level, Organisational Fluidity and Agility was supported through the use of flexible processes, systems, roles and responsibilities. This allowed employees to better handle the dual demands placed on their time, knowledge and skills for OI.

The contribution this study makes is that OI is closely linked to Organisational Agility and Fluidity, both at the individual and organisational levels. Organisations do not necessarily need to undergo major transformation to gain the benefits of OI. The characteristics of agile and flexible organisations (such

as: porous boundaries, fluidity in processes & systems, resource mobility and temporary project teams) appear to facilitate OI in the Biotechnology industry. At the individual level, individuals in Biotechnology SMEs are orientated towards collaboration (internally and externally) due to their scientific training and overall nature of knowledge intensive drug development process. Additionally, the small size and resource constraints of these Biotechnology organisations is the reason for individuals to adopt a more collaborative attitude towards innovation to stay ahead of competition. However, these findings are from one industry compromising of SMEs. Future research is required to explore these findings in other industries.

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List of Abbreviations

AUD	Australian Dollar
ASX	The Australian Securities Exchange
CEO	Chief Executive Officer
CRO	Contract Research Organisation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSO	Chief Scientific Officer
DSDBI	Department of State Development, Business and Innovation
FDA	Food and Drug Administration
HC	Human Capital
IB	Industry Body
ICT	Information and Communication Technologies
IP	Intellectual Property
IT	Information Technology
IPR	Intellectual Property Rights
KPIs	Key Performance Indicators
MD	Managing Director
NASDAQ	National Association of Securities Dealers Automated Quotations
NIH	Not-Invented Here
OI	Open Innovation
OECD	Organisation for Economic Co-operation and Development
OTCQX	Over-The-Counter securities
PwC	Pricewaterhouse Coopers
P&G	Procter & Gamble
R&D	Research & Development
RI	Research Institute
SME	Small Medium Sized Enterprise
U.S.	United States

Chapter 1

Introduction to the Study

This chapter presents an overview of the thesis. It begins with a background to the research and the research context, followed by the research problem. Next, the aim of the study is presented. This is followed by an overview of the research design and methodology. Subsequently, the discussion progresses towards a preview of the significance of the findings. The chapter ends with an overview of the thesis organisation.

Background to the Research

Open Innovation (OI) has become a popular innovation model since 2003. A reason for its popularity can be that it provides new avenues for innovation by opening up internal and external channels. However, it has faced considerable debate in literature about whether it is a new phenomenon or not. Therefore, it is no surprise then that literature offers limited variation on how OI is defined. The most cited definition describes it as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation, respectively" (Chesbrough Vanhaverbeke & West, 2006, p. 1). Research has provided evidence that OI's application is growing and it is becoming a field of study that is connecting various fields of management sciences (Chesbrough, 2006; Fredberg Elmquist & Ollila, 2008). It has been recognised as a new paradigm for the management of innovation.

The starting point for the idea of openness is that a single organisation cannot innovate in isolation (Dahlander & Gann, 2010). The OI concept advocates that organisations need to engage with a range of partners to acquire ideas and resources from the external environment to stay abreast of competition. In OI external actors can leverage on an organisation's investment in internal Research and Development (R&D) through exploring combinations of previously disconnected silos of knowledge and capabilities (Dahlander & Gann, 2010). Organisations of all sizes are shifting to an OI model whereby they employ both internal and external resources to exploit technologies and find means to simultaneously acquire knowledge from external sources (Chesbrough, 2003).

A growing number of organisations that previously used closed and insular innovation models are finding that the open approach is a better fit for the knowledge economy in which creativity and R&D talent are globally dispersed (Radjou, Prabhu & Kaipa, 2011). The OI paradigm acknowledges that due to the degree of technological complexity associated with a world-wide economy, it is necessary to find partners to collaborate with (Chesbrough, 2003). Under OI innovation is seldom undertaken in-house in a closed way, but becomes more 'open' through the involvement of many actors at different stages of the innovation process (Pénin, Hussler & Burger-Helmchen, 2011).

The OI approach is based on the premise that organisations cooperate with different actors, including customers, rivals, suppliers, distributors, and academics for innovation (Bigliardi, Galati & Petroni, 2011). It encourages innovation by allowing a number of diverse organisational partners with similar interest to join forces (Almirall & Masanell, 2010). Although OI by combining internal and external resources generates more business value it complicates the whole innovation management process leading to implications for the management (Fredberg et al. 2008). These implications form the basis of the research problem briefly discussed in the section following the research context.

Research Context

Country Context

This study explored OI in the Biotechnology industry in Victoria (Australia). It comes at a time when like most economies Australia realises the importance of innovation to its economic growth. This is evident from the Australian Government's National Innovation and Science Agenda (2015) that commits to an investment of $1.1 billion Australian Dollars (AUD) over four years (Australian Government, 2015) to promote innovation. The Agenda illustrates that with the diminishing mining prospects Australian Government acknowledges the contribution innovation and science can make towards offering new growth areas, and economic prosperity. Moreover, the Government's Australia Innovation System Report, 2015 (Department of Industry, Innovation & Science, 2015) acknowledges that innovation in present time is open and highly networked where interaction between various organisations is crucial. This is further supported by the Agenda's recognition of collaboration as one of the key pillars of innovation.

Australia has been rated low in collaboration between industry and academia across the Organisation for Economic Co-operation and Development (OECD) countries (PwC, 2015). Furthermore, when compared to other OECD countries Australia is one of the lowest rated in terms of: level of network and collaboration for innovation (PwC, 2015). The need for more collaboration for innovation is particularly noticeable in light of the fact that more than 90% of Australian businesses have no co-operative arrangements for innovation (Gahan et al., 2016). Moreover, research found that only a few Australian businesses collaborate for research with other businesses and/ or research institutions (Gahan et al., 2016). The most common barrier to innovation in Australian businesses can be ascribed to skill-shortages making the lack of collaboration and networks for innovation a major cause for concern (Gahan et al., 2016). The Australian Government has realised the need for collaboration for innovation and is encouraging universities to engage in partnerships for research with industry.

In addition to Australia's lack of collaboration for innovation another on-going issue highlighted in Government reports impacting innovation is related to leadership and management (Gahan et al., 2016). Previously the Karpin Report (1995) and Green (2009) found that issues related to management and leadership negatively impacted innovation in Australian businesses. It is worth noting here that these different reports conducted at different times, by different researchers all seem to point towards leadership and management issues impacting innovation progress in Australia over the years; thus,

indicating it to be an on-going issue for decades now (1995-2016). This makes examining the views of individuals at the leadership and management level critical to further innovation success in Australia.

The importance of innovation to Australian businesses is evident in literature available on the subject (Bhattacharya & Bloch, 2004; Bosworth & Rogers, 2001; Feeny & Rogers, 2003; Gans & Stern 2003; Jensen & Webster, 2008; Rogers, 2002, 2004; Yigitcanlar, O'Connor & Westerman 2008). This is because innovation can lead to improved performance in Australian firms (Bhattacharya & Bloch, 2004; Feeny & Rogers, 2003; Huang & Rice 2009). Another important reason for the Australian focus of this study is that little is known about which firms in Australia are actually innovating, what factors drive or hinder innovation, and where Australian organisations stand with respect to innovation (Palangkaraya, Stierwald, Webster & Jensen, 2010). Since innovation can position Australia more competitively in a global context there is a need to understand and explore it domestically (Australian Innovation System Report, 2011; Samson, 2010).

For Australia, it is important to take into account the fundamental change in the business models of a large number of leading firms in the OECD countries. Businesses worldwide are transitioning from internally focused systems of value generation, to business models that are substantially more open (Chesbrough 2006; Chesbrough & Appleyard, 2007). The World Economic Forum states that, Australia is among the countries that have reached the innovation driven stage of development which means, businesses must compete through innovation (Agarwal & Green, 2011). Many consider innovation as the ultimate weapon for all Australian businesses (Samson, 2010). According to a report prepared by Smith, Courvisanos, Tuck and McEachern (2012) for the Australian Government, Australia's poor performance in relation to other developed economies gives reason for researchers to address this issue. It further states that, Australia's trade dependence on a few large industries that are vulnerable to the changes in the international economy and the recent global economic downturn only emphasise the need for Australian industry to become more innovative.

Studies have found links between uniqueness of country cultures and OI implementation as well as, correlation between openness towards innovation activities and a country's specific characteristics (Bae & Chang, 2012; Savitskaya, Salmi & Torkkeli, 2010). An Australian study by Bhattacharya and Bloch (2004) argues that openness encourages innovation and improves ability to enter foreign markets and to compete domestically. OI initiatives are significant to Australian businesses for two important reasons: firstly, in global terms it is an expensive country to operate in due to high labour costs, and secondly it faces the location challenge (Samson, 2010). Accordingly, studying this matter within an Australian context will provide a valuable insight.

OI is based on the principles of collaboration and cooperation for improving innovation. Indications are that when compared with other OECD countries Australia shows a poorer tendency to collaborate (Australian Innovation System Report, 2011). The Australian Innovation System Report (2011, p.1) states that a major challenge for Australia is its underperformance on most measures of collaboration.

In the Australian Government report called ‘Powering Ideas’ (2009, p.8) the need for Australian organisations to collaborate is emphasised as it “is increasingly the engine of innovation”.

The importance of collaboration to the innovation scenario in Australia has also been captured by Gans and Stern (2003, p. 49) in their seminal work ‘Assessing Australia's Innovative Capacity in the 21st Century’ that concludes that for Australia “collaboration within and across industrial areas” as well as cooperation on “shared priorities” is vital for future. The case for studying OI in Australia is also promoted by Arundel (2011) who strongly argues that Australia has no choice but to be connected to global research and take advantage of new technological developments in other countries. This is largely due to the reason that it produces a small percentage of global knowledge. It is highlighted by Palmberg et al. (2009) as well that according to OECD data, Australia only produces 2% of global patents (cited in Arundel, 2011). The reason for this can be found in Marceau and Turpin’s (2007) deduction that the amount of funds spent on research by Australian industry is lower than the OECD average. This also provides a compelling argument to study Australian industry’s innovation practices.

A report prepared by Samson (2010) for the Industry Innovation Councils (IIC) of Australia, has argued that innovation can give Australia a competitive edge. Another report prepared for the IIC states that not much is known in Australia about which firms are actually innovating, and what factors drive or hinder innovation (Palangkaraya et al., 2010). This report suggests that it is important to understand where Australian firms stand with respect to innovation. The report ‘Management Matters in Australia’ (2009) has stated that when comparing Australian management performance internationally it was found that “the top 27% of Indian and Chinese manufacturers are better managed than half of Australian manufacturing firms.” The Australian Management Practices study, with a focus on Australia’s positioning in management practices globally and domestically found that at a global level Australia is weak in people management (Agarwal & Green, 2011).

OI is mostly about developing bilateral (or multilateral) collaborations, it is about organisations that trade knowledge on markets for technology or that outsource a part of their research (Pénin et al., 2011). An example from India of the use of open innovation can be observed in Biocon striking a $350-million marketing alliance with Pfizer, the world's largest drug maker. This deal illustrates an example of an organisation that does not believe in hoarding its R&D inventions but willingly shares them with partners like Pfizer (Radjou et al., 2011). A few noteworthy success stories of organisations that have succeeded by leveraging the basic research of others are Cisco, Intel and Microsoft (West & Gallagher, 2006). The decentralised research labs of organisations such as SAP and Microsoft; Philips' open innovation park; Xerox's Palo Alto Research Center; Siemens' open innovation program; IBM's open source initiatives; Bayer with its Creative Center; Eli Lilly’s Innocentive Initiative; Pfizer’s in-licensed drug Lipitor; as well as Apple opening its proprietary technology to high-tech users are some more examples of success stories of OI (Enkel Gassmann, & Chesbrough, 2009). Samson (2010) found that in Australia, innovative companies practice OI by working collaboratively with a range of partners to achieve win-win innovation outcomes. In his view, “Open innovation can be very powerful” (Samson 2010, p.15). Some Australian

businesses that have successfully adopted OI initiatives are: The Specialty Group, Stretchtex, Ferguson Plarre Bakehouses, Textor, GRL Mobile, Lonely Planet Australia, GPC Electronics, Microsoft Australia and Newcrest mining business (ibid).

Based on the above, it is evident that OI concepts are important to Australia. However, the literature is scant in helping businesses to understand this phenomenon and how to develop its management practices and policies. The key issues for Australia that require attention in relation to innovation appear to be: that of collaboration and management. This study by focusing on understanding OI (that is based on the premise of collaboration for innovation) from individual managers' perspective in the Australian Biotechnology sector not only presents an in-depth understanding on how individual managers view and engage in OI; it further contributes to an understanding of its implications, as well as provides insight into the management of it.

Industry Context

Australia is recognised as a growing knowledge economy (Yigitcanlar et al., 2008). There has been a rise in the knowledge industry as well as increase in revenue from these industries (Frederick, Beattie & McIlroy, 1999). One industry that remains competitive globally is the Australian Biotechnology Industry. Australia rated fourth globally in Biotechnology for two consecutive years (2014 & 2015) on the Scientific American Worldview Scorecard that assesses 54 countries on their innovation potential in Biotechnology (Scientific American Worldview, 2015). Australia rated second best in categories such as: growth in Biotechnology public markets, greatest public company revenues, most public companies, and greatest public company market capital. In relation to Biotechnology productivity, Australia rated second despite the challenge of location in comparison to the U.S.. In terms of intensity that measures a country's overall efforts to boost Biotechnology innovation on the scoreboard Australia was rated third best. Additionally, according to 2016 data reports from AusBiotech (a premier national industry body in Australia) the Biotechnology industry employs over 45,000 Australians in high-value jobs. It also contributes to the economy through exports worth $3.5 billion a year (AusBiotech, 2016). Literature suggests that the importance of the Biotechnology Industry (along with nanotechnology) for the future is considerable (Arundel, 2011).

Based on the contribution and impressive performance of this sector examining OI in the Biotechnology Industry (in Victoria) was considered to benefit other industries in Australia that struggle to remain competitive globally in regards to innovation. As a result, creating an opportunity for best practice sharing with other Australian businesses.

The "2011: Australian Innovation System Report" states that, Australia needs to embrace complexity by learning not just who is innovating but how they are innovating. The report acknowledges that management plays a key role in driving innovation and productivity in organisations. Other reports sponsored by the Australian government, such as 'Management Matters' by Green (2009) and Samson (2010) present similar findings that well-managed firms tend to exhibit superior innovation capabilities. The report by Green detailed that:

- Size is a factor in management performance as large organisations scored better than smaller ones,
- Multinationals organisations performed better than local ones,
- Australian publicly listed companies adopt modern management practices,
- International exposure was important,
- Level of education and skills of management and non-management staff impacted management performance,
- Organisational hierarchy positively correlated to management scores, and
- Flexibility in people management was important to successful management and well managed organisations displayed superior innovation capabilities.

Overall, the research findings of Green (2009) indicate that the national debate about the productivity performance of the Australian economy should focus on how effectively Australian organisations are managed. It also suggests that attention should be paid to "the openness of domestic and international markets the role (of)…management practices of organisations in adapting to and shaping future opportunities" (Green, 2009, p. 9). The 2011: Australian Innovation report also reflects the findings of Green (2009) asserting that, the global innovation environment is seeking more innovation and managerial skills. Additionally, that managerial skills in particular represent an important challenge for many Australian firms competing globally.

The Australian Management Practices study, with a focus on Australia's positioning in management practices globally and domestically found that globally, Australian organisations were weak in people management (Agarwal & Green, 2011). These findings were found to be consistent with the research conducted by the Society of Knowledge Economics which indicated that "Australia lags behind in terms of business management and innovation capabilities at the workplace level" (cited in Agarwal & Green, 2011, p. 95).

Furthermore, a multi-country research conducted by Bloom, Genakos, Sadun and van Reenen (2012) based on management data of 10,000 organisations across 20 countries aimed at understanding the role of management in competitive performance showed that Australia's management performance is average in comparison to United States, Japan, Germany, Sweden and Canada (as indicated in the figure below). The data used in the Bloom et al. (2012) and Green (2009) studies indicate that better managed firms are more innovative and have higher levels of productivity.

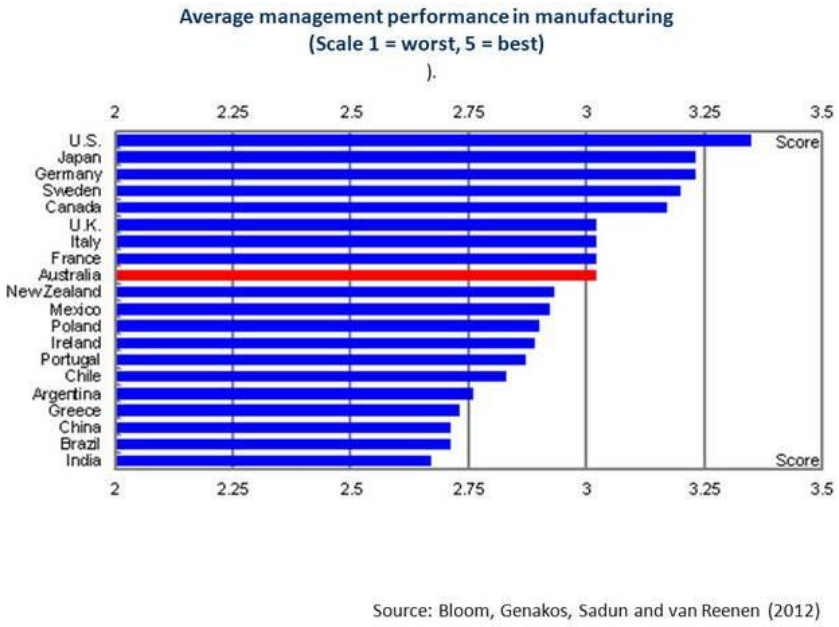

Figure-1, Multi-country research on management performance. Source: Bloom et al. (2012, p. 209)

Overall, there is evidence that Australian businesses need to improve their innovation management practices in order to stay competitive with their global counterparts (Agarwal & Green, 2011). Given all this it was considered important to focus on the firm level and individual level perspective to examine the microfoundations of OI in the Australian context.

Research Problem

The predominant perspectives that have been identified in relation to OI have been the firm perspective and the ecosystem perspective (Wikhamn & Wikhamn, 2013). Another perspective that has been highlighted recently is the individual perspective at the organisational level (Salter, Criscuolo & Ter Wal, 2014). However, there is so far scant research on understanding and examining OI from the individual perspective.

Literature recognises that using an OI model to innovate can have significant implications for the organisation and individuals. At the organisational level, the adoption of OI can require changes in the policies, processes and systems, especially in the management of knowledge and innovation (Ernst, 2006; Pénin et al., 2011). First, there is a need for more research that can guide managers in becoming more successful in adopting, implementing and managing OI initiatives (Chiaroni, Chiesa, Frattini, 2010; Giannopoulou, Yström, Ollila, Fredberg & Elmquist, 2010; Pénin et al., 2011; Vanhaverbeke, Van de Vrande & Chesbrough, 2008). Second, there is a need to examine the implications of OI on managerial practice in terms of communication and coordination complexities, resource allocation, managing collaboration and changing employee attitude to support OI (Chesbrough, 2003; Pénin et al., 2011; Witzeman et al., 2006). Third, although evidence indicates that OI has changed R&D practice, there is a need for further research to understand what these changes are and the implications (Bigliardi et al., 2011; Schroll & Mild, 2011).

Interest is growing in the organisational implications of OI and the changes required to become 'open'. This is because OI has led to considerable challenges and opportunities for personnel associated with it, as well as for the internal R&D department (Bigliardi et al. 2011). However, there is insufficient research on understanding OI at the individual level within organisations. This has been discussed in recent studies by Salter et al. (2014), as well as Gambardella and Panico (2014) who suggest examining the perceptions of people associated with OI so that organisations can gain maximum value from it. In addition, the management of innovation in organisations is known to determine the payoff it receives from its OI activities thus, examining perceptions of individuals involved in management is crucial (Almirall & Masanell, 2010; Salge, Bohne, Farchi & Piening, 2012). Furthermore, there is a general lack of research in Australia on OI leading to a need to understand it in the Australian context (Su & Lee, 2012).

Open innovators are required to make a change in hard and soft aspects of their organisation such as organisational structure, management systems and/ or culture, individual competencies respectively. What the implications of these changes are has not been studied. A recent review of literature by Fernandez et al. (2019) found that implementation of OI strategy in SMEs are closely linked to the cultural, financial and technological aspects that need to be discussed when implementing an OI strategy. The findings of this study highlight how business strategy plays a role in practising OI in Biotechnology SMEs. For the most part, there has been a lack of studies that focus on an organisation's internal environment when employing OI practices.

OI was mostly studied from a U.S. context in the early 20th century; however more recently it has primarily been studied at the country level, European countries, especially: UK, Italy and Belgium have dominated the discussion on OI (Gjergji et al. 2019). However, there has been some level of the interest from South Korean institutions (Fernandez et al., 2019) and some research in China (Hossain, 2015) as well. Few studies examining OI in SMEs (Fernandez et al., 2019) have taken place. An area of research highlighted by Fernandez et al. (2019) is the need for studies to identify the factors at the strategic and leadership levels that facilitate OI practices. This research offers the perspective of employees at senior level who can be categorised as leaders in the Biotechnology industry in Victoria, Australia.

Since SMEs have restricted capabilities and resources it leads to trust issues when practicing OI. Based on a bibliometric analysis Fernandez et al. (2019) suggest examining companies that are able to permit information to flow between partners freely. This research provides some insight into SMEs who have successfully achieved balancing the dualities of OI. Further, Hossain's (2015) literature review also discusses the need for understanding how SMEs can balance revealing and protecting knowledge during collaboration. Examination of recent literature by Fernandez et al. (2019) on OI shows that there is scarcity of research on regulated sectors in high-technology. Biotechnology is a highly regulated sector; therefore, this research also addresses this gap. Hossain's (2015) review of literature on OI in the context of SMEs revealed there was scant research in terms of proposed relevant theories and

models for managers. The present research, by focusing on understanding OI at the individual manager's level, will be useful to advance theory in that context. Laxamanan and Rahim (2020) and Natalicchio et al. (2017) discuss how OI has been scarcely examined by adopting a Knowledge Management (KM) perspective. This study employs a Knowledge Based view of the firm. The OI practices used by the Biotechnology firms in the sample are classified according to knowledge flows in or out of the organisation. Only few researchers have focused on the ad hoc implementation of OI (Martin-de Castro, 2015; Soliman, 2015). Given the above, the findings of this study advance the theory on how this works in reality.

Research Aim

The issues identified from the literature review form the basis of this study that aims to understand the micro-foundations of open innovation and its implications from individual managers' perspective in Biotechnology organisations; and to explore how organisations and individuals can manage these implications.

An Overview of the Methodology

The interpretivist paradigm was chosen as it enables an understanding into the reality of the phenomenon as seen by individuals. The focus in this paradigm is to develop understanding rather than seek explanation (Grix, 2010). In line with the interpretivist philosophical underpinning, an inductive approach was deemed suitable for this research to study the empirical evidence (Creswell, 2013).

This study adopted a qualitative methodology. This allowed a closer collaboration between the researcher and participant by enabling the researcher to understand the OI phenomenon from the participant's point of view (Baxter & Jack, 2008). Based on the literature reviewed for this study and given that there is a lack of research on OI from an individual level perspective in Australia a qualitative case study approach emerged as the suitable choice. Purposive sampling was considered to be the most appropriate method for this research as it allows the selection of sample to be based on specific themes and appropriateness to the research aim. Sample size was determined based on principles of theoretical saturation. This study used diverse data sources as a check to identify if the same conclusions are supported (Maxwell, 2013). Semi-structured interviews were used in conjunction with various other data sources (such as: annual reports, corporate websites, media reports & industry literature) to improve validity and maintain research rigour. In order to enhance the rigour and robustness of the findings data triangulation was conducted in conjunction with other practical critical steps (for example, maintaining a case study protocol and a case study database etc.) at each phase of the research. These are discussed in detail in the methodology chapter.

Research Scope

Significance of the Findings

Unlike previous studies (such as Boscherini, Chiaroni, Chiesa, & Frattini (2010), Buganza, Chiaroni, Colombo & Frattini, (2011), Chiaroni, Chiesa & Frattini (2011), Mortara & Minshall (2011)), this study found that OI does not necessarily require heavy investment into new or modified systems, processes and structures. What is needed is the organisation's capability to adapt quickly in the face of diverse simultaneous internal and external demands due to OI activities. The research results showed that OI requires contending with dualities and paradox not only externally (industry, business environment) but also internally (company wise). Therefore, what is needed is the ability to manage these in order to gain success from OI activities.

The Biotechnology organisations by continuously adapting and modifying their approach have made the most of the limitations within and around the business (such as skill shortage, location challenge and resource constraints etc.). Other businesses in Australia can learn from these Biotechnology firms that it is not necessary to undergo major transformation to benefit from OI activities; instead what is required is greater focus on- agility and fluidity. These Biotechnology organisations displayed a capacity to modify, and adjust over a period of time when required due to change in internal or external aspects whether on their own or with their collaboration partners. The fluidity and flexibility of these organisations was apparent in the way they continuously changed structures, depended on speedy improvisation, and ad hoc responses to meet their innovation needs or hurdles on the way to innovation. The Biotechnology firms approach to managing OI and its implications show that they have learnt the art of balancing the paradoxes and dualities encountered due to the openness in their innovation activities.

At an individual level an implication due to OI was that of differing and dual demands placed on individuals. Individuals struggled to manage timelines and resource constraints while striving for quality, learning to balance between disclosure and discretion when interacting with new partners, retrieving internal knowledge while gaining new knowledge, working collaboratively internally and externally while being individually responsible. These were managed by individuals by being open to change, using teamwork that is, sharing roles and responsibilities, adopting an entrepreneurial attitude, undertaking cross-skilling and being flexible in their approach.

This research has advanced theoretical understanding of OI at an individual level, and contributed to its managerial practice. By providing a greater understanding of individual managers' perspectives on OI it offers realistic guidance in managing the implications of OI at an organisational level. Further this study provides a basis for subsequent quantitative studies in this area.

Thesis Structure

This chapter has provided an introduction to the study. The successive chapter 2, examines and explores the literature to illustrate the thought behind the identification and formation of the research

questions of the study. Chapter 3, outlines the research design and methodology followed for the study. Chapter 4, showcases the first level data analysis providing an in-depth insight into the data. Chapter 5, presents a comparative analysis across the data units to ascertain common patterns and/ or themes. Chapter 6, contains a final discussion of the key findings of this research and draws conclusions based on the data analysed as well as suggests recommendations for future studies.

Chapter 2

Literature Review

This chapter begins with a consideration of the past work and definition of innovation and its various themes. It then provides an introduction to R&D and innovation. Next, the chapter explores the theoretical perspective for this research to further understand OI; the Knowledge Based View (KBV) of the firm and its link with Absorptive Capacity (AC) is discussed. Consequently, the chapter brings together the concepts of OI, organisational knowledge, KBV, and AC. This is followed by an introduction to the field of open innovation (OI), types of OI and practices associated with it. Subsequently, the chapter narrows down the research gaps in OI and discusses the importance of each of the emerging key themes in the literature under the following headings: Individual-level Perspective on OI; examining challenges to OI; and Implications of OI at the Organisational level and the Individual level respectively. Under the section on Implications of OI aspects such as: complexity of managing OI; changes in processes and structure; changes in aspects of incentives, career paths; shift in role, responsibilities and competencies of internal R&D and; whether OI substitutes and/ or complements internal R&D are discussed. The key themes identified and discussed form the basis of this study's research questions.

Defining Innovation

As this study is set in Australia it is important to note that the official definition of innovation that is accepted in Australia (as well as the United States (U.S.), Canada, Japan, New Zealand, and all European countries) is the one offered by the OECD. The OECD's (2005, p. 46) definition of innovation is as follows: "…the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations". This definition highlights the themes found in the innovation management literature over time. The common theoretical themes that emerge across different definitions of innovation are discussed next to gain a wider perspective on how innovation has been studied by various scholars.

'Innovation', as a part of management studies is heterogeneous in nature, with studies using perspectives from micro-psychology to structuralist sociology and neo-classical economics (Eisenhardt & Santos, 2002; Searle & Ball, 2003). A definition of innovation which is still of relevance is by economist Schumpeter (1934, p. 47) who describes it as a result of experimentation with "new combinations" of existing resources. Schumpeter's simple definition has been corroborated by Barnett (1953, p. 181), who argued that in innovation there is a close relation or synthesis of different elements that have not been earlier linked in a similar manner earlier, which causes development of something entirely new. Other definitions of innovation also reflect Schumpeter's initial offering, with Rogers (1983, p. 11) describing innovation as "an idea, practice, or object that is perceived as new by an individual or other

unit of adoption", and Manso (2011, p.1824) referring to innovation as “the exploration of new untested approaches”. Finally, Bröring (2005, p.11) continues the theme of innovation as a source of newness as an ‘invention’, though adds an economic condition to the definition by claiming that “Innovation = Invention + Commercial Exploitation”.

The theme of innovation as something new is reflected in almost all definitions present in the literature. Two important caveats to the concept of innovation have been suggested by West & Farr (1990) and Damanpour (1991). For West & Farr (1990) innovation is the purposeful introduction and use of new ideas, processes, products or procedures to the unit of adoption at which it is aimed, considerably improving the organisation as well as society. Conversely, Damanpour (1991, p. 556) refers to innovation as “an adoption of an internally generated or purchased device, system, policy, program, process, product, or service that is new to the adopting organisation”. The definition by Damanpour (1991) further stimulates the discussion of innovation as it suggests that the nature of whether an organisation is generating or adopting already existing innovation impacts its internal organisational processes. These definitions suggest that, innovation has a utilitarian component, and that it represents a process, rather than a stand-alone activity.

Poole & Van de Ven (1989) and, Damanpour & Gopalakrishnan (1998) highlight that innovation is a multifaceted process: it represents more than a single-step or stand-alone action. Damanpour and Gopalakrishnan (1998) go further in offering an ideal description of the innovation process (idea generation; project definition; product design and development; marketing and commercialisation) and for organisations wishing to adopt existing innovation (innovation, attitude creation, evaluation, decision to adopt, trial and sustained implementation). Tidd, Bessant and Pavitt (2005, p. 87) build on this approach and stress the importance of management in the innovation process, indicating that “the influences of the process can be manipulated to affect the outcome that is, it can be managed”. The notion that innovation can be managed additionally, suggests that innovation is not a static, standard one-size-fits-all action and emphasises the importance of appropriate management of innovation to overcome any potential barriers to the process (Brem, 2009).

Globalisation has added an additional layer of confusion to definitions of innovation due to socio-cultural and economic differences in perceptions of innovation practiced in different areas of the world (Brem, 2009). Moreover, activities used by organisations to develop their innovation management strategies are affected by globalised market conditions, and therefore, necessitate global definitions or understandings of innovation (Brem, 2009). This will also enable global teams working on international R&D projects to have both a common repertoire and decrease rates of failed collaboration (Brem, 2009). Recognition of the importance of national socio-cultural and economic contexts alludes to the second caveat suggested above; specifically, that innovation is not a universal concept and instead represents a process which, at times, can be difficult to navigate (Brem, 2009).

Another key theme that emerges in the literature related to innovation is that of knowledge. Wallin and Von Krogh (2010, p. 145) highlight these aspects together in their definition of innovation as "a process that covers the creation and use of knowledge for the development and introduction of something new and useful". This definition identifies knowledge as the critical element of innovation and states that innovation cannot occur without knowledge (Wallin & Von Krogh, 2010). Organisations require cooperation and collaboration between people and teams with different knowledge bases to innovate thus there is a need to identify and integrate knowledge throughout the innovation process (Wallin & Von Krogh, 2010). Due to the fact that the innovation process essentially comprises of knowledge creation and utilisation (Leonard & Sensiper, 1998; Miller & Morris, 2008) this issue will be discussed next.

Knowledge Creation and Innovation

Innovation is a process where an organisation creates new knowledge to resolve issues that it has identified (Nonaka, 1994). Since organisations are continuously dealing with a dynamic environment, it is required that they not only process information but actively engage in the development of new knowledge (Nonaka, 1994). Knowledge is defined as "justified true belief" which includes subjectivity and human contexts (Nonaka, 1994; Nonaka & Toyama, 2005). Nonaka and Toyama (2005) view the organisation as a knowledge-creating entity. They assert that an organisation is a lively unit that dynamically relates to the environment and reforms it, as well as its own self while in the process of creating knowledge (Nonaka & Toyama, 2005).

Innovation is about knowledge sharing and creation; and requires merging of knowledge from diverse perspectives in this present day (Bergman, Jantunen & Saska, 2009, p. 139). It is necessary to discuss what organisations consider to be knowledge, as well as its creation. Nonaka (1994) and Nonaka & Toyama (2005) provide an apt, though short, definition of what knowledge is in this context, by suggesting that organisational knowledge is created by individuals, with 'individuals' said to refer to an organisation's employees, customers, suppliers, competitors and other internal and external stakeholders. When this individual knowledge is organisationally 'amplified' it becomes a part of the organisation's knowledge network and culture (Nonaka, 1994). This definition suggests the subjective and dynamic nature of organisational knowledge, as well as the importance of the human element in defining and creating knowledge, and producing innovation.

Knowledge is categorised as explicit or tacit, the former referring to knowledge that can be communicated in a formal, systematic manner. Tacit knowledge refers to something 'we can know more than we can tell' (Nonaka, 1994; Nonaka & Toyama, 2005). Alternatively, tacit knowledge is explained as knowledge that is difficult to communicate due to its rootedness in action, commitment, and context within an organisation's culture (Nonaka, 1994). March (1991) has suggested that tacit knowledge is embedded in an organisation's rules, norms and culture, and is enhanced through learning from other members of an organisation over time. Due to its uniqueness to each organisation, tacit knowledge has been said to contribute significantly to a firm's competitive advantage (Grant, 1996; Foss, 1996a). The process of knowledge-creation requires interaction with others and is a dynamic process that involves

a constant discourse between tacit and explicit knowledge (Nonaka, 1994). Knowledge results from a constant, dynamic discourse between stakeholders who create as well as share tacit and explicit knowledge, leading to innovation.

Knowledge is known as crucial to understanding innovation. One such element is the state of technological knowledge in the firm's environment which is continuously changing. This knowledge includes all available and relevant technical information and knowledge within and outside the organisation (Utterback, 1971). Flows of knowledge between the firm and its environment are important and any obstructions can decrease the effectiveness of the innovation process (Utterback, 1971). For innovation to be successful, research shows that internal resources of technical knowledge that is, the R&D are crucial for problem solving along with external knowledge flow (Utterback, 1971). Nonaka (1994) has identified the transformation of tacit knowledge into explicit knowledge as a key challenge for firms in their efforts to remain competitive. Furthermore, literature discusses how organisations have had to depend on external sources to enhance their innovation, due to the increasing level of complexity of knowledge bases (Fagerberg, 2004; Granstrand, Patel & Pavitt, 1997). This rings true for small and large organisations alike (Fagerberg, 2004). This led to the recognition of knowledge transfers within and outside of organisations as vital to innovation.

A continuous flow of internal and external forms of knowledge is necessary for creativity and innovation within the organisation (Conboy & Morgan, 2011). This aspect of knowledge transfer has been discussed in innovation management literature. For example, Spender and Grant (1996) argue that the issue of knowledge transfer is significant between organisations, as well as within the organisation. Oldham and Cummings (1996) suggest that an organisation's ability to innovate its products, processes, and systems reflect as well as define its capacity for survival. De Leede and Looise (2005, p. 108) have argued for the relationship between utility and innovation by referring to the latter as a "deliberate and radical change in existing products, processes or organisations in order to achieve a competitive advantage over competitors". Simply put, for innovation to be acted upon, it must provide organisations with some form of competitive edge, for example offering a new way for the organisation to survive in, and adapt to globalised economy which is rapidly changing and becoming increasingly competitive (Brem, 2009).

Discussion in literature of the ever-changing state of technological knowledge shows that all knowledge, both within and outside the organisation, has an impact on organisational performance (Utterback,1971). Internal and external knowledge flows are important due to the fact that the increasing complexity of knowledge bases require organisations to place equal emphasis on internal and external knowledge and knowledge sources to enhance their innovation and improve their organisational performance (Fagerberg, 2004; Granstrand et al., 1997; Utterback, 1971). This is required of all organisations, irrespective of size (Fagerberg, 2004; Granstrand et al., 1997; Utterback, 1971). As such, organisations can be viewed as institutions for knowledge integration (Grant, 1996), though the understanding of how the forms of knowledge relate to innovation, as well as their operation at the

institutional level, are still at a rudimentary stage (Fagerberg, 2004). The discussion so far leads to understanding the relationship between knowledge and innovation.

Internal R&D and Innovation

According to Bigliardi, Dormio and Galati (2012, p.33) “internal R&D refers to the traditional form of R&D, where the number of collaborating parties is low and most innovation takes place within the wall of the firm”. Historically, an organisation’s internal R&D was considered to be a sufficient source of innovation (Herzog, 2008). Scholars such as Cohen and Levinthal (1994); Dosi (1988); Freeman and Soete (1997) have discussed internal R&D as the major driver of innovation activities. This view is further supported by Cassiman and Valentini (2009) who interpret R&D as enabling the ability of organisations in various industries to create and sustain competitive advantage.

In a traditional innovation model it has been observed that an organisation controls each aspect of the innovation process (i.e., idea generation, development, production, marketing, distribution, service, and finance) (Chesbrough, 2003). This can be attributed to the belief that successful innovation requires control and protection of Intellectual Property (IP), with an emphasis on ‘innovation from within’ through a well-funded R&D department capable of enhancing and creating new technologies and techniques that the organisation can commercialise (Badawy, 2011; Chesbrough, 2003, p. 20). Cohen & Levinthal (1989, p .593) argue that one of the reasons organisations invest in basic R&D is to be able to identify and exploit useful scientific and technological knowledge generated by others and “thereby gain a first-mover advantage in exploiting new technologies”. In addition, the reason for conducting basic research is connected with the organisation’s incentive to learn (Cohen & Levinthal, 1989).

An organisation’s internal R&D investment is the degree to which it invests in in-house activities (such as new product development) and resources in R&D (Hung & Chou, 2013). Internal R&D is essential for gaining control and for understanding tacit knowledge rooted in the organisations inbound processes (Hung & Chou, 2013). Furthermore, organisations with high R&D intensity have enhanced technological knowledge that enables them to recognise valuable new ideas, integrate new technological knowledge and benefit from external prospects (Hung & Chou, 2013). That is, the importance of internal R&D is that it helps the organisation to identify and keep track of relevant new technologies in the market, as well as leading to better monitoring and use of external knowledge resources (Chesbrough, 2003; Chesbrough, Vanhaverbeke & West, 2006). Results of a study by Caloghirou, Kastelli and Tsakanikas (2004) showed a strong positive correlation between an organisation’s innovative performance and R&D capabilities, as well as its human skills. Therefore, R&D contributes considerably to the knowledge base of an organisation which according to Kogut and Zander (1992, p. 383) is essential for an organisation’s “growth and survival”.

According to Bogers and Lhuillery (2011) internal R&D is viewed as an important source of innovation and a major impetus of innovation activities in scholarly literature. Research shows that internal R&D is crucial in determining the extent to which an organisation is able to gain and convert external technological knowledge (Cohen & Levinthal, 1990). This is mainly because internal R&D enables the

organisation to examine the similarities and differences in its collaborator's skills and knowledge in addition to, enabling the organisation to better use its current knowledge (Hung & Chou, 2013). However, it cannot be discounted that non-R&D internal functions also contribute to an organisation's overall innovation efforts and, its external sources of knowledge (Bogers & Lhuillery, 2011).

Overall, an organisation's internal R&D capability is seen as a significant factor in determining its ability to develop and exploit technological know-how which helps organisations stay competitive (Pisano, 1990). According to OECD (2002) R&D researchers and managers involved are especially important since they play a major role in knowledge creation and exchange. This might be the reason behind Barge-Gil's (2010, p. 580) assertion that, "R&D is generally used as a proxy for AC". This is due to the fact that internal R&D is essential to tap into the external R&D capabilities and technological know-how of competitors, suppliers and other organisations, in order to engage in contractual agreements such as licences, R&D agreements, and joint ventures (Pisano, 1990). Consequently, internal R&D enables knowledge sharing and collaboration which is significant and valuable for an organisation's competitive advantage in addition to improving an organisation's innovative performance (Bogers, 2011; Cassiman & Veugelers, 2006; Vanhaverbeke et al., 2008).

This perspective of knowledge sharing and collaboration leads to the idea of openness in innovation which is based on the belief that an organisation cannot innovate independently; organisations need to collaborate with various partners externally in order to compete in a global marketplace (Dahlander & Gann, 2010). This requires an approach to innovation that is more open and distributive. According to Schroll and Mild (2012) in the earlier vertically integrated innovation models, knowledge was internalised and controlled by the organisation, whereas a strong interaction between the organisation and its environment is required in present times. This further requires a "porous innovation process" which enables knowledge flows inside and outside the organisation (Schroll & Mild, 2012, p. 86). This recognition of the importance of external sources of knowledge alongside internal ones has led to increased movement away from just using in-house sources of innovation towards more 'open', external sources. This idea of openness termed as 'Open Innovation' (OI) can be useful to the knowledge intensive high-technology sector. The OECD (2008, p. 11) has recognised the importance of knowledge and OI, reflected in the following statement, "As knowledge becomes the key resource, OI needs to be embedded in an overall business strategy that explicitly acknowledges the potential use of external ideas, knowledge and technology in value creation". Next, the theoretical perspective for this study is defined. Subsequently, the discussion will move to understanding the literature that explores the linkages between the theorectical perspective and OI.

Theoretical Perspective: Knowledge Based View (KBV) of the firm

There are a range of theories of 'the firm', that seek to address the "issues of the existence, the boundaries, and the internal organisation of the multi-person firm" to explain how organisation's operate (Foss, 1996a, p. 70). Academic work (e.g., Deeds & Decarolis, 1999; Grant, 1996; Kogut & Zander, 1992; Nelson & Winter, 1982; Nonaka, 1994; Teece, 1981, 1982; Winter, 1987) has sought to

emphasise knowledge, resulting in innovation, as more than an intangible organisational resource and potential source of competitive advantage, growth and wealth creation. This has stimulated discussion, refinement and adoption of the KBV of the firm among the academic and business communities (see also Conner & Prahalad, 1996; Kogut & Zander, 1993). Spender and Grant (1996) has argued that knowledge should not be considered a resource as it does not represent an apparent and exchangeable commodity. Knowledge is much more than just a resource of the organisation and must be viewed as such (Spender & Grant, 1996). Spender and Grant (1996) further asserts that, the theory of the organisation should be considered as a different concept for knowledge than the resource-based one. Other scholars such as Cook and Brown (1999) also argue that the perspective of "knowledge as resource" lacks depth.

Kogut and Zander (1992) argue that knowledge is a key reason for the existence of firms. Later the work of Nonaka (1994) popularied KBV of the firm. The knowledge-based theory asserts that humans, unlike machines, cannot be replaced and are capable of surpassing limitations through knowledge creation in pursuit of their aims (Nonaka & Toyama, 2005). The KBV affirms that organisations are better and more cost effective at the integration of knowledge than via the market (Kogut & Zander, 1992). The ability to acquire, create, exploit, share and accumulate knowledge features its credential as more than just a resource that can be managed to produce an economic advantage to a firm (Nonaka, 1994). Further, Foss (1996a) discuss the need for knowledge based view of the firm because it conceptualises organisations as diverse, knowledge-bearing units.

The suitability of the KBV for this research is its ability to address organisational issues beyond the customary concerns such as strategic choice and competitive advantage (Grant, 1996). The KBV acknowledges some key issues of the theory of the firm, such as: "the nature of coordination within the firm, organisational structure, the role of management and the allocation of decision-making rights, determinants of firm boundaries, and the theory of innovation" (Grant, 1996, p. 110). Eisenhardt and Santos (2002) outline some of the advantages of the KBV as a theory of the firm. The validity of the KBV is that it provides a useful understanding of the various social processes for knowledge sourcing, transfer and integration in and across organisations to gain competitive advantage (Eisenhardt & Santos, 2002). Developing external collaborations helps in reviewing and revising the current knowledge base of the organisation (Eisenhardt & Santos, 2002). Based on this R&D collaborations are an entry point to enhance the knowledge network and critical for knowledge communication (Eisenhardt & Santos, 2002). Advocates of the KBV argue that diverse knowledge bases and capabilities are major factors for competitive advantage and performance (Deeds & Decarolis, 1999). The world is dominated by a knowledge economy and the KBV offers a perspective on the shift from tangibles to intangibles or intellectual capital (Bogers, 2012).

In the context of innovation, knowledge is the essential source of original ideas and aids new product development which consequently adds great value to organisations (Lameras, Hendrix, Lengyel, de Freitas & More, 2012). This is reflected in Koschatzky's (2001, p. 6) assertion that organisations that

are uncooperative and unwilling to participate in knowledge exchange end up diminishing their knowledge base for in the long run, resulting in loss of capacity to participate in knowledge transfer with other organisations. This highlights the importance of collaboration and knowledge exchange. Collaboration in the KBV is a way to take advantage of the "complementarities" among partners (Bogers, 2011, p. 96). In R&D collaborations evaluation of knowledge is an important matter that requires skilful handling (Bogers, 2011). Due to the growing complexity of knowledge, organisations require diverse partners to accomplish their goals which might include partners from universities, industry and public research organisations and even competitors (Bogers, 2011). As Simon (1985) pointed out, the coexistence of diverse knowledge structures prompts learning and problem solving that produces innovation. Collaboration for knowledge is critical as it allows for transfer and absorption of external knowledge and hence acts as a supplement to the organisation's internal innovation activities (Vanhaverbeke, Van de Vrande, & Cloodt, 2008).

Understanding how organisations absorb and integrate external knowledge is an important aspect of innovation. This leads to the concept of Absorptive Capacity (AC) that Cohen and Levinthal (1990, p. 128) define as "the ability of the firm to recognise the value of new, external information", and the subsequent ability of the firm to "assimilate it, and apply it to commercial ends". Of course the ability of the firm to assimilate and apply such knowledge is limited by its AC, raising questions as to the relationship between knowledge, the enterprises' AC and its potential for innovation (discussed later on in this chapter). The concept of AC is discussed next.

Absorptive Capacity (AC)

From the literature reviewed, it has been concluded that a number of factors affect the ability of an organisation to develop and adopt innovation. The most important factors identified include the organisation's AC and its OI or closed innovation alignment. These factors will now be discussed.

Cohen and Levinthal's (1990) work on AC was in essence, an extension of Nelson and Winter's (1977, 1982) work on the importance of knowledge to organisations. Cohen and Levinthal (1990) built on Nelson and Winter's work to show that an organisation's ability to evaluate and use outside knowledge is mostly dependent on the level of existing associated knowledge within the organisation. This helps the organisation to recognise the value of the new knowledge, integrate it into existing company practices and ultimately use this in the creation of new knowledge that can be used towards commercial goals (Cohen & Levinthal, 1990). AC is essential for an organisation's technological learning (Cohen & Levinthal, 1990). It has two important elements, namely existing knowledge base of the organisation and commitment to solving problems (Cohen & Levinthal, 1990; Kim, 1999). There are other scholarly views on AC as well, which are discussed next.

Vanhaverbeke et al. (2008) provide a slightly more nuanced definition of AC in that they consider it a component of the 'know-what' of the organisation, or the ability of the organisation to identify and evaluate relevant external knowledge. As well as the 'know-what' component, Vanhaverbeke et al. (2008) suggest a 'know-why' component to AC, which they relate to the ability of the organisation to

commercialise external knowledge. Another recent process-based definition is discussed by Drechsler and Natter (2012, p. 439) who highlight the view of AC shared by Jiménez-Jiménez and Sanz-Valle (2011) that it is the organisation's ability to use external knowledge "through sequential processes of exploratory, transformative and exploitative learning".

For Mowery (1983), organisations that have invested in their own, internal R&D departments are more capable of evaluating external knowledge, suggesting that AC is correlated with investment in R&D. Cohen and Levinthal (1990) also viewed AC as a by-product of an organisation's investment in R&D. It is considered important for this research to briefly discuss the association made in literature between AC and R&D of an organisation.

Long before Cohen and Levinthal's (1989) paper, Tilton (1971) discussed the link between R&D effort and an organisation's ability to assimilate new technology (Lane, Koka & Pathak, 2006). This was followed by other studies by Allen (1984), Evenson and Kislev (1975) and Mowery (1983) who found additional support for this argument. Since then, researchers have examined AC in an R&D context and found it related to R&D intensity (Barge-Gil, 2010; Meeus, Oerlemans & Hage, 2001). R&D investment has long been discussed as an indicator of an organisation's AC in scholarly literature (Boscherini et al., 2010; Cohen & Levinthal, 1990; Lane et al., 2006; Spithoven & Teirlinck, 2010). A study by Spithoven and Teirlinck (2010, p. 981) also concluded that AC is "embodied in human capital in general and in R&D personnel in particular". An organisation's AC is not just representative of its employees' absorptive capacities, or its 'direct interface with the external environment', but also in the abilities and technical training of the individuals who stand at the interface of the firm and its external environment, as well as those between sub-units within the firm (Cohen & Levinthal, 1990, p. 131; Rosenberg, 1982 & 2010).

Cohen and Levinthal (1990) suggest that before complex and sophisticated technological knowledge can be integrated into the organisation, there must be a minimum level of available, competent staff that have expertise in both their own position in addition to the organisation's particular needs, procedures, routines, capabilities and external relationships. Von Hippel (2007) has shown, for example, that having a close relationship with an organisation's buyers and suppliers helps individuals become cognisant of different external capabilities and knowledge. Fundamentally, the organisation and its employees must offer a base that receive new knowledge, as well as easily adapt to it. Without this expertise, the ability of an organisation to absorb new knowledge will be restricted (Vanhaverbeke et al., 2008). As a competitive advantage can result from an organisation's ability to integrate internal and external knowledge in its innovation process, the AC of an organisation is a significant factor which contributes to such success (Rigby & Zook, 2002). Using both internal and external sources of knowledge in the innovation process has led to the concept of OI. The definition by Cohen and Levinthal (1990) is of greater relevance and a more widely accepted concept that relates to OI (Christensen et al., 2005; Drechsler & Natter, 2012). The relevance of AC to OI is discussed next along with its connection to the KBV.

Open Innovation (OI), Knowledge Based View (KBV) and Absorptive Capacity (AC)

In the context of innovation, it has been noted that, knowledge is the essential source of original ideas, benefits production and adds great value to organisations (Lameras et al., 2012). The importance of collaborative innovation for both economic and corporate benefits is widely acknowledged however, there is still need for further understanding regarding the management of knowledge in open collaborative innovation (Bogers, 2012). As innovation is carried out using the OI approach, organisations need to frequently commercialise external and internal knowledge by deploying external as well as in-house avenues (Chesbrough, 2003; Hill & Birkinshaw, 2008). According to Bergman et al. (2009) in case there was no openness organisations would have missed an opportunity for creation of valuable knowledge. There is a close relationship between knowledge sharing and OI, this is best explained by Gambardella and Panico's (2014) assertion that, the crux of OI is that different partners exchange in sharing of knowledge or other resources irrespective of the fact who owns it. Knowledge therefore (as discussed previously) is an important element for OI.

Moreover, it has been recognised that the concept of AC relates to an organisation's openness in innovation (Drechsler & Natter, 2012). AC represents an organisation's competence to explore, assimilate and combine outside ideas, knowledge and technology for innovation purposes and an organisation's internal R&D provides this competence and organisations that conduct internal R&D display more openness in innovation (Drechsler & Natter, 2012). The ability of an organisation's R&D to use knowledge enables an organisation to get more value internally out of external ideas and improves its AC in the long term (Hughes & Wareham, 2010). A study by Kastelli, Caloghirou and Loannides (2004) found that an organisation's AC enables its ability to exploit benefit from R&D cooperation.

Cohen & Levinthal (1990); Drechsler & Natter (2012) and Kostopoulos, Papalexandris, Papachroni & Ioannou (2011) discuss how AC relates not only to finding the right partners in innovation, but also to an organisation's ability to recognise the significance of new external knowledge, assimilate it and apply it to internal R&D projects. AC consequently enhances an organisation's OI through facilitating the search for new technologies, finding new partners and integrating and internalising new external knowledge, thus enabling the organisation to form knowledge-generating R&D alliances that support exploration (Lavie & Rosenkopf, 2005). AC, then, helps organisations to communicate, understand and collaborate with a diverse range of partners and expands the array of opportunities available, hence aiding OI (Lane, Salk & Lyles, 2001).

In order to increase an organisation's knowledge base, the exploitation of current capabilities is required to explore new capabilities. This leads to the exploration and exploitation of knowledge being critical to form a path for an organisation to evolve its AC (He & Wong, 2004). Also, an organisations' acquisition of external knowledge represents their openness in innovation (Dahlander & Gann, 2010). In AC literature, Cohen and Levinthal (1990) have argued that individuals and organisations with a widespread

knowledge base are more likely to benefit from external sources. OI enables organisations to widen their knowledge base by including all sources of knowledge. There is consequently a close relationship between AC, knowledge base of the organisation, its employees and the organisation's OI efforts. This forms the basis of this research's theoretical foundation.

The connection between the concept of OI and AC is noticeable in literature (Barge-Gil, 2010; Huang & Rice, 2009; Watkins & Paff, 2009). Huang and Rice (2009) concluded that AC is essential for an organisation to benefit from its OI efforts and improve its innovation performance. Undoubtedly, the external knowledge flows have a positive influence on an organisation's innovation performance and integration of this knowledge is dependent on an organisation's AC. Due to this, it becomes an important element for organisations (Cockburn & Henderson, 1998; Escribano, Fosfuri & Tribó 2009).

An organisation's AC is dependent on its available knowledge, which in turn is rooted in its products, processes and people. These factors therefore, become important for an organisations' innovation as well its OI practices (Escribano et al., 2009). Additionally, factors such as the structure, culture, collaboration, attitude towards change and organisational communication impact the AC of an organisation (Murovec & Prodan, 2009). An organisation's AC is dependent on individual AC and this in turn is enhanced by individuals' awareness of external capabilities and knowledge that is promoted by close relationships with buyers and suppliers (Cohen & Levinthal, 1990; Von Hippel, 2007). This is further merged through the use of an OI framework that combines the inbound and outbound dimension and the critical organisational factors of intra and inter-organisational knowledge transfers. Since AC and the inbound dimension of OI are focused on sourcing external knowledge, both require the internal structures and processes of the organisation to be analysed in order to understand how the organisation can tap into external knowledge (Vanhaverbeke et al., 2008). According to Buganza and Verganti, (2009) OI is not about outsourcing R&D of an organisation, but comprises a cooperative approach to R&D and to take advantage of OI organisations need to concentrate on developing its AC.

According to Vanhaverbeke et al. (2008) though OI and AC are popular concepts in innovation management literature have not been connected to each other in a systematic way. The current research adds value by studying OI from the perspective of the internal player, meaning the personnel associated with the organisation's OI practices who contribute towards its AC. Tying the concept of AC and OI can further enhance understanding of AC and improve its managerial practice (Vanhaverbeke et al., 2008). Furthermore, the literature suggests that, "developing and improving the AC of innovating firms is at the heart of OI" (Vanhaverbeke et al., 2008, p. 2).

An important pre-condition for the success of inbound OI is to organise the organisation's AC which helps to internalise external knowledge (Spithoven, Clarysse & Knockaert, 2011). This is due to the fact that organisations need to possess AC in order to interact effectively with its environment and to gain, transform and use knowledge required for innovation (Igartua et al., 2010). When literature on AC is considered, it becomes clear that external knowledge assimilation and integration requires the support

of internal knowledge generated by the organisations' R&D. This idea is highlighted by Vanhaverbeke et al. (2008) that AC and OI enrich each other and; both OI and AC focus on sourcing external knowledge.

The concepts of OI and AC can be said to be connected because both relate to how organisations integrate external knowledge (Cohen & Levinthal, 1990; Christensen et al., 2005). OI scholars have been arguing in line with Cohen and Levinthal (1990) (who introduced the concept of AC) about the need to balance the ability to profit from external knowledge sources and the ability to develop and exploit internal knowledge (Vanhaverbeke et al., 2008). In the case of both AC and OI, time is required to identify and evaluate new knowledge and this can impact on managerial focus, energy and resources (Vanhaverbeke et al., 2008). OI implies changes to the concept of AC due to its emphasises on exploiting internal knowledge externally (Hughes & Wareham, 2010).

Various scholars (e.g., Giannopoulou et al., 2011; Huang & Rice, 2009) stress the importance of AC for inbound and outbound dimensions of OI and suggest that investment in AC is required to integrate internal and external sources of innovation and knowledge. As OI allows for more interaction with the external environment providing increased opportunities for knowledge exchange, it has an impact on an organisation's AC demonstrating an important link between the two concepts. This research links together organisational knowledge, AC, internal R&D and the KBV of the firm to understand OI.

Organisational knowledge is important for innovation and that organisations depend on both internal and external sources of knowledge for innovation (Cohen & Levinthal, 1989, 1990; March & Simon, 1958; Spender & Grant, 1996; Wallin & Von Krogh, 2010). Similarly, OI relates to inflows and outflows of knowledge (Chesbrough, 2003; Chesbrough & Crowther, 2006; Chesbrough, Vanhaverbeke & West, 2006; Chesbrough, Vanhaverbeke & West, 2006) and so it is postulated that there is a close relationship between OI and organisational knowledge (Wallin & Von Krogh, 2010).

As mentioned earlier, outbound OI is opening organisational boundaries to make use of underutilised internal knowledge and innovation, and inbound OI is about opening organisational boundaries to use external knowledge (Chesbrough et al., 2006; Fritsch & Lukas, 2001; Hung & Chou, 2013). External knowledge assimilation and integration into the organisational knowledge requires internal R&D and AC (Cohen & Levinthal, 1989, 1990). Further, internal R&D and AC contribute to internal knowledge and are essential and useful for both inbound and outbound OI (Cohen & Levinthal, 1989, 1990). Therefore, it is no surprise that both internal and external knowledge flows contribute to an organisation's OI practice (Chesbrough & Crowther, 2006; Chesbrough et al., 2006; Chesbrough et al., 2008). OI is characterised by its "porous innovation process" (Schroll & Mild, 2011, p. 478) leading to permeable boundaries in organisations where different actors in and out of the organisation contribute to the innovation process (Fredberg et al., 2008). This in turn allows the organisation to introduce new creativity and knowledge by embracing diversity in the innovation process (Schroll & Mild, 2011).

Organisations can gain better outcomes by relinquishing total control over their innovation activities and intellectual property (Chesbrough, 2003). Raymond and St-Pierre (2010) assert that OI is how organisations discover, employ and integrate knowledge and ideas from external sources in their innovation processes to optimise their potential. Given this acknowledged importance, discussion now turns to the concept of Open Innovation.

Defining Open Innovation

When exploring the subject of OI it becomes imperative to understand what socio-economic reasons set the precedent for such a phenomenon. The literature suggests that the current innovation landscape has changed due to global economic movement, labour mobility, reduced product life cycles, increased opportunities for venture capital and knowledge dispersion across various public and private organisations as well as, improved intellectual property rights (IPR) (Van de Vrande, De Jong, Vanhaverbeke & De Rochemont, 2009). These aforementioned factors have been aided by the contribution and advancement of technologies that have allowed for new ways for organisations to collaborate and coordinate across locations (Chesbrough, 2003; Van de Vrande et al., 2009). Technology has enabled the barriers of distance and time to be overcome which has allowed for free flow of knowledge aiding the path to OI. Moreover, the social and economic changes in working patterns have replaced the earlier notion of job-for-life with portfolio careers requiring organisations to seek new ways to access talent that might not be available exclusively and directly (Dahlander & Gann, 2010). Thus, industries are more likely to engage in OI if they are characterised by globalisation, technology intensity, technology fusion, new business models and knowledge leveraging (Gassmann, 2006). Hence, a potentially effective way high-technology sector organisations can deal with pressure from competitive environments is to collaborate with others for development of new products and services (Dittrich & Duysters, 2007).

The reason the system introduced by Chesbrough (2003) is called ‘open’ is due to the fact that the boundaries of the organisation are permeable where some ideas for the organisation are introduced by other parties and some projects leave and are further enhanced by other parties (Dittrich & Duysters, 2007). One definition of OI explains the concept as “…the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation” (Chesbrough, Vanhaverbeke, & West, 2006, p.1).

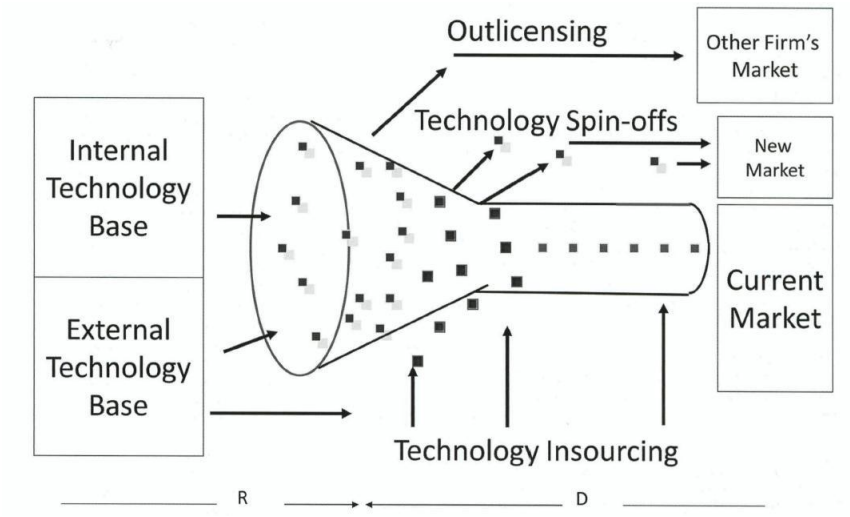

Figure-2, Open Innovation Model. Source: Chesbrough, 2012 (p.22-23)

In the OI model presented by Chesbrough (2012) shown above, the purposive inflows refer to technology exploration that relates to capturing benefit from innovation activities by adapting external sources of knowledge to enhance current technological development. Purposive outflows of knowledge or technology exploitation meanwhile are innovation activities that leverage existing technological capabilities outside the boundaries of the organisation (Van de Vrande et al., 2009). To fully benefit from the OI model, firms use both knowledge exploitation as well as technology exploration in order to create maximum value from their technological capabilities (Chesbrough & Crowther, 2006). The inflows and outflows of knowledge allow organisations to expand not only their technology and knowledge base but also create expansion in their current market and exploit other new markets. What happens in an OI setting is that two or more partners are jointly engaged in a coordinated effort to create new ideas and transform them into an innovation, by combining different types of technology, concepts, skills, and means (Fagerberg, 2004 cited in Du Chatenier, Verstegen, Biemans, Mulder & Omta, 2010).

Interest in the term 'open innovation' (OI) began around 2003, with the model and associated research generating curiosity among a variety of management fields (e.g., Chesbrough, 2006; Fredberg et al., 2008). Since then, it has not only gained recognition but has also been associated with various terms that define the same phenomenon (Pénin, 2008). These terms include: collaborative, disintegrated, distributed, collective, or free innovation, open source software, open knowledge disclosure or free knowledge disclosure (Pénin, 2008).

OI is a body of work that combines concepts discussed in studies by Allen and Cohen (1969); Chan and Heide (1993) Cohen and Levinthal (1989, 1990); Tidd (1993); Tushman (1977) and Vyas, Shelburn and Rogers, (1995). It is analogous to the work of DeBresson and Amesse (1991) that discusses innovation as an output of collaborative work. OI is useful to both new and old organisations whether in emerging or established industries (Bogers, Chesbrough, & Moedas, 2018).

Scholars such as Schroll and Mild (2012), West and Bogers (2014) and Greco et al. 2015 have studied the success of OI based on its ability to improve innovation performance. In addition, research from Miotti and Sachwald (2003), Negassi (2004), Czarnitzki et al. (2007), Chiang and Hung (2010), Grimpe and Kaiser (2010), Duysters and Lokshin (2011) and Schweitzer et al. (2011) has established that OI mostly has a positive impact on innovation performance. However, scholars have also found that there might be some deviations due to over search and over collaboration (Bader & Enkel 2014; Laursen & Salter 2006; Kang & Kang 2010; Duysters & Lokshin, 2011; Greco et al. 2016).

Research on OI has focused on organisations, users, open source software, collaborations in community setting, crowds and networks (Bogers, Afuah, & Bastian, 2010; Dahlander & Magnusson, 2008; Grimaldi et al. 2017; von Hippel, 2007). Mowery (2009) suggests that in the late 19th and early 20th centuries several of the elements of OI approach to R&D management were apparent. Further that OI activities were more predominant than closed innovation ones (Mowery, 2009). Literature such as that by Chen et al. (2015) also supports that most organisations have been aware of the advantages of external knowledge to support its innovation for some time. As Bogers, Chesbrough, Heaton, and Teece (2019) summarised, OI has been used to describe diverse activities ranging from open source software development to crowdsourcing to competitions and prizes, to licensing, to contract research, to industry-university collaborations and engagement between corporations and start-ups.

Chesbrough and Bogers (2014, p.12) have redefined open innovation as “a distributed innovation process based on purposively managed knowledge flows across organisational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organisation’s business model.”

Over the years OI has been investigated theoretically (Chesbrough, 2003; Gassmann & Enkel, 2004), initially via qualitative studies (Kirschbaum, 2005; Rohrbeck et al, 2009), and later quantitatively through large scale studies (Laursen & Salter, 2006). Later studies were conducted to understand a variety of aspects such as: its complexity and various features (Huizingh, 2011; Aslesen & Freel, 2012), its aspects and various levels of openness (Herrmann et al., 2007); its adoption and implementation (Bigliardi et al., 2012; Dahlander & Gann, 2010). Further studies on OI were conducted to examine innovation practices (Baldwin & von Hippel, 2011; Galati et al., 2015; Saguy & Sirotinskaya, 2014); as well as the effect of OI activities and practices (Tomlinson, 2010; Dahlander & Gann, 2010; Tomlinson & Fai, 2013; Greco et al., 2015).

Empirical research on the OI model has shown that, alliances between organisations allow for collaboration in the creation of new practices and ideas that may be subsequently shared between stakeholders (Giannopoulou, Yström, Ollila, Fredberg & Elmquist, 2010). The OI model by Chesbrough (2003, 2006, and 2012) has been empirically studied by Chesbrough (2003, 2006 & 2012), Chesbrough & Crowther (2006) and Chesbrough et al. (2006) among others. Chesbrough (2003) has highlighted these principles at work among a number of high-technology organisations (e.g., Lucent, 3Com, IBM, Intel and Millennium Pharmaceuticals) with OI’s ability to open new internal and external avenues for

innovation through collaboration allowing for cost savings or in some cases cost sharing of R&D among the stakeholders. As well, the potential for R&D outcomes to be transferred both internally and externally across organisational boundaries has been found (Badawy, 2011; Bigliardi et al., 2011; Fredberg et al., 2008). A study by Linder, Jarvenpaa, and Davenport (2003) detailed that of the companies sampled, 45% of the total innovation was generated from external sources. A study by Bae and Chang (2012) also concluded that organisations with an OI approach have better efficiency and effectiveness in comparison to organisations that are closed to external technology and knowledge. Furthermore, a study by Ili, Albers and Miller (2010) also found that OI improves R&D productivity. A study by Duarte and Sarkar (2011) concluded that regardless of whether an organisation practices formal or non-formal OI strategies it is intended to increase the speed at which it introduces products and competitiveness. Therefore, it is generally assumed that OI has a positive impact on the organisation's performance (Bae & Chang, 2012). This might be one of the reasons that organisations such as Philips have developed a "well-established open innovation environment, while Siemens started a huge corporate open innovation program in 2009" (Enkel, et al., 2009, p. 312).

Even though OI has been found to add value to organisations, it has received its share of criticism. It has been referred to as 'old wine in new bottles' with Christensen, Olesen, and Kjær (2005) arguing that neither external sourcing of knowledge nor the external commercialisation of innovation are new practices. As stated by Chiaroni, Chiesa and Frattini (2009) the issue of whether OI is a new paradigm for managing innovation or not is still a current issue of debate. The literature argues that it has repackaged the concepts and findings from the innovation management literature. Kutvonen (2011) observes that since the late 1980s, technology transactions have increased and have been recognised as part of business strategy due to the use of external acquisition. OI is similar to the collaboration approach discussed by DeBresson and Amesse (1991) that innovation is an outcome of collaborative efforts of few parties. Trott and Hartmann (2009) note that the work of scholars including Allen & Cohen (1969); Chan & Heide (1993) and, Cohen & Levinthal (1989, 1990); Tidd (1993); Tushman (1977); Vyas, et al. (1995) have all added to what we know as 'open innovation' today. Huizingh (2011) argues that though the idea of OI is not really new, in reality not many organisations have really followed a completely closed approach. OI was made relevant by changes in the wider economic and social environment. Consequently, Chesbrough's timely labelling a single term 'Open innovation' gave it a name and body of literature allowing academics to examine innovation in the networked world (Huizingh, 2011). OI has become "the umbrella that encompasses, connects, and integrates a range of already existing activities" (Huizingh, 2011, p. 3).

After reviewing the literature on OI including its alternative names, it is clear that it is not a completely novel concept, though this does not undermine its value and usefulness to businesses today. OI as propounded by Chesbrough has led researchers in various fields from management, to economics, to information technology to start defining, understanding and evaluating a very complex innovation trend that has been used by businesses worldwide since globalisation and some would argue even before (Afuah & Tucci, 2012). As observed by Duarte and Sarkar (2011, p. 438), "What OI brings that is new,

is how knowledge may become available freely…OI further includes free revealing of innovations". An example of free knowledge is what happens in the case of Open Source Software (OSS). Additionally, OI is considered useful by practitioners as it helps to organise the innovation activities of various stakeholders in a firms supply chain (Von Krogh, 2011). OI also encourages managers to find new ways of innovating with experts and their partner organisations (Von Krogh, 2011). Furthermore, Chesbrough (2006) pinpoints eight key elements that distinguish OI from previous innovation theories. These are as follows: greater importance of external knowledge, the significance of business models, the capability of converting unproductive R&D projects into successful ones, purposeful outflow of knowledge and technology, vast knowledge possibilities, proactive role of IP management, the advent of innovation intermediaries, and new metrics for innovation capability and performance (Chesbrough, 2006).

Being effectively open to external knowledge can help organisations adapt to turbulent environmental, technological and market conditions by continuously renewing their knowledge bases through simultaneous use of internal and external sources of innovation (Hung & Chou, 2013). This provides both short-term monetary benefits, as well as longer-term strategic benefits for organisations (Enkel, et. al., 2009). In addition, research by Bae & Chang (2012), and Chesbrough & Crowther (2006) highlight that OI is important not only in cost reduction, but also for sustained growth, meeting customer demands, and reducing time-to-market.

OI can enable external actors to influence an organisation's investment in internal R&D through expanding opportunities by offering new combinations of previously disconnected silos of knowledge and capabilities (Dahlander & Gann, 2010). To fully use the OI model, firms need to use both knowledge exploitation and exploration in order to create maximum value from their technological capabilities or other competencies (Chesbrough & Crowther, 2006). By integrating the efforts of a number of diverse but complementary firms to enhance and develop products, OI can bring new creativity and know-how into the organisation ultimately resulting in innovation (Almirall & Casadesus-Masanell, 2010). A further advantage of OI proposed by Bigliardi et al. (2011), and Chesbrough, Vanhaverbeke & West (2008) is the possibility for interaction between employees of different organisations, which offers an opportunity for cross-pollination of unique skill sets and otherwise-prohibited inter-company collaboration. Additionally, the sharing and co-utilisation of skilled workers, the creation of networks of collaboration between companies can produce innovation and opportunities for commercial gain far beyond what a single company could achieve, through for example, shared IP usage and utilisation of suppliers (Adner, 2006; Chesbrough, 2003).

Given the changing nature of knowledge and work, most organisations can no longer afford to innovate autonomously; they need to engage in alternative innovation practices (Van de Vrande et al., 2009). Organisations are adopting the OI approach due to the increasing costs of independent R&D and the need to diversify the competences of their R&D departments (Bigliardi et al., 2011). This is causal to the distributed nature of knowledge where even the most capable R&D organisation needs to "identify, connect to, and leverage external knowledge sources as a core process in innovation" (Chesbrough et

al., 2008, p.2). Organisations are aware that they need to work with smart people inside, as well as outside the company (Chesbrough, 2003). Some success stories of OI reported in literature are: Cisco, Intel, Microsoft (Chesbrough, 2003), Procter & Gamble (P&G) (Dodgson, Gann, & Salter, 2006; Huston & Sakkab, 2006a), DSM (Kirschbaum, 2005), Nokia (Dittrich, 2008) and Air Products (Tao & Magnotta, 2006).

As a result of the benefits and advantages detailed, a growing number of multinational organisations and indeed SMEs are shifting to an OI approach (Chesbrough, 2003). Recent research has clearly established that organisations should not consider OI just "a fad" but as a tool that can help improve performance and productivity (Bae & Chang, 2012, p. 976; Ili et al., 2010). To adopt OI however, organisations need to consider that though the integration of internal and external resources in case of OI generates more business value, it complicates the innovation management process (Fredberg et al., 2008).

The reviewed literature emphasises that if organisations decide to adopt an OI strategy they need to ensure that it is supported by organisational structures and processes whilst also developing employee capabilities (Giannopoulou, Yström & Ollila, 2011). OI requires a different culture since it involves greater appetite for risk (Herzog, 2008). Therefore, for an organisation to be able to adopt an OI approach there needs to be certain changes such as overcoming the Not-Invented-Here (NIH) syndrome, in its company culture as well (Herzog, 2008). Despite these complications, OI can create value by encouraging managers to explore new ways of innovating with their partner organisations and other experts through the exchange of ideas, knowledge, and technology in order to "improve efficiency, effectiveness and management of risk in the innovation process" (Wallin & Von Krogh, 2010, p. 147). To achieve these various dimensions of OI, its practices and perspectives need to be understood. These aspects are discussed next.

Different forms of OI

The literature reviewed discusses two dimensions of OI based on the premise of in-flows and out-flows of knowledge; these are referred to as inside-out and outside-in OI (Enkel et al., 2009). Also known as the follows: buying and selling side of OI; exploitation and exploration as well as, inbound and outbound OI (Chesbrough & Crowther, 2006; Sandulli & Chesbrough, 2009). However, Gassmann and Enkel (2004) suggest that there is another core process that is the coupled process which is a combination of inbound and outbound OI. Each of these is discussed next.

Inbound OI

Organisations use inbound OI to further enhance their current knowledge through the use of available external knowledge (Hung & Chou, 2013). The aim of inbound OI is for the organisation to gain essential technologies to develop its own products and to compete in the market for technology by using external knowledge to complement what it already possesses (Hung & Chou, 2013). This dimension of OI allows inflows of external knowledge into the organisation's knowledge base by involving its suppliers, customers and external knowledge sources to increase its innovativeness (Enkel et al. 2009; Gassmann

& Enkel, 2004). Some popular examples of organisations that have involved customers into their innovation process are that of Dell (through IdeaStorm) (Di Gangi & Wasko, 2009) and Starbuck (through MyStarbucksIdea) (Blohm, Köroglu, Leimeister, Krcmar, 2011). Also, LEGO invited customers to give ideas for new models for a financial reward (Bughin, Chui & Johnson, 2008). Companies such as Pfizer have created collaboration programs such as "Drug Pfinder" that is aimed at forming relationships with universities who are seen as knowledge producers (Buganza & Verganti, 2009). Another example is that of Procter and Gamble (P&G) that develops more than 50 per cent of its products using external sources of innovation (Buganza & Verganti, 2009). According to Chesbrough and Crowther (2006, p.229), "inbound OI…is the practice of leveraging the discoveries of others: companies need not and indeed should not rely exclusively on their own R&D". For example, Eli Lilly licenses and sells products developed by other organisations (Bughin et al., 2008).

Spithoven, Clarysse and Knockaert (2009) state that the integration of external knowledge in case of inbound OI entails organisations to have search processes. This is why for inbound OI to be successful organisations need to have the necessary competence, AC, and management skills that enable them to combine internal company resources with resources and knowledge available through their suppliers, customers and other members in their supply chain (Fritsch & Lukas, 2001). When these are available the organisation is able to discover new knowledge that enriches its existing knowledge base and expand it to unique technological fields (Hung & Chou, 2013; Laursen & Salter, 2006). According to Bianchi, Cavaliere, Chiaroni, Frattini & Chiesa (2011, p. 24) organisations usually use, "in-licensing, minority equity investments, acquisitions, joint ventures, R&D contracts and research funding, purchase of technical and scientific services and non-equity alliances" for inbound OI.

Outbound OI

According to Bianchi et al. (2011, p. 24) in the case of outbound OI organisations use, "licensing out, spinning out of new ventures, sale of innovation projects, joint venture for technology commercialisation, supply of technical and scientific services, corporate venturing investments and non- equity alliances". Outbound innovation (or external exploitation of knowledge) has been defined as the purposeful use of outflows of knowledge to increase markets for external use of innovation (Chesbrough et al., 2006). In other words, outbound OI enables organisations to find new ways to market, such as looking for other organisations that have business models that are more suitable for commercialising technology. (Chesbrough & Crowther, 2006).

Generally speaking, research-driven companies engage in outbound innovation that seeks to commercialise and profit from underused ideas, selling IP, out-licensing or free revealing of innovation, thus increasing and multiplying technological knowledge outside the organisational boundaries to gain monetary or non-monetary benefits (Chesbrough & Crowther, 2006; Hung & Chou, 2013). This can lead to co-exploitation and co-development for innovation with external partners (Chesbrough et al., 2006). Outbound OI allows organisations to externalise knowledge and innovation to market faster, as well as to commercialise ideas outside their own industry and market (Gassmann & Enkel, 2004). The outbound process allows the organisation to explore new knowledge, talent and capabilities that will enable for

survival in the fast changing technological environment (Hung & Chow, 2013). In addition, this process can also lead to considerable financial benefits. An example of this is IBM earning licensing revenues of more than $1.2 billion in 2004 (Chesbrough, 2006). Additionally, Huizingh (2011) suggests that outbound OI may be a more profitable strategy in environments where IP protection is reasonably simple in comparison to areas where it is difficult to protect inventions.

Research by Andersen & Konzelmann (2008) and Gambardella, Giuri & Luzzi (2007) show that organisations need patent protection to capture the benefit of outbound OI. There are various strategic objectives for organisations to engage in outbound OI these can be: acquiring new knowledge, diversifying and multiplying current technologies, regulating technological paths, learning more about knowledge transfer, exploring external knowledge as a primary business model and influencing the market (Kutvonen, 2011). The reasons organisations chose to engage in outbound vary depending on their strategy and long term business goals.

In sum, inbound aspect of OI is about external exploitation of knowledge whereas outbound refers to external exploitation of internal knowledge (Huizingh, 2011).

Coupled Process

The coupled process is about co-creation with partners by combining the outside-in and inside-out processes, and involves working in conjunction with matching partners where there is a give and take of knowledge through the use of alliances, joint ventures etc. (Enkel et al. 2009; Gassmann & Enkel, 2004). For example, Pharmaceutical companies such as GlaxoSmithKline (GSK), Pfizer and Eli Lilly have formed drug discovery alliances with external partners (Schuhmacher, Germann, Trill & Gassmann, 2013).

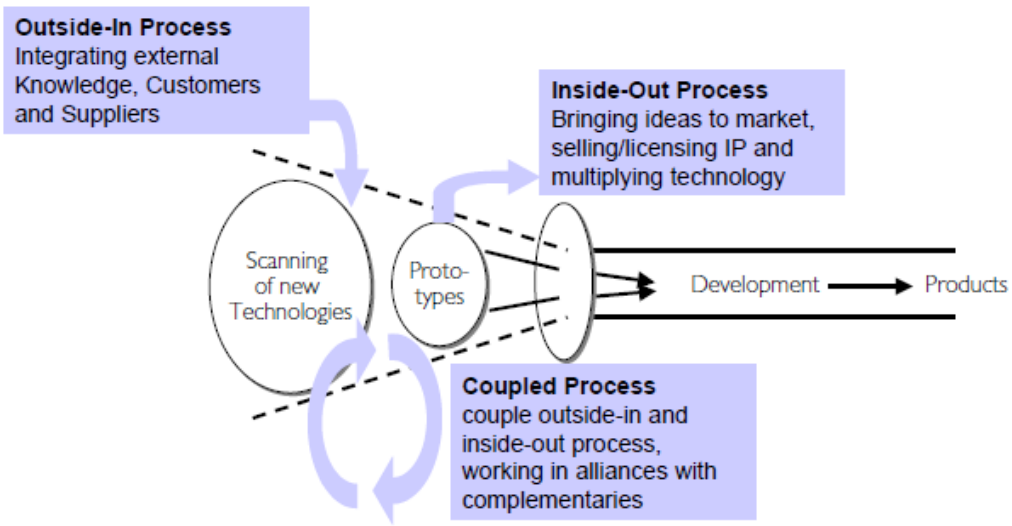

Figure- 3, Open Innovation Processes. Source: Gassmann & Enkel (2004, p. 7)

The coupled process as a core process helps organisations to increase their returns by multiplying their exploitation of internal and external knowledge sources (Gassmann & Enkel, 2004). To collaborate successfully, a give and take of knowledge is essential that requires a combination of inbound and outbound OI which can ultimately lead to better innovation results. Mortara and Minshall (2011) observed that organisations implement both in- and out-bound OI activities that is, coupled OI to achieve ambidexterity as a way to gain and discover new innovation opportunities outside their core business area while decreasing risks in doing so.

According to Enkel et al. (2009) the coupled process is prevalent in organisations of all sizes that have ample resource allocation. Furthermore, both inbound and outbound aspects of OI depend on the organisation's strategic approach and are viewed to be essential rather than optional to counter competition (Bogers, 2011). Coupling can indeed be part of the competitive strategy in industry innovation, with the sharing of IP between companies. Bogers (2011) explores the coupled aspect of OI which is evident in R&D collaborations of organisations such as: Lionix, Philips, ABB, Acreo, Eka Chemicals, Ericsson and Volvo. According to Bogers (2011) the coupled process raises tensions in area of knowledge sharing and protection which can be equilibrated by using a knowledge exchange strategy and licensing.

According to Enkel et al. (2009) research so far has mostly focused on exploring the inbound aspect while the outbound side has received comparatively less attention. However, the study by Chesbrough and Crowther (2006) examined organisations that used both inbound and outbound OI in non-high technology sector. The study found that only a few of the companies in the sample had significant outbound OI efforts. However, Chesbrough & Crowther (2006, p. 233) argue that since "one organisation generates a reciprocal outbound effort from some other organisation" so what the study found may have been due to the area of research focus, rather than a representation of the market in general. Consequently, Chesbrough and Crowther (2006) assert that focusing on understanding of inbound practices of OI is sufficient. Other empirical studies have also found that organisations conduct more inbound than outbound OI for example, Bianchi, Campodall'Orto, Frattini, & Vercesi (2010), Cheng & Huizingh (2014), and Chiaroni, Chiesa & Frattini (2010). Huizingh (2011) therefore suggests further examining if inbound OI is indeed more prevalent than outbound OI or research samples in the studies are not reflecting accuracy. Mortara & Minshall (2011) conclusion summaries the reason for an organisation's choice of OI practices as contingent on its innovation needs. That is, when an organisation is looking for ambidexterity it will use a combination of inbound and outbound OI whereas if the need is to complement its current innovation pipelines then it would opt for inbound OI (Mortara & Minshall, 2011).

OI Practices

Different organisations use a wide range of OI practices to meet their innovation needs. The OI paradigm proposes that organisations cannot conduct all R&D activities self-sufficiently. Due to this fact, there is the need to capitalise on external knowledge that can be licensed or bought (Van de Vrande et al., 2009). Given the changing nature of business, it may be necessary to regear the

organisation's business model and develop internal research engines. There are various practices that organisations are using to tap into the external sources of knowledge and innovation. For example, organisations now view users of innovation as more than just passive adopters (Von Hippel, 2005). Literature on OI shows this relationship is associated with open source, user co-creation, user centred innovation and customer integration and distributed innovation (Giannopoulou, Ystrom, & Ollila, 2011). For example, "in 2007 Dell invited end users to share their ideas and collaborate with Dell to create or modify new products and services through an online community — Dell IdeaStorm" (Di Gangi & Wasko, 2009, p. 303). Moreover, an organisation called Living Labs which includes users in real life environments in the innovation process through designing, developing and validating new technologies, products and services (Almirall & Wareham, 2008). Additionally, customer involvement, external networking, employee involvement and participation in R&D outsourcing are appropriate OI practices used by organisations to boost their innovation (Van de Vrande et al., 2009). Other practices like outward and inward licensing of IP, venturing and external participations in other enterprises are used as well, though to a lesser extent (Van de Vrande et al., 2009). The study by Huang et al. (2014) is one of the few studies providing insight into understanding the behaviours and strategies of Australian firms engaged in open innovation practices. It found that IP concerns during knowledge exchange hinder OI adoption. Therefore, it is important for firms to manage the trade off and risks in knowledge sharing and knowledge projection.

OI is not just about using external sources for innovation. Internal knowledge and ideas are also crucial. Employees both inside and outside the R&D department can also be a source of internal knowledge that can contribute to innovation. Employees can be involved in multiple ways in the innovation process, namely, by encouraging them to take initiatives beyond organisational boundaries or by using employee suggestion schemes such as boxes and contests (Van de Vrande et al., 2009). An example is Google, where employee ideas led to products like Orkut and Google Desktop (Whelan, Parise, Valk, & Aalbers, 2011). Other examples include Disney, Corning Incorporated, Cisco Systems Inc, and the Ritz Carlton (Samson, 2010). The way Ritz Carlton has used employees' creativity to enhance customer experience is by successfully implementing a four-step innovation process: "inspire vision, foster the right environment, stimulate ideas and test ideas" (Samson, 2010, p. 16).

Another way employees can contribute to the OI process is by external networking through forming informal ties with people from other organisations. This can be crucial in understanding how new products are created and commercialised (Chesbrough et al., 2006). Van de Vrande et al. (2009, p. 3) suggest that such networks "include all activities to acquire and maintain connections with external sources of social capital, including individuals and organisations". Networks encompass both formal collaborative projects and other informal networking activities that allow organisations to rapidly fill in specific knowledge needs without having to spend large amounts of time and money to develop the knowledge internally or acquire it through vertical integration (Van de Vrande et al., 2009). Furthermore, once networks are developed and maintained, they can later evolve into formal collaborative efforts such as R&D alliances. These can be part of an organisation's OI portfolio (Van de Vrande et al., 2009).

Research by Dittrich and Duysters (2007) illustrates how Nokia Corporation has used innovation networks over the years to overcome competition.

Analysis of OI literature

Based on a bibliometric analysis of the literature on OI, two dominating perspectives emerge, namely the firm perspective, and the ecosystem perspective (Wikhamn & Wikhamn, 2013). The ecosystem perspective is related to innovation activities occurring external to the organisational boundaries in the wider business environment (Wikhamn & Wikhamn, 2013). In this perspective of research, users as innovators have been examined by others (such as von Hippel 1986, 1989, 2005; Franke & von Hippel, 2003; Lee & Cole, 2003) even before the concept of OI was coined by Chesbrough (2003). This perspective includes Open Source development and innovation communities where people outside the organisation create knowledge voluntarily (Wikhamn & Wikhamn, 2013). In this perspective innovation is viewed as part of the wider ecosystem.

The other perspective is the firm perspective. In order to understand the transfer of ideas and innovation across organisational boundaries Chesbrough took a firm perspective (Wikhamm & Wikhamm, 2013). In this perspective, open innovators are organisations that: get involved in several inter-organisational relationships with a variety of partners and use external organisations at various stages of the innovation process (Boscherini, Chiaroni, Chiesa, & Frattini, 2010). To be open innovators it is suggested that organisations need change in certain aspects (Boscherini et al., 2010; Buganza, Chiaroni, Colombo, & Frattini, 2011 among others). Literature differs on what changes are requires and its implications (Boscherini et al., 2010; Buganza et al., 2011). Some suggest that change is required at two levels: the “hard” aspect which refers to the organisational structure, performance evaluation and management systems, and the “soft” aspect which is about the culture, organisational values, and individual competencies (Boscherini et al., 2010). Others have suggested that changes can be required at three levels (Buganza et al., 2011). One level involved organisational structures that refer to whether organisations had established new units dedicated to OI or had re-organised current units (Buganza et al., 2011). The second level was the organisational procedures required for identifying and evaluating technologies internally and externally for the organisation’s innovation projects (Buganza et al., 2011). The third level was the reward and incentive systems (Buganza et al., 2011). However, it seems that some organisations considerably modify the organisational structure to enhance coordination and assimilation of external and internal knowledge while others just modify existing structures and distribute OI activities among its R&D and IP units (Buganza et al., 2011). In few cases organisations introduced structured processes to evaluate and manage OI projects, others used unstructured and non-formalised processes to screen, evaluate and manage OI projects (Buganza et al., 2011). Therefore, the changes required for OI can vary from organisation to organisation. This highlights that implementing OI is less about industry trends and more about an organisation’s business strategy (Keupp & Gassmann, 2009). Nonetheless, these organisational changes for OI would have implications at not just the organisational level but also at the individual level.

It has been suggested that future studies should investigate the roles played by individuals in order to understand the organisational implications (Buganza et al., 2011). Studying the internal environment in an organisation has more value than studying the external environment in order to acquire a deeper understanding of OI implementation (Huizingh, 2011). Buganza et al.'s (2011) suggestion for future research along with Huizingh's (2011) as well as, Keupp and Gassmann's (2009) argument implying the need for an alternate perspective when studying OI is what guided the researcher to evaluate and investigate the individual level perspective of OI at an organisational/ firm level. Therefore, the individual perspective on OI is discussed next.

The Individual-level Perspective on OI

Another perspective that has been highlighted recently by Salter, Criscuolo and Ter Wal (2014) is the individual perspective at the organisation level. The need for more research in evaluating the changes to the nature of R&D at the individual level reverberates in recent literature (Alexy et al. 2013; Salter, Ter Wal, Criscuolo & Alexy 2012; Salter et al. 2014). It has been asserted that the literature "does not explore the micro-foundations of open innovation" (Salter et al. 2014, p. 4). Moreover, the implications of organisational changes on individuals have been neglected (Salter et al., 2012). This is further linked to the fact that there is inadequate research on OI in general, as well as a lack of theoretical research in the field (Duarte & Sarkar, 2011).

Since there is scarcity of research on the day to day challenges that R&D professionals encounter due to OI, and the ways these individuals cope with it Salter et al. (2014) examined this in a large multinational organisation. This was achieved by interviewing R&D technologists and managers, along with closely studying R&D professionals engaged in inbound OI. The individual perspective can be better understood by briefly discussing some of the changes found in the study by Salter et al. (2014). These are as follows:

1. The norms and expectations about R&D work are different for OI. In case of OI, individuals are required to scout for external ideas, integrate external ideas in internal processes and help assimilate these. This may require them to participate in external communities and interact with external stakeholders and in some cases to be seconded in other organisations.
2. OI leads to changes in working routines and job functions, as well as requiring a different mind-set and a supportive environment.
3. Due to incompatibility of OI with the existing organisational way of doing things, it may require employees to develop coping mechanisms to work effectively towards achieving organisational goals in addition to their individual work roles. This may lead to development or adjustment to formal procedures or a "break with conventions and expectations" in the current setting (Salter et al. 2014, p. 5).

A summary of the individual level challenges faced by R&D professionals as highlighted by Salter et al. (2014, p. 26) are presented in Table 1.

Table 1: Individual-level challenges of open innovation at various stages of external engagement

Stage of engagement	Company stance	Individual-level challenge
Getting the right mindset	All scientists and engineers are expected to embrace open innovation.	Perception of external engagement as second best.
Building partnerships	Established procedures have to be followed when building collaborations with new parties.	Preference for the safety of comfortable partners with whom they worked in the past.
Starting the conversation	No disclosure of internal knowledge to third parties without confidentiality agreement in place.	Difficulty to overcome the paradox of disclosure when starting new collaborations.
Taking advantage	Managerial pressure to increase the number of R&D projects that involve external parties.	Difficult to make external knowledge digestible in terms of alignment with internal knowledge, procedures and objectives.

Source: Salter et al. (2014, p. 26).

The study by Salter et al. (2014) provides a strong basis for understanding the individual level challenges due to inbound OI and the coping strategies used by R&D professionals. However, the study is not without its limitations. A limitation that is of relevance to this study is that it is based on a single organisational setting. Salter et al.'s (2014) study did not make a comparison across different organisations. Further it is based on a multinational organisation whereby there is more access to resources and less infrastructure issues. In addition, the study focuses only on inbound OI.

The importance of individuals involved in innovation can be found in Caloghirou, Kastelli and Tsakanikas's (2004) assertion that employee skills are necessary for an organisation to be able to develop new products and exploit external knowledge. This indicates that employee skills are linked to innovation. Considering Australia's innovation performance this aspect is important to explore as Australia still lags behind in innovation in comparison to other OECD countries (as indicated in OECD reports discussed in chapter-1). Evaluating innovation at employee/ individual manager level can impact overall organisational innovation and have an impact at a macro-level that is, national innovation output.

Moreover, the literature refers to employees as the Human Capital (HC) of the organisation. HC is understood as the knowledge, skills, attitudes, and intellectual ability of employees (Ross, Roos, Edvinsson & Dragonetti, 1997). The management of innovation has become an important topic because people rather than products are the major assets for an innovative company (Shipton, West, Dawson, Birdi & Patterson, 2006). Literature acknowledges that HC of an organisation is a crucial source of sustained competitive advantage (Laursen & Foss, 2003; Shipton et al., 2006). Moreover, in the case of OI, employees are important because they determine the organisation's degree of openness and

define its culture (Herzog, 2008). This further supports the argument to understand OI from their point of view for practicing and managing it successfully.

Further, investigating employees' attitudes can help to understand the differences in the adoption of OI in organisations (Burcharth, Knudsen & Sondergaard, 2014). The unwillingness of employees towards knowledge exchange prevents the adoption of inbound OI and outbound OI practices respectively (Burcharth et al., 2014). This can be in the form of negative attitudes towards external knowledge sources known as the not-invented-here (NIH) syndrome and against externally exploiting knowledge assets referred to as the not-shared-here (NSH) syndrome (Burcharth et al., 2014). This also highlights the importance of employees in adopting OI.

The way organisations adopt OI varies based on their innovation requirements, time of implementation and organisational culture (Mortara & Minshall, 2011). This process of change for OI has been observed to be discontinuous and fraught with difficulties; in fact, it is "characterised by shocks" (Mortara & Minshall, 2011, p. 587). This might be because OI requires changes to be supported and organised both at external level that is, in terms of network of inter-organisational relationships as well as, requires changes internally (Chiaroni, Chiesa & Frattini, 2009). Internally it requires changes to roles and responsibilities, use of new collective cognitive processes to overcome the resistance to inflows and outflows of knowledge and, introduction of new structures and management systems (Chiaroni et al., 2009). Subsequent research by Chiaroni et al. (2010) identified that organisations need to make the change along four organisational dimensions in order to shift from closed to open innovation. These dimensions are: inter-organisational networks, organisational structures, evaluation processes and knowledge management systems (Chiaroni et al., 2010). This re-organisation for OI is bound to have implications on the organisation which has to re-define and re-align its processes, structure and systems as well as, on the role and nature of its R&D and the people involved. This is succinctly illustrated in Figure 3 below based on the findings by Bigliardi et al. (2011, p. 71).

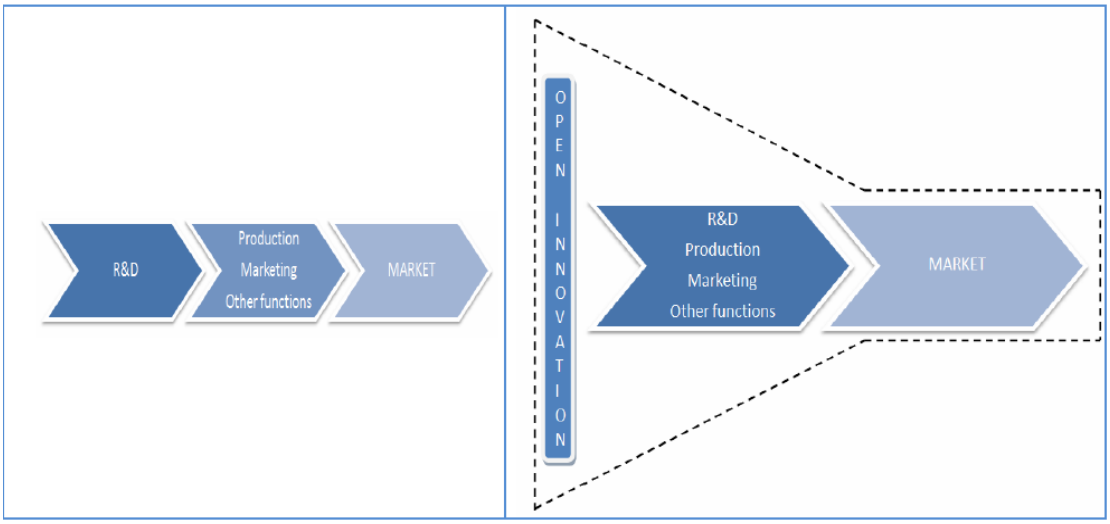

Figure-4. Comparison between the flow and management of technological innovation before (on the left), and after (on the right) the adoption of OI practices. Source: Bigliardi et al. (2011, p. 71)

Implementing OI as mentioned earlier is not a smooth process and involves shocks. The shocks can be because of the resistance towards shifting to OI which alludes to “dynamic tensions” due to opposing forces; one pushing for change and the other advocating the current modus operandi (Witzeman et al. 2006). This tension arises from the need to overcome biases in employees’ perception of OI. This is a major impediment to OI implementation and success referred to (previously too) as the “Not-invented here” (NIH), “Not-shared Here” or “Not-sold-here” (NSH) syndrome (Burcharth, Knudsen & Søndergaard, 2012; Chesbrough 2003; Chesbrough & Crowther 2006; Herzog & Leker 2010; Huston & Sakkab 2006a;). This implies that the unwillingness of employees to accept external knowledge transactions can have a major impact on the adoption and implementation of OI (Burcharth et al., 2012). Employees may not feel the need to send and receive knowledge which can inhibit the OI process (Haas & Park, 2010). A study by Huston and Sakkab (2006a & 2006b) of P&G’s ‘Connect and Develop’ program showed that employees were anxious that it might lead to loss of jobs and capabilities within the organisation. This was further reiterated by Burcharth et al. (2012) that employees tend to feel threatened by outside ideas and may undervalue those in order to promote in-house projects and capabilities.

It is important to overcome employee resistance since “innovation begins with the efforts of one or more individual” and “innovations are created by individuals or groups of individuals usually within organisations” (Chesbrough et al., 2006, p. 6). For OI to be successful there is a need to stimulate change in the organisational culture to inspire new thinking and to integrate external innovation (Slowinski, Hummel, Gupta & Gilmont, 2009). Employees should not consider external innovation as a substitute, nor a competitor to internal innovation (Ollila & Elmquist, 2011). However, as established in the discussion previously about studies on NIH and NSH, they often tend to succumb to this way of thinking. Moreover, there is a lack of attention given to the mind-set and the attitudes within the organisation required to implement the OI process (Gassmann, Enkel & Chesbrough, 2010).

Employees’ participation and responsibility in the adoption and implementation of OI cannot be ignored. This is because employees’ non-alignment with top management’s efforts to implement new practices related to OI can create blockages, thus, hampering the implementation of OI (Burcharth et al., 2012). The major challenges in the adoption of OI are not only about coordinating the processes of knowledge creation and accumulation, but in addition ensuring that employees are committed to the open-ended process of knowledge sharing (Burcharth et al., 2012). Further, despite overcoming individual effects of the NIH syndrome, the restructuring required for OI will directly impact the purpose and organisation of internal R&D activities (Chesbrough et al., 2006, p. 6). This restructuring of R&D activities will have implications on individuals and literature has mostly neglected to examine the individual perceptions associated with OI in depth. This is an important area for further research given the role employees play in innovation process in general and in an organisation’s success related to OI.

For OI to be effective it is not only crucial to overcome the individual effects of the NIH syndrome but also, it is important to learn how individuals create knowledge in OI and the problems they face (Du

Chatenier, Verstegen, Biemans, Mulder & Omta 2009). Given the important role employees play in innovation one would assume there would have been more studies to investigate the impact of differences at the individual level between conducting internal R&D and a more open approach however; that is not the case (Alexy, Henkel & Wallin, 2013). Recent research has again identified this as an area for research, it is reiterated that little is known about the challenges faced by R&D professionals in an OI environment (Salter et al. 2014). Considering that internal R&D has a positive impact on an organisation's performance and investment in R&D leads to more benefits from OI it is important to study the implications of OI on individuals related to R&D (Hung & Chou, 2013). This is because research indicates that OI has raised questions about the role of R&D (O'Connor, 2006). In the OI concept "R&D is seen as an open system, with several ways in and out, instead of a closed system, where there is only one way in for innovations – the R&D division of the firm" (Duarte & Sarkar, 2011, p. 436). The changes related to OI highlighted in the research by Bigliardi et al. (2011) that impact the internal R&D are noteworthy in this discussion. These are as follows: R&D function is no longer responsible for technological innovation and in order to adopt external knowledge and technology, other functions such as production, marketing, and legal need to be involved in the evaluation process and work along with the R&D of the organisations (Bigliardi et al., 2011). Individuals in R&D would hence experience a major shift in their roles, responsibilities and day-to-day operations to facilitate OI implementation (Bigliardi et al., 2011). Evidently, this means that OI requires some key changes which can lead to challenges for all stakeholders.

OI means substantial change to organisations, implementing OI is not just about searching for external knowledge on an "ad hoc basis…OI requires instead a corporate-wide re-organisation process" (Boscherini et al., 2010, p. 1067-68). An example of changes due to OI is presented in a study by Chiaroni, Chiesa and Frattini (2011) in which an Italian cement manufacturer underwent an organisational change process in order to implement facilitation of OI. Other prominent examples available in research literature of organisations that underwent changes to implement OI are: Nestle, General Electric (GE), Ford, and P&G. Mortara and Minshall's (2011) assertion that to make innovation open calls for considerable change appears to be valid. These studies have described and illustrated changes required for OI. What they have failed to take into account, however, is how individuals in organisations experience this shift towards OI. The next section explores the literature related to OI in terms of, what challenges it can lead to for organisations and individuals; it is important to understand this briefly prior to examining the implications of these.

Examining Challenges to OI

In this section the literature on OI is examined based on challenges and barriers mentioned. As with most aspects of OI these have mostly been investigated at an organisational level and not particularly at the individual level.

It has been suggested that the challenges and barriers to adopting OI need more research in different organisational settings (Van de Vrande et al., 2009). This is because success of OI can differ across technologies and industries, and research on its challenges and requirements can bring more valuable

insights to practitioners (Christensen et al., 2005; Dahlander & Gann, 2010). Literature on OI has acknowledged that the shift towards OI has led to not just opportunities but also challenges for R&D professionals (Salter et al., 2012). OI challenges according to Enkel et al. (2009) showed loss of knowledge (48 per cent), higher coordination costs (48 per cent), as well as loss of control and higher complexity (both 41 per cent). Additionally, there are other challenges due to internal barriers, such as: the struggle in finding the right partner (43 per cent), imbalance between OI practices and day-to-day business activities (36 per cent), and insufficient time and financial resources for OI (Enkel et al., 2009). Challenges while collaborating for OI also include: the difficulty of balancing individual and alliance interests, lack of trust, the difficulty of absorbing and communicating knowledge between partner organisations, as well as the absence of traditional hierarchical lines (Du Chatenier et al., 2010). Other most common challenges towards OI mentioned in the literature are: the NIH syndrome, lack of internal commitment and the 'Only-Used-Here' (OUH) syndrome (Chesbrough & Crowther, 2006). Some others that are noted include lack of resources, free-riding behaviour, and problems with contracts (Du Chatenier et al., 2010; Van de Vrande et al., 2009). OI is perceived as requiring a shift and difficulties due to more channels of knowledge flow internally and externally (Chesbrough & Crowther, 2006; Du Chatenier et al., 2010). Furthermore, problems due different cultures or modes of organisation, or bureaucratic elements can arise (Boschma, 2005). A noteworthy challenge in OI can be matching the organisation's goals with the goals of its partners and dealing with power differences (Du Chatenier et al., 2010).

Cost is another major OI challenge. The costs involved in maintaining too many relationships for OI is known to not only hinder the smooth flow of its operations but it also leads to a diversion of managerial attention (Dahlander & Gann, 2010). Moreover, it also leads to increased coordination costs due to the involvement of various parties (Almirall & Casadesus-Masanell, 2010; Dahlander & Gann, 2010). In addition, there is the issue of cost of competition that emerges from the risk of the possibility that one partner might act opportunistically in bad faith (Dahlander & Gann, 2010). This means that organisations have to ensure ways to protect their ideas to which others may have access (Dahlander & Gann, 2010). This refers to the costs associated with the exploitation of resources by competitors. OI can lead to resources being exploited by others due to IP being difficult to protect and benefits from innovation difficult to account for (Dahlander & Gann, 2010). The IP dichotomy shows that OI can be challenging in more ways than organisations may anticipate at the outset, that is, the mechanisms for protection might act as challenges to the operation of OI. The next few paragraphs dwells on how OI is perceived to be a challenge for managers.

In addition to strong IP protection, organisational structures, and politics can hinder the implementation of a new business model required to support OI (Giannopoulou et al., 2011). This would need managerial intervention. Some challenges of OI for managers can be related to motivation and soft-skills, knowledge assimilation, and being in control of the innovation process (Wallin & Von Krogh, 2010). For OI to be successful the role of managers is crucial in identifying knowledge, choosing integration mechanisms as well as, changing and balancing incentives and controls (Wallin & Von

Krogh, 2010). This is supported by the research of Mann, Kumar, and Mann (2009) that argues that introducing control mechanisms for OI helps the outcomes.

Additionally, in spite of managers realising the benefit of gaining ideas, expertise from outside the organisational boundaries and trading IP, they may still be apprehensive about relinquishing exclusive rights to product technology (Wallin & Von Krogh, 2010). This may be due to the fact that most managers are trained in the traditional management thinking and practice as well as related to sense of loss of control (Almirall & Casadesus-Masanell, 2010; Wallin & Von Krogh, 2010). This in turn can lead to challenges in implementing and executing OI practices.

OI requires organisations to manage not only internal R&D but more complex innovation processes that are intertwined with it and these processes might start or finish outside the organisational boundaries (Carlsson & Corvello, 2011). Evidence suggests that OI can present various challenges for managers and R&D employees depending on the external party involved and as mentioned earlier there are usually a few different parties involved in OI. For example, in the case of intermediaries like InnoCentive research has shown that managerial challenges are attaining the support of internal scientist to work with external partner; selecting the right problem; and formulating the problems in a manner that can be easily understood by diverse experts (Sieg, Wallin, & Von Krogh, 2010). In the case of engaging with innovation communities, managers face different challenges. These may include selling the idea of how the community can provide the specialised knowledge that is required, and the ability to manage the community while maintaining a balance between control and growth (Fichter, 2009; Dahlander, Frederiksen & Rullani, 2008). Furthermore, the control and coordination mechanisms previously used by management may no longer be adequate in an OI scenario (Pénin, Hussler, & Burger-Helmchen, 2011). This can be due to the diversity and variety of stakeholders which adds to more complexity in managing OI. Other issues for managers highlighted in literature due to diverse partners involved in innovation are: misalignment in goals between partners, and competition for resources whereby internal researchers have to compete with external partners (Almirall & Casadesus-Masanell, 2010). Therefore, Carlsson and Corvello (2011) suggest the need for more research on the challenges and changes managers face due to OI from their viewpoint. This has been taken into account in the research aim for this study to examine OI from individual managers' viewpoint.

To summarise some of the challenges associated with OI discussed above include the difficulty of balancing individual and alliance interests, lack of trust, influencing external partners and managing cultural issues within and outside of the organisation, control issues, costs, coordination issues, IP protection, the problem of free riding, the difficulty of absorbing and communicating knowledge between partner organisations, and the absence of traditional hierarchical lines (Du Chatenier et al., 2009, 2010; Pénin et al., 2011; Wippich, 2012). These challenges underlying OI would have an impact on the people within the organisation. There is consequently a need to understand and investigate the human side of innovation (Du Chatenier et al., 2010). This discussion also shows the crucial role that managers can play in managing the challenges of OI. However, there still is a lack of research on understanding OI

from the individual perspective. Therefore, research needs to first understand the way managers conceptualise and perceive OI that is, its benefits and challenges before the management of OI can be explored.

The importance of understanding the implications of OI at an individual level has been repeatedly highlighted (in the discussion so far, as well as) in literature such as by Alexy et al. (2013); Burcharth et al. (2012); Du Chatenier et al. (2010); De Leede & Looise (2005); Giannopoulou et al. (2011); Salter et al. (2012); and Shipton et al. (2006) among others.

Implications of OI at Organisational level

The use of OI practices is considered to have certain implications. One that is widely debated in literature is whether OI complements and/ or substitutes internal R&D- this is discussed in the following paragraphs. After that the implication that is discussed is related to the complexity of managing OI practices, that is mostly due to the diversity of partners and internal organisational barriers. Subsequently, the discussion proceeds to OI's implications on organisational structure and boundaries, processes, role, responsibilities, and group dynamics.

There is debate in the literature whether OI complements or substitutes internal R&D in organisations. It appears that with the upsurge of OI practices internal R&D's role is questioned (Schroll & Mild, 2011). OI is not about new and easier ways to do things, nor for organisations to substitute its internal R&D with cheap and easily available innovation solutions in the external environment (Carlsson & Corvello, 2011). What OI does is complement the internal R&D activities of an organisation (Drechsler & Natter, 2012). It has been found that innovative organisations leverage and support internal R&D by using OI practices (Drechsler & Natter, 2012).

The results of Drechsler and Natter's (2012) study based on German organisations about OI complementing internal R&D were parallel to the findings of a previous study by Caloghirou, Kastelli and Tsakanikas (2004) that openness to knowledge sharing does not substitute but complements internal efforts and is important for enhancing an organisation's innovative performance. In addition, Vanhaverbeke et al. (2008, p. 3) also state that, acquiring external knowledge complements rather than substitutes internal R&D. This is further supported by other research such as by: Cassiman & Veugelers (2006); Chesbrough & Crowther (2006); Hung & Chou (2013); and Van de Vrande et al. (2009).

Moreover, a study of Australian SMEs in the manufacturing sector by Huang and Rice (2009) also geared towards a complementary relationship between OI and internal R&D. In recent times, this notion has been supported by the findings of the study by Salge, Bohné, Farchi, & Piening, (2012) that points towards a complementary relationship between the two. This is primarily due to the fact that in addition to internal knowledge, organisations now have access to an increased number of external innovative ideas that can support its internal R&D and knowledge (Salter et al., 2014). An explanation for this can be that when organisations use external knowledge, the internal R&D can be more productive in efforts

to create new products and find new ways to market current technology and knowledge (Salter et al., 2014).

It is worth noting that these studies are in contrast with an earlier study in this area by Laursen and Salter (2006) which reported a different result, observing that OI substitutes rather than complements internal R&D. Later, a study by Watkins and Paff (2009) found comparable evidence in American Bio-pharmaceutical and software industries that external R&D substitutes internal R&D. Schroll and Mild (2011) argue that previous studies by Chesbrough & Crowther (2006), Laursen & Salter (2006), and Van de Vrande et al. (2009) that have looked at whether OI substitutes or complements internal R&D have not considered whether the OI was inbound or outbound, which led to the substitution or complementary effect. The Schroll and Mild (2011) study investigates this affirmation and concludes that OI mostly complements R&D but in the case of inbound OI, internal R&D is substituted. According to Bigliardi et al. (2012) OI can be viewed as complementing internal R&D when organisations focus on the outbound aspect of OI because then organisations are able to produce knowledge through internal R&D that can be externalised. Conversely, when organisations try to reduce costs of internal R&D by using external knowledge as in the case of inbound OI then it can be seen as a substitute for its internal R&D (Bigliardi et al., 2012). Based on the discussion until this point, it is clear that, R&D and openness have a contentious relationship (Barge-Gil 2010). This is reflected in Dahlander and Gann's (2010) conclusion that internal R&D is essential to complement openness for outside ideas, however, whether the outside ideas can be a substitute for internal R&D lacks clarity.

The discussion above highlights not only the need for examining the implications of the substitute and/ or complementary nature of OI for at the organisational level but also at how it is perceived at the individual manager level (this aspect is discussed in the subsequent section). Another aspect of implications of OI that is highlighted in literature and discussed in previous section, is that its adoption leads to internal challenges that need to be managed well before it can be successful. In the next few paragraphs the complexity of managing OI is explained and examined further.

It appears that though the concept of OI is more widely accepted organisations are still learning how to execute it (Wallin & Von Krogh, 2010). OI is not just a technological phenomenon, it requires managerial changes such as adapting business models, managing new R&D organisations as well as, dealing with cultural change towards NIH attitude in employees (Chesbrough, 2007; Huston & Sakkab, 2006). A reason for this is that since OI involves external parties it leads to issues related to governance of the innovation process, its outcomes, and assets (Wallin & Von Krogh, 2010).

The OI model implies that the management and organisation of innovation processes becomes more complex, that is, it includes many more activities than just those that were assigned to a traditional R&D department (Van de Vrande et al., 2009). That is why, "OI needs an open culture and an open state of mind, which can be difficult to cultivate and maintain" (Giannopoulou et al., 2011, p. 519). Therefore, managers must find new ways to conceptualise because now innovation proceeds along less

hierarchical lines (Dahlander & Gann, 2010). From these perspectives, the OI literature can be viewed as an illustration of how firms make decisions whether to develop innovation internally or partner with external actors (Dahlander & Gann, 2010). Organisations aiming to capture value while cooperating with others would either need to develop or adapt their business models to allow for the greater flexibility required for OI (Giannopoulou et al., 2011). This is because for openness there is a need for a model that helps in organising OI practices throughout the process of innovation and further a need for defining organisational capabilities required for it (Giannopoulou et al., 2011).

The influence of the operational level staff needs to be considered while forming a strategy for OI because engineers and managers are the ones who are regularly interacting with external partners and are more aware of the technological changes (Wippich, 2012). The study by Wippich (2012) suggests that though technical know-how is important for R&D managers the importance of commercial aspects such as "strategic thinking, intellectual property management…coordination skills" are required of team members. A study by Du Chatenier et al. (2009) on the activities performed by OI professionals showed that the three main tasks they engage in are: managing the inter-organisational collaboration process; managing the overall innovation process, and creating new knowledge collaboratively. Additionally, Giannopoulou et al. (2011, p. 518) suggest the following as the main managerial activities in OI, "organising for openness, leadership for diversity, co-creating value and IP management." These seem to relevant too based on the challenges discussed in the previous section.

What happens in an OI setting is that two or more partners are jointly engaged in a coordinated effort to create new ideas and transform them into an innovation, by combining different types of technology, concepts, skills, and means (Fagerberg, 2004 cited in Du Chatenier et al. 2010). Therefore, leadership in an OI scenario is about managing relationships; this is paramount as there are various stakeholders both inside and outside of the organisation (Fredberg et al., 2008). Overall in an OI scenario managers need to encourage people to participate and build new relations, while building trust and creating a culture that supports and enables OI (Giannopoulou et al., 2011). Also, managers need to realise that the value they are generating for their organisation by collaboration with others accounts for any loss that they might perceive (Henkel, 2009). The following paragraph talks more directly about the complexity in managing OI.

OI has made organisations realise that they can develop more complex products faster and efficiently by using various sources of knowledge, as well as to discover new ways to employ and use their internal knowledge more productively (Carlsson & Corvello, 2011). To drive maximum benefit from partnerships with external partners, organisations need not just realise the importance of external innovation but be able to utilise the value by effectively managing the process (Fetterhoff & Voelkel, 2006). For managing the OI process the development and management of relationships is not only crucial but also complex to conduct consistently (Slowinski & Sagal 2010). Management's role is "to accept and master this complexity" (Carlsson & Corvello, 2011, p. 3). OI leads to more complications in managing and organising innovation processes due to the inclusion of more activities and partners than in the case of

traditional R&D (Enkel et al. 2009; Van de Vrande et al. 2009). Nambisan et al. (2012) state that though the involvement of senior management is important to OI, the day-to-day operational work is undertaken by the mid-level managers who interact with the innovation stakeholders inside and outside the organisation making their role crucial to its success. Managers have to coordinate and integrate the resources of two different organisations with varied processes and systems, reporting structures while ensuring timelines are maintained (Slowinski & Sagal, 2010, p. 45).

There is no doubt that OI model leads to complications for management due to each partner and/ or organisation attempting to capture optimum value from their respective external partner's knowledge (Fetterhoff & Voelkel 2006; Wippich, 2012). The complexity in managing OI is a repeated theme in literature which arises due to the increased interdependence among organisations working together requiring better management of the innovation process (Huston & Sakkab, 2007). This is similar to Fredberg et al. (2008) argument that OI requires managers to be able to handle various stakeholders in a complex and uncertain environment. For the organisation to be able to fully utilise and derive benefits managers need to be able to integrate internal and external knowledge (Vanhaverbeke et al., 2008). Consequently, making their role crucial for OI success. In OI, managing various resources, knowledge and organisation's project portfolio management and external relationship management become especially critical (Igartua, Garrigós, & Hervas-Oliver, 2010). Research stated thus far shows that OI has implications for managerial practice and organisations are still learning how to work with it (Giannopoulou et al., 2011). The next few paragraphs discuss implications of OI on organisational structure, processes, role, responsibilities, organisational boundaries, and group dynamics.

An important precondition for collaborative innovation is the ability to assimilate foreign knowledge and technology into the organisational knowledge base and externalise it to help the partner learn (Gassmann & Enkel, 2004). This assimilation of external knowledge sources requires a change that will enable the enhancement of the internal knowledge base (Gassmann & Enkel, 2004). The key to success here is first to find the right partner who has the competencies and knowledge required to achieve a competitive advantage in the industry (Gassmann & Enkel, 2004). The dependence on external knowledge means that organisations have to change their internal innovation activities in comparison to a closed innovation approach (Vanhaverbeke et al., 2008). In OI organisational boundaries are blurred in organisations and even industries (Wippich, 2012). Opening up of the organisational boundaries has been mentioned in literature to lead to implications as organisations need to rethink their structures and processes to allow for an effective flow of knowledge between various internal and external stakeholders (Chesbrough, 2003). It appears from literature that in order to practice OI successfully organisations need to adapt their structures, and processes to manage the increasing number of partners (Chesbrough, 2003; Wippich, 2012).

OI has specific organisational needs (Bröring & Herzog, 2008). Research by Nambisan et al. (2012) indicates a need to implement more measures such as changes in the organisational structure and processes that will enable them to bridge the gap between the organisation's OI vision and its existing

innovation function. Organisations that engage in any form of OI would need to change the processes used for creating and integrating knowledge (Chesbrough, 2003). The fact that OI leads to changes in processes or in some cases requires new processes is evident in the example of Colgate-Palmolive's managers developing processes for assessing opportunities for collaboration in innovation (Witzeman et al., 2006). For external innovation to be effectively used by organisations they need to change and review their various processes such as: new product development, supply chain, strategic planning, reward system, and their technology roadmap among others (Witzeman et al., 2006).

On the topic of the influence of OI on internal structure of R&D, Bigliardi et al. (2011) state that, it has led to the adoption of matrix or network structures rather than functional structures. Organisations have also decentralised organisational structures to support OI so that there is a higher involvement of line managers (Nambisan et al., 2012). Nambisan's et al. (2012) study found eight factors that contribute to the success or failure of an OI project, four of these related to the organisation's structure and processes. Two of these factors were the "willingness to undertake organisational change to support open innovation" and another one that is of relevance to this study is "sustained senior executive involvement" (p. 54). The study by Nambisan et al. (2012) is significant as it indicates that organisations that readily recognise the need to make operational changes for OI are likely to achieve more success. Additionally, it also suggests that organisations need to have a closer working relationship that allows for more information sharing with its innovation partners which in turn requires changes in their processes and structures. This is similar to the research on three IT companies by Alexy et al. (2013) that showed that opening up the R&D process requires the organisation to adapt and restructure current processes. This is reiterated by another study by Bigliardi et al. (2011) that argues that since OI leads to integrating external knowledge it requires multiple points of contact with stakeholders within the organisations thus, requiring a different organisational structure.

It has been found that in the OI scenario roles and responsibilities are left vague to allow for more freedom and interaction for cross-functional alignment and innovation (Wippich, 2012). In the OI scenario to meet their goals effectively and efficiently employees are encouraged to find external resources (Witzeman et al., 2006). For example, P&G's "Connect + Develop" which is highly cited in literature as an example of successful OI has 50 Technology Entrepreneurs whose work is to identify the "wants" and help managers "find" external resources (Witzeman et al., 2006). An example from the Biomedical industry is Eli Lilly's attitude of "research without walls" based on the philosophy that their business is a "small part of a global research community" (Witzeman et al., 2006, p. 22). As organisations are surrounded by networks, industries and sectors these need to be considered as well for OI (Chesbrough et al., 2006). This requires transformation in organisational boundaries into a "semi-permeable membrane" to allow for smoother movement of innovation between the external environment and the organisation's internal innovation process (Gassmann & Enkel, 2004, p. 1). Therefore, the OI approach is about acquiring flexibility in the organisation's strategic process and driving the diffusion of innovation (Gassmann & Enkel, 2004).

There is a need to understand other changes to organisational and group dynamics necessary to support OI (Chesbrough et al., 2006). Research has also found that in some cases systems have to be set up to facilitate OI (Witzeman et al., 2006). A case in point is the example of Eli Lilly setting up an office of Alliance Management as part of an internal infrastructural system to facilitate OI (Witzeman et al., 2006). In addition, organisations need to add responsibilities to their current groups such as legal, IP, and business development (Witzeman et al., 2006).

What has been highlighted in the discussion so far is well reflected in Huston and Sakkab's (2007, p. 24) assertion that in the OI scenario instead of inventing within the organisational walls where there are usually issues of power and control due to position and hierarchy it is required to leverage people without direct control through relationship building, trust, and motivation. Hence, for an OI strategy to be successful it is imperative to build good relationship and alliance skills (Huston & Sakkab, 2007). Huston and Sakkab (2007, p. 24) summing up the OI paradigm suggest that managers need to operate with the mind-set that "we've got 9,000 people inside…but 1.5 million outside". Furthermore, organisations and managers need to understand that the new innovation model is based on connections and not just invention (Huston & Sakkab, 2007). Overall it appears that literature highlights that OI requires changes at the organisational and managerial level to be successful (Bigliardi et al. 2011; Bigliardi et al., 2012; Dodgson et al. 2006; Huston & Sakkab, 2007). Thus, indicating implications not just at the organisational level but also at the individual level. These are explored next.

Implications of OI at Individual level

It has been established in the previous discussion that OI leads to changes in organisations at a structural level as well as, in processes, systems, roles, complexity in management and group dynamics. These changes would have implications for individuals involved too. This section discusses OI's implications on individuals due to: diversity of teams; changes in aspects of- reward systems, incentives, career paths; addition of new job roles; shift in the role of R&D and changes required in the attitude, competencies, and skills to manage OI among other areas.

In case of organisations that have highly varied and rich R&D resources, being open can lead to tensions within which impacts managers and team members too (Wippich, 2012). Since OI is based on the collaboration of different actors, it is not surprising that it raises issues related to large and inter-organisational teams (Pénin et al., 2011). It can lead to social and communication problems for individuals, which may result in not just conflicts but also project failures (Du Chatenier et al., 2010).

OI teams are formed by professionals from different organisations to create new knowledge collaboratively (Du Chatenier et al., 2010). This diversity of organisational backgrounds is an important source of creativity and is considered critical for the success of innovation projects (Ritter & Gemuenden, 2002). However, R&D staff such as researchers, scientists and engineers can feel uncertainty due to competition to be knowledgeable and competent in comparison to outside researchers such as, in universities (Bigliardi et al., 2011). Managers and team members in an OI scenario can experience a sense of lack of control and increased dependency on the external

environment (Wippich, 2012). Managing diverse stakeholders in an OI scenario can cause internal conflict and can be frustrating (Du Chatenier et al., 2009 & 2010).

OI leads to changes in the norms and reward systems in most organisations for the internal R&D (Chesbrough et al., 2006). Recently, Salter et al. (2014, p. 4) have reaffirmed that OI changes "norms and expectations" of R&D operation. This is because for OI to be successful organisations need to go further to ensure an overall culture that supports innovation in any form by being more accepting of failure on the innovation journey in their norms and reward systems (Fu, 2012; Nambisan et al., 2012). However, more research is required to establish how the new requirements for OI affects the organisation of R&D workers, their incentives, recognition and motivation (Buganza et al., 2011; Chesbrough et al., 2006; Fu, 2012). The research on OI related to incentives is discussed next.

The issue of incentives in an OI process is highlighted by several studies for example: Chesbrough & Crowther (2006), Bergman et al. (2009), Giannopoulou et al. (2011) and Witzeman et al. (2006). The importance of incentives to innovate may change in the case of OI due to the fact that the key internal inventors in an OI model may feel they are not as important as before (Fu, 2012). Bergman et al. (2009, p. 152) also mention that a risk associated with OI is that of letting go of rewards and incentives. The reward and incentive systems in OI needs to include goals and metrics that are more focused on openness (Buganza et al., 2011). For example. organisations like P&G have reward systems that favor innovations developed from external ideas (Chesbrough & Appleyard, 2007). P&G's reward structure is based on two goals: one, to ensure that best ideas regardless of source get attention and; second, to encourage a change in attitude from NIH (Chesbrough & Appleyard, 2007). Conclusively, in case of OI, management must develop a system that rewards both internal and externally sourced innovation (Giannopoulou et al., 2011). This is why it has been suggested by Salge et al. (2012) that for high returns from OI, organisations need to have (among other factors) a dedicated incentive system. In addition, Salge et al.'s (2012) analyses suggests that both pecuniary incentives (in the form of link between salary, bonus or promotion and achieving innovation objectives) and non-pecuniary incentives (in the form of internal recognition, flexibiity and more desirable tasks) are key to capturing the value of openness. Similarly, Mortara, Slacik, Napp and Minshall (2010) note that the performance metrics applied to the researcher in case of OI would be different and this would be a challenge for researchers and managers. Fu's (2012) research is significant in this aspect as it highlights that the organisation's adoption of OI transforms the overall innovation model that individuals operate within as well. This point is of importance to the firms that shift to the OI model to ensure that they introduce practices, process, and systems that take into consideration how opening up for innovation will interact with R&D employees.

Furthermore, job roles associated need to be redefined in OI as well (Alexy et al., 2013). In addition to the technological monitoring and gatekeeping roles there are new roles that have come up in the industrial research structure (Bigliardi et al., 2011). OI leads to a shift in the role of internal R&D, "from discovery generation as the primary activity to systems design and integration as the key function"

(Chesbrough et al., 2006, p. 10). In OI, there is a greater need for R&D personnel to engage and relate well with other departments within the organisation (Bigliardi et al., 2011). Studies suggest that the role of R&D has changed from having a strategic advantage of knowledge producers to more of scouting and integrating external knowledge (Bigliardi et al., 2011; Laursen & Salter, 2006). For example, the study by Nambisan et al. (2012) discusses that new roles such as that of an innovation capitalist have emerged due to OI. The literature suggests that the innovation capitalist takes the innovation process further than the broker by searching, evaluating, building prototype on the new technology and product ideas based on validated market potential (Nambisan et al, 2012). The study by Bigliardi et al. (2011, p. 72) concluded that OI leads to "less important role of senior scientists, while the "T-Man" professional profile has been added". The new role and responsibility of researcher referred to as "T-Man" in the research by Bigliardi et al. (2011) can be summarised as follows:

- "T-Man" is able to integrate and combine technical-scientific knowledge with managerial requirements.
- This person has a technical-scientific background which enables understanding of the nature and potential of new knowledge and technologies.
- This is someone who has an understanding of the problems faced by the organisation in implementation of strategies, marketing and production.

In an OI scenario, researchers in addition to their technical lab skills may be expected to be able to access and source ideas while not weakening the employer's IP (Mortara et al., 2010). It appears that this new role reflects the paradigm shift required in R&D personnel and their overall orientation to work in an OI environment.

Other roles found were by Chiaroni et al. (2011) in the organisations they studied there was creation of a new gatekeeper role and the creation of innovation champions for each of the organisation's main research areas. Furthermore, according to O'Connor (2006, p. 19) R&D role has changed to that of being "evaluators and assemblers of technology" and unlike IBM, Intel, and P&G who still are committed to internal R&D, some others are using OI as an excuse for reducing it. Therefore, in some established organisations, OI can be viewed as a threat to the role of R&D (O'Connor, 2006).

When firms open up their innovation process there are bound to be changes in the way things were done previously (Fu, 2012). It has implications not only for the innovation process but also the people involved. Considering that roles are created and/ or modified in an OI environment it is understandable that the skills required of researchers and managers in an OI environment are different too (Mortara et al., 2010).

According to Wippich (2012) the skills and competencies for managing OI scenarios are under-researched. In addition, how managers build trust with team members inside and outside of the organisational boundaries in order to derive maximum benefit from its R&D process also needs more investigation (Wippich, 2012). A study by Di Minin, Frattini & Piccaluga (2010) supports Wippich's (2012) argument, stating that OI requires a considerable change in the attitude, competencies, and

capabilities of researchers. For example, in OI researchers are required to adopt an outlook that is more externally focused, display an entrepreneurial spirit and be open to risk in their innovation efforts (Di Minin et al., 2010). Zhang, Baden-Fuller & Mangematin (2007) made a similar observation that OI requires considerable involvement of scientific personnel outside the organisation while this can be seen as a challenge by older scientific personnel; younger researchers would tend to view it as an opportunity. Organisations devoted to more openness in innovation have realigned their internal R&D efforts from problem solving to problem formulation (Felin & Zenger, 2014). Also, Di Minin et al. (2010) like Bigliardi et al. (2011) suggest that R&D personnel involved in OI are required to develop know-how of other organisational functions such as production, finance and marketing. The evidence from these studies suggests that organisations would then have to redefine the criteria for new researchers to focus not just on competence in technical and scientific knowledge but to include entrepreneurial outlook and an inclination towards trial and error.

Since the new or modified roles for OI need additional skills that require the identification, assessment and integration of different technological knowledge from external sources as well, internal knowledge they have led to changes in the career paths of researchers (Bigliardi et al., 2011). Research indicates that OI can indeed lead to deviation in career paths and needs of research personnel causing feelings of instability consequently, making formal career paths in organisations to no longer be adequate (Bigliardi et al., 2011). This is because it involves the additional role of finding, retrieving and assimilating technological knowledge from external sources while being able to generate internal knowledge (Bigliardi et al., 2011). Hence, R&D managers are required to evaluate performance on a different criterion and consider alternative ways to promote as well as, allow researchers to do assignments in other departments (Bigliardi et al., 2011). Moreover, Bigliardi et al. (2011, p. 72) found that the organisation they studied had adopted “an open dual ladder model…allowing a researcher mobility within and between firms”. It seems that research (such as by Bigliardi et al., 2011; Fu, 2012; Salge et al. 2012 to name a few) clearly shows how the adoption of OI has altered aspects of R&D and its personnel management, however it does not examine the implications of this shift due to OI on individual managers.

OI calls for a change in the way research managers operate and this requires an open mind-set that inspires researchers to view the world as their technology base (Witzeman et al., 2006). Witzeman et al. (2006) argues that the role of R&D leadership shifts as organisations start operating in external sourcing. Furthermore, managers need to view and promote outside innovation as means that allows for costs control and risk sharing instead of as a threat (Witzeman et al., 2006). Advocates of OI assert the need for organisations to access external knowledge sources through various means such as the use of innovation intermediaries or innovation brokers that enable innovators to practice using external ideas more swiftly (Chesbrough et al., 2006). Understanding the sub-firm level analysis will help gain insight into the sources of innovation because innovations are generated by individuals or collection of individuals typically within organisations (Chesbrough et al., 2006). Therefore, it is important to overcome employee resistance since innovation starts with the work of an individual or two

(Chesbrough et al., 2006, p. 6). Managers are hence required to push the change in organisational culture to encourage new thinking and give way to integrate external innovation (Slowinski et al., 2009). Employees on the other hand, need to stop viewing external innovation as a substitute or competition to internal innovation (Ollila & Elmquist, 2011). Employees' responsibility for the implementation of OI cannot be ignored this is because employees' non alignment with top management's efforts to implement new practices related to OI can create blockages for managers and hamper the implementation of OI (Burcharth et al., 2012). Therefore, Burcharth et al. (2012) argue that the major managerial challenges in the adoption of OI are not only to identify inbound and outbound practices but to coordinate the processes of knowledge creation and accumulation as well as, ensure that the employees are committed to the open-ended process of knowledge sharing. Literature acknowledges that the adoption of OI is a complex activity that requires establishment of a range of processes, structures and activities to support the receivers and handle demands of external partners (Burcharth et al., 2012). Further research emphasis the lack of attention given to the mind-set and the attitudes within the organisation required to implement the OI process (Gassman, Enkel and Chesbrough, 2010; Wippich, 2012).

It needs to be considered that despite overcoming the individual effects of the NIH syndrome the restructuring required for OI will directly impact the purpose and organisation of internal R&D activities (Chesbrough et al., 2006, p. 6). As previously discussed it raises some issues related to building trust, motivation, influencing external partners, and managing cultural issues within and outside of the organisation among others (Wippich, 2012).

To summarise, in the case of OI organisations have to manage various actors outside the boundaries of the organisations which leads to blurred boundaries in organisations and even industries (Ollia & Elmquist, 2011; Wippich, 2012). This has implications for the internal R&D that is at the centre of all innovation activities of the organisation. It has hence been noted that employees in an OI scenario face problems in forming new partnerships, exchanging knowledge across boundaries, and assimilating external knowledge internally, maintaining the capabilities to meet individual goals as well as, organisational goals (Salter et al., 2014).

Based on the evidence presented (including the organisational level implications of OI), it is apparent that OI transforms the overall innovation model that individuals operate within (Fu, 2012). This underlines the need for research to understand the experiences of and the consequences for personnel in an OI environment. By examining the prespectives of individuals in management associated with OI this study will help enhance the understanding of how organisations can gain maximum value and manage OI's implications effectively. This has been mentioned in a recent study by Gambardella & Panico (2014) as an important area for future research.

Here it is important to briefly note that for Australia, where OI research is still in its early development stage, it is relevant to study the individual employees' perspective to enable wider adoption and quicker

implementation of this concept in various industries. As indicated by the discussion so far the research that has examined implications of OI on individuals is limited. More research is required to understand the connection between OI practices and R&D changes and to understand how organisations and individuals manage these implications (Bigliardi et al., 2011). The complexity of managing OI calls for in depth case studies especially for themes that deals with issues related to management practices (Carlsson & Corvello, 2011). This research is therefore, focused on understanding the manager's perspectives on OI and its implications which will help in better management of OI. This study proposes to investigate the implications of OI not just at an organisational level but also, at an individual level as these are interconnected.

From the discussion, it is evident that the relationship between OI and internal R&D is complex. OI requires an organisation to manage external flow of knowledge and assimilate it into its innovation processes allowing it an equal position as internal knowledge (Chesbrough, 2006; Chiaroni et al. 2009). It necessitates changes in internal organisation, namely the changes in management practices as well as career paths, role and responsibilities, skills of employees involved in the innovation process. The evidence presented illustrates the need to address the following research aim:

- To understand the micro-foundations of open innovation and its implications from individual managers' perspective in Biotechnology organisations; and to explore how organisations and individuals can manage these implications.

This will be undertaken by examining the following research questions:
RQ1: How do individual managers in Biotechnology organisations conceptualise OI?
Innovation is known to shift the prevailing technologies, products, and services, thus changing how individuals' function within an organisation (Christensen, Suárez, & Utterback, 1996; Spieth, Schneckenberg, & Matzler, 2016).

Given the lack of evidence in investigating the impact on individuals due to OI practices transforming the innovation model in organisations researchers have suggested that future studies should investigate it at an individual level (Burcharth et al. 2012., 2014; Gambardella & Panico 2014; Salter et al. 2012; 2014; Alexy et al. 2013). Recent research has also referred to progressing OI management competencies as vital to successful OI implementation (Klaß, 2020).

Managers responsible or involved in research are required to operate in a different paradigm requiring more acceptance to openness at almost all stages of the innovation process, as well as helping employees make the shift. Similarly, Tranekjer and Knudsen (2012) also talk about how managers responsible for research in organisations have to explain the advantages of openness. Therefore, examining their understanding of what the concept of OI means is imperative for future studies (Burcharth et al., 2012; Witzeman et al., 2006). Previous literature such as Fu(2012) and Gambardella and Panico (2014) has suggested exploring the implications of OI on individuals and how it can be managed. There is call for research on the premise of what entails OI and employee's attitudes towards

it (Burcharth et al., 2014; Salter et al. 2012, 2014; Alexy et al. 2013). A literature review of OI by Hossain and Kauranen (2016) found that there was a need to research the attitude of managers to understand the management of openness. Furthermore, Klaß (2020) has recently also suggested detailed research on OI professionals which would be useful for various fields, such as human resource development, and innovation management. Thus, examining the understanding of the concept of OI was considered a good starting point in order to examine the micro-foundations of OI at an individual level, and as Bogers et al. (2018) point out, managers play an important role in the search in open innovation.

RQ2: What are the perspectives of individual managers on OI?
Recently, Barchi and Greco (2018) have also recommended that future research should focus on managers and key figures of other organisations (research institutions, and public governance), involved in OI collaborations. This study's sample population consists of managers in Biotechnology as well as key figures in industry governance and research institutes in the state of Victoria, Australia. It was considered that their perspective will help managers and key figures in other industries to understand the skills, strategies, and best practices required to enhance OI (Barchi & Greco, 2018).

To develop understanding of OI at a microfoundational level it is imperative to understand "how the interaction of individuals leads to emergent, collective, and organisation-level outcomes" as suggested by Felin et al., 2015, p. 576). Further, the success of OI practices are reliant on the actions and characteristics of individuals operating on the front lines of open innovation" (Salter et al., 2014, p. 78) therefore; a focus on understanding their perspectives is crucial to enhancing our knowledge of management of OI (Bogers et al. 2018).

Managers have to be able to define and manage the boundarylessness for innovation, while ensuring the ability to search for the suitable sources for implementing OI practices and processes (e.g. Du Chatenier, Verstegen, Biemans, Mulder, & Omta, 2010; Podmetina, Soderquist, Petraite, & Teplov, 2018) and at the same time be mindful of industry specific conditions. There is a growing interest in the need to assess OI at a micro-level rather than the organisation (Bogers, Foss, Lyngsie, 2018). Despite studies such as by Ahn et al. (2017) and Rangus and Černe's (2017) there is lack of insight into the individual-level factors at an organisational level (Bogers et al., 2017).

RQ3: What are the implications of OI in Biotechnology organisations; and how these can be managed?
Bogers et al. (2017) demands more research on industry-specific conditions. Specifically, Bogers states that the literature is scant on general OI research that addresses an industry that is subject to distinct characteristics such as biotechnology. Given this, he adds that knowledge of industry particularities can benefit others by exposing the effectiveness of OI in different conditions.

Recent research has called for more investigation into management habits and organisational processes (Klaß, 2020). Organisations involved in OI face issues division of responsibilities and daily

management of tasks (Klaß, 2020). Chapter 3 further addresses the specifics of the biotechnology industry.

In terms of conceptualising OI, some aspects that were focused on based on the literature review were: novelty of the OI concept and whether it substitutes or complements internal R&D. Under the research question focused on understanding the individual level managers' perspectives, a key focus area was to understand the benefits and/ or opportunities that participants associated with OI; the challenges and/ or drawbacks the participants related with OI and; understanding how participants summed up their overall experience of working in an OI environment. Lastly, the third research question was divided into two key areas: one related to organisational level and the other which looks at individual level implications.

Understanding the concept of OI from individual managers who are practitioners and examining their perceptives on OI was considered important by the researcher because viewpoints of individuals directly involved in OI have not been examined first hand by majority of research so far. Examining the micro-foundations of OI from the individual managers' point of view would help to infer the best practices for the management of its implications at an organisational and individual level.

Chapter 3

Research Design and Methodology

The previous chapter set the foundation for understanding the context and identified the research questions from a critical analysis of extant literature on OI. This chapter examines the research design for this study. The chapter begins by identifying the research paradigm. It is followed by an introduction to the qualitative research methodology, a description of the case study approach, and the rationale for its use. Then the reason for focusing on the Biotechnology industry is provided. Next, the chapter focuses on data collection and aspects of sampling technique used. Subsequently, the chapter is structured under the following sections: the case study instrument, data collection process, and data triangulation methods. An in-depth discussion on data analysis techniques is also included. Next, the key issues for the quality of research are discussed through an examination of matters related to validity and reliability as well as, a section on research rigour relevant to this research. Finally, the chapter concludes with an explanation of ethical considerations and limitations of data for this research.

Research Paradigm

A research paradigm is an inclusive system of interrelated practice and thinking that defines the nature of enquiry (Terre Blanche & Durrheim, 1999). Research Paradigm has been defined as the "basic belief system or world view that guides the investigation" (Guba & Lincoln, 1994, p. 105). Different scholars have categorised research paradigms in different ways. For example, Terre Blanche and Durrheim (1999) describe three paradigms: the positivist, interpretive and constructionist, whereas Gephart (1999) categorised research paradigms into positivism, interpretivism and critical postmodernism. On the other hand, Lincoln and Guba (2000) presented two paradigms: constructivism also known as the 'naturalist paradigm' and the 'positivist paradigm'.

Research is considered positivist if it uses or involves formal propositions, quantifiable measures of variables, hypothesis testing, and draws inferences about the phenomena using a representative sample of a population (Orlikowski & Barioudi, 1991). A positivist paradigm forms the basis for quantitative research while interpretivist and constructivist paradigms form the bases of a qualitative approach (Mertens, 2005; Wiersma, 2000). In Sobh and Perry's (2006) view, interpretivism or constructivism is a main alternative to positivism in social sciences. Individuals interpret knowledge and meaning therefore there is "no objective knowledge" as such but "subjective meanings" about how individuals understand, interpret events and settings (Swanson, 2005, p. 18). The focus in interpretive research is to comprehend phenomena through the meanings individuals ascribe to it (Myers, 2013). This research sought to explore individual managers' interpretation of the OI phenomenon based on their experience as well as, their current organisation's innovation practices in order to identify how organisations and individuals can manage implications due to OI.

The interpretivist paradigm allowed the researcher to search for patterns of meaning while describing meanings managers prescribed to OI; their view of its implications and examining the reality of managing it. The nature of knowledge in this paradigm is based on abstract accounts of meanings and organisational members' definitions of circumstances in the natural contexts (Swanson, 2005). Hence, it was considered unsuitable to prescribe a prior framework for this research as meanings and contexts could not be presumed by the researcher (Swanson, 2005). The researcher's intent was to understand the meanings and interpretation of OI as others perceived it, for example individual managers (Creswell, 2013). The emphasis was on understanding and not on establishing causal explanations. By examining the participants' views on OI and its implications the researcher could understand the OI phenomena through the meaning that participants brought to it (Creswell, 2013; Iyamu, 2011). To achieve this, direct observations of empirical evidence was required which led to an inductive approach for this study.

In this approach the process usually starts with observations of particular occurrence in order to find generalisations about the phenomenon being studied (Hyde, 2000). As an inductive approach helps to develop understanding rather than seek explanation it was considered appropriate in order to understand participants' meanings and interpretations of the phenomena under study (Grix, 2010; Landman, 2000). The next few paragraphs provide further detail into the reasoning behind the research approach and paradigm for this study based on this discussion.

The literature review presented in the preceding chapter indicates that to date limited research, on OI in the Biotechnology industry, exists in Australia and especially in Victoria. As discussed previously, majority of literature published on OI being in the European or American context illustrates a need to develop an understanding of this relatively new phenomenon proposed by Henry Chesbrough in 2003 other contexts as well. OI is a "relatively novel" field of investigation where the purpose at the time this research was initiated was to provide a detailed presentation of the phenomenon being studied as suggested by previous research at that time (Chiaroni et al. 2011, p. 37)

Similar to Chiaroni et al.'s (2011, p. 37) research framework this research aspired to "advance theory after the initial definition of the research question with references to extant literature". Since at the time this research was undertaken there were more unknowns regarding OI especially in the Australian context, "hypotheses about specific relationships between levers, phases of the process and dimensions of Open Innovation" was not considered appropriate (Chiaroni et al., 2011, p. 37). Scholars have expressed that in order to achieve a real understanding of the theoretical relevance and practical implications of OI studies need to observe it through qualitative lens so that the subtleties of its practice and adoption can be revealed (Mortara & Minshall, 2011). Some other scholars (discussed in detail in Chapter-2) such as Alexy et al. (2013) and Salter et al. (2012) to name a few also highlight the need for more in-depth explorative studies to understand individual level perspectives of OI.

As the study's aim was to understand the phenomenon of OI from the individual managers' perspectives; the interpretivist paradigm was chosen to guide this research. It was considered that this

would enable an understanding into the reality of the phenomenon as seen by the practitioners of OI. The focus in this paradigm as mentioned in the previous discussion is to develop an understanding rather than seek explanation (Grix, 2010). Participants' description of their reality of OI enabled the researcher in this study to not only gain an insight into their perspectives but also allowed a deeper understanding of their organisation's actions and practices in managing OI (Baxter & Jack, 2008). This allowed the researcher to identify a "pattern of meanings" in order to create and/ or advance theory on OI (Creswell, 2013, p. 9). The interpretivist paradigm follows an inductive approach, which is considered more suitable for studying the empirical evidence for this study (Creswell, 2013; Eisenhardt, 1989).

An inductive approach is also in line with Yin's (2009) reasoning that forms the basis of qualitative study that seeks analytical generalisation because in qualitative methods the aim is not to create a general profile of the sample population but to offer conclusions that explain the specifics of each particular case or situation (Hyde, 2000). The purpose of qualitative research is to expand and generalise theories, not to conclude the likelihood of the occurrence of the phenomenon in the observed population (Hyde, 2000). As qualitative methods are aligned with an inductive approach, they were considered more suitable for this study.

The choice of methods used for the research is usually guided by the paradigm (Guba & Lincoln, 1994). According to Guba and Lincoln (1994) the question about methods is secondary to the question of paradigms; having identified and defined the paradigm used for this research the following discussion will be on the methods used. This section concludes that this research will adopt an interpretivist view and an inductive approach towards answering the research questions. The suitability of the qualitative methodology is further justified in the next section.

Research Methodology

Qualitative Research

Research methodology is used to discover reality. Qualitative research usually starts with general questions that are followed by collecting enormous amount of data and presenting the findings in words (Leedy & Ormrod, 2005). Burns and Grove (2003) describe a qualitative approach as a methodical subjective approach used to define life experiences and situations so as to ascribe meaning. This is achieved through interviews, observations, documents, and visual data analysis. Qualitative research encompasses collecting data in order to understand it in a certain context (Smith, 1987). Therefore, Leedy and Ormrod (1997, p. 105) suggests that qualitative research is a process of inquiry to understand "a social or human problem based on building a complex, holistic picture, formed with words….". That is qualitative research aims for more depth and to gain a greater understanding of life experiences instead of cumulative results (Amber, Adler, Adler & Detzner, 1995). Qualitative research methods enable the researcher to explore the "subjective experiences of organisational life" (Cassell, Symon, Buehring & Johnson, 2006, p. 291). This suggests that qualitative research is context specific and subjective in nature (Whitmore, 2001).

It is evident from the previous discussion on qualitative research it was appropriate for this study as it enabled the researcher to answer questions of meaning, interpretation and socially constructed realities by providing a more holistic picture through exploring subjective experiences of people involved (Newman, Ridenour, Newman & DeMarco, 2003). As one main objective of this study was to advance knowledge of OI from individual level perspective using a qualitative approach provided data that presented a more complete picture, an in-depth account and justifications of processes in its contextual setting (Miles & Huberman, 1994). This in turn allowed the research to maintain a sequential flow that is, understand the relationship between events and consequences in order to derive explanations to understand the OI phenomenon (Miles & Huberman, 1994). This further enabled the researcher to derive inferences about its management. In addition, it is acknowledged that qualitative methods have an extensive history and tradition in the field of business and management research, and have a well-recognised pedigree (Cassell et al., 2006, p. 291).

In order to select the most suitable method Yin (2009) suggests considering the type of research question; that is, whether the research requires control over behavioural events and whether it focuses on contemporary events. In this study the research questions sought to understand "how" individuals (that is, managers) conceptualise, view and use OI, and to explore various aspects of their experience of working in an OI environment to understand the phenomena's implications and management. This did not require control over behavioural events and the focus was primarily on contemporary events.

A key feature of qualitative methods is that they facilitate the description and presentation of a phenomenon as it is experienced by the participants (Ritchie, 2003). This enables a deeper understanding of issues as understood by the people experiencing them (Ritchie, 2003). This type of qualitative research has been termed as descriptive or exploratory by Marshall and Rossman (1999) and contextual by Ritchie (2003). The purpose of this type of research is to explore and describe the study population's "understanding and interpretations" of phenomena in order to capture its intrinsic nature (Ritchie, 2003, p. 40). On close examination it was found that the explanation by Ritchie (2003) of contextual or descriptive or exploratory qualitative research fits aptly with the aims and research questions of this study.

Case Study

Case study methodology is useful to provide a basis to apply solutions to situations, to explore, or to describe a phenomenon (Yin, 2009). This can be achieved by using different types of case studies based on the research aims as explained by Yin (2009). An exploratory case study is aimed to gain a better understanding of a phenomenon's nature, as well as, its problems. As the aim of this study was to understand the nature and implications associated with the OI phenomenon which to date is only sparsely explored in the Australian context, it is exploratory in nature.

Case study methodology allows the researcher to maintain a holistic context of real-life events (Yin, 2009). It is known to be useful where contextual conditions and events are significant to the research

aim (Yin, 2009). This aligns with the research aim and questions for this study. Furthermore, it has been acknowledged that the complexity of managing and organising OI calls for in-depth case studies (Carlsson & Corvello, 2011). In addition, Vanhaverbeke et al.'s (2008) suggestion for the need for studies that transform OI from an abstract concept to a concept managers can related to highlights the need to understand OI in its real-life practice-based context from the managerial point of view. Overall, based on the literature reviewed for this study a qualitative case study approach emerged as the suitable choice. The next section further argues the appropriateness of case study research method discussing the strengths and criticisms associated with it.

Gillham (2000, p. 1) defines the word 'case' as, "a unit of human activity embedded in the real world; which can only be studied or understood in context; which exists in the here and now; that merges in with its context so that precise boundaries are difficult to draw". Yin (2009, p. 18) defines the case study research method "as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used". These definitions illustrate that a case study method allows for a thorough examination of the phenomenon and leads to a greater understanding of how the process and/or behaviour are effected by and impact the context (Hartley, 2004). This is relevant to the aim and research questions for this study. Moreover, case study research method is considered useful for studying phenomenon where research and theory are in the preliminary developmental phase (Benbasat, Goldstein & Mead, 1987). Given the lack of research on OI from an individual level perspective in Australia, the case study research method was considered appropriate for this study.

It needs to be noted here that the case study method has received criticism due to the higher possibility of research bias, lack of replication and generalisation of findings, and huge amount of data that it generates which can make it difficult to manage (Blaikie, 2000). How these challenges of case study research are addressed in this study is elaborated later under the section on 'Quality of research: design tests'. Despite the criticism, case studies have received support from Blaikie (2002), Creswell (2013), Dooley (2002), Eisenhardt (1989), Maxwell (2013), and Yin (1994, 2003) for exploratory studies and are frequently used in management research (Rowley, 2002; Yin, 2003). The advantages and relevance of the case study method for this research is discussed next.

Case study research is considered useful in theory development as well as, for in-depth exploration (Eisenhardt, 1989; Miles & Huberman, 1994; Yin, 2009). This is because the case study is not a representation of a sample as the objective is to extend and "generalise theories (analytical generalisation) and not to enumerate frequencies (statistical generalisation)" (Yin, 2009, p.15). Therefore, researchers from many disciplines use the case study method to build on theory, to produce new theory, to challenge theory, and to explain a situation (Eisenhardt, 1989; Miles & Huberman, 1994). Moreover, theory developed from using case studies is considered to possess "novelty, testability, and empirical validity" (Eisenhardt, 1989, p. 548).

One recognised strength of case study research is the ability to include multiple sources and techniques of data collection and analysis (Dooley, 2002; Yin 2009). Therefore, data collection tools in case study can vary from surveys to interviews, to document analysis and observation to questionnaires as well (Dooley, 2002). Case studies adopt an interpretive approach to data and examine the area of study within the context while considering the subjective meanings that the participants bring to the situation (De Vaus, 2001). The results from a case study can be related to real events and experiences that facilitate a deeper understanding of complex real-life situation and enhances theory (Dooley, 2002). Thus, case study method is known for its relevance to real life by examining contemporary, human situations (Dooley, 2002).

According to Yin (2009) research design is the rationality that associates the data collected and the inferences reached to the preliminary questions of research. Therefore, first and foremost the research questions have to be determined and defined. As mentioned by Dooley (2002) and Yin (2009), to determine and define the research questions it is first important to establish the aim of the research which is based on the literature review. The aim of this research is:

- To understand the micro-foundations of open innovation and its implications from individual managers' perspective in Biotechnology organisations; and to explore how organisations and individuals can manage these implications.

Yin (2009) advocates that the research questions should be derived from the literature review. As a result of the comprehensive literature review conducted (presented in chapter 2) the research questions are:

- How do individual managers in Biotechnology organisations conceptualise OI?
- What are the perspectives of individual managers on OI?
- What are the implications of OI in Biotechnology organisations; and how these can be managed?

Next, a brief insight is provided into the reasons for the focus on the biotechnology industry in Victoria, Australia.

The Biotechnology Industry

Biotechnology emerged in the late 1970s; it was a dramatic change in the technological environment of pharmaceutical organisations (Pisano, 1990). Since biotechnology requires skills different from those typically required for pharmaceutical organisations Pisano (1990) argues that it is viewed as competence destroying on the R&D end. Therefore, established pharmaceutical companies used new ventures to conduct commercial biotechnology. This required collaboration between the established pharmaceutical organisations and the new biotechnology firm to create a win-win situation. Through this collaboration, the pharmaceutical companies gained the distinctive R&D offered by the biotechnology companies while the biotechnology companies received a way to commercialise their products (Pisano, 1990). In the bio-pharmaceutical industry, exploitation of external knowledge starts earlier than the pre-clinical tests (Enkel et al., 2009). These efforts may involve including knowledge brokers and cultivating technology network relationships, conducting an evaluation of the technology

for negotiation purposes and integrating exploitation efforts as part of corporate strategy (Enkel et al., 2009). These efforts are aimed at improving the organisation's innovation returns and securing greater organisational learning benefits (Enkel et al., 2009).

Biotechnology was defined in 2002 by the OECD as, "the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services" (van Beuzekom & Arundel, 2009, p. 9). Internationally, Australia is known for its R&D aimed at promoting research strength in the biosciences and biotechnology (Gillespie, Privitera & Gaspero, 2019).

A review by Gillespie et al. (2019) highlights that traditional propriety, non-collaborative biotechnology firms are increasingly using principles, processes, and structures of OI to improve R&D usefulness and productivity. Schuhmacher, Germann, Trill and Gassmann (2013) observed that companies are moving their business models towards drug strategy that are more collaborative.

Research undertaken by Paul et al. (2010), Munos (2009, 2016) and Shaw (2017) has suggested that traditional R&D models have been criticised for being costly, lacking efficiency and transparency, thus, creating the need for new strategies. Further there has been a lopsided relationship between the contributions made (e.g., funding, lab space, researchers, scientific knowledge) and results (e.g., new biological entities, new molecular entities) (Bowen & Casadevall, 2015). These issues have led drug development companies to focus on strategies based on collaboration, communication, and network oriented scientific development (Gillespie et al., 2019).

An increasing number of biotechnology companies are using collaborative approaches and knowledge sharing (Gillespie et al., 2019). According to Almirall and Wareham (2008), OI is the managerial answer to the trend emerging in major technology organisations such as Boeing, General Electric, IBM, Intel, Microsoft, Philips, and Siemens that are shifting their important R&D operations offshore. OI was also found to be beneficial for innovative performance by Parida, Westerberg and Frishammar (2011). OI is helping high-technology and R&D intensive organisations like Eli Lilly and Procter & Gamble to find solutions to their high-technology problems in a virtual community of over 50,000 scientists (Allio, 2004).

Hughes and Wareham's (2010, p. 325) assertion that "OI is an established phenomenon in Pharma, and a rich setting for research, despite limited studies in this industry" is significant for this study on OI in regards to the Australian biotechnology industry. Given this, the research sample consists of participants from the Biotechnology industry.

Australia is recognised as a growing knowledge economy (Yigitcanlar, O'Connor & Westerman, 2008). This nation has seen a rise in the knowledge industry as well as increase in revenue from these industries (Frederick, Beattie & McIlroy, 1999). An important reason for selecting the high technology market in Australia is that it is well represented here. As in the case of the biotechnology industry, Australia is home to around 527 biotechnology companies (OECD, 2011).

In 2010, the Australian Government committed $38.2 million over four years to the National Enabling Technologies Strategy for the responsible development of enabling technologies. The aforementioned facts highlight the importance of studying high-technology sectors such as ICT and biotechnology in Australia. Subsequently, it is essential to understand the importance of studying the high-technology sector in Australia with specific focus on Victoria.

Victoria leads the Australian technology and telecom industry with more than 8,000 companies generating around $30 billion in revenue, and accounting for 29% of national ICT revenue and employment (Invest Victoria, 2013). Eight of Australia's top ten spenders on R&D are located in Victoria (Mohannak, 2007). Furthermore, in accordance with its Technology Plan (cited in the Australian Innovation System Report, 2012) the Victorian Government committed $150 million to the development of technology in the high-technology sector.

Literature suggests that the importance of the biotechnology (along with nanotechnology) for the future is considerable (Arundel, 2011). This sector can have an evident effect on the Australian economy through direct employment up to 2025 (Arundel, 2011). OECD (2009 cited in Arundel 2011) data shows that biotechnology could be used in applications that account for nearly 2.7% of the GDP of developed countries. According to Arundel (2011) biotechnology is significant for Australia due to the fact that it has applications (for example, agriculture, forestry, fishing, food processing, pharmaceuticals etc.) in sectors that lead to nearly 9% of the economy.

Additionally, the BioMelbourne Network (that is "a regional industry association for the biotech sector (BioMelbourne Network, Annual report, 2013, p. 5)) states that "Victoria leads Australia's biotechnology research and development sector…". Some noteworthy facts mentioned about the Victorian biotech industry in the BioMelbourne annual report 2013 (p.7) are as follows: "Approximately 260 operational life science companies are based in Victoria with a market capitalisation over $30b (Blake Industry & Market Analysis Pty Ltd December 2012) and $657 million invested into the Life Sciences sector in FY2012….Victorian companies generated total revenue of $8.2billion, and increase of 7.6% on the previous year." It further mentions that in June 2013 Scientific American World View scored Australia in the seventh place. It states that since Melbourne "has the largest biotech cluster supported by the largest medical research cluster in the country it's reasonable to draw the conclusion that Australia's strength in biotechnology is to a large degree drawn from the state of Victoria".

Furthermore, there is a growing interest in the need to assess OI at a micro-level rather than the organisation (Bogers et al., 2018). Despite studies such as by Ahn et al. (2017) and Rangus and Černe's (2017) there is lack of insight into the individual-level factors at an organisational level (Bogers et al., 2017). Given all of this, the biotechnology industry was considered appropriate and in order to understand the microfoundations the focus on the individual level perspective at the firm level using the case study approach was deemed to be critical to advance knowledge.

It is important to define the boundaries of the case study by defining the appropriate social setting, organisation, or location (Yin, 2009). This study examined OI from the perspectives of managers in the Biotechnology industry in one state that is, Victoria in Australia (due to the scope of the study) to learn

about the phenomenon. The relevance of this group and significance of this study to Australia has already been discussed in the introduction chapter.

Based on the paradigm and research questions a qualitative case study method was deemed suitable for the study. In the upcoming section, the chapter will identify and explain the research methods for data collection and analysis.

In accordance with the case study approach this study used various data sources such as interviews, corporate websites, annual reports, industry literature, and media reports. Using multiple sources of data helps to avoid bias and improves research rigour. For this study multiple level of data analysis was conducted as it allowed identifying similarities and differences across the data. This is known to improve the validity and reliability of the findings (Miles & Huberman, 1994).

One aspect of research design that is, the link between research questions and research approach, has already been discussed. The other significant aspect mentioned by Yin (2009) is data collection. The details of data collection for this study are discussed next.

Data Collection

Yin (2009) has suggested that a case study database should be planned before the data collection process starts and is maintained throughout. According to Darke et al. (1998) as well case study data needs to be documented and organised as it is collected. For this research, a case study database was created and maintained that was a central repository of the evidence collected so that other investigators (that is, supervisors) were able to review the evidence on a regular basis (Yin, 2009). The case study database is discussed under the section on research rigour. The following section discusses aspects related to data collection such as sampling technique, criteria, access and size.

Sampling Technique

It is important to select the sample carefully and describe the sampling strategies because sample selection has a significant impact on the quality of the research (Coyne, 1997). Although in comparison to quantitative studies sampling techniques in qualitative research are not as strictly set, purposeful sampling is recommended in case study research to maximise the learning (Audet & d'Amboise, 2001; Coyne, 1997). It is also known as criterion based or purposive sampling (Patton, 2002). For this research the term purposive sampling is used and is discussed next.

For this research selecting individuals and settings that could contribute to answering the research questions was an important consideration (Maxwell, 2013). Purposive sampling is focused on identifying "information-rich cases" that allow the researcher to learn in-depth about matters that are key to the aims of the research (Patton, 1990, p. 169). This is supported by Maxwell (2013) as well who advocates that in purposive sampling the researcher intentionally selects specific settings, persons, or activities that will add valuable information relevant to the research questions and goals. The sample is

selected based on particular features or characteristics that will allow in-depth exploration and understanding of the central themes that are significant to the research (Ritchie, Lewis & Elam, 2013). For this study this was of relevance hence finding companies that illustrated using OI practices or indicated using practices related to OI in some form or another, as well as, finding participants with specific experiences and roles that were involved in the phenomenon or innovation management was crucial to achieving the research aims.

In qualitative sampling selection of cases should either be based on literal replication that predicts similar results or theoretical replication that it, predicts contrasting results (Eisenhardt, 1989; Yin, 2009). This indicates that sampling is an ongoing process and is closely connected to the progress of the research (Fossey, Harvey, McDermott & Davidson, 2002). In purposive sampling, case selection is based on replication logic and not on generalisation of results (Audet & d'Amboise, 2001). Further, purposive sampling increases the representation of diverse points of view about the research questions (Fossey et al., 2002). This challenges the researcher's perspective and reduces bias (Fossey et al., 2002).

One goal of purposive sampling is that it adequately captures the heterogeneity in the population (Maxwell, 2013). This is achieved by defining the dimensions of variation in the population that is of relevance to the study and by selecting individuals or settings that represent these variations. In order to capture the heterogeneity of the population, this study used virtual, small as well as, medium sized Biotechnology firms that are engaged in a variety of aspects from drug development to diagnostics to exploring the diverse use of their platform technology. This sampling technique ensured that the conclusions would not only adequately represent the range of variation but also, allow for literal and theoretical replication (Maxwell, 2013; Yin, 2009).

Furthermore, Maxwell (2013) suggested selecting participants who not only help answer the research questions but with whom the researcher can establish the most productive relationships. This is to ensure that the best data is secured for the study. To determine the most appropriate participants who could answer the research questions, a preliminary examination of the information contained on the company's websites was undertaken to determine if the participating organisations used OI practices in the form of knowledge inflows and outflows or collaboration practices for innovation in some form or another. The participating Biotechnology organisations mostly indicated either on their website or via correspondence that they engaged in collaboration for innovation. Except for one organisation B3 that listed a number of strategic partnerships on the website however, at the time of interview it was discovered that the company had changed its strategy. As mentioned earlier in this section this was considered as part of theoretical replication to explore a contrast and present a diverse view on the research questions. In addition, industry experts and professionals from a Contract Research Organisations (CROs), a premier Research Institute (RI) and an Industry Body (IB) with experience and insight into the Biotechnology industry in Australia were selected and interviewed for data triangulation. This population due to their interaction with the Biotechnology firms offered a different perspective of

OI in the industry. It helped capture the heterogeneity as well offered comparisons. This selection helped meet the goal of the principles of purposive sampling as mentioned by Maxwell (2013).

Additionally, this study took into account the feasibility of access and data collection, validity and ethics in its selection decisions (Maxwell, 2013). Purposive sampling was considered most appropriate method for this research as it allowed for the selection of interviewees to be based on specific themes and appropriateness to the research aim.

Sample Criteria

In purposive sampling participants are selected with a purpose in order to characterise a setting in the context of a key criterion (Ritchie et al. 2013). For this research the purposeful selection criteria were based on the review of relevant literature, research questions that determined the nature of organisations to be explored and whose views in the organisation need to be explored (Ritchie et al., 2013). Since this research examines individual manager's perspectives on OI in the Biotechnology industry the sample chosen to present a detailed picture of the phenomenon (Ritchie et al., 2013). This is represented by individuals who understand the organisation's R&D and who have been identified by the organisation as being knowledgeable in terms of its OI practices and activities. The sample comprised of mostly senior managers in Biotechnology industry who were in charge of innovation, cooperation, IP and R&D. An overview of the key criteria considered while selecting participants is presented below.

Sample Criteria:

- Industry: Biotechnology;
- Company characteristics: part of the Biotechnology industry, active in R&D, uses or has used partnerships and collaborations for innovation and R&D;
- Participant characteristics: management of innovation, involvement in collaboration for innovation, and/ or R&D, an interest in the research aim and willingness to participate in this research.

Sample Size

In a qualitative study there are no guidelines to determine the size of the sample. This is primarily due to the fact that the sample size does not impact the significance or quality of the research study (Holloway & Wheeler, 2002, p.128). It has been suggested that sampling continues until saturation has been achieved, that is, no new information is generated (Holloway, 1997, p.142). This is a repeated theme highlighted by various scholars as discussed next.

Theoretical saturation is the point when incremental learning is small due to prior observation of the phenomena (Eisenhardt, 1989; Miles & Huberman, 1994). This approach corresponds with the use of purposive sampling where sample size is often determined on the basis of theoretical saturation (Ulin, Robinson & Tolley, 2004). Lincoln and Guba (1985) also talk about saturation of categories that is when the knowledge gathered is not substantial in comparison to the effort expended. Hence for the purpose of this study the sample size was an outcome of the guidelines for theoretical saturation.

It has been acknowledged in literature that the premise of qualitative data is the richness of information and not the size of the sample (Patton, 1990). The aim of case study research is to understand deeply a particular subject in its real life setting and not to make statements about the cases to a larger population (Farquhar, 2012). Therefore, the data for this study was collected based on the considerations of theoretical saturation that is recommended for qualitative case studies. This led to participation by eight Biotechnology organisations. A total of twenty interviews were conducted with ten participants from the Biotechnology organisations. In addition, for triangulation six interviews with five participants from three Biotechnology industry organisations that are, a CRO, a premier RI and an IB for Biotechnology in Australia were conducted.

It has been recognised in literature that in case of qualitative research a large sample size might not necessarily lead to more enriched data (Crouch & McKenzie 2006; Sandelowski, 1993). This is supported by Guest, Bunce and Johnson (2006) who found that in their study seventy-five percent of the codes were derived from the analysis of the first six interviews and saturation was reached after twelve interviews. These further supports following the principles of theoretical saturation.

Additional sources of data were used to corroborate the findings from the interviews. These secondary data sources were- printed material collected from participants' office (such as brochures, booklets), observations made during interviews, corporate websites, annual reports, media reports and industry literature.

Access to the Sample

Names and contact details of Biotechnology organisations were obtained from the Australian Government and Victorian Government websites. The Victorian Biotechnology Advisory Council sits within the Department of State Development, Business and Innovation (DSDBI); the names of member Biotechnology organisations are publicly available on the website.

An email with an invitation to participate along with participant information sheet (Appendix 3.1A & 3.1B) was sent to either the Chief Executive Officer (CEO) or the Chief Scientific Officer (CSO) in each organisation. Final selection of participating organisations was based on their relevance to the research, sampling criteria and accessibility.

Overview of the Sample

The table below represents the sample Biotechnology organisations that participated in this study.
Due to confidentiality the names of organisations are not mentioned. The organisations are referred to as B1 to B8.

Case number	Number of employees	Organisation Type	Internal R&D	ASX Listed	Interviewee/s position
B1	7	Virtual	No	No	CEO
B2	9	Small	Yes	Yes	Senior Director Operations And Senior Director Business Development
B3	24	Small	Yes	No	Managing Director
B4	40	Small	Yes	Yes	CSO
B5	110	Medium	Yes	Yes	Vice President, Research Operations
B6	19	Small	Yes	Yes	Commercial Director and IP Manager
B7	4	Virtual	No	NO	CEO/ CSO
B8	75	Medium	No	Yes plus NASDAQ	Scientific Director

Table 2. Overview of sample Biotechnology firms

Note: Size is based on Frascati Manual (para. 183). Small firms are defined as those with *fewer than 50 employees* and medium-sized firms as those with *50-249 employees*. Source: OECD (2002), Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development, OECD, Paris, www.oecd.org/sti/frascatimanual.

Case Study Instrument

To increase the reliability of the case study research a case study protocol was developed consisting of the instrument, procedures and general guidelines to be followed throughout the study. This was used as an outline and checklist to guide the researcher (Appendix 3.2). Also, an interview guide was designed with interview themes and questions relating to the research questions defined through the literature review.

The aim of any qualitative research interview is to view the research subject from the standpoint of the interviewee and to comprehend how and why it was arrived at (King, 2004). Therefore, formulating good interview questions is not just a process of logically transforming the research questions but requires creativity and insight (Maxwell, 2013). The interview questions for this study were developed keeping in mind that the questions are not contrived to evoke particular responses but to enable participants to bring their knowledge on the questions that might not even have been anticipated by the researcher (Maxwell, 2013).

Semi-structured interviews can be based on a set of pre-defined open-ended questions while allowing other questions to emerge from the discourse between the participant and the researcher (DiCicco-Bloom & Crabtree, 2006). Semi-structured interviews are known to facilitate a better exploration of the research questions (Fossey et al., 2002). As this style of interview allows for flexibility, a more conversational manner as well as, gives the researcher the opportunity to follow up on specific issues as they emerge it was considered appropriate for this study (Fossey et al., 2002). Using this style allowed participants to express their perspectives freely in their own words without interference from the researcher. This method enabled a deeper understanding of the OI phenomenon and the way it operates in organisations.

The Interview Guide

Patton (2002) suggests different types of open-ended interviews as basic approaches to collecting qualitative data: the informal conversational interview and the general interview guide approach. The key difference between these approaches lies in the purpose and the extent to which the questions are formulated before the interview occurs. The informal conversational style of interview has no structure and is time consuming thus it was considered unsuitable for this study.

In the case of the qualitative research interview an interview guide is used instead of a formal list of questions which are pre-determined and asked verbatim (King, 2004). The interview guide for the qualitative research interviews contains topics and suggests probes that can be used to gather more information from the participants. These can be modified based on what emerges during the interview.

A general interview guide approach ensures that the same basic line of inquiry is pursued with every participant (Patton, 2002). In this case the interview guide has a set of issues defined before the interview, allowing for discussion to explore unconsidered topics that may arise during the actual interview. Therefore, these interviews are a “co-elaborated act on the part of both parties” not a gathering of information by the researcher (Miles & Huberman, 1994, p. 8). This approach was found to correspond well with the semi-structured style of interview questions discussed earlier making it appropriate for this research.

This study employed the general interview guide approach to ensure that the same basic line of inquiry was pursued with each participant. Following the interview guide also helped in analysis and comparison across the data later. Also, this style did not limit the exploration of issues while maintaining a systematic and comprehensive approach to make the best use of time available with the participants.

The questions for the interview guide were structured around the key themes identified from literature review that formed the basis of the research questions. Interview guide was designed so as to ensure that the interviews lasted no longer than sixty minutes. In order to follow the most rewarding form of inquiry to obtain the maximum from time with each interviewee the interview protocol was not necessarily followed (King, 2004). However, the focus was to follow similar lines of inquiry; therefore, the researcher aimed to cover all the themes with each participant as suggested by Patton (2002).

Furthermore, it was considered essential to use similar questions and words for each interview in order to ensure an appropriate level of structure for compatibility and comparison across data later (Bryman & Bell, 2011).

Data Collection Process

The study was based in Victoria (Australia); all participants were selected from this state based on the sample criteria mentioned in the previous section. The initial contact with the companies was first established in May 2014 through formal email invitation letter and followed up with participant information to the consenting companies. Primary interviews were held between July and November 2014 and lasted up to 60 minutes approximately. All interviews were voice recorded with the consent of the interviewee. Most interviews were held at the participating organisation's office. This provided the researcher an opportunity to observe the R&D facilities of the organisations if they had a R&D facility in-house. Data was collected from the participant as well as, from printed material (such as brochures, booklets, and so forth) from the office. Follow-up interviews were conducted either via phone and/ or in-person whatever was preferred by the participant. As suggested by Creswell (2002) in cases where further information or clarification was required (about the content of the interview or information made available) follow-up communication via email or over the telephone with the interviewees was undertaken. In addition, other sources of data were sought and collected (if available) such as relevant information from company website, annual report, brochures and pamphlets, industry report, media releases, observation and field notes, as well as, company documents and presentation (if any) shared by the participant/s. Additionally, to triangulate six interviews were conducted in three industry organisations as mentioned earlier. Table 3 presents a table of the data collected for each case. This is available on the following page.

Organisation	Participant/s	Data collected
B1	P1	Interviews, corporate website information, company documents and presentation shared by participant, observation and field notes.
B2	P2A & P2B	Interviews, corporate website information, annual report, brochures and pamphlets, industry report, media releases, observation and field notes.
B3	P3	Interviews, corporate website information, brochures and pamphlets, observation and field notes.
B4	P4	Interviews, corporate website information, annual report, brochures and pamphlets, industry report, media releases, observation and field notes.
B5	P5	Interviews, corporate website information, annual report, brochures and pamphlets, industry report, media releases, observation and field notes.
B6	P6A & P6B	Interviews with each participant, corporate website information, annual report, brochures and pamphlets, industry report, media releases, observation and field notes.
B7	P7	Interviews, corporate website information, company documents and presentation shared by participant, media releases, observation and field notes.
B8	P8	Interviews, corporate website information, annual report, brochures and pamphlets, industry report, media releases, observation and field notes.

Table 3: Data collected

Data Triangulation

Research questions define what the researcher wants to understand, whereas interview questions are what helps to develop that understanding (Maxwell, 2013). In case study research interview questions are at the heart of this method where the purpose they serve is to keep the researcher focused and on track (Yin, 2009). However, Yin (2009, p. 108) does ask the researcher to be aware that interviews are verbal reports and this can lead to problems related to “bias, poor recall and poor or inaccurate articulation”. This is why corroborating interview data with two other sources of data is crucial (Yin, 2009). This is known as triangulation, which involves using various methods and/ or sources to confirm the integrity of interpretations and conclusions derived from the data (Ritchie, 2003).

The use of multiple sources of data expands the range of issues that can be addressed (Yin, 2009). For case studies Yin (2009) suggests six sources of evidence including: documentation, archival records, interviews, direct observations, participant observation and physical artefacts. Use of various sources of data is known to be a major advantage of using the case study method (Yin, 2009). Triangulation involves looking for the converging lines of inquiry that corroborate the same finding and/ or conclusion to make the results more convincing (Yin, 2009).

This study used different data sources as a check to identify if the same conclusions are supported (Maxwell, 2013). This reduced the risk of biases and increased the understanding of various aspects of the phenomena studied, that is, OI (Maxwell, 2013). It has been suggested that qualitative researchers

consider using informal data-gathering approaches that are viable as long as it is ethical to include (Maxwell, 2013). This approach was adopted when collecting data for this study.

In the study by Buganza and Verganti (2009) on OI that used a qualitative approach with theoretical replication, the data were collected using a data-gathering method that triangulated primary data sources, that is, the interviews, with secondary data sources such as annual reports, corporate web sites, media reports and industry literature. Likewise, for this research which is based on a similar approach, these sources of secondary data for triangulation were primarily used as well as, observation and collection of printed material from company offices where feasible. The annual reports for five companies (B2, B4, B5, B6 and B8) were downloaded between August and October of 2015. Subsequently, these reports were thoroughly analysed and relevant information used to corroborate data from the interviews. In some cases, such as: B1, B3 and B7 where no annual reports were available, a request was made to the participants to share additional company documents and information. The information provided is included as part of the case itself. B3 did not respond to the researcher's request for more information however, other publicly available sources were used to gather more information about the company. In addition, interviews with participants from the Biotechnology industry (RI1, IB1 & CRO1) form part of the triangulation process (Table 4).

Organisation	Organisation Type	Interviewee/s Position	Participant	Data collected
RI1	Research Institute (RI)	Director of Commercialisation and Lead Scientist, Biotechnology	RIP1 & RIP2	Interviews, corporate website information, company documents and presentation shared by ROP2, observation and field notes.
IB1	Industry Body (IB)	CEO	IBP1	Interviews, corporate website information, company documents and presentation shared by participant, observation and field notes.
CRO1	Contract Research Organisation (CRO)	Co-founder/ Chief Scientific Officer and Co-founder/ Chief Commercial	CRP1 & CRP2	Interviews with each participant, corporate website information, company documents and presentation shared by participant, observation and field notes.

Table 4: Triangulation Data

For the purpose of triangulation, the themes of the interview questions were maintained and the same interview guide was used. As the participants were not a Biotechnology company, but nonetheless were part of the Biotechnology industry the questions were slightly modified; for example, instead of asking: "Does your organisation make a practice of bringing in external know-how and/ or technology? What kind of know-how and technology?" the participants were asked, "What kind of know-how and/ or technology do the Biotechnology firms seek from your organisation?" or in case of IB1 "What kind of external know-how and/ or technology do Biotechnology firms usually use or approach external partners for?". Another example, instead of asking, "What kind of changes took place due to OI on aspects related to reward systems, career paths and role, responsibilities and skills for their R&D staff in the organisation?" participants were asked, if in their opinion the nature of R&D has changed due to an OI

approach in the industry and if yes, in what way and how these changes impacted the career paths, roles, responsibilities and skills of scientists within the Biotechnology industry. Hence, the key themes and the core areas covered by the interview question remained the same with just a slight variation in the language to suit the audience. Moreover, the interviews were of the same duration and same protocol was followed in all aspects of data collection and analysis. The data analysis procedures and strategies used for this study are discussed next.

Data Analysis

Data analysis should be treated as part of the research design in a qualitative study; this is because how the analysis is done is informed by the rest of the design (Maxwell, 2013). Data analysis in qualitative research should be conducted simultaneously as the data is collected (Coffey & Atkinson, 1996). In this research study, data analysis began immediately after the first interview was completed and it continued as the study progressed (Maxwell, 2013).

In this study, interview data formed majority of the data collected therefore; as recommended by Kvale and Brinkmann (2009, p. 190), the analysis of interviews was maintained as an on-going process from "the preparation of the interview guide, the interview process, and the transcription of the interviews". For analysing the data, the process followed included first re-organising each transcript and undertaking appropriate data reduction. This was based on Miles and Huberman's (1994) recommendation that a part of the analysis involves analytical choices of which data is most relevant. Further, Patton (1980) has also suggested that for the purpose of presenting a complete but manageable case record "information is edited, redundancies are sorted out, parts are fitted together, and the case record is organised for ready access"' (p. 313). For the purpose of this study, data were primarily analysed for their relevance to the research questions. Additionally, some participant responses were moved or relocated to section/s that were a more appropriate fit. This is because as interview data were based on semi-structured interviews, in some cases participants provided relevant information at an earlier stage on questions that were asked later or provided more information later in the interview on earlier questions.

Next, information from the interviews was organised based on the list of themes presented in figure-4. These themes emerged from the research questions (based on the literature reviewed), and formed the foundation for the key themes that defined the interview questions. Hence, data from each interview was first re-organised and divided under the following themes to ensure direct correspondence with the research questions.

- Background information and organisation profile
- Conceptualising Open Innovation
    - Open Innovation description and definition
- Perspectives on OI
    - Benefits of OI
    - Challenges of OI
- Organisational implications of OI
    - Planning and Preparing for OI
        - Finding partners
        - Evaluation and selection of partners
    - OI Practices and Management
        - Different forms of OI practices
        - Management of OI
- Individual level Implication of OI
    - Reward systems
    - Career paths of scientists
    - Role, responsibilities and skills

Figure 5, Themes for analysis

Coding

Coding was undertaken after the initial data reduction and organisation according to the key themes listed above. A code in qualitative research is understood to be "a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/ or evocative attribute for a portion of language-based or visual data" (Saldaña, 2009, p. 3). In this study, the interview transcriptions were examined to identify the initial set of codes and then studied to determine any emerging meaningful patterns (Yin, 2009).

The first cycle coding method used was open coding. This type of coding is also referred to as initial coding (Charmaz, 2006; Saldaña, 2009). It is considered appropriate for interview transcripts especially for beginning qualitative researchers. Also, it is suggested by Saldaña (2009) as compatible with thematic analysis. Open Coding for this study involved systematic analysis of interview data transcripts word-by-word, line-by-line and/ or sentence-by-sentence (Charmaz, 2006). The interview responses were coded according to the points significant to addressing research questions (Allan, 2003). Here the codes were derived from the data and are not predetermined (Carson, Gilmore, Perry & Gronhaugh, 2001). This was in accordance with Saldaña's (2009) suggestion that Initial Coding is without "necessarily a specific formulaic method". To illustrate how the first cycle coding was conducted an example of how the researcher undertook initial/ open coding of the data is presented next. Under the first research question theme 'Conceptualising OI, the interview question theme was 'OI description and definition'. Examples of how open coding was undertaken is shown below, to illustrate brief extracts (quoted exactly) from two interviews.

Defining Open Innovation participant's response:

I mean, I certainly know what innovation is. I mean, I know what collaboration is…the reason small companies like ours can exist is because of this (**Overcoming size constraint**) sort of more of a confederate type of collaborative approach (**Collaboration**)…. Biotech…It's a very complex process, so it takes a lot of different types of inputs (**Diverse expertise required**)

When asked to further specify his understanding of Open innovation participant says:

"…I would say it's essential.…Yeah, I'm breathing and that's positive, but also—look, it's essential I think" (**Essential**).

Figure 6- Example Open Coding Interview#1 with P1 from B1

Oh, open innovation to me is one of, I guess, two things really, or three things. It's looking for skill-sets that are outside of your organisation that you either don't have internally, or you don't have the equipment or capacity to do yourself, or you don't have the time to do it yourself (**Overcoming Resource constraint**). So probably either of those three things are our legitimate reason why we go outside. I mean, going outside comes with risks of cost, and time, and quality control (**Risky**). And investment, emotional investment…but you've got absolutely no choice but to do it **(Necessary**). So when you acknowledge that you don't have the expertise in-house, you can either spend, I don't know, one year, two years, three years training people up to have that level of expertise, or you just go out to the people who have it **(Fast solutions**). And so that's always the preference because you're not wasting time. And when you're wasting time in a biotech, you're wasting money (**Risks vs benefits**). So you've got to move as fast as you can, and moving as fast as you can means going to external expertise when you don't have it yourself.…(**Fulfils business need).** In research you absolutely hit a point when you go, 'Oh gee, I don't quite have the expertise there.' (**Nature of research**) **(Diverse expertise required**). And you'll go to a conference, and you'll see – which has happened to me. I go to a conference, and I see X talking, and he's done exactly what I'm trying to do. So I go and talk to him, and before you know it I do a two-year collaboration with him because he says, (**Collaboration**) 'Oh yeah, I do all that. That's what I do for a living. Here, have my stuff. Fix it.' **(Fixing knowledge gap**)

Figure 7- Example Open Coding Interview#1 with P4 from B4

As illustrated in the examples above, when a concept or idea or event relevant to the research question theme and subsequent interview question emerged it was assigned a code or a name to represent it. Hence a code was an abstract representation of a significant idea or event or narrative that was highlighted in the interview (Miles & Huberman, 1994; Saldaña, 2009). This process was conducted for each interview transcript and assigned codes were then analysed for similarity or distinctiveness.

Next, pattern coding was undertaken to identify an emerging theme or derive an explanation. As suggested by Miles and Huberman (1994, p. 69) "pattern coding is a way of grouping…summaries into a smaller number of sets, themes or constructs." It is considered compatible with thematic analysis

(Saldaña, 2009). This coding was considered appropriate for second cycle of coding after initial coding and for development of major themes from the data (Miles & Huberman, 1994). Pattern codes are known to combine “a lot of material into a more a more meaningful and parsimonious unit of analysis” (Miles & Huberman, 1994, p. 69). These codes helped to identify causes and explanations in the data that was useful for this study to achieve the research objective.

The way pattern coding was conducted was as recommended by Saldaña (2009); the first cycle codes were assessed for their commonality and a pattern code was assigned. This pattern code was then used to develop a statement that described a major theme from the data (Saldaña, 2009). A brief example of this is (using the same interview extracts quoted in Figure 5 & 6) presented in Figure-7.

RQ theme	**Interview Question/s theme**	**Interview with P1, Initial/ Open Coding**	**Interview with P4, Initial/ Open Coding**	**Pattern Coding/ Emerging theme**
Conceptualising OI	**Defining and/ or Describing OI and understanding factors that led to the description**	Overcoming size constraint	Overcoming resource constraint	Influenced by company factors (such as: size and resource constraint)
			- Fulfils business need - Fast solutions - Fixing knowledge gap	Problem solving
		Collaboration	Collaboration	Collaboration
		Essential	Necessary	Necessity
			- Risky - Risks vs benefit	Paradox of saving and risking
			- Nature of research - Diverse expertise required	Influenced by industry factors (such as: nature of research, need for diverse expertise)

Figure 8: Example of Pattern Coding

As suggested by Saldaña (2009) coding is a cyclical act and after recoding data further the data generates categories, themes and concepts and enables theory building. Thus, these first steps of coding enabled the researcher to organise and group similarly coded data under themes based on shared characteristics and patterns that were identified (Saldaña, 2009).

Furthermore, a four-level thematic analysis across all data as proposed by Christie, Rowe, Perry and Chamard (2000) was used. Thematic analysis was used to seek the emerging thread of overall themes and the purpose of these themes (Gaskell, 2000, p. 53). These themes were examined in context of the aim of the research, that is, the content under each theme was directly linked back to the theoretical principles and research question/s (Kvale & Brinkmann 2009). As followed in the study by Christie et al. (2000) the first three levels of this study too consisted of analysis of: individual data of a participating organisation, followed by comparison of data and then grouping of data with similar patterns. Finally, the fourth level was a summation of all data (as suggested by Christie et al., 2000). The step-by-step process used by Christie et al. (2000) was used as it was a rigorous way to conduct further analysis. It has been used as a basic framework to guide the analysis of key themes of this study presented in the following chapters.

Level	Analysis	Purpose
1	Individual data Analysis	Similarities and differences of the activities of an individual organisation were identified
2	Cross data analysis	Data across all units/ organisations were compared for patterns
3	Group Analysis	Similar data of the cross-data analysis was grouped together
4	Summation of all levels	Overall emerging patterns in the data were identified

Table 5: Four level data analysis (based on Christie et al., 2000)

Each of the above is discussed in the following section.

Four-level Case Data Analysis

First Level: Individual Data Analysis

Data analysis in case study research is aimed at “discovering regularities or patterns” within the case study evidence (Darke et al., 1998, p. 284). This is achieved by describing in detail the case and writing on the case data (Darke et al., 1998). For this study, this has been achieved through the write up on each organisation that participated and is presented briefly in the next chapter.

In this study, the initial process started with writing a detailed report for interviews and organisation taking into account other sources of information provided and collected at or prior to the initial interview. The next chapter represents this step. As Miles and Huberman’s (1994) recommend using a format for first level analysis that includes following research questions; therefore, for this study, the key themes in the research questions were used as a format for first level analyses (as illustrated in Figure 4).

The aim of the first level analysis was to ensure familiarity with each data set or organisation in this study (Bryman & Burges, 1999). This enabled the researcher later to be able to compare and draw conclusions based on the emerging patterns (Bryman & Burges, 1999). This process is known to entail

exhaustive presentation of data and might be seen as descriptive in nature by the reader (Miles & Huberman, 1994).

The reason for investigating each organisation and individual level view is because it leads to understanding the broader picture. This happens because the point of view of individuals is also the basis for understanding the diversity of views and the fact that the case is embedded in a broader context (Bazeley, 2013; Maxwell, 2012). Therefore, at the first level analysis stage it was considered important to also be mindful of the recommendation that analysis is not just about segmenting and coding data but also about ascertaining the bigger picture (Bazeley, 2013). This enabled the researcher to understand the significance and meaning that participants attached to an event or the OI phenomenon, as well as, identify underlying connections within and across the data units (Bazeley, 2013). Thus, examining and understanding each data unit/organisation on its own was considered crucial before proceeding to a comparison across data. Hence analysis of data from each of the eight Biotechnology organisations is presented in the following chapter (Chapter 4). The first level data analyses for triangulation data was similar process. The first level data analyses for triangulation are included in the Appendix (3.3). The format and analysis procedures followed were consistent throughout.

The overall case study was developed by combining information from interviews with key informants, observations and documentation such as company website, media reports, industry literature and/ or any data researched and obtained prior to the interview for each organisation that participated in the study. The key discussion points emerging from each organisation for each of the key themes listed above (in Figure 4) is discussed in the first analysis chapter that is, Chapter-4. In the first-level analysis, a narrative style or a story-like approach has been followed (Miles & Huberman, 1994). A similar format is followed with variation based on the depth and breadth of data gathered for each participating organisation.

Second Level: Cross Data Analysis and Group Analysis

Next, the cross-data analysis was conducted which is referred to as grouping together responses from various data units for one particular interview theme or question, that is, to analyse diverse viewpoints on a particular issue (Patton, 2002). At this stage Christie et al.'s (2000) recommendation of grouping together similar data was also undertaken. This is presented in Chapter 5.

Cross data analysis was used in this research in order to provide comparative analysis across data to discern patterns and/ or themes and determine if the collective evidence supports or refutes the theoretical expectations and evidence from the literature. As suggested by Eisenhardt (1989) patterns can be recognised in case studies by identifying dimensions from literature and then examining for similarities as well as, differences. This second level of data analysis was found to be useful as it allowed the researcher an understanding of the commonalities across multiple occurrences of the OI phenomenon; thus, contributing to conditional generalisations and deriving conclusions later (Bryman & Burges, 1999, Miles & Huberman, 1994). It also stimulated the researcher's imagination, instigated

new questions, revealed new perspectives and alternatives that would have otherwise remained unexplored (Stretton, 1969 cited in Khan & VanWynsberghe, 2008). Furthermore, it allowed comparison of data from various settings providing an opportunity to learn from the similarity and differences across diverse data units (Khan & VanWynsberghe, 2008). This helped to understand not just the commonalities but to examine closely divergences as well as, to ensure that data explanations are drawn carefully (Miles & Huberman,1994). This also, enabled the researcher to build a logical chain of evidence (Yin 1994; Miles & Huberman 1994).

There were some challenges and concerns that were encountered while conducting this level of data analysis. Khan and VanWynsberghe (2008) suggest that in addition to developing a stance on generalisability there are other concerns for case study researchers to address; these are as follows: preserving the essence of the cases, reducing or stripping the case of context and selecting appropriate cases to compare. How each of these were managed in this study is discussed next. To preserve the uniqueness of cases the second level data analysis in this study has attempted to maintain the complexity and uniqueness of the data collected (as suggested by Mahoney & Rueschemeyer, 2003; Tesch, 2013). This has been achieved by providing ample contextualised details of the data while understanding the commonality across the data units (Stake, 2006). This also helped to avoid the danger of contextual stripping. However, as mentioned by Ayres, Kavanaugh and Knafl (2003) losing some contextual details is unavoidable as the aim of the cross comparison is to identify themes. Being aware of this danger enabled the researcher to consider the importance of contextual factors in each data unit while looking for common patterns and themes across the data. Finally, in this study the researcher was mindful of the overall aim of the study while searching for comparisons until the search no longer yielded new insights and a theoretical saturation was achieved (Khan & VanWynsberghe, 2008). The analysis of this study took into account the linkages between data, literature and the research questions and used an iterative approach until a level of satisfaction was reached that no new explanations were being generated. In terms of the challenge of selecting appropriate data sets to compare Yin (1994) has suggested the use of pattern matching when comparing data across. This was achieved by comparing tabular summaries for each of the cases to identify patterns. To illustrate a step in the process, and explain the basis of how this level of data analysis was conducted an example of key themes emerging across interview questions is presented in Table 6. The first level written analyses and the cross-data analysis matrix representing key pattern for each theme were then used to assist in the final analysis process. The discussion now moves to the last stage of data analysis.

The themes that emerged from the interviews about participant's description and/or definition of OI are as follows: • OI is not a novel concept • OI is about collaboration for knowledge and problem solving irrespective of source or location • OI is essential for small and virtual Biotechnology • OI made necessary by wider environmental changes	Subsequently the factors that led to this description of OI were explored based on the interview data. The factors that emerged were: • Need for wide range of expertise • Company strategy • Limitations of small listed Biotechnology • The nature of drug development	Exploration: research alliances, purchase of scientific services, joint ventures, in-licensing. Exploitation: Involvement of non-R&D workers in innovation initiatives, Out-licensing.
Benefits of OI: • OI can be more cost effective than internal R&D • OI can help organisations save time • Access to top global expertise based on organisation's needs • OI enabled learning (and/ or increased knowledge) • Benefit from reputation of collaborators • Improved staff morale and team work • Contributed to growth	Challenges of OI: • Lack of control: Maintaining organisational boundaries, Loss of control on IP and confidentiality of data • Overcoming ego, fear and distrust at the initial stages of the partnership • Differences in priorities & expectations of collaborators • Risk of time and money	Practicing OI: To summarise, no specific systems, processes or procedures were highlighted in the data for managing OI. Maintaining control over the innovation process through close monitoring of projects with externals and good relationship management along with a flexible attitude seems to be crucial for success through OI for these organisations.
Rewards and incentive systems: • Measuring performance- a challenge • Team work not individual goals and performance are important • Non-pecuniary rewards as important as pecuniary • Profit sharing and bonus for R&D staff based on company's performance • Emphasis on linking business goals to team and individual goals	Role and responsibilities for internal R&D has shifted due to OI in these organisations • Change in roles and responsibilities of R&D due to change in management and strategy • Change in focus of R&D towards commercialisation • Dedicated project managers • Addition of new roles and divisions as product progresses • Formation of cross functional teams and cross skilling • Employees involved in knowledge exploration • Reallocation of staff	Key skills highlighted in the interviews are as follows: • Time management • Awareness of IP and confidentiality issues • Team worker • Ability to be flexible and adapt to change • Attention to detail • Ability to share knowledge • Commercially savvy and business oriented • Good interpersonal and communication skills • Multi-skilled and have knowledge across scientific disciplines • Sales oriented and entrepreneurial in outlook • Openness to learn and take suggestions from other stakeholders • Problem solving attitude • Ability to work as a 'broker' to recombine ideas from inside and outside the firm

Table- 6: Key themes emerging across interview questions

Third and Fourth level: Summation of all Levels

This last level of analysis, involved a summation of all levels of analysis to identify the key emerging patterns across all data sources and units. At the last stage, the researcher looked for underlying explanations for emerging patterns. This allowed the researcher to overcome first impressions of the data by using a more structured and diverse lens (Bryman & Burges, 1999). The patterns were examined and compared with literature and reasonable explanations sought for contrasting and compatible themes. Examining literature that denied the emerging theory as well as, supported the findings was undertaken to enhance validity and/ or generalisability (Miles & Huberman, 1994).

The issues of credibility and validity are a major concern in conducting case study research (Maxwell, 2013; Yin, 2009). The steps undertaken to increase the credibility and validity of this case study research are explained next.

Quality of Research: Design Tests

According to Yonge and Stewin (1987) an issue with qualitative research is to develop criteria and procedures for enquiry that will make the research process more feasible through the use of common language structure, well defined goals, methods and analysis. Riege (2003) suggests (based on Denzin & Lincoln, 1994; Lincoln & Guba, 1985) that the following design tests: credibility, transferability, dependability and, confirmability are important to pursue to make qualitative research more viable and acceptable. In case of this research, these tests were taken into account and are discussed in table-7 on the next page.

Design test	Questions to ask	This research
Credibility	• How rich and meaningful or "thick" are the descriptions? • Are the findings internally coherent? • Are concepts systematically related? (Riege, 2003, p. 81).	• This thesis presents the in-depth first level data analysis of each of the eight organisations, followed by cross-data analysis in order to illustrate the patterns of emerging themes. • Multiple sources of data were used • Data was triangulated
Transferability	• Do the findings include enough "thick descriptions" for readers to assess the potential transferability appropriateness for their own settings? • Are the findings congruent with, connected to, or confirmatory of prior theory? (Riege, 2003, p. 81).	• In-depth descriptions and data analysis have been provided in chapter 4 and 5 • In this thesis the replication logic has been followed • Patterns across data and triangulation data were verified • The multi-level analysis approach followed ensured that alternative viewpoints and explanations were considered for the data
Dependability	• Are the research questions clear and are the features of the study design congruent with them? • Have things been done with reasonable care? (Riege, 2003, p. 82)	• A case study protocol (Appendix 3.2) was maintained and served as a guide. • An interview guide was used for all interviews • Case study database was established and maintained • Standard forms and procedures were used: such as letter of invite, participant information etc.. • Data collection and analysis process were similar throughout.
Confirmability	• Are the study's general methods and procedures described explicitly and in details? • Do we feel that we have a complete picture, including "backstage information"? • Are study data retained and available for re-analysis by others? (Miles & Huberman, 1994, p.278-9)	• Case study database was reviewed by others. • This chapter describes details of methods and procedures followed (while being restricted with restrains of time and length of PhD thesis) • Academic peer reviewing throughout the thesis with university standardised milestones procedures to gather feedback from external reviewers ensured that the researcher interpreted data in a reasonable manner • The section on research rigour later in this chapter furthers addressed steps undertaken to reduce bias.

Table 7: Design Tests (Adapted from Riege 2003, p. 81-82)

Based on Cho and Trent (2006), Maxwell (1992, 1996), Riege (2003) and Yin (2009) validity (internal, external and construct) and reliability are key quality tests that are more critical in case study research. These are discussed next.

Validity

In qualitative terms, an account is considered valid and accurate if it correctly represents those characteristics of the phenomena that it is proposes to define, expound or theorise (Hammersley, 1992). Qualitative research is just as focused on avoiding unsound or unjustified findings as quantitative inquiry (Maxwell, 1992). To achieve validity a researcher can use respondent validation and triangulation (Long & Johnson, 2000).

For this study, the case study database was maintained and protocol was followed. All transcripts were sent to the participants for respondent validation and member checks were conducted post data

analysis. Triangulation of data through the use of various sources as illustrated in the section of data triangulation was conducted for validity.

Reliability

Reliability focuses on standardising data collection instruments (Mason,1996). It refers to the dependability and uniformity of the instrument used to measure what it is intended to measure (LoBiondo-Wood & Haber, 2002; Polit & Hungler 1991). Furthermore, Hammersley (1992, p. 67) suggests that reliability "refers to the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions". Therefore, reliability refers to the credibility and repeatability of the research; that is, if the research were to be conducted again would it provide credible and similar results (Denzin & Lincoln, 1994; Guba & Lincoln, 1989). As regards credibility and repeatability, the way that the research was conducted is clearly explained in this chapter, and the arguments in the empirical analysis (presented in the next chapter) are supported by examples from the interview transcripts to provide the reader a chance to evaluate the appropriateness of the interpretations. The literature review presented in Chapter-2 and the connections made between empirical findings and earlier literature also supports the reliability of this research.

	Case study techniques	**This research**
Reliability	• Give full account of theories and ideas • Ensure congruence between research issues and features of study design • Record observations and actions as concrete as possible • Use case study protocol • Record data, mechanically develop case study database • Ensure meaningful parallelism of findings across multiple data sources • Use peer review/ examination	• A full account of theories relevant to the study are presented in the literature review chapter • Congruence has been illustrated in the research design and the aim of the study in this chapter • A case study protocol was developed and followed • Case study database was maintained • The research has been reviewed by supervisors and colleagues. Third party reviewers during university milestones also provided feedback on the study.

Table-8: Reliability (Adapted from Riege, 2003, p. 79)

Research Rigour based on Design Tests

Appropriate and practical critical steps were taken at each phase of the research to ensure the quality of research rigour. Yin (2003) has suggested that to increase the reliability of the case study research a case study protocol can be used. A case study protocol was developed consisting of the instrument, procedures and general guidelines to be followed for each case. This was used as an outline and checklist to guide the researcher (Appendix 3.2). Data was documented and organised as they were collected (as suggested by Darke et al., 1998). Data was collected and multiple sources of data were stored systematically (Dooley, 2002; Maxwell, 2013 & Yin, 2009). The database was securely stored and password protected with access granted to only the investigators involved in the study. The case study database in this research in addition to audio recordings and transcription of interviews included the following evidence: observations and information noted when visiting participant's office, information on corporate websites, documents provided by participants, annual reports, industry literature, and media reports. As suggested by Yin (2009) a case study database that is formal and presentable and

is available to be reviewed by other researchers increases the reliability of the study. The database for this study was maintained so as to follow this guideline.

Denzin's (1978) suggestion that "local informants can act as judges, evaluating the major findings of a study" was followed (Miles & Huberman, 1994, p. 275). All participants were provided with the interview transcript and requested that they review it and provide feedback.

The study used different methods as a check to identify if the same conclusions are supported (Maxwell, 2013). This reduced the risk of biases of a specific method and increased the understanding of various aspects of the phenomena studied (Maxwell, 2013). In this study in order to ensure construct validity and reduce bias, multiple sources of evidence were used. Data from interviews with key informants in the Biotechnology firms were triangulated with other sources, these were:

- Information on company websites: the websites of the Biotechnology firms were monitored and thoroughly analysed in order to gain insights to the organisations' focal points.
- Annual reports from 2015 were collected and analysed after the interviews. Except for B1, B3 and B7 the other Biotechnology had annual reports on their company websites.
- Observation and field notes: Most of the primariy interviews were held at the case companies' offices (except for interview with B7 which was at the researcher's university in a meeting room). Visiting the company offices provided the researcher an opportunity to observe the office site and R&D facilities of the companies that had on-site R&D. The participants acted as guides and obliged the researcher with a tour of the office. The researcher was also able to collect printed material (such as brochures, booklets, and so forth) from the case companies' office while on site.
- Local industry information channels such as newsletters, media reports and industry literature were used to identify innovation trends and practices in the Biotechnology companies.
- Interviews with industry experts were conducted. Interviews with participants from the Biotechnology industry were undertaken as part of the triangulation process.
- Data from various sources were then cross-analysed for trends and inconsistencies to identify key findings for preparation of the final report.

Ethical Considerations

Ethics in research are a set of moral principles that guide a researcher in ways to conduct research when dealing with people in regards to issues related to "confidentiality, anonymity, legality, professionalism and privacy" (Blaxter, Hughes & Tight, 1996, p. 148). Ethics in research is explained by Denscombe (2002) as moral standpoint vis-à-vis a practical one. Punch (2000) discusses the areas in which ethical issues can arise as follows: harm, consent, deception, privacy and confidentiality. The university's policy and guidelines related to the issues pointed to by Punch (2000) have been taken into account. This research was approved by University's Human Research Ethics Committee, approval number 17499.

The researcher ensured that the participants were informed and their consent obtained and recorded before the interviews (Lewis, 2003). The consent form used for this research is included (Appendix 3.4). Anonymity was maintained by not disclosing the identity of participants outside the research team. Further, tapes and transcripts were labelled in ways that could not compromise anonymity (Lewis, 2003). Some participants requested certain details about their products and technology be removed from the transcripts sent to them for review, this was followed and updated transcripts were re-sent to participants for their final approval.

To ensure that there was no initial bias towards the conclusion, the sample organisations and the researcher had no earlier connection. The researcher was aware of the need to be neutral during the interviews in order to avoid any distortion or biased behaviour. All the interviews were conducted using the same interview protocol and a similar interview style was maintained to avoid any variation that might cause difference in results.

Limitations

One key limitation of the study is that it is primarily focused on Victoria's Biotechnology industry, making the research outcomes context specific. However, although the limitations of sector and focus on a particular state can be seen as limitations, they are chosen to generate rich and detailed data through a qualitative methodology. Future studies will benefit from a more diverse cross-sector quantitative data collection across Australia. A further limitation is that since this study is based on qualitative data it may be seen as subject to different interpretations by different readers.

The sample size might be considered small by some but as is well recognized the focus of qualitative research is not necessarily a large sample size but rich data (Crouch & McKenzie 2006; Sandelowski, 1993). Further, as suggested by Guest et al. (2006) theoretical saturation can be arrived at times in as many as twelve interviews.

Chapter 4

Case Study

This chapter presents first level data analysis for this study. This chapter focuses on in-depth exploration of each data unit. Each data unit presented here is developed by combining information from the interviews with key informants, from corporate websites, industry reports, media releases, along with any notable observations and field notes or documentation such brochures and pamphlets collected at the organisation and any other source of information provided to the researcher by the interviewees.

A similar format of analysis is carried out for each data unit/ organisation with noted variations due to the depth and breadth of data gathered for each. First a brief description of the organisation that is, background information and an organisational profile is provided. This enables understanding of the context and scope of OI practices in the organisation. It also helps in understanding the perspective of the participants through a view of the environment they operate in. This is followed by the key informants' insights on all research question themes discussed during the interviews. As discussed in Chapter-3, research questions have been linked to particular themes and these themes (presented in Figure-4) are used as the key headings for the first level of analyses presented in this chapter. However, it needs to be noted here that not all corresponding themes are mentioned for each organisation. This is primiarily because only relevant information that was found to add value related to a particular theme is mentioned in the analysis.

This first level of data analysis enabled the researcher to organise, compress, and assemble information (Miles & Huberman, 1994). The purpose of this level of analysis was for the researcher to become familiar with the data before making comparisons and drawing conclusions (Eisenhardt, 1989). Therefore, the views expressed in this chapter are of the participants during the interviews or strictly based on information gathered during the data collection process and the researcher has just put it together as a narrative. The analysis presented in this chapter encompasses exhaustive data write-ups for each participating organisation/ data unit and has a descriptive element to better ground the succeeding level of analysis.

B1

B1 focused on clinical development of innovative gene therapy for the purpose of treatment or failure of specific type of body implants. B1 is a virtual company and does not have an internal R&D however this was not clear on the website of the organisation. It is a small company comprising of seven personnel including the Chief Executive Officer (CEO) and the Chief Scientific Officer (CSO). It is not listed on the ASX (Australian Securities Exchange). The office is close to Melbourne City Centre where the interviews took place. B1 did not have an IP manager but consulted with patent attorneys in Australia

and in the United Kingdom. B1 did not have a HR department nor a formal performance management system. The company had regular staff meetings to strategise, plan, and evaluate their performance and re-evaluate the business's approach as required.

Based on the information and articles written by the CEO on the website, the company was approached. The CEO of the organisation agreed to participate in the research henceforth referred to as P1. B1's website (2012-2016) indicated that it has international and domestic partnerships. It partnered with a university overseas and well reputed premier research organisation in Australia and overseas. The company used external partners for its R&D whether it be Contract Research Organisations (CROs) or universities or research institutes. The website indicated it had active collaborations with universities such as- Berkeley (U.S.), Oxford University, The Tokyo Institute of Technology, and a number of other universities in Europe as well as, top research institutes in Australia.

Conceptualising OI

P1 has extensive experience in the Biotechnology industry. Over the years P1 has worked in various roles such as Chief Chemist, Head Discovery Partnerships, Business Development, Managing Director (MD) and CEO. P1 associated OI with collaboration for innovation, he said:

> I don't sort of relate to it as a precise meaning. I mean I certainly know what innovation is. I mean, I know what collaboration is (sic).

The participant did not relate to OI as a new concept but pointed out that it has been practiced since 1988. For P1, OI in the Biotechnology industry is an alliance of different groups working together because of the collaborative nature of the industry and scientific work.

The importance of OI for small virtual Biotechnology is highlighted by P1 throughout the interviews. In P1's view the reason a small company like B1 can exist is because of OI. According to P1 OI is "more of a confederate type of collaborative approach" that even bigger organisations are emulating. Hence for P1 organisations such as B1 cannot exist without OI practices and it is "essential" (P1) for the Biotechnology industry. According to PI, innovation requires investment of time, money and infrastructure that is not available to small virtual Biotechnology such as B1, by using an OI approach such organisations can still innovate while having limited resources.

P1 is of the opinion that, organisations need to have the expertise in a core knowledge area however, to better utilise this core knowledge it might need help from others. In the case of B1, P1 states:

> You have some core components but you have to bring in those other components so that you can function (sic).

For example, B1 outsources all its manufacturing because it needs to be made by a credible and rated manufacturer. The data from interviews with P1 shows that for a small virtual Biotechnology with limited resources it is not possible to possess a wide variety of expertise in-house. Therefore, B1 seeks external expertise irrespective of distance to meet its business requirements. Furthermore, the discussion with P1 highlights that at B1, OI does not substitute but acts as a complement to the organisation's core

knowledge. For B1, bringing in external knowledge is unavoidable due to business reasons for instance lack of expertise in the area or convenience, for example, in the case of manufacturing.
P1 states that OI is integral and essential to B1's business model and strategy. In P1's view OI is "not new" for reasons that knowledge sharing and transfer are necessary for the product development in virtual Biotechnology. The diversity and variety of knowledge required plus limited infrastructure are key reasons that OI whether (known by name or not) is of value to B1. For B1 a strong core internal knowledge base is a central aspect to enhancing and benefiting from OI practices, the two are viewed as inter-dependent by P1.

Individual-level Perspectives on OI

Benefits of OI

There are four key benefits that emerge from the interviews data with P1. One, benefit of OI is it allows organisations irrespective of size access to different type of expertise as per organisation's needs at any given time. Two, it allows access to reputation and expertise of collaborators. Three, partnerships can be formed for various reasons for example to enhance branding or access a specific technique or technology. Four, OI helps form business partnerships that "are mutually beneficial".

Furthermore, P1 states that working with external partners such as university researchers brings in new knowledge. External partners specifically university and research institutes work independently of the business and do not seek specific results which is beneficial to research. In P1's opinion external partners have a more open attitude towards R&D due to wider vision compared to R&D within the organisation. This may lead to a chance discovery that may bring something new that the company did not consider before.

Challenges of OI

Some key challenges that were discussed during the interviews with P1 were: maintaining organisational boundaries, fear of "accidentally disseminating" IP (or "inadvertently disclosing IP") as well as, deciding how much information needs to be shared with the external partner. According to P1 big Pharmaceutical companies have "boundaries with razors around" to avoid any stealing or leakages of information which is not possible for a small Biotechnology firm. Based on P1's extensive experience in the Biotechnology industry sharing too much can prove risky due to loss of IP. P1 describes the challenge of sharing information with external partners as follows:

> It is important that some information is secure…it's like family and friends of the family…there are things that you may do together but there are things that are definitely not the business of the collaborators.

Although B1 is a small Biotechnology it operates cautiously towards external partners before engaging with collaborators for sharing knowledge and IP. This means consulting with lawyers to draw contracts and/ or agreements before sharing any information is an important requirement although contrary to the characteristics of OI. According to P1, OI tends to lack controls on issues associated with knowledge exchange.

P1 suggests that "due diligence" needs to be conducted that is, it is necessary to seek and have regular access to legal support throughout the innovation process. According to P1:

> It is unwise to start without proper agreements that can be a problem in how you share the IP outcomes and that could be a barrier if you wanted to commercialise.

Ensuring proper agreements helps B1 better manage the IP thus, leading to a greater sense of control that otherwise is weakened due to high involvement of external partners in the innovation process.

Discussion with P1 highlights that aspects of when and who to partner with requires discretion. Additionally, close evaluation of various aspects of the collaboration, that is, in terms of transactional aspects related to cost, time, IP vis-à-vis relational aspects that is reputation, match in key competences and communication styles has to be undertaken at initial stages of partnerships based on limited information. It is inferred from the data that the key challenge for B1 is related to finding a well balanced approach towards managing knowledge and maintaining a certain control on the innovation process. Moreover, according to P1, balancing the softer aspects of relationship building with new partners while being careful about IP management requires a mature management style.

Organisational Implications of OI

Planning and Preparing for OI

P1 indicated that there was no preparation phase for OI because B1 has dealt with external partners all the time due to its business model. Being a small virtual company B1 plans strategically about its associations with external partners. B1's business plan is a dynamic document that is updated regularly to meet the organisation's evolving business requirements. To meet its business needs B1 invests time and efforts on a regular basis towards networking in order to be aware and be open to new external partners.

At B1, OI efforts are dictated mostly by the needs of the business, the work that needs to be accomplished and/ or project requirements. Even when considering the number of potential partners to contact for a given project, it is based on the scope of work and expertise required. For example, P1 commented:

> It depends on the work; you would not go looking for 3 different patent attorney you will go to one who specialises in the field whereas in case of CROs it might be smart to get a few quotes.
> (By CROs P1 is referring to Contract Research Organisations)

B1 has a small core team that consists of mostly scientists with previous experience in the Biotechnology and Pharmaceutical industry. Therefore, when using external knowledge resources, it follows a carefully considered approach as evident in the comment above. Basic planning is undertaken to identify the key aspects of the project that external partners will contribute to and based on the needs of the project partners that are the best match are considered.

Finding partners

B1 is a small organisation whose partnerships for innovation (as mentioned above) are need based. Its decisions to use external partners is based on few factors associated with "expertise, cost and recognition by the regulator" (P1). B1 approaches partnerships more through informal means of personal and/ or professional networking which is dictated by the nature of work in question. Sometimes "serendipity" (says P1) plays a big role in meeting the right partner/s. An example, shared during the interviews is as follows:

> A good example for our company is we were meeting with some good X-specialised companies and we developed a really good friendship with a senior person in one of the big X companies who subsequently left that company and we got in touch and we found he was really interested to actually work with us (sic).

B1 also liaises with Government departments for grants and with Consulates from different countries to discover new partnership opportunities to expand business overseas. Attending conferences in Australia and overseas is a regular practice undertaken to identify and meet new prospective partners.

Evaluating and selecting partners

B1 does not have a formal process for selection and evaluation of partners. It uses referrals from its existing network to identify partners and evaluate them based on reputation in the market and gather word-of-mouth feedback about them. However, in case B1 is unable to find a partner through its existing network then it uses companies that act as brokers in order to be introduced to new suitable partners that have the specific expertise that is required.

Usually partnerships are based on the CEO that is, P1's and the CSO's evaluation of the other party. The technical skills and knowledge the partner offers are considered additionally; it is also taken into account if the personal rapport is there between the two parties. If knowledge and skills are the same across different prospective partners, then B1 chooses and selects the partners primarily based on how well the initial interaction is and if they can work on a long term basis with that partner. B1 prefers to form long term partnerships therefore, P1 emphasised that personal face-to-face interaction is important at some stage of the partnership even in the case of overseas partners.

It emerges from the discussion with P1 that for B1 partnerships are not solely determined based on cost saving. As P1 mentions, "Cost is important but you don't do things in this industry just based on cost". Quality of work and reputation are important considerations for B1 when forming partnerships for R&D purposes. Since B1 does not have its own internal R&D a well reputed external partner is preferred as it enhances the credibility for B1's product/s and technology.

OI at B1

Different forms of OI

B1 has realised a number of OI aspects since its business model is based on acquiring and combining technologies together to produce and/ or package a new product instead of developing new technologies. This requires forming partnerships with people and organisations across the globe. As P1 points out:

> Biotechnology needs expertise not just in one field…it's a complex field….have to interact and know a lot of other things so it takes a lot of different types of inputs.

For example, over the years B1 has partnered with Commonwealth Scientific and Industrial Research Organisation (CSIRO), Oxford University and a few other international universities as well as with individual external inventors.

B1 engages in a few different activities for exploration of knowledge (inbound OI). It purchases scientific services for bringing new knowledge into the organisation as and when the need arises. It uses CROs for this purpose. Additionally, in-licensing of technology from research institutes, universities or external individual inventors is used by B1 to bring new IP and technology into the organisation. For exploration of knowledge (that is, outbound OI) out-licensing is conducted. As out-licensing is the key to earning profits B1 prefers to own all the IP at the earlier stages when working with external partners in the innovation process. This enables B1 greater control at a later stage when it is ready to out-license the product/s.

For OI, B1 engages in are: purchase of scientific services, research alliances as well as in-licensing and out-licensing. Additionally, they work with external partners throughout the innovation cycle at B1 as the business model of the company is based on collaboration for innovation. B1 uses different partners depending on the stage and need of the project. For example, it collaborates with universities at initial stages of the innovation process or a CRO to find a certain solution to a problem if it finds itself stuck at a certain stage. Whereas at later stages it works with surgeons in hospitals for clinical trials and forms out-licensing deals with large Biotechnology.

Individual-level Implications of OI

Reward systems

As B1 is a small virtual Biotechnology there is no HR department. Due to its flat organisational structure there is no formal reward system in place either. However, B1 has organisational goals and meeting the goals is an important basis for measuring success and defining monetary rewards for its small team.

Career paths of scientists

P1 is not able to share any particular examples about career paths for scientists from B1 as it is a small virtual Biotechnology with no internal R&D. However, P1 has worked in large Biotechnology firms for a few decades in a scientific capacity hence P1 offers to share those experiences and perceptions on the career paths of scientists over the years.

P1 left the security of employment with big Biotechnology and Pharmaceutical companies choosing to venture out on his own. P1 suggests that given the dynamic nature of the economic and business environment it is important for scientists to learn to adapt and to possess a wider range of skills. One suggestion that is put forth in the discussion is that in bigger Biotechnology scientists should be given secondments to learn about how other departments function. This will help them later advance their

careers by providing them with more options. P1 asserts that exposure to different knowledge and skills is crucial for scientists nowadays.

When asked specifically about implications of OI on the career paths of scientists, P1 observes that it has meant that scientists working in an OI environment have more options and can consider moving to other areas. This is because working in an OI environment allows them opportunities to learn more about the business due to higher involvement and interaction with a diverse set of people. It further enhances their people skills.

Based on P1's previous extensive experience as an employee in the Biotechnology industry it is mentioned that job security is an issue for scientists nowadays in the Biotechnology industry in Victoria. For example, P1 states:

> The pressures are changing; you can't have a job for 20 yrs anymore. There are no secure jobs.

This shows that the career paths of scientists have changed. However, according to P1 this change cannot be attributed solely to OI. This is because in his opinion a greater dependence on a collaborative mode of innovation (that is, OI) is in part due to the wider environmental (business and economic) changes.

Role, responsibilities and skills

The following skills for scientists working in an OI scenario are suggested by P1. One, scientists working in an OI environment need to be multi-skilled and have expertise in at least two or preferably three areas in various scientific disciplines. Scientists have to be motivated not to be focused only in one area but expand their core expertise; this will help when collaborating with external partners. P1 emphasises that in case of small Biotechnology that depend on collaboration for innovation especially there is a need to be more "more multi skilled" and therefore, scientists cannot be confined to laboratories "…no silos". Scientists are required to have the ability to talk to different people with diverse knowledge backgrounds. Scientists need to interact and network more therefore, need to develop inter-personal skills. As P1 says *"*The scientist cannot be restricted to the bench anymore*".*

Two, there is greater need for scientist in Australia to be more upfront, entrepreneurial and possess the ability to sell. P1 emphasises that scientists need to be sales oriented in small organisations that is, they should be able to "explain it to people who don't have a PhD…so you need to be able to communicate with lay people*".* P1 asserts that scientists (especially in Australia) need to be able to sell and have to be business orientated. According to P1 in Australia unlike the U.S. there is a need to change the perception as selling is seen as "crude" in the scientific community. P1 expresses this as follows:

> Earlier in science there was a mentality that business is the dark side….things have changed now…earlier it was one or the other, it does not have to be this way anymore. Both are important for scientists.

Three, scientists need to have good communication skills. P1 shares an example that scientists might have to speak to people in the finance sector who are smart but might have short attention for technical scientific aspects. Hence scientists need to develop communication skills to be able to explain technical scientific aspects to people from different areas in a simple manner. As P1 comments:

> Tell them what you're doing so that they understand it…the ability to communicate to a range of different type of people.

Another suggestion given by P1 is that scientists need to learn about IP starting at the university level. Knowledge of IP is critical for scientists in small Biotechnology this is because as P1 points out "you're either generating it or handling it". Overall, the discussion highlights that to work in an OI environment in the Biotechnology industry scientific knowledge, as well as business acumen is important along with the ability to work across diverse areas. Ability to adapt, possess good communication skills along with knowledge of IP while being multi-skilled are important requirements for scientists to advance their careers.

B2

B2 is a small Biotechnology company comprising of 9 employees with headquarters in Melbourne City. It is listed on the ASX since 2007. The company specialises in the development of antibodies for various types of cancer. According to the participants B2 operates as a virtual organisation even though it has its own research laboratory based in Germany and an office in Australia. At the time of the interviews the R&D strategy for this organisation was to conduct basic research in their laboratory based in Germany and other research through partnerships and collaborations which were managed at the Melbourne office.

It has a flat organisational structure with the CEO on the top and then the rest of the employees. For this research the Senior Director Operations (referred to as P2A) and the Senior Director Business Development (referred to as P2B) agreed to participate. The interviews were conducted at their Melbourne City office.

P2A is responsible for operations at the research level as well as for all collaborations. P2A's role included sourcing relevant research groups, managing collaborations, working with manufacturers and CROs for clinical trials. The other participant, P2B was responsible for the management of IP for the company as well as business development. For this purpose, P2B worked closely with various patent attorneys. Since B2 is a relatively small company it does not conduct "pure business development" (P2B). The way business is developed at B2 is by liaising with other companies that are interested in its products or interested in learning about its products.

The research laboratory in Germany is responsible for basic research and for clinical trials. A few years back B2 had a R&D team in Australia too, however the company decided to close the laboratory for various reasons. According to P2A one reason was that management of two teams in two-time zone

was difficult, and also due to the change in focus to the clinical side of the business. This is further discussed in the following sections.

Conceptualising OI

B2's approach to innovation is inherently open. This is highlighted by P2A in the following comment:

> Innovation these days is actually to source out where are the experts and who can do the job the best and very often we connect those people that are doing different things for us. So we link different research groups because that may even be more productive (sic).

Hence it is understandable that even though B2 has research support in Germany P2A asserts "but majority of it is all over the world". For B2, OI means sourcing the best expertise and person to do the job to get the best possible results.

As mentioned B2 has had considerable transition in its R&D department as the company closed down its research team in Australia and scaled down its R&D in Germany. The reason for this was mostly strategic. The work conducted in Australia was not foreseen as becoming the company's core technology for future growth. Therefore, in order to streamline the cash outflow and invest more money into developing its products to the next stage the company decided to close the R&D in Australia. P2A states, "it was not stopping the research activity it was just restructuring it". However, P2B admits that there has been decrease in R&D internally; this is illustrated in the comment below:

> The R&D capacity has decreased that is people who are solely on our payroll have decreased over time. Probably what we are doing with other partners and other service people have increased.

Regarding the scenario at B2, it is of relevance to know whether R&D has been substituted or not due to OI. When asked about this both the participants said that they did not view OI as either a substitute and/or complement to R&D. P2A said that reason for this is the effect OI has on R&D varies according to the organisation's development stage. This was further explained by P2A that at earlier stages of B2's inception there was more invested into its R&D however, as the organisation grew it had to be strategic in its use of resources. As P2A mentions, "when you come to clinical trial and manufacturing stage then resources have to be allocated accordingly*"*. P2B also stated that, for B2 scaling down its R&D was dictated by its overall strategic direction and business needs.

B2 still maintains its basic R&D as it is considered essential to its business needs and growth. The internal R&D at B2 also enables the organisation to better utilise external knowledge and technology and adapt it to its core technology. Moreover, the company decided to close investment in pre-clinical research because it had been conducted previously and instead decided to focus on commercialisation of a couple of its products. Due to its size and infrastructure constraints it was considered strategic to reduce basic research team to direct funds to push its products further down the pipeline. At B2, OI is viewed as part of its strategic orientation as the organisation continuously aligns and re-aligns itself towards being a profitable business in order to add value to its shareholders.

Individual-level Perspectives on OI

Benefits of OI

Most important benefits that the participants mentioned during the interviews are related to the flow of information and knowledge. Different people give different ideas that can be beneficial for innovation. B2 collects and connects its various collaborators at research level in order to enhance best practices and information sharing. This further helps the organisation to develop new knowledge in different areas.

Additionally, for an organisation such as B2 with limited infrastructure it is considered cost effective to form partnerships based on its innovation needs. It was mentioned by participants that there are high risks involved to take a product from inception to completion. OI reduces the risks involved by allowing B2 to form partnerships at different stages of the innovation process. It allows flexibility for technology and/ or product/s to exit and/ or enter at different stages of the innovation cycle. Thus, allowing the company to identify potential risks and benefits so as to act in accordance to meet its business goals.

Challenges of OI

Challenges B2 faces while working with collaborators are related to managing timelines and delivery times while ensuring product quality and meeting its over-arching vision and business needs. Working with external collaborators is viewed as challenging mostly because it requires managing two different perspectives. Since working in an OI scenario requires managing diverse set of people and expectations on a regular basis, it can lead to communication issues. Furthermore, managing different people, timelines, priorities and viewpoints can be a tough balancing act. Managing different collaborators requires considerable coordination and can be time consuming.

The biggest challenge however for B2 is related to IP. As P2B said that:

> IP issues most of the time is mainly the reason why we would not work with universities or other companies. It basically comes down to IP.

IP is mentioned to be particularly challenging when working with universities as their legal departments are not business savvy. Further, universities insist to own some part of the IP in case something innovative is found. Another challenge that B2 has faced while working with universities is that researchers are more academically oriented and lack a sense of business and urgency to get the product ready. This is apparent from P2A's comment:

> They don't have the perspective that it is a product and it has a time line towards commercialisation. They are of the idea that we do it for the beauty of it because we have a revolutionary idea and we can spend 10 yrs researching that idea. In the real Biotechnology world, you have to juggle and balance how much time you're going to spend in research and discovery and if that is absolutely crucial and beneficial for the development of your product. University research can be a bit slow because they don't have a sense of business urgency.

Overall at B2 the challenges are related to managing diverse set of OI partners and maintaining a degree of control on the innovation process. IP issues are the reason that B2 might deter from engaging with external partners.

Organisational Implications of OI

Planning and Preparing for OI

B2 did not undertake any planning or preparation for OI. It was viewed as part of change in strategy from internal R&D focus to using funds for the clinical side of the business while collaborating and forming partnerships for research.

Finding partners

There was no formal process for finding partners at B2. Networking was considered important to find the right partner. For example, P2B stated that:

> A high percentage of the people we're working with at the moment that we know or other people that we know, know them and they have said they are good people to work with (sic). Others we've sort of sourced and over a period of time you develop a rapport with those people.

However, in case it is not able to find the right knowledge expert through its network B2 engages in cold calling as well as using various search engines to locate top expertise across the world.

Using its network and accessing current scientific literature to find the right expert is the most common method of finding partners for B2. This is apparent from the following comment by P2A:

> If you don't know anyone you start asking other researchers and someone would know someone. If no one knows anyone then you use Google to find who has published a paper on that topic (that's actually how we found someone we work with now) then you find the paper and contact them and ask if they can do this for us.

Evaluation and selection of partners

There was no formal process that was followed by B2 to evaluate and select partners. However, some times in case of new partners conducting an initial pilot study helps it evaluate new partner's expertise. As P2B mentioned:

> You might do an initial project with them and if that goes well then you broaden the scope of what you're doing. Often in a way there is a very small evaluation period.

B2's short evaluation process is based on "common procedures and knowledge" (P2A). For example, when evaluating whether to in-license a technology B2 would evaluate it based on the phase the product or technology is at, how much has already been invested in it and the risk involved. In order to further conduct a thorough investigation on the risk involved B2 may buy reports to get more information on a particular area.

Furthermore, in terms of evaluating collaborators and companies that they intend to form business partnership with B2 usually evaluates it based on the capability of the partner and the knowledge they can offer and how well it would fit in with the company's needs and current technology portfolio. This is apparent from P2B's following comment:

> We need to evaluate if it is a clear fit with our technology and is it easy to explain to investors and shareholders because ultimately if it's a complex technology that we might be looking at we can't explain it to people why we're doing it, it will be very hard to then ask our investors to give us money, often it comes down to that. (sic)

Therefore, P2B mentions that for B2 it is two key elements in the selection process, one is the "simplicity of the product" and other its value or combination with the company's existing portfolio. Additionally, cost is also an important factor as sometimes B2 finds products or technology that fit well, however, the company cannot afford it.

For B2 being a small company the network it has and personal relationships it forms with its partners is important. Therefore, other factors that it takes into account when evaluating partners is whether there is good relationship potential between the two as well as, if the partner company is reliable and has a good reputation. Quality of work along with meeting expectations in terms of time and delivery is crucial for B2 as it is a publicly listed company. However, it is highlighted that quality of work is just one aspect that is considered in evaluation; timing is critical too, this is illustrated in P2A comment:

> …they might do a terrific job, but if we have to wait five years for them to deliver something, that's not acceptable for us.

At B2 when evaluating external partners, the criteria appears to be a combination of various factors around whether the company can build a good on-going working partnership and if the partner will be able to help B2 achieve its business goals in a timely manner. P2A further elaborates,

> To be honest these days when it comes to knowledge and expertise they all have it in their areas. If you source a research group in a particular area you can be sure they know their area more or less it is just a matter of how much effort and time and resources they can allocate to us and that is what we're evaluating.

Based on the discussions with P2A and P2B it is apparent that although there is no set formal process for evaluation and selection of partners B2 has certain key criteria such as: capability, knowledge, quality of work, their commitment to help achieve B2's goals, timing, and potential of long term relationship (among other aspects). A combination of various elements is considered at the time of evaluation of partner depending on the business need of the company and the level of expertise required for the project.

OI at B2

Different forms of OI

The interviews indicate that the company engages in, in-licensing and out-licensing but the overall aim is to out-licence the product to a big Pharmaceutical company. Due to this B2 is careful about the type of partnerships it considers and engages in. The organisation is mindful of the number of partnerships it forms across the innovation cycle. This is because in case it decides to out-license the product at a later stage it wants to keep its royalties to various parties to a minimum so as to maximise its profits. This is highlighted in the following comment by P2A:

> So to avoid complexity in case we at some stage want to sell the whole product so we want to keep it as clean as possible. We're really choosey of what we want to do at this stage we can afford to be; at a later stage we may take a different approach (sic).

In-licensing of technology is through universities, research institutes, scientists and independent researchers. Additionally, it purchases scientific services as and when required based on its business needs and product requirements. B2 also engages in research alliances from time to time with Pharmaceutical companies who are sometimes interested in its technology. Overall the aim of B2 is to out-license its technology and/ or products to large Biotechnology and Pharmaceutical companies.

During the course of product development B2 engages with various partners at different stages of the innovation process. For example, it engages with universities for gaining in-depth knowledge, other companies or institutes for specialised expertise in certain areas such as: toxicology, or animal experiment and for research clinical trials with CROs. For inbound OI (that is exploration of knowledge) it also purchases scientific services. At the time of the interviews B2 had around "20 different collaborators or contract organisations" (P2A). However, on the research level at the time of the interviews B2 had "5-6 collaborations" (P2A).

Management of OI

A large part of P2A's role as the Senior Director Operations encompassed sourcing research groups for collaboration as well as directing and coordinating those. However, due to its small size work at B2 is shared based on business and project needs. Staff members provide regular inputs to each other on various projects. This is apparent from P2B's comments that,

> There is a single person responsible for a particular line of investigation or work that does not change but the input from others can change over a period of time.

There is multi-skilling and job sharing across B2. Both participants emphasised the need for teamwork and regular communication within the team in order to manage and coordinate work with various external partners.

Individual-level Implications of OI

Reward systems

At B2 there is no formal performance management system. There is no regimented performance review and evaluation that is conducted as employees do not have set goals. The reason for this is that at B2 it is believed that in research the outcomes cannot be predetermined. Moreover, as there is considerable team work that happens it is hard to determine individual contribution. As P2 A explains:

> The problem is that it is research so you cannot have a performance outcome because the outcomes are really unknown. Some activities work better than others but we have 50-50 amount of work that ends nowhere. You just end up with a little bit of scientific information but nothing sensational (sic).

Nonetheless, it is taken into account how smoothly collaborations are running and whether resources are optimally utilised. Additionally, it is considered whether strategic thinking is applied in order to secure the best possible outcomes from collaborations with various people outside the organisation.

From the discussions with P2A and P2B it seems that although there is no formal performance management system all employees are goal oriented and aligned towards meeting organisational goals

and shareholder expectations. There is a great sense of team work and motivation to meet business goals as the success of the organisation impacts all team members.

Career paths of scientists

B2 closed its research laboratory in Australia and the scientific staff was made redundant. The company still has a small team in Germany that conducts basic R&D which has been scaled down too. There are not many opportunities for scientific staff to grow as there is no formal performance evaluation system set in place. Both P2A and P2B are scientists by training who have now transitioned into the business side of Biotechnology.

P2A and P2B share their observations and experience of career paths of scientists in Australia. P2A points that nowadays, “researchers have to move around more”. P2B who has previous experience working as a researcher at a university discusses her career path, pointing out that when she started her MBA she did not share this information with her colleagues because, “they would think that I was not a serious researcher because I was doing a business degree”.

On the topic of whether OI has changed career paths of scientists in any way the interviews data reflects that the participants did not view any particular changes having taken place particularly due to OI. However, they observed that due to the dynamic economic environment scientists in Australia no longer have job security. Mostly scientists are now employed on a contract basis making it harder for scientists to grow in their careers.

Role, responsibilities and skills

As mentioned previously B2 did not have a formal organisational structure. Hence, roles and responsibilities of staff at times overlap depending on business needs. P2A mentions that there is:

> Rough division as in who is taking care of what…This means there is a division of jobs in terms of projects and collaborators or companies allocated as in who is managing which collaboration or project (sic). This means that one person is responsible for coordinating, managing and maintaining the contact.

For example, P2A is responsible for managing the scientific project side of business whereas P2B is responsible mainly for business development and IP however often their work overlaps. P2A and P2B job share, as P2A observes “in the sense that we sort of all write press releases when needed, we write papers, we write for grants”. There is an emphasis on communication internally so as to ensure that other staff members know about what others are doing. There is a sharing of ideas and suggestions to help each other.

Overall interviews from B2 shows that for scientists working in the Biotechnology sector flexibility, team work, multi-tasking, openness to feedback and inputs from other team members are essential skill requirements. Success of work is inter-dependent on all team members working together while dealing with the dynamic nature of business needs to work in small sized Biotechnology.

B3

B3 is a small sized Biotechnology organisation that provides customised chemical solutions to organisations. It is not like other Biotechnology in the sample that have a product line. At the time of the interviews there were 24 employees at B3 in total and ten were associated with R&D. When the organisation started it was a research focused organisation with around 40 scientists. However, the company moved away from pure R&D and the R&D has been re-aligned to have a more commercial focus. Most of the employees at B3 have been with the organisation since its inception. It has a flat organisational structure with the top management and then the rest of the employees. It is a small close-knit organisation that takes pride in its technology and team work. Based on the company's website which indicated various strategic partnerships an invite to participate was sent to the MD (referred to as P3) who agreed to participate. During the interviews it was discovered that the company had a change in ownership which had led to change in its strategy and approach to research and collaboration for innovation.

At the time of the interviews, B3 unlike other Biotechnology firms in the sample had limited external partnerships for R&D due to the new owner's preference for a more competitive and self-reliant business model. However, the company collaborates with external researchers in case it faces specific issues and needs solutions.

P3 has been at B3 for over 25 years. P3 has a scientific background and has been associated with research and production over the years at B3. The interviews were conducted at their office in the South East of Melbourne.

Conceptualising OI

B3 used to work with strategic partners more actively in the past. Each partner contributed at different stages of the drug development process. The company still engages in partnerships to some extent but due to the change in ownership it has started using a less collaborative approach and there is less focus on R&D. B3 has changed ownership over the years this has impacted its innovation approach. When asked to define the innovation practices of B3, P3 states it is "Self-reliant, self-thought". P3 was not familiar with the term OI. However, P3 defines innovation at B3 as, "…trying to find new and novel ways to do things".

At B3 in spite of the redundancies in R&D over time, P3 does not see that its R&D has been substituted in any way. This is due to the fact that there has been a change in focus for the organisation from being a research organisation to a working in a more commercial environment. P3 explains the transition at B3 as follows:

> So it's no longer pure research for pure research's sake. It's research to get a product for the customer (sic).

The basic R&D processes are still there at B3 hence it is not considered that it has been substituted however; there have been considerable changes over time. The changes in R&D are described by P3 as follows:

> To get that product out the door… As opposed to previously we were looking at real innovation, or innovative-type research. A new technique completely or a new product a new something that you could get out into the market. These days it's not like that.(sic).

Although the staff at B3 miss the "excitement" of pure innovative research moving to commercialisation is considered "satisfying". In P3's words

> To do commercialised production is satisfying but doesn't have the same excitement level and everything else. (sic)

Overall at B3 the basic technology and knowledge is still there and it cannot be substituted. As P3 mentions there is a deep sense of pride and loyalty the employees have in the original technology of the organisation.

Individual-level Perspectives on OI

Benefits of OI

One of the benefits of collaborating with external partners for knowledge at B3 is it allows the company to gain more experience and technical knowledge. B3 expands its knowledge base and expertise while interacting with its partners and clients. For example, P3 shares:

> Like there's a project that I'm working on at the moment which is causing a lot of problems along the way and I'm discussing this with the client (sic). I'm saying, 'These are the problems,' but I'm not telling him what the solutions we find are.

This project has led to B3 generating new IP for itself along the way.

Overall, P3 finds working in a collaborative manner with external partners to be a positive experience that leads to learning and eventually growth in knowledge and expertise as well as sometimes, discovering new solutions.

Challenges of OI

One of the key challenges of working with external collaborators for B3 is the cost and the risk associated with it. As the outcomes in scientific work cannot be guaranteed hence sometimes in an attempt to try to do something new or try a new method of doing things B3 loses money. Over the years the company has learnt from its mistakes and also become more business savvy. It now tries to build risking sharing into the contract and ensures that there are milestones along the way. However, at times it still loses money and time.

Organisational Implications of OI

Planning and Preparing for OI

There has been no planning and preparation for OI at B3 because the company now works on a more competitive model. It associates mostly with universities and researchers to find solutions to problems it encounters.

Finding partners

The organisation looks for partners on need basis. It uses scientific journals and database to stay abreast of new developments in its area. Also, the company has over the years built a network that it uses from time to time for finding experts.

Evaluation and selection of partners

There is no evaluation and selection process followed at B3 as it is not actively looking for collaborators but only when it faces a scientific problem that it cannot resolve on its own. For this purpose, it prefers to collaborate with universities and research institutes with proven expertise in the area.

OI at B3

Different forms of OI

The company realised that as a research organisation it has built considerable expertise and technology in its core area and decided to focus on commercialising it. Therefore, B3 did not engage in-licensing or out-licensing although previously it has out-licensed and still has a few patents. B3 still engages in exploration of knowledge (inbound OI) through purchase of scientific services based on its business needs. As P3 explains that it works with scientists closely in order to understand new developments, "…so ideas which you see in the literature and you actually need to figure out in discussions with different scientists". It mostly collaborates with partners in case it faces a challenge that it cannot resolve with its internal expertise. As P3 states:

> However, if we do have problems we do actually discuss things with different people to try and come up with solutions. Specifically, with the researchers.

Overall due to its "self-reliant" model at the time of the interviews, B3 did not engage in diverse OI practices and had limited number and variety of partners. This is explained as primarily due to the new management's preference for a competitive model, as outlined by P3:

> The new owner wants it to be a competitive nature because he believes in competition models as opposed to helping each other models.

Given this scenario at the time of this research B3 had limited evidence of OI and partners whereas earlier it engaged in a wider variety of practices. B3 worked with external researchers and scientists to understand new technology and ideas emerging in the scientific literature relevant to the use of its technology. As P3 clarifies in the following comment:

> …researchers, PhDs, professors for problem solving. Mostly in universities but occasionally outside of that (sic).

The type of partner B3 engaged in depended on the need. The ultimate aim for the company previously was to get a drug to the market and different partners in the past were part of the process. Earlier there was a greater rigour around this however, due the change in its management B3 currently works mostly with distributors.

> It depends on what it is.…well, the strategic partners in the past have been ones whereby you have a whole chain associated with trying to get drugs to market, so we are one part of that chain. And so the strategic partners are actually doing different parts of that chain. And that still happens to some extent, but these days we're actually much more with the distributors…(sic).

The response above indicates that B3, engaged with partners especially universities more for knowledge, and with other partners more for market expansion, distribution and commercialisation purposes.

Management of OI

At the time of the interviews B3 did not have an IP manager or alliance manager. This was mostly because alliances were limited due to change to a competitive model whereby it no longer engaged in in-licensing or out-licensing of IP. The organisation's flat structure meant that the top management was highly involved in all operations and partnerships. There had been different areas that have taken prominence at different times. Since the company had conducted major R&D in earlier stages it is currently commercially focused.

B3 has had to shut down various divisions over the period of time, this was mostly due to strategic reasons. However, B3 still has a production division and one key personnel is responsible for division of work and/ projects. This is evident from the following comment:

> We have got different production groups still and each has a leader. And we have one person that sort of divides out all the work that comes in.

The strong IT systems that the company has developed over 25 yrs of operation aids in the management of its library of products and acts as a common platform for communication on various projects and departments across the company. This is reflected in the following comment:

> We have a very high IT platform, so they can actually…everybody can see the different stages. The production team will actually advise the sales team or the sales team can look in our production system and know what's going on and say, 'Look, I've noticed that it's bottlenecked here. Can you tell me what's happening?' Things like that (sic).

The IT platform system allows easy communication and saves times as all departments can view the progress on a project.

Individual-level Implications of OI

B3 does not have a HR department. The company has a flat structure with the top management and the rest of the staff members. The company has suffered loss previously hence it does not have a proper performance management system in place as it is still recovering from its losses.

It is inferred from the interviews that the transition towards commercialisation has had an impact on the R&D employees. This transition is described as "frustrating" by P3. This was mainly as most of the R&D staff started as researchers with the company and being shifted to a commercial environment was challenging for them initially. This is expressed by P3 as:

> …actually because most of us started off as researchers, so they've found that going to a more commercial, customised platform quite frustrating initially….Although now, because they're actually sort of their own little project managers and things like that, they're actually much more settled (sic). So we've got about half the staff upstairs that have been with us for more than fifteen years and probably the other half have been more recent. And we have a lot of casuals that come in and out to turn around and fill the peak times and things like that (sic).

Given the changes in their roles and responsibilities and the overall emotional impact on the R&D employees it is evident that P3 relates to their frustration as the participant shares their passion for research and innovation. The decrease in the number of R&D staff and employment of casuals to fill gaps suggests the flexibility the employees and company have had to learn and develop over a period of time.

Reward systems

At the time of the interviews B3 was considering offering its R&D employees rewards in terms of a profit-sharing model. The commercialisation employees focused on sales at B3 were already on a commission basis. The company had been running in losses earlier and has recently starting earning profits. Therefore, it was considering rewarding its R&D employees by sharing the success to keep them motivated.

Career paths of scientists

At B3 there have been redundancies over the years in its R&D. However, the career paths of scientist have not changed. P3 shares the journey the company has taken and the impact on career paths of scientists:

> It's hardly moved these days. Because whereas before we had, you know, at one stage I think we had about 70 staff upstairs (sic). We've gone down to about fifteen upstairs at the moment. So it's not so much as career path as, 'What are the extra jobs you're picking up around you?' and things like that all the time (sic).

The company has had to cut down divisions; it has closed the Chemistry division. Some staff have moved from the Chemistry division to Production. The transition the company has seen over the years has meant that it had to close down a considerable part of its R&D. As P3 shares:

> And whereas before we had a big R&D section, that closed down and things like that (sic). So lots of different areas have closed down at different times and what we've ended up with is this one poor business (sic).

At the time of the interviews there was no set formal performance management system for R&D staff. Hence there were no career paths that the company could offer. However, job sharing, secondments and multi-tasking among employees was promoted by management and encouraged. As P3 explains the performance management situation at B3:

> There's none at the moment. It's a case of they are set pretty much where they are (sic). There's sharing between the different positions in the different areas but there's nowhere really to move to….it's like a family situation, you know? (sic). The family's a family. You're either the mum or you're one of the kids and that's pretty much it, you know! (sic)

The flat structure of the organisation meant that scientists had nowhere to move but could learn new skills through opting for job-sharing and engaging in multi-tasking.

Role, responsibilities and skills

At B3 due to the transition the company has been through over the years there have been considerable changes for the R&D staff. Five of the original staff members that started with the company since its inception are still there. However, their roles and responsibilities have changed. The company had become smaller and more commercially focused whereas earlier it was a research organisation with a big R&D section therefore, the R&D staff had moved from leading teams to working in smaller groups. P3 explains the situation for the R&D staff in terms of responsibilities:

> The roles have changed in terms of the position that they actually have, quite significantly, if you take a look where they were 25 years ago versus now. The responsibilities probably less than what they've had before in some cases, whereas people, you know, may have headed up and had a staff or three or four before, now there's nobody – there's just their partner they're working side-by-side with, and things like that (sic).

In terms of skills, P3 suggests these have been changes there as well. These changes are part of growing and learning over a period of time through experience. Employees at B3 are moved around to different areas in R&D to enable multi-tasking and learning new skills and gaining new knowledge. Over the years P3 has noticed that scientists need to be more computer savvy compared to earlier. B3 takes pride in its IT systems and the technical knowledge that it has developed over the years. The company earlier had an IT division earlier and employed a programmer previously however, it has been outsourced. These redundancies have meant that internal staff over time has had to learn IT skills and improve their IT knowledge as they are required to handle day to day breakdowns on their own. There have been no new roles created at B3 in R&D; however, it has increased its sales staff due to its focus on commercialisation.

B4

B4 is a Biotechnology firm that has a unique platform technology that is able to deliver actives and drugs through the skin. At the time when the research was conducted it traded on the ASX and OTCQX (Over-The-Counter) in the USA. It comprised of 40 personnel, 17-18 were part of the internal R&D department. Initially the invitation letter along with the participant information form was sent to the Chief Scientific Officer (CSO) of the company. The CSO (referred to as P4) agreed to participate but could not provide any interviews with a R&D employee as the company was undergoing major restructuring. The interviews were conducted at B4's office in the South East of Melbourne.

B4 has a heavy focus on R&D. It has a Formulation division, a Bio-analytical division, a Clinical division, Regulatory expertise and a Manufacturing division. B4 conducts most aspects of innovation from conceptually thinking of a drug/ product all the way through to the development in order to test it.

Conceptualising OI

B4 is based on a core platform technology that requires inputs from various fields in order to diversify its utility. B4 is a progressive organisation that has an internal R&D led by a young CSO. B4's technology makes its necessary for it to be associated with partners. B4's need for OI is considered to be greater than most other Biotechnology firms as the organisation has "no choice" (P4), but to collaborate with partners to discover novel ways for its technology.

It is not possible for a Biotechnology organisation to possess all the skills and knowledge required to optimise use of a platform technology. Hence P4 describes OI as follows:

> Looking for skill sets that are outside of your organisation that you either don't have internally or you don't have the capacity or equipment to do yourself or you don't have the time to do it yourself (sic).

OI provides B4 the means to meet its need for expertise it does not possess internally at a fast pace because building internal expertise requires a few years. For a Biotechnology firm such as B4 it is considered preferential to associate with external partners based on its business needs so as to save time and money.

For B4, OI is a practical solution and is used not to replace its internal R&D but to fill a gap. OI also enables B4 to learn new skills therefore, it is viewed as supplementary to its R&D in the beginning. Over a period of time B4 is able to learn the skill or understand the technology better and then the external expertise becomes complementary. This is expressed by P4 as follows:

> It starts off as supplementary not from the perspective of replacing anything it fills a gap…So it starts off as supplementary when that skill set does not exist internally but for the most part you then proactively bring that skill set in or learn from them and then the external person becomes complementary.

For B4 the focus of R&D is on its core technology and diversifying it into new areas. OI can support an organisation where it lacks a certain skill or expertise. It is a tool used at B4 to support its core R&D activity.

Individual-level Perspectives on OI

Benefits of OI

OI has helped B4 save time in situations where there is a lack of internal expertise. In order to provide its shareholders value for money it is crucial for B4 to find solutions to problems as soon as possible. As building internal expertise can take considerable amount of time and being a publicly listed company B4 needs to be conscious of time because if it is not generating money it means it is costing the shareholders money. Hence P4 states that, “A company cannot spend 1-3 yrs building some expertise in-house when that can be obtained from outside”. It is easier to find solutions and expertise than developing it in-house in some situations. In P4’s experience it saves time and costs less in most cases. P4 has observed that B4 has been able to grow considerably in the last thirteen years by using external partnerships and collaborations to make the most of its technology. As shared by P4:

> We wouldn’t be a 40-person company escalated from a four-person company in absence of externals they have been pivotal to the growth. It’s because of us but we couldn’t have done it without them (sic).

Hence for B4, OI has not only helped it save time and money but has also, contributed to its growth at a faster pace than would have been possible otherwise.

Challenges of OI

At B4 some of the key challenges of OI are related to time, quality of work and cost issues. In P4’s own words, “Going outside comes with risks of cost and time and quality control and investment…emotional investment”. Working with external partners is viewed as challenging also due to difference in priorities and expectations. Furthermore, external partners may or may not be able to deliver or possess the level of expertise required. An example shared during the interviews reflecting P4’s disappointment with external partner’s lack of expertise after the initiation of the project is described next. B4 handed over responsibility for a certain aspect of a project to an external partner after being assured that they had

the required skills and expertise for the job. However, after two weeks P4 realised that the partner organisation did not possess the skills to perform the job either. P4 therefore, finds it challenging to work with partners as it can cost the company to lose time and money if the partner organisation does not meet expectations.

P4 explains that B4 being a publicly listed company has to be mindful of meeting its timelines and responsibilities to shareholders, this is expressed in the following comment:

> Importantly its time because publicly listed company you make announcements to the market about when you're going to do this here and this here and when a lot of those timelines rely on third parties a lot of time overseas so you don't have visibility you can't wander down the street, knock on the door and say show me what you're doing and you've put faith in them that they will get the job done and then it turns out that either they don't have the expertise to do the job or they are not putting sufficient resources behind it (sic).

B4 has had challenges with "big players" overseas as these organisations do not display the same commitment towards B4's business goals as an internal expert would. These organisations usually put the most junior project manager on B4's project when the company has made a considerable amount on investment. This is shared by P4 as follows:

> We have got involved with big guys overseas what for us are big amounts of money but for them it's not and they put the most junior project manager they have on it and they don't just take your job seriously and it's your company's life is really on the line (sic)…so that's why anything you can do internally and have that control over is preferable because for a publicly listed small Australian Biotechnology with limited time and limited funds every time you hand over responsibility to someone else you lose a bit of control over meeting all the deadlines so that's always the major risk.

Due to the challenges it has encountered B4 prefers to work with internal experts and intends to gain as much knowledge and learn as much as possible when working with external partners so that the company would not need to go outside for the same knowledge at a later stage.

Organisational Implications of OI

Planning and Preparing for OI

B4 did not engage in any planning or preparation stage for OI. This is because the company has a culture that is based on collaboration and team work. P4 believes that science is a collaborative field and scientists by virtue of their scientific background and training understand the need for collaboration at an early stage in their careers. Hence a scientific organisation like B4 does not need any planning or preparation to look for OI practices. As P4 comments:

> As scientist we're all trained to acknowledge where we have hit the point that is not within our expertise and so we go out and we find where the expertise is.

Therefore, at B4 collaborating with external partners for innovation is viewed as a natural process and is part of its R&D culture. As outlined by P4:

> In this industry anyway coming from science, we're all trained…mean you do your PhD, you look through the literature you're always oh! I don't know about this, a guy over in Germany did a similar experiment let me just contact him and see (sic).

This shows that for B4 OI is a natural way of conducting R&D to fill in the knowledge and expertise gaps from time to time based on its business needs.

Finding partners

OI at B4 is due to the fact that generally scientists encounter a knowledge gap that cannot be filled through internal knowledge. This leads to the need to engage with external collaborator/s who can offer the appropriate knowledge required. B4's engagement with external partners is dictated primarily by its business or knowledge needs at a certain period of time. The strategy followed at B4 is that whenever the internal team faces a knowledge gap they look outside for someone who can fix it and they learn from it so that next time there is no need to look for the same knowledge outside. This way the company keeps expanding its knowledge base. P4 summarises B4's approach to looking for external knowledge as follows:

> Initially when we started none of the expertise was internal so we had to do a lot of stuff with the external expertise and as we grew we started to bring that expertise in-house and then we grew to a certain stage again where we had expanded our technology to the point where we did not have the expertise in-house again so we looked outside and came back in. At any one time we have a range of skill sets that are outsourced as we grow we tend to bring that skill set in-house but then we grow further and look outside again. So we have worked with many many (sic) people and have an ongoing relationship with outside expertise (sic).

B4 usually uses scientific advisors, CROs, and its network to find new partners. Scientific advisors sometimes act as intermediaries and introduce B4 to partners who have similar research interests or can offer required expertise. P4 explains:

> We've had plenty of situations where one of our advisors will go, 'You know what? Your stuff looks really good. You should talk to this guy. He's looking for something like this. I'll introduce you.' And so there's a lot of who you know about it. And that goes into the investor relation side as well…so there's a lot of that kind of stuff, and a lot of shared expertise (sic)

At times attending conferences has helped to find new partners as well. P4 shares an incident where at a conference a chance meeting with another scientist whose work was similar to P4's led to a discussion between the two scientists that resulted in a two-year long collaboration. Networking and word of mouth appear to be useful tools to find experts too.

Evaluation and selection of partners

Evaluation and selection of partners at B4 is conducted on the basis of the work in question. For example, the company would not internalise expertise that it may need or use only once. One criterion taken into account in all cases is the reputation and recognition of credentials of potential partners. A preliminary research is conducted to see what kind of organisations or experts can offer B4 the required expertise.

In case B4 is only seeking contractual work that is, purchase of scientific services it will ask for 'a request for proposal' from a few selected companies. This proposal highlights the scope of work that B4 is interested in engaging the external partner for and a request to provide with a quote and a breakdown of costs and timelines. Reputation, credentials, along with cost and time are some aspects that B4

considers while selecting and evaluating partners. P4 declares, "Everything is about cost and specifically time…And then you obviously use that, factoring in other things as well" (sic). P4 cites an example of how the toxicology firm that B4 works with was selected. Talking about this firm P4 states that it was:

> ….not the cheapest but absolutely the most well-reputed firm in the U.S. with respect to that (sic). So in this game you really want to do things as much as you can once and do it properly…Expertise is worth its weight in gold in this industry. So if you're talking to someone who has done something very similar to you before odds are you'll pay a bit of extra money to ensure that what they do is something that the FDA will recognise (sic).

At B4 the cost factor is weighed in conjunction with risks and benefits. Therefore, in some cases the company may opt for the most expensive expert if the work is of critical importance to its success.

OI at B4

Different forms of OI

B4 is a Biotechnology organisation whose main purpose is drug development for internal programs as well as for external parties such as other larger Biotechnology and Pharmaceuticals companies that may want to use its technology. B4 engages in licencing-in technology and out-licensing. Due to its strong research base B4 is able to form research alliances with Pharmaceutical companies and larger Biotechnology firms to work on certain aspects together. The focus for B4 in such scenario is to create a product for these companies that they would want to license. In other cases, B4 has its lead products that it develops to a certain stage in order to license it out to Pharmaceutical companies. Therefore, B4 is more orientated towards licensing out technology as P4 elaborates:

> At all stages it will be a licencing out, you've to either licence out or sell or launch the product yourself and we're a research company we don't have the infrastructure to have a sales force that would sell drugs or the amount of money it requires to get a drug approved on the market so it's always about licensing it off (sic).

Furthermore, it purchases scientific services from independent researchers, scientists and CROs. The company website mentioned a number of partnerships across the globe and during the course of the interviews it was mentioned that 16 of those were still in place in addition to another 20. It engaged with a wide variety of partners. B4 had collaborations with key opinion leaders from industry and academia who act as scientific advisors for the company. B4 had joint development programs on products with Pharmaceutical companies both small and large in addition to other Biotechnology firms. Additionally, B4 has a development partner in Germany. B4 worked with regulatory agencies to refine its submissions to the Food and Drug Administration (FDA) in the U.S. along with a contract manufacturer in the U.S.. It engaged consulting agencies on abuse liability with respect to one of its products and, another for other aspects related to commercial manufacturing. For clinical work it collaborated with CROs, since it did not have expertise for Phase 2 and Phase 3 trials at the time. It partnered with experts in animal health and veterinarians to diversify the use of its technology. Furthermore, it has a personal care brand

that required that it has partnerships with departmental stores, as well as other sales and marketing agencies.

Partnerships at B4 are usually formed at the later stages of the innovation cycle. It has internal expertise to assess a product and determine its commercial potential, design formulations, conduct pre-clinical testing and conduct clinical trials with the help of CROs. However, at Phase 2 and 3 is where the company lacks expertise and infrastructure.

Management of OI

B4 has no specific resource who is an alliance manager to manage all its partnerships and collaborations for OI. Also, the company does not employ an IP manager. Nonetheless there is a dedicated Business Development Manager. At B4, due to resource constraints the management of OI activities are the responsibility of Divisional Heads who also form external liaisons for their respective divisions.

From time to time there are different project teams that are formed based on project needs and each has a different Project Manager depending on the expertise required. The Project Manager is responsible for each aspect of that particular project at a given point in time, involving managing partners and collaborators. Expertise and phase of development are factors that determine the Project Manager. As outlined in the P4's observation:

> So everyone has to have their expertise, but realise that they are working in a patchwork quilt of interrelated things, which the Project Manager sits over top, and makes sure that they're all playing nicely together, and that they're all plugging in where they need to plug in (sic).

According to P4, B4 follows a project-based approach to manage its collaborations throughout the innovation process.

Individual-level Implications of OI

Reward systems

According to P4 measuring performance is not easy in case of scientific work. B4 is in the process of revising the Key Performance Indicators (KPIs). In P4's opinion, "KPIs are notoriously difficult", the reason being that everything is inter-linked so it's hard to measure performance. The nature of work is that of teamwork and team goals take precedence as each employees' work is part of a chain and relies on other people. An example that illustrates this is outlined by the participant:

> You might say to someone who handles the toxicology that one of your KPIs is that we've to finish the toxicology study by Christmas but for her, and this is a real situation, for her to finish the toxicology study by Christmas she has to have a product manufactured, for that product to be manufactured, the CMO has to finish the tech transfer from the formulation team and the formulation team have to get stuff from CMC in order, so she only needs a tiny thing to go wrong here (*points to different sections on the table*) here, here, here, and here before it snowboards into her not meeting timelines for the KPIs (sic).

P4 prefers to have a mixture of overarching company KPIs and linking these to staff incentives. An example given by P4 is that, the company may decide that share options might be exercised if the share price reaches 'X' in order to align all staff to work towards a common business goal. As at the time of the research the company's performance management systems were being reviewed and reconsidered P4 could not share more details about it. It was disclosed that the company planned to hire external HR consultants to work on its performance management system.

Career paths of scientists

P4, the CSO of the company started his career as a research assistant with B4 about 14 yrs back when the company comprised of only four people. He has seen the organisation grow to its current capacity. Career growth in B4 at the time of research was restricted to divisions this is because the company had already had a period of growth. R&D personnel can grow within those divisions. P4 explained the scenario at B4 as follows, "now I guess for new people coming in there will be walls and fences whereas when we started there was nothing" *(sic).*

Furthermore, the focus of the company has now shifted from Research to Development. For the R&D staff there is a basic technology that the company has already discovered and there is less innovation and science involved. The direction the company has taken is described by P4 as:

> We were a research company, and now we're becoming a development company. And research is to explore, invent, try things. Development is this standard way of doing things, and we have to do it that way. And so there's less room to freely explore the science of it (sic).

Whereas earlier the company would recruit from universities like in the case of P4 who started with the company while pursuing his PhD. Now the company would recruit scientists from other Biotechnology or Pharmaceutical companies. There is not much internal growth that is available to scientists as the company has reached a certain level of maturity.

Role, responsibilities and skills

B4 has job descriptions but since the company was undergoing a major restructuring at the time in terms of its human resource practices, everything was being reviewed and revised. P4 mentions that B4 prefers to recruit R&D experts in particular areas from the Biotechnology industry. It is expressed by the participant that there have been no specific changes in the roles and responsibilities of scientists due to OI although new consulting roles are added from time to time based on business needs. The company has its basic R&D divisions but as it grows it intends to acquire greater expertise over a period of time.

In terms of skills it is mentioned that scientists need to be knowledge experts in their field plus, need to be more commercially orientated as well as ensure rigour and accuracy around documentation. Scientists in small Biotechnology firms like B4 have no other big divisions to rely on for work and input therefore, they need to be creative problem solvers. Additionally, due to the interconnected nature of R&D work at B4 teamwork, and clear and timely communication are highlighted as key skill requirements for scientist. This is highlighted in P4's comment:

> No one can work in their own little silos of hidden information everything that needs to be shared has to be shared in a timely manner otherwise because this guy is not sharing information it can have implications for this guy, this guy and this guy (sic) (P4 points to different ends of the table).

Moreover, according to P4, in small Biotechnology like B4 scientists have to be multi-skilled and engage in job sharing from time to time. As P4 points out ",….everyone does a number of jobs all the time. So you're wearing many, many hats." (sic)

At B4 there were no specific changes in roles and responsibilities of scientists although there was no denying that the skills and expectations from scientists have changed over the years such as need for more team work, communication, multi-skilling and project management.

B5

B5 is an ASX listed Biotechnology company with offices in Australia, the U.S. (in New York & Texas) and Singapore. The company has 110 employees. The Melbourne City office has 20 employees who are primarily involved in basic R&D through partnerships. At the time of this study B5 engaged more in development work as the basic research was conducted by the company earlier. The current strategy is described as "commercial development work" by the participant. In terms of hierarchy it is a flat organisation, the organisational structure is described as mostly flat, the top-level being the CEO, the next level is the executive group followed by the rest of the team.

P5 the Vice President of Research Operations who was previously Vice President Alliance Management agreed to participate. However, when asked about help with getting participation from any of the R&D team members and the HR Director the request was turned down. The HR Director was contacted directly by the researcher but no response was received. At the time of the research P5 had been with B5 for nearly seven years. The participant had a successful career spanning over thirty years in the Biotechnology industry in Australia. The interviews were conducted at B5's office in the City of Melbourne.

Conceptualising OI

P5 who has been working in the Biotechnology industry in Australia for thirty years finds that OI has been practiced in some form in Biotechnology for more than two decades. The definition of OI as given by Chesbrough appears to P5 as "coining a phrase for something that has happened in Biotechnology for a long time". Nevertheless, P5 admits that there have been certain changes over the years. One, that there is a bigger pool of experts to choose from. Two, the advent of ICT has made the business more international whereas earlier it tended to be more locally dependent. Additionally, P5 expresses what has changed to a lesser degree is the emphasis on confidentiality, patents and payments.

Despite the challenges that are discussed later, P5 finds working in an OI environment a rewarding experience but adds that is "when it all works". Working in an OI scenario is described as considerable amount of hard work to keep "everything on track and to manage the alliances appropriately". It is reiterated by P5 throughout the interviews that finding expertise irrespective of location is important to

innovation at B5. For B5, OI is a complement to its R&D. B5 heavily depends on in-licensing from other organisations it is considered “the backbone” of development of the products.

Individual-level Perspectives on OI

Benefits of OI

P5 finds OI useful as it is expensive to completely develop a product in-house. Organisations cannot afford to employ 20 researchers and even then the researchers may not have the necessary specific expertise that is required for a particular project. Therefore, organisations have to look for expertise elsewhere. P5 expresses that, OI not only allows access to global R&D but also, allows greater choice and in addition offers a bigger playing field for organisations to operate and function in. Moreover, partnering with other companies allows for commercialisation in areas that may have been otherwise not possible.

When B5 approaches a university or an institute for a specific expertise then it benefits from the knowledge and skills of all the people from that department. If these people were employed by B5 then the company may not need their expertise once the project is finished. Thus, P5 considers it more beneficial to collaborate to increase “efficiency” and get “targeted knowledge” as and when required based on project and/ or product needs.

Challenges of OI

According to P5, too much openness in innovation can be detrimental and can sometimes stifle innovation. In P5’s experience it is important to ensure that B5 has exclusive rights to knowledge and technology so that it is able to use it to its advantage. In P5’s opinion a key challenge when working with outside researchers is that they get distracted by “interesting results” and “want to go off on tangents”. This has been a big issue for B5 as it operates with strict timelines, milestones and company objectives that are impacted.

The challenge while working in an OI scenario is to maintain a balance between meeting the development objectives of the company while allowing scientists engaged from outside the flexibility to initiate new leads. Additionally, collaborators’ priorities are not the same as B5’s. Therefore, P5’s role as an alliance manager becomes crucial at times in order to ensure that the collaborators stay focused, and stay on track with B5’s timelines and deliverables.

Another challenge of OI mentioned is that the organisation loses control on the confidentiality of its data. This is something that can happen while working with universities where students might be involved. The students might not fully understand the commercial requirements of confidentiality. Therefore, setting up a structure with collaborators who are not used to working with companies beforehand is of critical importance. P5 says, “You know, clients are very different, and the structure of the institutions are very different”. P5 explains the challenges of working with researchers from universities and research institutes as follows:

> The stimulating interest and the flexibility of the investigators to want to chase new leads. So that's always been a challenge. Institutions have lots of programmes, and lots of projects, and lots of students, and their priority isn't necessarily yours. So that's why alliance management is important, because you need to stay in touch, you need to get everybody to keep focused, you need to be watching the timelines, you need to be watching the deliverables. So that's what the challenge is. I guess the other is that there are a lot of students that get involved in the research, or can get involved, and students don't fully understand the whole commercial requirements of confidentiality. You've got to spend time setting up that structure with people who aren't used to working with companies….When it's out there, you lose control of the confidentiality of your data.

This shows that the management of proprietary information is a considerable challenge when various researchers from different groups are working on the same project.

Organisational Implications of OI

Planning and Preparing for OI

B5 has grown exponentially over a short span of few years which has led to an increase in the number of collaborations and alliances. During the growth stage the organisation looked into investing in buying processes and systems to manage its alliances. The company evaluated project management systems (such as Stage Gate) but it was considered to be expensive and cumbersome for an organisation of B5's size. Also, the relationship database management system and/ or the legal tracking systems available in the market were not considered a good match to B5's medium-sized alliance management needs. The ideal situation for B5 would have been to get one of the systems customised to its needs but that was something the organisation realised it could not afford. So B5 devised a manual process using MS Office (MS-Excel and Project) and developing templates for summary documents for various projects.

In P5's opinion as B5's aim is to develop "commercially viable products" the organisation works on a business model that is based on working with partners to get the best results for its technology. Therefore, the employees in the organisation did not have to undergo any training or preparation to work with partners. R&D employees are expected to find the best partner who can aid in the development work of the organisation. The R&D at B5, in P5 words is "pretty much open".

Finding, evaluation and selection of partners

B5 does not have a formal screening and selection process for partners. The reason provided by P5 is that all the partnerships are different. Sometimes partnerships are opportunistic and in some cases the field is so specialised that there are only one or two groups around the world that have the required expertise. B5 has an internal group called '*New Product Evaluation Committee'*. This group evaluates ideas and proposals based on various factors such as cost, technology and value from partnership. The focus at B5 as stated earlier is to develop commercially viable products through strategic partnerships. Therefore, it engages with different collaborators who might have their own proprietary product that are tested against B5's technology to identify the right partner. Flexibility and speed of response emerge as important qualities sought in collaborators because sometimes timelines are delayed and sometimes are accelerated.

OI at B5

Different forms of OI

B5 collaborates more with institutes and universities. Partnerships are based primarily on the product being developed and the stages of development. These partnerships are spread throughout the innovation process. A strategy followed when working with institutes is to first conduct a short pilot study and on the basis of that data B5 then evaluates if it would like to expand the study further.

P5 states that when partnering with universities the aim is to develop “cutting edge” technology. B5 considers working with universities mutually beneficial because the university provides the expertise and the company has the capacity for large-scale manufacturing and clinical trials to get the technology to market. Sometimes B5 might work with inventors from universities and research institutes on the basis of an IP arrangement and if the research proves valuable then it is licensed.

At B5, in-licensing is considered important to bring new IP especially, in cases when it’s a brand new area where there is a lack of skills and/ or expertise within B5, then the preference is to license-in. In P5’s opinion, B5 prefers to fully own the IP because this way it is “cleaner” in case there is an out-licensing deal with a Pharmaceutical company later. According to P5, B5 only engages in out-licensing as the “commercial exit” for the product to generate income for further R&D for new products and opportunities. This allows for a pipeline of products that they can develop. Hence, the overall strategy at B5 in P’s view is to “in-license everything” to ensure “all (our) bases are covered” in order to licence out.

B5 has also engaged in sub-licensing that is, it has transferred technology to an overseas company giving them the rights to manufacture and market the product in that particular country. Overall, B5 is open to partnerships will a diverse group of companies irrespective of location however; P5 makes it clear that B5 does not engage in partnering with competitors.

Management of OI

As mentioned formerly P5’s role was wholly alliance management however, due to some internal restructuring the role is no longer dedicated to just alliance management but also, oversees the Research Operations. P5 described the alliance management role as “complex” due to the fact that relationships are diverse in nature in the Biotechnology sector, especially with partners located across the globe and in different areas of expertise. Alliance management is still considered critical to the organisation’s partnerships as there is a need to keep a track on all the alliances, royalties and other payments. Over the course of time the company has realised that having a centralised alliance management role is not ideal due to the nature of its business. Hence, there was a transition in P5’s role.

B5 is described as a matrix type organisation in terms of work distribution. As P5 says:

> So you kind of work as a team together, but the alliance management person really keeps it all working. It’s setting up the meetings, it’s reminding people where we are, it’s reviewing the business pans, reviewing the

> budgets, you know, just saying, 'Hey, things are not quite going according to plan here.' You call the internal meeting. Then you go out and you meet together as a group. So it's not one on one, it's always a team base, but the alliance manager is the champion that just keeps everything on track, you know (sic).

P5's role is primarily responsible for alliance management however; the role encompasses being part of various teams for different projects. This is because each project team needs representation from different departments. While P5 is responsible for driving the relationship with the partners in terms of strategy, outcome and deliverables, other team members look at other aspects of the project and partnership. Therefore, although P5 has a senior management role for alliance management, this role is not the single point of contact for all partnerships. For every project there is a team that comprises of personnel from various departments for example, for a particular project the head of pre-clinical, head of research and project expert as well as the alliance manager will be a team. P5 observes "we're all fluid across the organisation". However, the alliance management role is crucial as the final responsibility of "keeping it all working" is its primary focus. This is done by P5 through setting up meetings, keeping a track of the progress and sharing it across the board, reviewing business plans, reviewing budgets, sending alerts if things are not going as per plan and, implementing improvements to meet objectives. Consequently, the alliance manager at B5 is the champion keeping collaborations on track.

At the time of the research, the organisation followed a project management approach towards OI. Overall, at B5 it was considered important that in order to managing OI it had an alliance management resource. According to P5 this is because to work with collaborators it is important to build a relationship with them in person, and get to know them. Additionally, regularly meeting with collaborators and showing passion and interest in the results was considered necessary and important by P5.

In terms of management of its IP, P5 says that once B5 identifies an idea that is of interest it exerts tight control through "strict confidentiality and non- disclosure provisions". The need for protecting ideas throughout the development process by use of proper contractual agreements with the partners is considered paramount. An alliance management resource was considered crucial for this purpose too.

Individual-level Implications of OI

Reward systems

At B5 the focus is generally on team work thus, performance evaluation is viewed as "subjective" (P5). The focus on team based objectives and not individual objectives makes measuring performance a considerable challenge. So the performance of team in P5's opinion needs to be measured in terms of whether the team is able to meet the deliverables and timelines. Overall at B5, employees are more focused on meeting organisational level objectives.

According to P5, in Biotechnology firms the work ethic is unlike other fast-paced companies. P5 observes that people at B5 are not driven by bonuses but a sense of achievement that is derived resolving problems in order to meet organisational goals. On the topic of incentives and reward systems

P5 summarised the discussion by saying “it’s nice to get a pat on the back but that’s not what incentivising people is”. This shows that what matters more at B5 for staff involved in R&D are internal drivers such as successful completion of tasks and acknowledgement by peers of good work.

Career paths of scientists

There is no specific information shared by the participant regarding career paths of scientists at B5. It is suggested as the discussion progresses that the HR Director might have more information however, since it has been an exponential rise very few people have been in the organisation for two years and more. Therefore, career paths were unspecified at the time of research. Also, since the company structure is significantly flat there is more lateral movement in terms of progression.

Role, responsibilities and skills

According to P5, team members involved in OI initiatives need to have good time management and organisational skills while maintaining and managing relationships. At B5 there were three project managers in the U.S. but all the roles had a project management component. Multi-skilling and teamwork are highlighted as very important components of all roles. Employees are expected to share work areas and roles from time to time. There is considerable focus on team work at B5 for R&D purposes. Most staff members are expected to multi-task across areas. Therefore, flexibility and adaptability to change emerge as critical areas when working in an OI type environment.

A few skills mentioned by P5 that have become more important for scientists working in an OI environment were: good interpersonal skills, organisational skills, and the ability to work in larger collaborative groups. It is highlighted that what has changed especially for scientists is that they need to be able to work in collaboration with a lot of different people at the same time and not just be restricted to laboratory research work. Further, R&D personnel need to have the ability to prioritise and focus on what is important and be more commercially savvy. P5 suggests greater “commercial sensitivity” as an important requirement along with the ability to meet “stringent commercial timelines” as important areas. In addition, an awareness of IP and greater understanding of confidentiality issues is required.

B6

B6 is a small sized Biotechnology located close to Melbourne City Centre comprising of 19 employees. This includes an internal R&D laboratory on-site comprising of 11 employees. The company is listed on the ASX. Historically B6 was a drug delivery company specialising and focusing on a particular type of technology. In recent times there has been a shift in its strategy as the organisation decided to actively look for new opportunities in different areas. At the time of this research B6’s strategy is described by the Commercial Director (P6A) as “open at the moment” and “not limiting” to its earlier core technology while “staying with drug products”. The company had a successful history of developing products in-house (three of its products were successful in the market at the time of research). The scientific and laboratory personnel that worked on those products were still part of B6’s internal R&D. In coming years, the company plans to use its prior experience and success to move into other drug development areas.

The participant referred to as P6A joined B6 in 2001 as a Senior Scientist then moved to managing the IP for the organisation. In 2006, P6A procured responsibility of the Business Development area, since then has been a Director at the company while still being responsible for the IP portfolio as well (though the company has an IP manager). At the time of the interviews P6A held the position as the Commercial Director of the company.

B6 is quite unique in its approach to OI, as it has a strategy of not only being open to external ideas for innovation but involving all employees in its efforts for finding new opportunities and ideas for innovation. The details of this will be understood better as the discussion progresses.

Conceptualising OI

At B6, OI is viewed as allowing an opportunity and/ or sharing an innovation opportunity with others in order that efforts can be combined towards developing it or allowing others to take it to the next level. OI is described by P6A as "self-help and helping others*"* by *"*sharing an idea so that everybody can help with the solution".

B6 embraced OI through the "Innovation Exchange" idea which was a membership based initiative that the company joined in 2004. In this initiative companies were allocated an intermediary who would look at the company and evaluate it. The intermediary would do a similar exercise with other member companies. This then enabled the intermediary to find matches between companies and bring companies with similar interests together. According to P6A this initiative was "an incredibly good initiative" however; B6 decided not to be a part of it anymore as it was "a bit complex". Moreover, B6 was more interested in being matched with other companies whereas, the initiative in the last few years started focusing more on matching companies with universities.

In P6A's experience OI complements B6's internal R&D because the company has developed its core knowledge through staff members who were brought in with specific knowledge and core competencies. Although the company has been open to new ideas and technology for some time recently it has further widened its horizon. According to P6A, B6 is no longer restricting to certain specific opportunities but exploring new avenues for novel ways of using its technology while not straying too far from its core knowledge area of drug development. The retention of knowledge through maintaining the key R&D staff over the years has helped B6 develop three successful products. Therefore, for B6 bringing new knowledge in is a way to enhance and to complement its core competency.

Individual-level Perspectives on OI

Benefits of OI

The key benefit of OI at B6 is not only in terms of increase in revenue but from an individual perspective the company has gained new knowledge through employee involvement in the process of innovation. Employee involvement in the idea generation process has led to staff viewing themselves as an integral part of the business. This is expressed by P6 as follows, "they are not just employee number" but "an essential cog in the wheel and they have value to add". In P6A's opinion, at B6 employee involvement

in OI initiatives have helped employees “recognise their own value” by using their skills, knowledge and efforts to help the company towards finding its next product.

According to P6A, the way B6 has used OI to generate ideas internally has led to an increase in staff morale because employees feel involved in finding the opportunities instead of “being told what to do”. It has helped “boost” staff confidence. The active involvement of all employees in identifying the next product for the pipeline has been in P6A’s words “really, really quite constructive” (sic). This has been advantageous in two ways; one, the company gets new opportunities and two, it is able to motivate staff through involvement in the direction of the business. Employees are encouraged to suggest and present their ideas to the ‘New Opportunity team’. This initiative has further enhanced employees’ presentation skills. In addition, when an employee presents their ideas it further helps the company showcase to other employees the kind of ideas that might be of interest to B6. So even in situations where the employee’s idea is not able to progress to the next level it still encourages others through recognition within B6.

Furthermore, B6 by opening itself up to OI has had the opportunity to learn from various perspectives and evaluate various possibilities that it might not have considered earlier. Also, OI can eventually lead to saving considerable amount of time and effort. Overall, P6A sums up the experience of working with OI as “I really enjoy it”.

Challenges of OI

P6A admits that collaboration is always more of a challenge than the company taking complete ownership of its innovation process. In P6A’s view the key challenge for B6 has been to decipher how much “commercially sensitive information” to “put out there” to attract attention from interested parties. P6A observes that it is about finding a balance between giving enough information to stimulate interest but not “giving too much” to avoid everyone knowing what the company is intending to work on next. In P6A’s experience “there are a lot of companies that are just fishing for competitive intelligence”. Therefore, in case of OI, P6A thinks that companies need to understand that there is a fine line between what information to showcase versus understanding what to keep secure. In terms of IP management in P6A’s experience OI works well as long as it is clearly outlined at the beginning of the partnership “who’s going to be responsible for each of the bits”. Otherwise it can lead to issues with partners down at later stages.

Organisational Implications of OI

Planning and Preparing for OI

OI was not a well-known concept at the time P6A joined the company in 2001. After being exposed to the idea of OI through the initiative ‘Innovation Exchange’ B6 experienced a gradual shift towards OI. Over a period of time the company understood how to find opportunities although in the beginning it found it not an easy process to source collaboration opportunities. B6 had to learn to decipher whether the problem led to the solution or the solution to identifying a problem that fits. Furthermore, the

company learnt that it needed to share a certain amount of information in order to attract interest whereby people would approach with ideas.

In order to prepare its employees B6 for OI, P6A shared the company had “a huge amount of training for managers”. Additionally, personality and psychological profile tests like Myers Briggs (and a few others) were conducted to ensure that project teams could be formed with personality types that would work as a cohesive team. B6 hired a consultant at that time to conduct these tests and form teams. Overall a top-down approach was followed to shift towards OI. The CEO at that time who was a scientist focused on innovation side of business championed the shift towards OI.

Finding partners

B6 has ‘New Opportunity teams’ that are focused on actively seeking and bringing new opportunities into the organisation. P6A observes that, B6 actively seeks partnership by keeping “an eye out” for what new research is happening. B6 involves all its employees in seeking and sourcing out ideas and partnership opportunities. P6A shares that all employees are “actively” looking for new opportunities and hence “have their eyes open”. In P6A’s opinion by involving its employees in OI initiatives B6 gains from different perspectives and benefits from “many eyes and ears”. This is done in a systematic manner. There is a set checklist available which needs to be considered by the staff member before submission of an idea.

Seeking opportunities through using all its internal resources is viewed by P6A as adhoc because what B6 is looking for is an open field. This means that the idea or opportunity is not restricted as long as it meets the criteria mentioned on the checklist provided to all employees. The idea eventually is evaluated through various levels of internal assessments and the top management decides if it will be pursued or not. The discussion with P6A highlights that the whole organisation is geared towards its OI efforts with employee involvement and efforts being made to finding the right partnership opportunities and/ or products for the company’s pipeline.

Additionally, B6 has contacts with key industry bodies such as BioMelbourne and AusBiotechnology. This allows the company to network regularly as well as to expand its network. These industry bodies also act as intermediaries by matching organisations with each other. For example, if the industry bodies are aware that B6 is seeking help to solve a particular problem and through its network is able to identify another organisation that can offer a solution they will help introduce the two. In addition, some of B6’s key investors act as brokers, by enabling partnerships through their contacts. Furthermore, B6 conducts online searches, has contacts at various universities as well as has access to various databases.

Evaluation and selection of partners

The opportunities found by the ‘New Opportunity teams’ are further considered and evaluated by the ‘New Opportunities Committee’ based on a selection criterion such as: technical feasibility, commercial feasibility and evaluating IP status of the technology whether there is potential to capture and protect the IP. Additionally, B6 also investigates who own the IP, what are the weaknesses of the party involved

for example, investing the financial status of the party. Further, it is also considered whether the technology investment is a key opportunity for B6, what is the maturity status of the technology, what value can B6 add to it and what value would it add value to B6 and its shareholders. Moreover, the engagement with collaborators depends on the product in question, the technology, timelines and cost involved.

B6 has learnt to have a systematic approach and set procedures for selecting partners. Hence B6 currently uses proper procedures and a checklist (the details of which the participant could not share) to ensure that due diligence is conducted before the contracts are signed. This approach in P6A's opinion allows B6 an opportunity at a later stage to revisit its evaluation and decision to engage in the particular partnership and be confident that it engaged with "the best possible partner, and (has) done the best possible deal" available at that time. Thus, during the discussion P6A reiterates that B6 has a systematic approach and "very, very uniform approach" when licensing in or out. P6A admits that there are set procedures and protocols that are followed this is primarily because "there's too much to lose by not following a systematic approach at that point".

OI at B6

Different forms of OI

At the time of the interviews B6 had seven partnerships. These have been formed by following a proactive approach to OI. Most of the opportunities B6 seeks and evaluates are a product in development or an idea or a technology. At some stage in the process B6 would either buy it or in-license it. Discussion with P6A illustrates that B6 has a preference to own the development program at early stages. This is because as P6A states, "collaboration is always more challenging than taking ownership". However, it is mentioned that B6 had a "50/50 venture" which could turn into "a true joint venture" at a later stage by setting up a subsidiary. Also, B6 has out-licensed some technology after evaluating that it was not their core knowledge area.

B6's strategy for OI is fuelled not only by externally sourced ideas but internal ideas from staff as well. An example shared by P6A is that for one of the company's key product in the market the "first name inventor is (our) finance guy". The employee was part of B6's 'New Opportunities team' as well as was involved in the 'Problem Solving team' at the time when the company was trying to overcome a problem. During one of the meetings the employee made a suggestion that the rest of the team agreed was a great idea. This idea then led to the development of one of the company's product in the market today. This is a good example of how the company has approached OI and used it to involve not just R&D staff but other employees in its innovation efforts.

Management of OI

P6A shares that when shifting towards OI, B6 hired a HR consultant for a "couple of years". This consultant had expertise in understanding personalities to help form teams accordingly and identify who needed training and for what purpose. The consultant's role was focused on training and development to gear employees towards an OI approach.

The shift to OI led to protocols of what R&D staff members need to follow. The company had protocols before however, a key the difference with the shift to OI approach was there was greater clarity of what was required of the employees to contribute to innovation. For example, there are specific assessment protocols that are followed for new technology/ idea so when an employee is looking at an idea there is a set protocol and checklist that needs to be completed before the idea can be submitted. This saves time and ensures that employees are not just giving ideas because they have to.

As is evident from the discussion so far, B6 has different teams and committees from time to time to overlook different stages and aspects of the product and/ or idea. There is a project management approach that is illustrated as teams are dynamic and members are replaced as the product and/ or idea progresses through different stages of the development process. Each project team is managed by Project Managers who have received specific training as well are aware of the communication style and other aspects of the members due to the psychometric tests. Hence, Project Managers are better able to understand the dynamics of the team and the make adjustments accordingly.

The senior management exerts its executive power to make key decisions towards what ideas will progress. The management has set key processes and systems in place for OI such as- checklists for self- evaluation of ideas before submission, processes for assessment of ideas that are submitted by employees, stages of evaluation and protocol to be followed before a technology and/ or idea is in-licensed or out-licensed.

Individual-level Implications of OI

Reward systems

P6A admitted to not being able to share specifics around incentive plans but agreed to discuss what “is in the public domain”. B6 has an incentive plan and employees are remunerated according to achievement of certain goals in the form of a bonus. The staff goals are aligned to meet business goals.

Reward system at B6 has not changed due to the company’s OI initiatives. This shows that there is no direct impact on employee remuneration due to the shift towards OI. An example given is that, even if an employee shares ten great ideas they are not rewarded based on it. Also, there are protocols followed before the company may actually decide to put time and money on an idea given. Therefore, employees are not evaluated or judged on their ideas. For example, the employee who came up with a product idea was not renumerated in any way but received recognition throughout B6. This is because it is mentioned in staff contracts that if the employees invent something as part of their work the company has ownership of it.

B6 has recognition awards for personnel who have a patent granted that the company owns but there is no monetary remuneration given for that. For example, the company might throw a big luncheon to honour the employee. Thus, OI practices are not directly linked to incentive plans or reward system at B6. However, P6A clarifies that although “it’s not (a) specific” link but “trickles down” as everything is

linked to the company's business goals and vision. In P6A's view, being more heavily involved in OI initiatives of the company from idea generation onwards helps employees to have greater visibility in terms of "why they are being asked to do something" as well as a deeper understanding of the strategic goals of the organisation.

Role, responsibilities and skills

In terms of R&D employees specifically there are KPIs aligned to their laboratory role. P6A shares that since B6 had re-organised its innovation processes recently it had altered the roles and responsibilities to make them stricter and clearer. In P6A's words:

> Reorganised a bit in terms of the innovation side of things…(roles)..slightly restricted. …more to relieve them (staff) of certain things as opposed to anything else.

When asked about the specifics of this, P6A states that would be confidential company information therefore, declines to share more.

The discussion with P6A indicates that there is slight reallocation from time to time of tasks depending on the business requirements. There are no new roles added to R&D. P6A elaborates that roles are added depending on the development cycle of the company. For example, when the company was developing its last product at the peak period there were 49 employees in the company, 30 in R&D. Therefore, P6A makes the points that employee roles and responsibilities evolve as products go through the pipeline. At B6 it is dependent on what area requires focus at a certain stage of the development cycle.

While discussing the skills required by R&D staff to work in an OI environment, P6A points out that although the company has the same staff members as before the shift to OI it did require developing certain skills through training. According to P6A, R&D employees were encouraged to have "an open mind" because if someone was "too rigid in their views and thinking" the concept of OI would be a struggle. An important skill that staff at B6 had to develop was the ability to work as a part of cross-functional teams. Managers were required to be able to manage cross-functional teams in particular. To form teams that encourage open communication the managers were encouraged to ensure that everybody in the team was able to communicate and express ideas openly. A deeper understanding of each team member and how the team functions has been something that managers at B6 have had to learn as the company adopted an OI approach. Therefore, P6A suggests "a leader, not just a manager" is required for OI; the focus is to "evolve everybody through the process". P6A states:

> The laboratory staff themselves are leaders of their bit…they are empowered to do what they need to do.

In P6A's opinion, this mindset and orientation helps the innovation process because if employees feels empowered they are able to achieve better outcomes. Thus, at B6 employee development has been a greater focus while shifting towards OI.

P6B

Another participant at B6 was able to participate in the research. P6B has been with B6 for over eleven years. The participant is a Chemist by background and joined the company as a laboratory technician. The company recognised that P6B's capabilities can be better utilised in another role and therefore, was offered a position that involved purchasing for the laboratory. After few years in that role P6B moved as an Assistant to the IP manager and was later promoted to the current positon of an IP manager. P6B has been in the current position for seven years. To perform this role better, the participant completed a Graduate Diploma in IP law.

P6B's role is being responsible for the IP portfolio of the company which includes liaising with partner's attorneys and licensing partners. The role is described by the participant as involving- "renewals, filings, office actions…prosecution of the patents in all the different jurisdictions". P6B has to work closely with the business development department. This is especially the case when the company is trying to identify new ideas and opportunities. Overall, P6B ensures that the IP situation is not compromised as well that the product or idea will eventually be commercially viable. P6B also has to liaise with the internal R&D department to understand the technical side of the product and/ or idea. Therefore, the role involves collaboration with various internal and external parties and the ability to understand the legal and the scientific side while maintaining a business focus.

Over the years P6B has seen the organisation evolve as the leadership changed from time to time. When P6B joined there was a major R&D focus this was aligned with the age of the business as B6 was in its early stages. Then when the CEO changed there was a more business orientated approach. At the time of the research, P6B points out that B6 had "come a little bit full circle" where the company is again focusing on the R&D side. Hence P6B viewed this evolution as a cyclical process. Although there have been changes the overall focus of the company has been the same over the years that is- to be innovative in the way it delivers its products. P6B described B6's business model whereby it evaluated products or drugs that were already in the market and found new ways to deliver "that will add value for licensing partners". In P6B's view B6 is open to always on the lookout for new ideas and innovation to see how it would fit into the organisation. P6B shared that B6 was open to pushing boundaries and evaluate new areas that it had not looked at before.

Conceptualising OI

P6B was familiar with the term OI as it was used in the course work undertaken for the degree in IP law. Also, P6B observed that it has been mentioned "quite a bit within the patent space".

When asked to define OI, P6B described it as "people collaborating to share knowledge and problem solve". P6B observes that this was quite common in R&D space in recent times. For example, B6 has worked with companies who have an idea but not the expertise and who consider collaborating as they are not able to achieve their goal otherwise. In P6B's words:

> So person A might have a certain skillset and person B might have a completely different skillset, and coming together they might, you know, solve a problem that individually they might not have been able to solve. So that's how I think of open innovation.

P6B has found that OI complements internal R&D at B6. The company has a talented workforce who is motivated towards achieving company goals. B6 brings in expertise to complement its existing core knowledge base and business needs. The company looks at bringing in new technology and innovation that would align with its pre-existing skills and knowledge.

Individual-level Perspectives on OI

Benefits of OI

At B6, collaborating with external partners has led to learning and enhancing knowledge. The knowledge gained then becomes a part of the organisational knowledge and helps the organisation at later stages. In P6B's view this knowledge and experience gained has also enabled the organisation to be better able to analyse its risks when venturing into new areas.

In some cases, P6B has observed that sharing information and knowledge with external partners has resulted in new perspectives that might not have been considered otherwise. At B6 the OI approach has led to a reassessment of the way work is done. P6B shares that this is because everyone works in a certain way and this can lead to remaining stuck in mindsets whereas collaboration brings in people from outside the organisation which change the way people think. Thus, it leads to a different perspective on the way things are done and provides employees with new approach to old things.

In P6B's case the experience of working with different experts in the IP area has led to new knowledge. P6B has found working in a "collaborative manner…a constant learning experience…feel like you're never stagnating". P6B observes that using the OI approach has "energised the company…everyone seems to have a bit of a spring in their step". This is evident in the case of R&D employees who are now able to see the bigger picture and understand how their role fits in overall. This has led to a greater understanding of their individual roles and motivated employees more towards the company's goals. Overall in P6B's opinion it has led to employees understanding that they are valuable members of the team.

Challenges of OI

The challenges of OI when dealing with external partners and internally are different. With external parties P6B found that OI can be a "little bit frustrating" due to the fact that it is "always a give and take of how much information you give" (sic). P6B states that can be challenging to strike the right balance between knowing "how much to reveal and how much to hold back". In terms of licensing deals P6B found partners to be "reserved" and "holding their cards close to their chest" when B6 needed more information in order to decide if it was a good idea to engage in that partnership. In P6B's experience despite confidentiality agreement the other party did not open up enough to enable B6 to assess the invention. In P6B's words:

> We were just trying to understand ways the innovation works, where does that innovation lie, because we needed to know what's the innovative step….They get a bit defensive, and we're not trying to attack it, we're trying to understand it. So all these questions we're asking, it's about understanding it, it's not discrediting it. But sometimes that's a difficult wall to pass over (sic).

Therefore, the issue of trust and lack of open communication appears to be a hindrance between prospective partners.

The challenge internally according to P6B is that working in an organisation that has an OI environment requires employees to work in a collaborative manner. This can be a challenge for some employees who do not like change. It seems OI requires adapting to change on a regular basis for employees with new partners, new way of doing things and new projects. P6B observes that employees who do not like change struggle.

Organisational Implications of OI

Planning and Preparing for OI

In order to prepare itself for OI, B6 conducted a series of seminars that were rolled across the organisation by senior staff members. These presentations enabled employees to understand what the company was doing, what was expected from staff, and how to assess the project that was assigned to a particular team. In B6's OI approach the whole organisation has been encouraged to participate in idea generation, as well evaluating. The move towards a more OI approach was undertaken in a systematic way through a top-down approach with employees having the transparency to see what the company wanted to achieve and how their contribution was valuable towards achieving it.

Finding partners

As part of the strategic planning the senior management team at B6 introduced a formal checklist to enable employees to think about new ideas and to identify new business opportunities. The checklist was presented as a part of the organisation gearing up to open itself up to new ideas and opportunities internally and externally.

Since employees are involved in the research for new ideas, the company created cheat sheets full of useful information, websites and provided other reading material to educate them about related matters. Employees were offered training to understand how to read patents and learn specific information to evaluate some scientific information. These enabled employees to conduct an initial assessment of their ideas instead of seeking help from an IP or business development personnel. This ensured that employees submitted only ideas that had potential and met the basic criterion laid out in the checklist to the evaluation team.

Another way B6 has found partners is through intermediaries who have introduced the company to third parties that have the knowledge and know-how related to the project or idea that is beyond current internal expertise.

Evaluation and selection of partners

At B6 it is a collaborative effort when it comes to evaluating new partners and technology. B6 as mentioned by P6B uses a checklist and has a team that evaluates new partnership opportunities. In P6B's view the use of the checklist ensures that due diligence is undertaken to ensure that the idea is "robust" before submission. Further assessment of the idea is undertaken by different employee project teams however senior management reserves the right on the final decision of whether the organisation would follow up with the idea or not.

The evaluation team for any project varies depending on the stage and expertise required. The assessment criteria for evaluating new ideas and opportunities were not shared by the participant. P6B shared that when assessing out-licensing deals the main criterion is evaluating the risk and reward factor. This is determined mostly by taking the product's market into consideration. For example, if the product is likely to have a big market then B6 would proceed with it to a later stage of development before considering out-licencing. This way the company can earn more revenue. However, this also would mean that the company is undertaking greater risk by investing considerable funds in the development process.

OI at B6

Different forms of OI

To foster OI internally B6 has focused on employee involvement through placing proper systems in order to utilise its internal knowledge and know-how. This is through OI project teams that are focused on idea generation to problem solving in a targeted manner. The example of the Accountant mentioned in the previous interviews by P6A is highlighted by P6B as well. Thus in P6B's experience B6 recognises that sometimes the "best ideas come from the strangest places". Overall, team work and collaboration within the organisation have been the cornerstones of B6's OI approach.

When looking externally for ideas, B6 is open to both licensing-in and licensing-out technology. At the time of the research the company was more heavily into licensing-out. This is because B6 has not found a technology that is the right fit which would enable better use of the company's in-house technology, knowledge and skills. In case of licensing-in B6 evaluates what would add value to its current expertise. In case of licensing-out B6 has had considerable success and has long term licensing partnerships. B6 has engaged in partnerships to commercialise products worldwide. Being a small sized organisation it does not have the capacity to market. B6 has worldwide licensing deals as well as targeted deals for each country or region depending on the product.

P6B has observed that at B6 preference is to sourcing external knowledge at later stages in the innovation process due to the risk involved with investment in early opportunities where potential is yet to be determined. B6 has mostly uses internal ideas though the company has opened up and is evaluating new areas and opportunities that it would have not considered before. The strategy is to bring external expertise depending on the project and its requirements. It might be for Formulation,

Clinical Trials and Manufacturing at a large scale. B6 usually prefers to use the same external experts unless it decides to venture into a new area.

B6 has been exploring partnering with other companies with similar technology if there is a difference in their approach. These companies may be competitors but with diverse platform technologies. Additionally, B6 partners with universities especially for early stage opportunities. Good relationships have been developed with some universities over the years; it has sponsored PhD students and offered students work experience in order to maintain the relationship with the university. Sometimes informal conversations with universities have been a source for new idea generation that has led to opportunities later for B6.

Management of OI

B6 has based its OI approach on employee involvement and participation. All employees are part of one project team or another at some stage and are encouraged to share ideas and find solutions in case project progression is stalled due to any problems. Different project teams are formed as the project progresses through different stages. This way different cross functional expertise can be utilised depending on the stage and expertise required to take the product and/ or idea to the next level. For example, there will be a team member with IP knowledge at the beginning of the project but as the project progresses the team may not need IP expertise. Later someone from business development might join the team and at another stage in case the project is at the formulation stage then someone with that expertise will join and someone else will leave the team. Therefore, each OI team at B6 is a cross functional assortment of employees bringing in expertise from various fields. All teams have at least one R&D personnel to ensure that the ideas are technically feasible.

Individual-level Implications of OI

Reward systems

P6B shares that employee contribution to generating new ideas is informally linked to performance appraisal but mostly company goals define team and then individual goals at B6. There has been no change in the reward systems at B6 even though employees are involved in the company's OI initiatives.

Career paths of scientists

As the company is planning to grow and expand further therefore, employees are encouraged to work collaboratively in cross functional teams to develop new skills and gain knowledge. This may later lead to an opportunity for the employee to move into a different functional area that may provide a greater sense of work satisfaction. P6B states that the career paths of employees at B6 are somewhat dependent on the stage the company is going through. For example, employees who were very focused on manufacturing before moved to regulatory side because B6 has no products at the manufacturing stage. This has allowed staff to be multi-skilled and in some cases showcase their skills for another area that they would like to move to eventually in their career.

Moreover, P6B states that since B6 is a small organisation where employees share work load and responsibilities this sometimes leads to resource re-allocation based on company needs and staff preference of where they would like to develop further. For example, P6B has from time to time had employees from other areas assist with the IP side of business when the workload requires extra assistance.

In terms of the participant's career path P6B got a promotion within B6 when the previous IP manager got a promotion. However due to the size of the organisation promotions are limited. The company has had the same R&D managers throughout.

Role, responsibilities and skills

P6B states that all employees at B6 are expected to "try and generate some new ideas or do a bit of research". B6 has formalised this process as part of staff responsibilities that they dedicate some time to doing research and identifying new ideas. R&D employees have experienced this push towards innovation as energising. P6B shares that earlier some of the R&D employees found their role to be mundane at times that is, doing the same experiment all the time whereas with the shift they are part of different project teams and are aware of the long-term business development goals as well as have knowledge of the clinical side of the business. This has enabled them to see and understand the bigger picture.

The importance of R&D staff to OI is highlighted in the following comment by P6B:

> There will always be R&D involvement, that's a crucial part of what we do here. Without R&D, we'd just be people thinking up ideas and then not going anywhere. Because you need that R&D expertise to be able to say 'Well, would this work and fit into…?' You know, push it through the lab and say 'Well this is interesting, but that's a no-go.' (sic).

Therefore, the roles of scientists have changed at B6, they are required to evaluate ideas and external technology suggested by other employees in addition to their usual work responsibilities.

Knowledge sharing among team members across the organisation has enhanced communication skills. Employees are no longer working in silos but as part of a bigger organisational team. Since B6 is a small organisation employees have to share duties from time to time. For example, P6B works in IP but at times has worked in the regulatory side as well as business development. Stepping outside of the set job descriptions is part of the way work is conducted at B6. However, it is dependent on the employee's willingness to step outside their comfort zone and participate.

Employees at B6 have been exposed to different areas enabling cross functional knowledge exchange and the ability to multi-task. In terms of P6B role's there has been a need to contribute more strategically towards business development thus the participant's role is not just IP focused but a dual role between IP and business development.

P6B has observed that working in a collaborative manner requires constant exposure to new information and changes this can cause some struggles for certain people. On the other hand, some people find it invigorating to be stepping outside their roles. For example, P6B found it exciting to be part of different teams and doing something outside of the IP portfolio. Hence, flexibility and openness to change appear to be crucial characteristics required for working in an OI environment.

B7

B7 is a virtual company that was founded in 2003 by P7. The participant is the CEO as well as the CSO of the company. P7 admits that his main focus is to oversee the R&D of the company. B7 is a virtual company with two other people who work in consultation with P7. B7 core capability is defined by P7 as "the ability to sort of hunt out new opportunities". This has changed over time as described next.

B7's strategy at the time the research was conducted according to P7 was to identify problems and then find answers to the problems irrespective of where the answer comes from. The participant had another Biotechnology company based on a similar strategy. P7 identified a problem and then spent considerable amount of time looking for technology that might solve the problem. This was aided by the fact that P7 is a scientist by education and training. The inception of his company came about when P7 figured out how to solve a certain problem. P7 found the technology at a University in the U.S. that had no patent. P7 decided to engage in a licensing deal with the university to commercialise the technology which led to foundation of B7B (P7's other Biotechnology). Based on this experience P7 realised that this model of identifying a problem first was much better though the participant acknowledges that "it is completely the other way around from what most Biotechnology" follow.

In P7's view at B7 the earlier model was based on identifying "magical IP" for this purpose the company website had a 'technology commercialisation form' (it was available at the time of participation). This form could be used by anyone interested in selling their IP to B7. However, P7 soon realised that there was an issue with this approach. P7 admitted that it was not possible to know about "every protein, every gene product, and every disease". Therefore, when B7 was approached by prospective partners the company had to hire advisors to understand the technology in question and in some case it was found that the advisors did not have deep knowledge either. Thus, this approach was disbanded as P7 was spending money and time on advisors and meeting people who, the participant shared "tell you all sorts of things, some of which are true and some of which are not true". In addition, P7 realised that not many people would go to the trouble of filling in a form and sending it. This experience led P7 to devise the current strategy that B7 was based on whereby the company proactively made contact with inventors, innovators, universities, research institutes among others after conducting a basic research on their work. This allows P7 to gain knowledge about the technology and understand its scope. Hence when B7 approaches the potential partners P7 already knows their publications, research and in some cases knows "almost as much about their research as they do". This way the conversation that P7 has with potential partners is more informed and if they say something that is not true then P7 can easily identify it. This approach has been found to be more beneficial for B7. P7 meets people who have

technology that is of interest and B7 has internal expertise to work with it. P7 states that finding the expertise or technology outside to answer the problem identified is not the issue but "the problem is what are you looking for? And you can't be looking for everything" (sic).

Conceptualising OI

P7 was familiar with the term OI. It was shared at a recent meeting in South Australia therefore; the participant studied it. P7 suggested that OI was best defined by "what it is not". An example given by P7 is that of a big Pharmaceutical company that conducts in-house R&D behind "closed doors and don't let anyone know what they are doing and then 20 yrs. later out comes a drug" (sic). This is defined as closed innovation by P7. OI is considered the "opposition of that" this is described by P7 as:

> You want to solve a problem and you just look as far as you can for where you might get the bits of the puzzle. And there might be one piece of the puzzle there and one piece there and somebody puts it together (sic).

Even though B7 has no in-house R&D, P7 views OI as a complement to its internal knowledge. This is primarily because P7 believes that it is best to do "whatever you can yourself and whatever you can't do yourself, you should get other people to help do it".

Individual-level Perspectives on OI

Benefits of OI

OI has allowed a company like B7 to flourish with limited resources and capital. It has enabled P7 to be an entrepreneur and create a niche for his company by using his own knowledge and expertise to identify problems and exploit external technology to find solution to those problems. In P7's view, OI practices are essential part of B7's approach and can generate considerable revenues when managed well. Furthermore, by collaborating with top R&D experts in the world B7 not only is able to gain access to required expertise but is also able to benefit from their reputation at the time of out-licensing the products.

Challenges of OI

P7 found dealing with "institutions, like universities or technology transfer offices…an abysmal experience. It is absolutely horrible". This is because in P7's experience universities are not able to judge if the project will be a success or not at an early stage and in case it "looks like a winner then they get greedy". In addition, P7 observed that there are different expectations and motivations between a university researcher and a Biotechnology scientist. P7 states that researchers at universities are not commercially focused and their motivation is different such as to attend conferences and write papers whereas a Biotechnology scientist like P7 is focused on ensuring that the technology can be of commercial value.

P7 found it "terrible" to work with universities, and research institutes. P7 shares that this is because to the university researcher it does not matter if the project fails because they still get paid, and can publish a paper on it therefore, the overall attitude towards the project is different. P7 states that "the fact that you might have spent five years on it doesn't matter to them".

In P7's experience OI works "great when we can control it". The way B7 operates is in a manner that the control lies within and external partners contribute to it. P7 emphasises that "as soon as you're under their control you're in big trouble". Overall it has been hard and challenging for P7 to work in an OI environment as, the participants shares that "lot of times it doesn't work".

Organisational Implications of OI

Planning and Preparing for OI

B7 is a small company with limited human resources therefore, there was no planning and preparation phase but a learning approach based on experience with different projects to plan and prepare for OI activities.

Finding partners

For P7, reading current literature to stay informed of new developments in the field is important to identify and find new partners. P7 also attends conferences within Australia and overseas as well as networking events to expand network. Furthermore, P7 had more than two decades of experience in the Pharmaceutical and Biotechnology industry has held important positions in various industry bodies. This experience enabled P7 to gain knowledge and skills to develop a vast network.

Evaluation and selection of partners

At the time of the study, B7 had four partnerships. There was no standard process for selection of partners. At B7 partnerships were dependent on how partners responded and their level of interest. Since B7 is a small virtual Biotechnology building credibility with experts in the field is considered crucial otherwise in P7's experience the partnership fails at the very outset. Therefore, P7's approach is to put time and effort into preparing to capture the partner's interest and curiosity. P7 expresses this as follows, "you can get entry if you put the time and effort into being able to talk like them".

Additionally, knowledge of other fields and clarity of what each partner will bring to the table is viewed as important by P7. Displaying knowledge and interest in other party's work helps to form rapport and connect at the initial stages of the interaction.

OI at B7

Different forms of OI

B7 associates with universities, research institutions, service providers; experts in the field irrespective of location for know-how and technology for R&D. Partnerships are mostly based on business needs and introduced at the stage when it is needed in the innovation process. P7 usually engages with external R&D collaborators to give shape to ideas. According to P7 drug development inherently is a based on collaborative effort as it requires support and involvement from a number of different parties at various stages of innovation.

There are no joint ventures as preference is to either generate IP independently and/ or to licencing-in technology if required. In P7's experience in-licensing is "notoriously difficult", though it can lead to large

gains at a later stage. For example, in case of B7B (P7's other Biotechnology company) P7 spent two years negotiating a license for a technology and bought it for $300,000. P7 shares that this was a "good technology and it was worth it" because the company is now worth $25 million. In spite of this experience P7 has focused on generating IP because "in-licensing is perilous. Perilous…in-licensing IPs is just so difficult" (sic). B7 therefore works with contract service providers and CROs to work on different aspects of its R&D process in order to generate IP.

P7 is an inventor of a new drug that was going to clinical trials the following year. B7 owns the IP for this drug and prefers to out-license it at the right time to generate major profits. Out-licensing technology is described by P7 as the ultimate aim of any Biotechnology and the best stage to do it is at the end of Phase-two. In case of B7, it out-licensed one of its projects to a public company which led to considerable revenue for the company.

Management of OI

In P7's view since all relationships cost investment of time and money therefore, B7 prefers maintaining few partnerships. This not only enables it to manage and keep track of partnerships but also build a good relationship with its partners.

IP management is considered critical to the success of small virtual Biotechnology like P7. Before engaging in any collaboration for R&D B7 ensures that proper agreements are put in place reflecting that the IP will be owned by B7. P7 states that this is done by the help of "consulting integrators".

The way B7 manages OI is project and need based. It works with fee-for service providers as well as collaborates for R&D with universities, research institutes, with CROs for clinical trials and bigger Biotechnology for licensing-out its technology. However, P7 views maintaining internal control in whatever aspects it can of the innovation process as imperative.

Individual-level Implications of OI

Since B7 has no employees but a small core team that comprises of P7 and two other members on its management team, therefore the company has no formal personnel management practices. B7's approach is to keep its costs to minimum in order to gain maximum benefits from its investment in various projects. Therefore, B7 does not have any full time or paid employees. In P7's opinion it is "the perfect business…better off just hiring people when you need them and then saying goodbye". B7 is a lean Biotechnology firm that uses its core internal knowledge to its advantage to convert external knowledge into commercially viable IP. It is an entrepreneurial venture of scientists from the industry with a vision and an open attitude.

B8

B8 has offices in Australia and the U.S. There are 50 staff members in Australia and 25 in the U.S. The participant P8 joined B8 as a Research Scientist ten years ago. At time of the research P8 had been working as the Scientific Director for over two years. P8's responsibility areas were primarily focused

on managing innovation including managing the company's R&D, external collaborations that is university collaborations in Australia as well as in the U.S.. Additionally P8 was responsible for the IP management and scientific training for the sales force in the U.S.. P8 managed all relationships with external collaborators for R&D purposes.

The core capability of B8 is described by the participant as "molecular genetics". P8 shares that B8 was "built on IP licensing" but currently operates on a different business model. The focus currently is on "oncology diagnostics".

The office in Australia is located close to Melbourne City Centre and consists of a laboratory. However, it does not conduct R&D on its own although 5 years ago it had a dedicated internal R&D. P8 shares that the company realised that conducting "blue-sky research in-house is not very profitable" and it could suffer fast and major monetary losses. The company underwent a change in management over two years ago that led to a change in its strategy.

P8 states that since R&D is expensive the current strategy of the company is to be more cost effective by providing grants to experts outside in the field for conducting R&D for B8. This change is reflected in the way B8 currently operates, P8 shares that it offers "small scale funding to external collaborators (for example, in universities) and then transitions that research" using in-house product development expertise. There is a team of 6 in-house scientists who are able to transfer the technology related to product development. P8 discusses that the main role of these scientists is less focused on R&D but is primarily product development that is, "taking the final piece of science from an academic lab…and making it work commercially" (sic).

Conceptualising OI

P8 does not provide a clear answer about familiarity with the term OI. Instead comments that "I'm very familiar with innovation management". In P8's view at B8 it is simply "innovation" that is:

> Innovation across all areas of the business-in terms of process management, how we can do things better and cheaper in the lab…how we can innovate our marketing collateral for customers, right back to the basic R&D.

P8 therefore emphasises that at B8 "we practice innovation quite widely. P8 states that "I do not associate OI with anything"; instead reiterates that a company is either innovative or not. In P8's opinion the word "open" in front of innovation "is completely meaningless".

At B8 innovation is viewed not only in terms of research work but in relation to business approach too. An example given by the P8 is that to improve efficiency the staff may identify improvements that can be made in the workflow. It might be transitioning from a paper based system or managing staff more efficiently. Therefore, at B8 it is considered worthwhile to find out ways about how to best utilise its capacity and expertise to be innovative at all levels of business.

At B8 external collaboration for R&D is considered both a substitute and a complement. P8 relates to the change in B8's R&D strategy as part of a worldwide trend where big companies are cutting down

on R&D staff in-house in order to be more cost effective. P8 states that for B8 it is “essential” to have external partnerships now because it has no R&D in-house. In this sense P8 sees a substituting effect on R&D in a way. However, P8 admits that since the current R&D laboratory employees at B8 are “very much about how to transition…science to commercial” therefore, internal expertise is considered necessary to absorb the external knowledge. Thus, P8 sees it as complementing internal knowledge too.

Individual-level Perspectives on OI

Benefits of OI

The benefits of OI for B8 are discussed by P8 in terms of time and money. In P8’s view, OI mindset has enabled B8 to react to “new discoveries quite quickly”. For example, in case there is a new discovery in the areas that B8 specialises in it can evaluate the science at a fast pace in order to bring it in-house. This is made possible due to its close partnerships with external experts. P8 states that, OI allows B8 to gain an “early access to some blue-sky ideas” that may become real products in the near future due to its OI network. P8 found that these partnerships were more cost effective than maintaining a big R&D department in-house because “people are expensive”. According to P8 if B8 were to invest in the infrastructure to develop products in-house and acquire the “high tech instrumentation” required for basic R&D, it would be at a greater risk to the business. Consequently, working with universities and other partners for R&D provides a twofold benefit of access to infrastructure as well as expert knowledge. This minimises the risk for B8 while being wise financially with its investments in the business.

For the employees at B8 benefits of a more open approach have been that due to cross-skilling staff is more motivated and team work has improved. This has had an indirect effect on turnover in laboratory that P8 observed is less. P8 suggested that the overall employment conditions have improved at B8 as the company is not risking investment in R&D. Hence, it can allocate monetary rewards (in terms of employee bonus) if the business performs well.

Challenges of OI

The drawbacks related to OI are described by P8 in terms of time and money again. Since B8 associates with universities and research institutes for its R&D needs, the slow pace of academic research is a contrast to what B8 is used to in the Biotechnology space. The time required for a research study by academics is a hindrance; thus B8 has to evaluate the pros and cons of working with universities. Another difficulty when working with universities is the financial aspects. P8 explains that, universities have “overhead which have got nothing to do with research funding but (we) end up paying twice for the same thing sometimes”. A challenge when dealing with other partners is related to negotiating the best possible agreement because in P8’s experience “sometimes they are just ego driven”. Another challenging aspect in P8’s view is the issue of control in the innovation process while dealing with external partners.

Organisational Implications of OI

Planning and Preparing for OI

At B8 there was no formal preparation for OI instead it was a slow transition that took place over a period of nearly two years. As mentioned previously the change in B8's strategy to open R&D was largely driven by the change in management. P8 shares that the company's new management recognised that "just relying on licensing income from one or two parties" was not enough to ensure long term business sustainability and growth. Therefore, in order for the company to survive it required a change in the way things were conducted. The company has adopted a proactive approach towards innovation and business by reviewing all areas of the business constantly. P8 shares, that for example, the financials get reviewed every week; the science strategy gets reviewed "perhaps less frequently but several times a year". This enables B8 to adapt to changing business environment and needs.

Finding, evaluation and selection of partners

The section of finding partners has been combined as it is guided by the data collected. For P8, working with OI means understanding customer needs whether internal or external. For example, how the laboratory technician can do the job more efficiently, what does innovation mean to employees whether it is working with robotics or something different. In terms of external customers understanding how the technology B8 is producing can improve their work.

P8 considers market research to be crucial to identifying customer needs as well as to identifying the impact of the innovation in terms of how many people will it help. Therefore, overall P8 recommends that the best way to evaluate an innovation is to understand the big picture. Hence the key criterion for collaboration with partners is evaluation of the technology especially in terms of a market analysis to determine the potential of the new product whether it was a worthwhile investment or not. This evaluation based on strong market analysis enables B8 to determine how the company can manage to sell the innovation later. This shows that thorough evaluation is conducted to establish if the commercial case for the technology is strong and whether it has a market potential. P8 shares that decisions are primarily based on a "very strong market analysis". According to P8, B8's strength is "commercialising science" and over the years the company has established a "very firm route map about how to do that" which the company rarely deviates from.

B8 seeks to associate with top leaders in the field for collaboration. P8 asserts that there was "no point in seeking a collaborator who is perhaps not a world expert on a particular subject". P8 admits that preference is therefore, given to "go to the top first". The formal process is to conduct due diligence to identify the top world leaders in the field. In P8's view reputation is an important criterion in forming collaboration hence a world expert "whose name might be better on the paper" is given preference. Another factor is time when evaluating partners this means that if a partner can commit to conducting the study in a specific time period or less time compared to others then B8 is likely to select that partner.

OI at B8

Different forms of OI

Since B8 depends on outside R&D it collaborates with the partners like universities, individual inventors, research institutes, and industry groups among others. The scientific team at B8 is actively searching for new innovation and discoveries in the field. Literature is reviewed every week this way if there is a new discovery in some relevant field the company is aware of it quickly. Additionally, B8 receives regular feedback and communication from doctors, hospitals about new discoveries that they may have made. Moreover, B8's customers share information regarding new product/s that may be useful to the company. This idea sharing and knowledge exchange provides B8 with new avenues it can examine for developing its next product.

In addition, P8 shares that the company has an "innovation database" where employees "can put forward new ideas, these may be ideas for process changes or might be all sorts of things. Nothing is excluded". This is based on an "innovation form" that is available to all employees that consists of- "what the idea is, the area…brief estimate of the costs, if its available to implement, how much work it is to implement". This form can be used by employees for various purposes whether for suggestions of improvement in the way the laboratory works and what can be done to increase efficiency or it might be an idea about a brand new scientific discovery somewhere in the world. The company then evaluates it and estimates the cost of bringing the idea/ technology in-house, it might happen within a few months' time span or later in the future.

At the time of the research B8 associated with six to eight partners for gaining external know-how and technology. B8 uses external technology only when it is commercially ready that is, at the product development stage. P8 states that this means that "the science has already been demonstrated to be robust outside preferably in multiple studies rather than just one". Therefore, P8 explains that the way B8 operates is that it identifies "commercially useful discoveries that are made outside" and collaborates with those parties in order to bring it in.

B8 engages in joint ventures for developing new IP. P8 shares that the company was founded on licensing its IP however, that business model is changing now because (according to P8) "it drums up a lot of problems in terms of company reputation". In terms of licensing-in to acquire IP, it is not something B8 has engaged in extensively but only on a small scale. Licensing-in is largely determined by market analysis and evaluating if it would enable the company to get a product to market quicker by buying into IP instead of conducting a research study. However, P8 foresees that as the company evolves it is something that would be more cost effective in the future.

Management of OI

P8 acted as the IP manager since there was no dedicated IP staff member at B8 for IP management. However, P8 shares that the company had a licensing team comprising of two employees that work specifically on the out-licensing of B8's "non-coded patents". P8 states that this team spends time "simply analysing patent infringement from external people". P8 on the other hand is responsible for

deciding the IP strategy, management and development of new IP and managing the company's patent applications with the assistance of patent attorneys. Additionally, P8 also manages all external R&D collaborations and oversees the internal R&D team.

Individual-level Implications of OI

Reward systems

There was a formal performance management review that is conducted once a year at B8 which is linked to the employee remuneration. The contribution employees make to the 'innovation database' or how they perform or manage external partners is not part of the KPIs. In case of P8 though one of the performance criteria is how the external relationships are managed as it is a major responsibility area for the role.

KPIs for each employee are set in collaboration with their manager. Focus although is more on the performance of the team. An example shared by P8 is that if the product development team was asked to set up and run a test in 12 months and they managed to do it in 10 months then P8 would consider that as high performance. P8 states that what is incentivised are aspects related to what the company has or can take to the market. Thus, employees at B8 are evaluated on aspects that impact business performance. They would have key performance incentives related to how the business as a whole is doing. An example given is that if the company were to achieve a particular business goal all employees would receive a bonus.

Career paths of scientists

According to P8 there have been no changes in the "sense of progression" though it is "not formalised but it does happen". The job titles may change over time but P8 suggested it is not unlike to what one might see in a university setting however, the pace might be quicker. The details of this process are not shared by the participant. However, shares that a case in point is his own career at B8. He has been promoted to the positon of Scientific Director from Research Scientist over the years. The company intends to grow in numbers and increase its capacity in the next ten years in Australia. This was dependent on other environmental and business factors about how the business progresses and grows.

Role, responsibilities and skills

Employees who were earlier part of the R&D that was responsible for B8's basic R&D have been reallocated to other projects in-house. None of the R&D staff members were laid off although there was change in their job description. Some roles were disbanded due to the shift in the R&D focus of the company. The way the transition in R&D was managed was that no formal new job titles were given rather just a change in the role. Overall P8 admits that the change led to improvement in employment conditions because "R&D is actually very risky business".

Due to the transition towards an open R&D, B8 underwent some change. A part of the transition over the last two years was that employees underwent cross functional training. A benefit of this was foreseen as greater flexibility and resource management. For example, if a staff member was to go on

leave it would not impact the business as another staff would have the ability to perform the same tasks. Additionally, P8 found that it is beneficial for the staff in terms of “their career training because they get expertise in more things than they would otherwise”. Therefore, employees at B8 have developed multiple expertise and have a broader skill set to operate from.

The company had to recruit in the U.S. This was particularly related to Quality Assurance. Quality Assurance Managers who were aware of technical requirements and paperwork in the U.S. were recruited by B8. Their role involved ensuring that the company followed regulatory paperwork and all staff in the U.S. had privacy training. P8 states that in the Melbourne office no new formal roles were created although, “work practices have changed…the way we go about our day to day job has changed” (sic). One major change that P8 has observed is related to “efficiencies” and being flexible. The company has had to build processes in its laboratory to manage increase in work load while being more efficient.

A key competency required for the R&D staff at B8 observed by P8 is the ability to develop “protocol and follow it vigilantly every time”. Attention to detail, time management and precision are important as well as technical knowledge. In addition, adaptability and flexibility are considered crucial by P8 to work in OI environment. In P8’s view employees at B8 are required to be “more imaginative” and be willing to become cross skilled across different areas.

Conclusion

This chapter has presented in detail the data collected through participant interaction. Since this is a qualitative exploratory research also known as contextual it is considered important to describe the study population’s understanding and interpretations of the OI phenomena in order to capture their meaning and form an informed narrative. As mentioned in the previous chapter the aim of the first level analysis is to ensure familiarity with each data unit in this study. Therefore, this is crucial step for the researcher to understand the data in order to identify the emerging patterns as well as for the reader to understand the comparisons drawn in the next chapter and the overall conclusions drawn later. It is acknowledged that this process can lead to exhaustive presentation of data and might be seen as descriptive in nature by the reader (Miles & Huberman, 1994).

Chapter 5

Findings

The previous chapter presented a first level thorough analysis of the data. As discussed in Chapter-3, this chapter will take the analysis to the second level that is, provide a cross data and group analysis. This chapter presents the themes emerging from a comparative analysis across the data units. This chapter determines if the available empirical evidence in aggregate provides answers to the research questions, theoretical expectations and evidence from the literature.

Conceptualising OI

Part of the aim of this research was to develop an understanding of OI from the individual level. As part of this, participants were asked to define and describe their understanding of OI as well as any experience or factor that led to it. The themes that emerged about participant's description and/or definition of OI are as follows:

- OI is not a novel concept in the Biotechnology industry
- OI is about collaboration for knowledge and problem solving irrespective of source or location
- OI is a necessity
- OI is not a substitute for internal knowledge and/ or R&D

Each of these themes is discussed next in reference to the data and literature.

OI is not a novel concept in the Biotechnology industry

As has been highlighted by the argument in literature of whether OI is 'old wine in new bottles' (Trott & Hartmann, 2009) the data collected for this research reflects that majority of the participants considered OI to not be a novel concept. The idea that OI is not really new and in reality not many organisations have really followed a completely closed approach found support too (Huizingh, 2011). Half of the sample was aware of the term OI while the other half had no prior awareness of the term. P1, P2A, P3, P5 and P8 were the ones who expressed either no awareness of the term and/ or could not see the novelty of it. These participants when familiarised with the definition presented by Chesbrough (2003) referred to it as nothing new. Only P2B, P6A and P6B among the other half related to the novelty of the concept. This was primarily because all these participants had undergone IP training and handled the IP portfolio. For example, P6A before being promoted to the current position managed the IP at B6. P6B currently was the IP manager. P2B was responsible for business development as well as IP at B2.

P1's assertion "*I've been practising it since 1988*" is reflective of Trott and Hartmann's (2009) and Kutvonen's (2011) view. Similarly, other participants' view echoed Kutvonen's (2011) observation that since the late 1980s, technology transactions have increased and have been recognised as part of business strategy. Further Huizingh (2011) has suggested that Chesbrough's labelling of OI was "timely" which is what P5 pointed towards as well that OI was made easy by the advent of ICT.

According to P5, advent of ICT led to less dependency on local knowledge by making a wider pool of expertise available hence enabling easier and quicker access to global knowledge.

Additionally, another perspective from literature that is supported by the data collected is that of DeBresson and Amesse (1991) that innovation by nature is an outcome of collaborative efforts of few parties. For example, this is reflected in P8's opinion, a participant who refused to define OI arguing that the word "open" in front of innovation did not mean anything. Furthermore, P4, P5 and P7 views resonated this as well. Similarly, P1 and P7 thought of it as a just a term that was coined to describe the collective activities that encompasses innovation practices in the scientific sector. It emerges from the data that Huizingh's (2011, p. 3) conclusion that OI is an "umbrella" term that "encompasses, connects, and integrates a range of already existing activities" has value in practice as well.

A closer examination of the data suggests that company and industry characteristics might be a factor in participants describing OI as not novel. Collaboration for knowledge is seen as inherent in the nature of scientific work by some participants in the study. A similar view has been suggested in the research study by Segers (2013) that alliances in Biotechnology are necessary. A study by Perkmann and Walsh (2007) also found that organisations in science-based sectors (such as Pharmaceuticals, Biotechnology or Chemicals) rely on collaborative research. This is similar to what P4 suggested that scientists are trained to collaborate from early days at universities. Similarly, P7 shared the view, "*drug development is a team sport*". P1's, P2A's, P2B's and P5's views resonate with P4's and P7's who also emphasise that collaboration for innovation is inherent in the nature of drug development as it requires different expertise at various stages.

Inadvertently it turned out that organisations that agreed to participate in the study were SMEs. Most participants in the study referred to the limitations of being a small Biotechnology firm with restricted resources and responsibility to shareholders as a factor influencing the innovation approach of the company. Literature has also recognised that SMEs have limited capacity to manage the whole innovation process on their own and need collaboration with others (Edwards, Delbridge & Munday, 2005). Data from B2, B4, B5, B6 and B8 suggest that it is crucial for small Biotechnology firms to make optimum use of time, money and expertise in order to be responsible towards shareholders even if that means downsizing the R&D department.

It has been long recognised in literature that SMEs use external means of innovation to a greater extent than larger firms (Edwards et al., 2005; Rothwell, 1991). This is because alliances and collaboration provide these organisations means to evolve their technical capability (Lee, Park, Yoon & Park, 2010). Therefore, Lee et al. (2010, p. 290) suggest that for SMEs OI is not a new concept as there is already an external focus that is; they "use non-internal means of innovation". Furthermore, reconsidering the theme of 'OI not being a novel concept' in light of factors such as: 'nature of drug development' and 'limitations of small listed Biotechnology', it appears that for small sized Biotechnology firms OI might not be a new concept partly because drug development requires teamwork and alliances (as suggested

by Segers, 2013) and SMEs need external partners to innovate. Hence given the industry (Biotechnology) and company (small size) characteristics it is understandable that the argument that OI is not a novel concept found support in this study.

OI is collaboration for knowledge and problem solving irrespective of source or location

The interview data overall highlights that innovation practices and strategies has evolved. Organisations (with the exception of B3) in the study were proactively looking for partnership opportunities for innovation irrespective of whether there was an internal R&D department or not. This was also evident from the websites and company reports of the participating organisations. Six out of eight Biotechnology that participated have a web link on their company websites inviting and/ or showcasing current and/ or past collaborations for various reasons from development to commercialisation (of products and/ or technology). Furthermore, the annual reports showcased the benefits (commercial and monetary) obtained from the partnerships.

When asked to describe and define the concept of OI, participants referred to two main aspects; that of collaboration for knowledge and, for problem solving. As first noted previously (in Chapter 2), within the knowledge-based view organisations are knowledge entities and knowledge has been recognised as a critical element of innovation (Nonaka & Toyama, 2005; Bergman, Jantunen & Saska 2009; Wallin & Von Krogh, 2010). In addition, collaboration between people with diverse knowledge bases is important for innovation to occur (Wallin & Von Krogh, 2010) (as discussed in previous section too). This was suggested by most participants. Additionally, the problem-solving facet of innovation has also been highlighted within the knowledge based perspective by well recognised research (such as by Nonaka & Toyama, 2005). As P7 stated:

> You want to solve a problem and you just look as far as you can for where you might get the bits of the puzzle. And there might be one piece of the puzzle there and one piece there and somebody puts it together.

As is reflected in data and literature (Nonaka & Toyama, 2005) organisations are known to create new knowledge to transcend its problems through interaction with individuals and environment. These themes are discussed next alluding to participants' point of view.

The data shows that identifying, connecting and leveraging external knowledge as part of the core innovation process is indeed essential for organisations (Chesbrough et al., 2008). Most organisations in this research collaborated throughout the innovation process with a diverse range of partners from universities, research institutes, individual inventors and other Biotechnology companies. This was due to the fact that (discussed previously as well) Biotechnology firms need a wide variety of knowledge.

B4 and B2 have a higher number of external collaborations than other organisations though both organisations have an internal R&D. Although B2 has research support in Germany the Senior Director Operations (P2A) asserted that the majority of it was all over the world. Other listed organisations such as B5 and B6 also had alliances with global collaborators and worked with various universities for

knowledge enhancement to complement their internal R&D. Certainly there appears to be a realisation amongst the participating organisations about the need to work with "smart people" inside as well as outside the company as suggested by Chesbrough, (2003, p. xxvi). This is further evident from P1's comment about how B1 approaches innovation, "*it's a confederacy of different groups working together*". This resonates with P2A's view. This is also highlighted by P4 who discussed how scientists are bound to hit a knowledge gap in their research efforts hence they are in a way forced to collaborate with others. Another example is the case of B3 that uses external scientists to understand the latest scientific research emerging from literature. This way the company gains more targeted knowledge while interacting with scientists outside the organisation. Furthermore, B3 collaborates with various researchers when faced with any problems in its R&D efforts. This finding found support with the triangulation data too, for example: RIP1 says that OI is a problem solving tool which can be an asset for Biotechnology organisations irrespective of size and internal R&D capacity. Similarly, IBP1 supports that OI is, collaboration for innovation. RIP2 expresses this benefit of OI in the following comment:

> The more open the innovation system is, the better ability we have to invent and solve really massive problems, really big challenges.

The problem-solving aspect of OI in relation to data is further discussed next.

For P6A, P6B and P7, OI is finding solutions to problem in collaboration with others. B6 is an organisation that emphasised the need to collaborate internally as well as externally for problem solving. B6 joined the 'Innovation Exchange' a global initiative for OI that enables organisations to problem-solve in collaboration with external partners. Throughout the interview P6A and P6B emphasised the problem-solving aspect of OI. Despite differences whilst B7 is a small virtual Biotechnology; B6 is a listed company with an internal R&D there was similarity in the participants' understanding of OI. B7's approach that has led to considerable revenue for the company, is to proactively identify problems and then seek innovative solutions through collaboration with others. Hence OI overall appears to be considered finding resolutions to problems in order to progress a product and/ or idea further down the development pipeline regardless of the nature and size of the Biotechnology firm.

OI is a necessity for Biotechnology SMEs

When discussing how the participants understood OI, it emerged that participants considered OI a necessity and essential. Data across cases suggests that there are a few factors that contributed to this. One, resource and infrastructure limitations of small and virtual Biotechnology made OI essential. Two, wider environmental changes made it necessary for organisations to seek collaboration for R&D. Three, these organisations were knowledge intensive and needed a wide variety of expertise that is difficult to possess internally. These factors highlight that OI is a necessity for small and virtual Biotechnology firms. The subsequent paragraphs discuss each of the three factors that support this theme from data.

OI is viewed necessary for these small organisations with limited means compared to large sized Pharmaceutical companies. It is noted in literature that collaboration for innovation in SMEs has been long established as these organisations lack the monetary resources and infrastructure to sustain

innovation portfolios (Nooteboom, 1994; Vossen, 1998). This has been supported by Van de Vrande's study (2009) that OI is prevalent in SMEs. In the Australian context, a study by Huang and Rice (2009) of 292 Australian SMEs (in the manufacturing sector) found that OI benefits an organisation's innovation activities. In addition, a study by Segers (2013) in the Biotechnology industry in Belgium had a similar finding that the OI approach is critical for generating opportunities for smaller companies. The data from this study confirmed that OI was indeed essential for Biotechnology SMEs to survive. B1 and B7 are virtual companies with no R&D support therefore OI was viewed as critical for survival. B4 on the other hand, is a small Biotechnology with 40 employees listed on ASX (as well as it also trades in the U.S.). Irrespective of the variation in size and organisation type the participants commonly viewed OI a necessity in order to find the best expertise and cost-effective solution to survive in a competitive environment. Others such as B2 and B8 indicated as well that being small organisations with limited means compared to Pharmaceutical companies there was a higher need to look for expertise outside based on organisational needs so as to reduce risks associated with high investment in R&D.

The analysis shows that participants considered that the shift to a more open approach was in part dictated by wider environment changes such as advent of ICT, economic changes impacting job security and increasing cost of R&D. As indicated in Chapter 2, literature on OI has similarly suggested that various environmental and economic factors impacted the adoption to a more open approach to innovation (Chesbrough, 2003b). The contribution and advancement of technologies has allowed for new ways for organisations to collaborate and coordinate across locations (Chesbrough, 2003; Van de Vrande et al., 2009). The data also reflects that ICT has promoted OI and made it easier to practice (Pavitt, 2003; Christensen & Maskell, 2003). For example, P5 who has been in the Australian Biotechnology industry for over twenty-five years shared that though OI was not a new concept, it has been made easy to practice due to ICT which led to less dependency on local knowledge by allowing a wider pool of expertise to be available swiftly. The fact that OI was made relevant by changes in the wider economic and social environment is further evident from B1 and B7, both small virtual Biotechnology companies founded by scientists who chose to venture out independently due to economic changes impacting job security. This finding was supported by the triangulation data for example, CRP1 explains that earlier Biotechnology companies had to have everything within due to the concern for IP as well as the quality of work and limited access to global knowledge. CRP1 says that drug discovery companies previously had their own design team, chemists and biologists etc. However, now there are Biotechnology companies consisting of just a few people that develop drugs due to ICT they can have a more open and collaborative approach.

In recent times though companies had to cut down on cost of R&D due to financial risk as in the case of B2 and B8. B2 previously had a R&D facility in Australia which was closed for various reasons one being company strategy but cost of R&D was also a factor. However, in the case of B8, conducting basic R&D in-house was considered high-risk and the company decided to instead seek R&D expertise outside. B4, B5 and B6 also were strategic in their use of OI to reduce risks. This finding is supported by literature that OI in some situations can be a less risky option and cost less than a closed innovation

approach (Kogut & Metui, 2001). This was supported by the triangulation data for example, RIP1 points out that most biotech firms are "*ideas-rich but money-poor, capability-poor or resource-poor*". This is where OI helps by enabling the transformation of ideas to innovation through the aid of external partners without heavy investment upfront into infrastructure.

Organisations in the sample had a need for a wide variety of expertise that is difficult to possess internally. Literature has acknowledged that many innovative firms now operate with limited R&D capacity but are still able to successfully innovate by using knowledge and expertise from a diverse range of external sources (Chesbrough, 2003a & b). This is particularly true in the case of B4, B5 and B6 that have a platform technology and an internal R&D department but still required external expertise in order to diversify their product portfolio. For example, for P4 the definition of OI shared is based on the fact that it is not possible to have the wide range of varied expertise in-house that is required to make optimum use of its platform technology. B4's technology can be used in animals as well as humans; to have expertise across this broad range is not possible for a small Biotechnology. Similarly, B5 also has technology that it uses over an array of health issues and is currently experimenting to expand its usage in new areas. B6 so far has relied on a particular core technology but now is in the process of expanding into newer drug development areas therefore; the organisation has adopted a more open approach.

OI is not a substitute for internal knowledge and/ R&D

Most participants viewed OI not as a way to substitute internal R&D. This is consistent with results found by Chesbrough and Crowther (2006) that external sources of innovation are not used primarily as a reason for cost reduction or outsourcing of the R&D function. As (argued in chapter-2) Cohen and Levinthal (1989, 1990) have discussed that R&D not only helps the organisation create new knowledge but also aids in the integration and exploitation of external knowledge. In line with literature, data shows that organisations with an internal R&D in the sample such as B2, B3, B4, B5, B6 and B8 all used their internal scientific knowledge to assimilate external knowledge. Participants expressed awareness of the value of internal knowledge and skills required to integrate external knowledge. For example, P4 the CSO at B4 displayed significant awareness towards the need to absorb external knowledge and improve company's AC in order to benefit from OI. To achieve this the scientific team at B4 was geared towards constantly learning and integrating new knowledge and skills internally that might be useful to B4 in the longer term.

An example of the complementary aspect of OI and internal knowledge is evident in the views of both the key stakeholders at B6. P6A and P6B recognised external expertise and OI efforts as complementary to the organisation's core competence and all employee efforts were focused on maintaining and enhancing that core competence. Likewise, P5 and P8 observed an OI approach to be complementary although most of the R&D work their organisations conducted was admittedly done through in-licensing or in collaboration with other organisations or universities. Similarly, P2A and P2B too, viewed OI efforts to match and complement B2's current product and technology portfolio.

Most participants highlighted the importance of organisation's core competence area and constant efforts to build internal knowledge and skills around it. OI was viewed as a tool used to remain open to opportunities and take strategic directions that may complement its existing knowledge base. OI for key stakeholders enables organisations to seek external expertise based on business needs and requirements. Additionally, OI efforts were considered important in order to get access to targeted knowledge and/ skill while being efficient as an organisation.

Data across resonates with Cassiman and Veugelers's (2006) assertion that it is not possible for organisations to possess and/ or create all required knowledge therefore, internal and external knowledge processes have to be complementary. Although the organisations in the sample such as B2, B3, B4, B6 and B8 have had some form of change in the internal R&D (operating at a reduced or a different capacity than earlier) key stakeholders in these organisations acknowledged and understood the importance of maintaining a basic research capability. These organisations still recognised (as suggested by Rosenberg, 2010) that a basic research capability is essential in order to monitor and evaluate research being conducted elsewhere.

Overall data indicates the complementary nature of external knowledge to internal R&D as well as the role of internal R&D in maintaining the organisation's AC. In line with other studies, the sample organisations recognised that internal R&D aided its AC to incorporate external knowledge (Catozzella & Vivarelli, 2014; Lokshin Belderbos, & Carree, 2008; Tsai & Wang, 2008). The complementary nature of internal and external innovation sourcing as reflected from the data in this study resonates with Arora and Gambardella's (1990) finding in large Chemical and Pharmaceutical firms in Biotechnology. This finding was also supported by the triangulation data, for example, in RIP1's view OI is not a substitute overall because organisations of all sizes usually look for solutions to fix some problem that cannot be resolved using internal resources. RIP1 asserts that OI helps organisations overcome limitations whether due to size, knowledge and/ or resource constraints in the pursuit of innovation. Similarly, IBP1 does not view OI to substitute internal R&D, rather views engaging is OI as unavoidable due to the need for diverse expertise in Biotechnology.

As mentioned previously (in chapter-2) there is contrasting evidence that is, some studies demonstrate that internal R&D and external knowledge sourcing for innovation are complementary (Brown & Eisenhardt, 1998; Caloghirou et al., 2004; Cassiman & Veugelers, 2006; Lokshin et al., 2008; Schmiedeberg, 2008; Tripsas, 1997; Tsai & Wang, 2008; Veugelers, 1997) and others that the two have a substitution effect (Blonigen & Taylor, 2000; Higgins & Rodriguez, 2006; Laursen & Salter, 2006; Watkins & Paff, 2009). The data for this study clearly identifies with the complementary nature of internal R&D (and external knowledge) and OI activities.

Discussion and Summary

Based on the key themes emerging from how participants described and/ or defined OI, it emerges that for key stakeholders in the Biotechnology industry OI is not a completely novel concept. Data suggests that the way individuals perceive OI is influenced by a few organisational and industry factors. OI is

viewed to be necessary for Biotechnology SMEs in order to gain new knowledge and to problem solve. This is because these organisations have resource and infrastructure limitations and are knowledge intensive. Additionally, the fact that scientific work requires diverse expertise as well is impacted by wider environmental (economic, technological etc.) changes means that OI is important in order to meet business needs at a fast pace. OI by allowing collaboration with a wide variety of partners across the world based on organisation's need for knowledge and/ or problem solving has become critical for the survival of small and/ or virtual Biotechnology in Victoria.

Another aspect that needs to be discussed after analysing the data is that company strategy seems to be a factor in the participants' understanding of OI too (such as in the case of in case of B3, B6, B8). This aspect of the data supports what has been mentioned by Keupp and Gassman (2009) that implementing OI is less about industry trends and more about an organisation's business strategy. For example, B3 unlike other organisations in the sample has taken a more "*competitive strategy*" that is, it does not actively seek to collaborate for R&D purposes but only in situations where it faces a problem. Another example is that of B6, the company has made a conscious decision to adopt an OI approach to meet its innovation needs based on its exposure to the 'Innovation Exchange' forum. Consequently, P6A's and P6B's understanding of OI was based on B6's overall strategy of collaborating to problem solve as well as find new ideas irrespective of source both internally and externally. Another example is that of B8 that decided to change its strategy to avoid risks of conducting new research.

A striking area of dissimilarity between previous research and this research data is that there was no evidence of the NIH syndrome found. This might be due to the fact that (as discussed previously) Biotechnology organisations thrive on collaboration for knowledge and problem solving. The data for this study also highlights that previous literature may have overstated the implications of OI especially due to the 'NIH' that leads to challenges created by employee attitude and resistance. Data indicates that employees in Biotechnology SMEs are generally orientated towards collaboration (internally and externally) due to the knowledge intensive nature of scientific work. Additionally, the small size and resource constraints of these organisations further enhances employees to adopt a more collaborative attitude towards innovation. However, it needs to be taken into account that although most organisations advocated the need for learning new knowledge irrespective of the source they were still mindful of maintaining their organisational boundaries.

Although the aim is to explore OI from an individual level what emerges from data so far is that the individual-level perspective is closely intertwined to organisational and industry aspects. This is probably due to the fact the participants (with the exception of P6A) were at a senior management level. Furthermore, given that all organisations were SMEs the individual and organisational level can be expected to be more closely intertwined and have a bigger impact on each other due to the size and flat organisational structure and/ or lack of hierarchy.

Overall it appears that Biotechnology SMEs engage in OI activities due to the intrinsic nature of scientific work that requires extensive and varied knowledge. For stakeholders OI appears to be a tool that allows them to problem solve and spread their knowledge base in order to enable their organisations to diversify their product portfolio or identify future products while minimising risks.

Perspectives of individual managers on OI

This research question was broken down into three sub-questions for the purpose of the interviews. These questions were related to: the benefits and/ or opportunities that participants associated with OI; the challenges and/ or drawbacks the participants associated with OI and; understanding how participants summed up their overall experience of working in an OI environment. The third sub-question is not discussed separately as data from it will be included in the benefits and/ or challenges section. Firstly, the common themes about the benefits of OI is discussed.

Benefits of OI

A few themes emerged from the data:

- OI can be more cost effective than internal R&D
- OI can help organisations save time
- Access to top global expertise based on organisation's needs
- OI enabled learning
- Benefit from reputation of collaborators
- Improved staff morale and team work
- Contributed to growth

Each of these are discussed next.

OI can be more cost effective than internal R&D

Data indicates that OI is considered to be more cost effective than conducting R&D internally. The research by Bae & Chang (2012) and, Chesbrough & Crowther (2006) likewise highlights that OI can lead to cost reduction. However, a study by Enkel et al. (2009) of 107 European SMEs and large organisations found that it can lead to higher coordination costs. The finding of this research contrasts from Enkel et al.'s (2009). The participants did recognise the challenge of coordination but in terms of cost it was suggested that it was more cost effective to partner for R&D purposes. Studies by Badawy (2011), Bigliardi, Galati & Petroni (2011) and Fredberg et al. (2008) also show that OI by opening new internal and external avenues for innovation through collaboration leads to cost savings (or in some cases cost sharing) of R&D among the stakeholders. The theme of cost effectiveness of OI vis-à-vis internal R&D is evident across the data.

There are a few reasons that are highlighted by the participating organisations as to why OI can be more cost effective. Firstly, the cost of recruiting and maintaining a team of R&D employees is considerable for Biotechnology in Australia. Secondly, SMEs do not have the capital to set up the infrastructure for R&D. Thirdly, it is risky to conduct R&D in-house as the product may or may not reach

the market. Finally, organisations can get access to a wide range of global expertise in the field instead of depending on a few R&D specialists in-house.

It has been noted in literature that R&D is becoming an expensive activity with shrinking revenues due to increase in competition and reduced product life cycles (Vanhaverbeke et al., 2008). Hence organisations have to find new avenues for R&D to remain competitive. By using OI organisations can delay high upfront financial commitment by instead investing gradually in the process (Vanhaverbeke et al., 2008) as was the strategy followed by B2, B5, B8. Similarly, in the case of small virtual Biotechnology businesses such as B1 and B7 to pay R&D employees every month requires capital which is a hindrance as these companies (like B7 and B1) have restricted investment capital. Participants were of the view that OI has made access to technology and resources previously unavailable to small companies and entrepreneurs possible. The triangulation data from CRO1, showed that the reason Biotechnology companies work with CROs is because it helps save time and money as well as to meet skill, technology and resource gap.

OI can help organisations save time

Most organisations that participated in the study discussed the importance of time for listed Biotechnology and how OI practices help save time while developing and commercialising products. Data highlights that OI reduces development time by allowing access to external knowledge (Chesbrough, 2003). Also, collaboration with external partners is crucial towards reducing time to market (Enkel et al., 2009). This is particularly important especially for Biotechnology companies that do not have manufacturing capacity or marketing and/ or a sales team.

In the Biotechnology sector, the increasing cost of innovation and shorter product life cycles requires that these organisations develop and market products faster (Tolstoy & Agndal, 2010). OI practices whether formal or non-formal are beneficial in saving time and improving the speed at which an organisation is able to introduce products (Duarte & Sarkar, 2011). Although the data from this study does not provide evidence in regards to the speed at which organisations can introduce products due to OI however; there is evidence that organisations save considerable time while developing products with the help of partners. This is because OI provides organisations means to swiftly meet specific knowledge requirements without expending huge quantities of time and money to develop it internally (Van de Vrande et al., 2009). Although B4, B5 and B6 have an in-house R&D these organisations still use external experts in order to meet business needs. A comment by P4 that highlights the reason for this is as follows:

> So when you acknowledge that you don't have the expertise in-house you can either spend I don't know 1 yr, 2 yrs, 3 yrs training people up (sic) to have that level of expertise or you just go out to the people that have it and that's always preferential because you're not wasting time…(P4, CSO at B4*)*

The importance of meeting timelines was highlighted in the data from B2, B4, B5, B6 and B8, all ASX listed companies. In fact, B4 trades over the counter at the US stock exchange whereas B8 is listed on NASDAQ as well. OI has allowed B8 access to new discoveries at an earlier stage while saving time.

This is in line with Huizingh (2011) that OI leads to greater saving in time and money if organisations use it earlier in the innovation process. The strategy of working with universities for research such as in case of all these organisations has been recognised in literature to reduce R&D costs and development time considerably (Perkmann & Walsh, 2007).

Literature has acknowledged that the time and cost involved in R&D has grown considerably making new drug development more challenging as well as reducing the success rate (Nigro, Morreale, Robba & Roma, 2013). This resonates with what participants have suggested as well. It also explains why the sample organisations relied on outside R&D expertise. Another benefit of OI that has been mentioned and is related to the aspects of saving time and money is that it allows organisations access to expertise based on its business needs. This benefit of OI is discussed next.

Access to top global expertise based on organisation's needs

Access to worldwide expertise due to OI practices was of importance to most Biotechnology firms in the sample. This is similar to Huston and Sakkab's (2006, p. 29) finding that P&G realised that, "for every P&G researcher there were 200 scientists or engineers elsewhere in the world who were just as good—a total of perhaps 1.5 million people" whose talents the company could possibly use. Tolstoy and Agndal (2011) similarly suggest that access to international resources is important for Biotechnology firms.

Most participants highlighted this benefit of OI (B1, B2, B4, B7 and B8). In case of B1 and B7 that are similar small virtual Biotechnology organisations the difference is that while B1 is based and focused on a specific technology; B7 is much more diverse in its operation and experiments with new technology. Both B1 and B7 have no internal R&D therefore, these organisations depend on accessing expertise based on business needs. On the other hand, B8 has an internal R&D focused on commercialisation of research. Like B1 and B7, B8 though bigger in size with R&D talent also believes that keeping R&D costs low while accessing top global expertise was more beneficial than maintaining an internal R&D department to conduct preliminary research. In case of B2 too that has a small R&D team in Germany it was considered important to access top expertise as and when required based on the organisation's needs. In contrast to others (such as B1 and B7) although B4 and B6 have a dedicated internal R&D, these firms also seek external expertise in new areas to diversify in since building internal expertise takes time. Hence most organisations depend on external partners to provide specific expertise.

OI enabled learning

The interview data from B2, B3, B4 and B6 shows that engaging with external partners for research and knowledge expertise helps organisations assimilate and learn new knowledge and skills. Data from B4 and B6 shows that access to global expertise leads to new knowledge and ultimately learning. This learning and experience gained through interaction with partners helps to renew their knowledge bases that in turn enables organisations to better adapt to the dynamic external conditions (such as change in environment, technology and market) (Hung & Chou, 2013). This is highlighted in the case of B3

although the organisation is currently working on a self-reliant competitive model, the benefit of collaboration and working with other partners who approach the organisation for solutions is perceived to lead to learning and new knowledge. As P3 explained,

> …it allows us to actually gain more experience all the time. So it actually allows us to get more technical knowledge.

At B4 and B6 the strategy that has been adopted is to learn as much as possible from external expertise on a particular area so that next time when the organisation faces a similar problem it can be dealt with internally. This is evident from P4's following comments:

> You look outside, you work with someone who can fix your problem and you learn from them…So we wouldn't necessarily go offshore for that in the future, we'd do it ourselves. Because we've learned everything that we could for them (sic).

A similar comment is made by P6B,

> I think it helps everyone here learn as well, because every time you're collaborating with someone externally, you're building on your knowledge. Next time you may or may not need that external collaboration, or you might need slightly different external collaboration because you've already had exposure in that direction (sic).

Moreover, at an individual level working in cross functional teams internally and interacting with external partners in an OI manner enables self-learning in employees as it allows them to reassess how they work. For example, B6's organisational alignment towards a more open approach internally and externally has helped employees learn and understand their own working styles vis-à-vis others. At B8 as well the transition to a more open R&D approach has led to greater learning opportunities for employees through training as well as multi-skilling opportunities.

In OI different partners work together in a collaborative mode. Sometimes organisations connect various collaborators at the research level to enhance knowledge exchange in order to bring about best practice and information sharing on their products and technology. For example, in the case of B2 the company has benefited greatly by encouraging its various collaborators to communicate with each other and in the process has gained new ideas and better solutions. Since OI requires that different organisations work together to develop new products, services, or markets this diversity can positively influence collaborative knowledge creation as is further evident from B3, B4 and B6 (Du Chatenier et al. 2009). This is supported by triangulation data, for example, RIP1 says that, OI provides a pathway for different experts to collaborate together leading to learning from each other which ultimately leads to "*better science*".

The data from this research shows that the integration of diverse but complementary organisations working together brings in new knowledge as suggested by Almirall & Casadesus-Masanell (2010). As mentioned in the literature (by Bigliardi et al., 2011; Chesbrough, Vanhaverbeke & West, 2008) OI enables a cross pollination of inter-company skills and knowledge which might otherwise not be possible (as in the case of B4 and B6). Furthermore, the learning investment gained from interaction with various

collaborators helps organisations (as in the case of B8 and B7) know more about different technological opportunities ahead as well as builds on its AC in different areas (as specifically aimed for by B4) (Vanhaverbeke et al., 2008). This is reflected in triangulation data too, for example, RIP2 states that for innovation more ideas and avenues become available when scientists with varied skills from different location, experience and mindsets combine their efforts. Likewise, CRP1 and CRP2 concur that OI leads to expertise and experience sharing and both parties learn something new in the process.

Benefit from the reputation of collaborators

Data reveals that working and associating with external expertise might be for more reasons other than knowledge and/ or skill exchange. This appears to be the case especially for small and/ or virtual Biotechnology (such as B1 and B7) and other organisations with limited R&D (such B8). In addition, it can have another benefit of reputation and branding. Reed and Jessup (2012, p. 68) also discuss the importance of reputation and branding taking on "new importance when OI is introduced into the process of creating and producing goods".

B1 a small virtual Biotechnology has worked with few well-reputed universities and research bodies in Australia and overseas. B1 associates with these institutions not just for technology but also for the benefit of branding. The importance of working with top experts and associating with the reputation of collaborators as a benefit of OI was highlighted by B7 as well. In fact, B7 starts the search for solving a problem by first identifying where in the world is the top expertise. A similar approach is followed by B8 as well, as is evident from the comment below:

> So we would very much target them as being thought leaders in the field. There's no point in seeking a collaborator who's perhaps not a world expert on a particular subject. So our preference is to go to the top first (P8).

B8 a listed Biotechnology firm though different in strategy and organisational structure from B1 and B7 considers reputation important when selecting partners. This is further highlighted by P8 that if there was a choice between two partners B8 would pick the one *"who's name might be better on the paper".* Therefore, associating with well reputed experts is a benefit that organisations (with no or limited R&D) seek in order to gain greater credibility for their products. For example, during interviews at RI1, it is mentioned that most Biotechnology firms usually approach RI1 as it is highly reputed.

Improved staff morale and team work

The theme of improved staff morale and team work emerges strongly in the data. Du Chatenier et al. (2009) suggest that since OI teams are not governed by traditional hierarchical relationships it has a positive influence on the knowledge creation process. The non-hierarchical team structure for OI can be found in case of B6, B4 and B5 where the teams are formed across levels and functions. At B6 the formation of cross-functional project teams across various levels of hierarchy has improved the sense of team work in the organisation, as P6A suggests:

> …when we have these OI teams, it doesn't matter who's in that room, you're on equal level playing field; there is no hierarchy in an OI team.

Both B6 and B8 are listed Biotechnology companies with in-house on-site laboratories. B6 conducts in-house R&D on-site, whereas B8 has a laboratory focused on commercialising science. Nonetheless, both organisations have an internal system whereby staff are encouraged to provide ideas that might be useful for innovation of new products. These organisations have had a recent shift in management for varied reasons, but what is common is that the strategies adopted by both reflect a more open and collaborative approach towards the organisation's innovation needs. The involvement of employees (at B6 and B8) in the innovation process and identifying the next product or idea has energised employees. Further it has led to greater clarity how their contribution can lead to the organisation's success. This is reflected in P6A's comments:

> But for them to bring us ideas, you know, the excitement from that perspective of if their idea gets picked to go to the next phase, that's a huge boost to their confidence. So it has two benefits: one is we find a new opportunity, and two is it helps their morale (sic).
>
> They feel part of the business; they're not just employee number, you know...So I think that helps them recognise their own value.

This theme of employees having a greater sense of value and higher morale is further highlighted in the interview with P6B as well, who comments:

> I feel like it's energised the company a little bit, everyone seems to have a bit of a spring in their step.

At B8 the shift towards OI is not as evident and the outlook of the management is more conservative. However, what is apparent is that there is a change in the organisation's approach that is, it is more open towards innovation externally. The fact that B8 no longer depends on an internal R&D means that it is taking less risk and is therefore, is able to invest more in its employee's well-being and development. It is able to look after its employees better by providing bonuses when the company makes profits, and provide training to cross skill employees which in turn has improved their career skills and future prospects and overall positively impacted the morale. Cross skilling of staff at B8 has also led to a greater sense of team work as employees know each other better and share work and tasks.

The enthusiasm that sharing information and ideas across the organisation has created at B6 and B8 is evident in the interview data. Furthermore, at B2, B3, B4, B5 too it is highlighted that team work is crucial for success of the organisation and its innovation efforts. Hence, OI can lead to a heightened sense of team work and improve staff morale among employees.

There is not much evidence in the literature on OI improving staff morale. In fact, most literature refers to employees feeling threaten due to opening up of the organisational boundaries and experiencing difficulty due to NIH syndrome (as discussed in Chapter-2). The data from this study shows a different situation within the Biotechnology companies in Victoria. As this benefit of OI has not been discussed much in the literature and therefore, it needs more attention in future studies.

Contributed to growth

The theme of OI contributing to growth emerges from data of B5, B6, B7 and B8. It has been recognised that OI allows organisations to grow at a fast pace into new business fields where they lack expertise (Rohrbeck, Hölzle & Gemünden, 2009). The study by Rohrbeck et al. (2009) found that OI enhances innovation capacity that translates into organisational growth. This finding resonates with other research findings for example, in the case of P&G new product introduction increased and R&D productivity grew by 60% (Huston & Sakkab, 2006).

There are a few factors that emerge from the data that point towards OI contributing to organisational growth. These factors are: OI provides new opportunities for commercialisation in areas that the organisation might not have considered otherwise (B2, B5, B6, B7 and B8), OI leads to improved revenue (B4, B6, B7 and B8) and, OI provides a bigger playing field for organisations to operate in (valid for all). Each of these factors with relevant case example is discussed in the subsequent paragraphs.

B5 is an organisation that has realised how OI had helped it commercialise in areas that it would not have otherwise considered. For example, the company has technology that can be useful for metabolic, inflammatory, cardiovascular and spinal conditions however; it is evaluating using it in other fields such as ophthalmology and neurology. The interview data with P5 highlights that to achieve this it needs external expertise because otherwise it will not be possible for a company the size of B5 to commercialise directly in all these diverse areas.

OI is important for sustained growth (Bae & Chang 2012; Chesbrough & Crowther, 2006). OI by allowing sharing and co-utilisation of skilled workers, the creation of networks of collaboration between companies and exposing organisations to new opportunities for commercial gain far beyond what a single company could achieve leads to innovation and growth (Adner, 2006; Chesbrough, 2003). For example, B4 is such a company as it depends heavily on external knowledge to make optimum use of its platform technology in diverse fields. The following comment by P4, the CSO of the company reflects the importance of external knowledge to B4's growth:

> We wouldn't be a 40 person company escalated from a 4 person company in absence of externals they have been pivotal to the growth. It's because of us but we couldn't have done it without them (sic).

Additionally, interview data from B6, B7 and B8 shows that for these organisations OI has led to improved revenues. As mentioned previously B8 has closed its internal R&D operations and changed it strategy to using external resources for R&D purpose. The logic behind this as pointed by P8 is

> ….doing blue-sky research in-house, it's not very profitable. We could easily lose all of our money very quickly doing that.

The OI approach has helped the organisation be more "*financially prudent*" (P8) and use its capital more efficiently therefore improving its revenue. In case of B7 too, it is considered that (when managed well) OI can generate considerable revenues for an organisation. The annual reports of these companies showed improved revenue over the years from 2012 to 2014.

Finally, OI provides a bigger field for organisations to operate in that leads to growth; this has been true for all the organisations that participated in this research. All interviewees have discussed how OI has made the world open to small sized Australian Biotechnology. In case of B5 (a listed Biotechnology company with 110 employees at various locations in the world), when talking about how OI had changed the way business is done, P5 mentions that it has "*just opened up the whole global R&D…a bigger pie...or a bigger field*". In fact, all organisations had global partnerships whether for research purpose or for commercialisation of their technology. Even the small virtual Biotechnology firms such as B1 had collaboration with top universities in Europe, whereas a similar organisation like B7 had collaborated with well renowned universities in the U.S.

This theme is reflected in the triangulation data whereby CRP1 and CRP2 concur that has made converting ideas into products much easier which leads to growth. Similarly, RIP2 states that OI enables organisations to draw ideas and knowledge from their customer, supplier and even competitors leading to better solutions and results. Thus, by combing innovation efforts organisations are able to form mutually beneficial collaborations that lead to saving time and money, better branding opportunities, learning, improved staff morale and productivity eventually resulting in organisational growth.

Discussion and Summary

It is considered that the benefits of OI would have a positive impact on the organisation's performance as has also been found by Bae and Chang (2012). The study by Bae and Chang (2012) concluded that organisations using OI practices have better efficiency and effectiveness in comparison to organisations that are closed to external technology and knowledge. In case of the participating organisations OI has led to considerable benefits in terms of cost and time saving as well as access to top global expertise based on organisation's needs thus; leading to improved efficiency and effective use of their current resources. Moreover, it has been found in a study by Ili et al. (2010) that OI improves R&D productivity. It is considered that the benefits of improved staff morale and team work, learning and increased knowledge are elements that would ultimately contribute to improved R&D productivity.

In summary, the benefits of OI found in this research reflect what has been suggested in previous literature however, the benefit of improved staff morale has not been highlighted in literature as much as the challenge of overcoming NIH syndrome, and staff resistance to OI. It is therefore suggested that future research should examine the benefits of OI more closely in terms of the positive impact on employees.

Challenges of OI

The following themes emerged from the data:

- Lack of control: maintaining organisational boundaries, loss of control on IP and confidentiality of data
- Overcoming ego, fear and distrust at the initial stages of the partnership
- Differences in priorities and expectations of collaborators

- Risk of time and money

Each of these is discussed next.

Lack of control

This theme can be further classified under the following sub-themes:

- Maintaining organisational boundaries
- Loss of control on IP and confidentiality of data

Maintaining organisational boundaries

Interview data from B1, B5 and B6 indicates that maintaining organisational boundaries can be a challenge in OI. Ollia & Elmquist (2011) and Wippich (2012) have mentioned that OI requires organisations to manage actors within and outside which leads to blurred organisational boundaries. Data shows that there is a sense of lack of control when opening boundaries for OI. This seems to be a challenge for organisations irrespective of size. For example, B1 a small virtual Biotechnology as well as B6 a listed Biotechnology company with an internal R&D department referred to it as a challenge. Additionally, B2, B4, B7, and B8 also refer to experience this aspect as a challenge. It is worth noting that B5 and B6 have similarities in terms of both being publicly listed companies with an internal R&D department however; B1 and B7 are small virtual Biotechnology companies with limited resources. It appears a certain cautious attitude towards opening up boundaries to share information and knowledge is prevalent regardless of the size of Biotechnology.

Data illustrates what has been mentioned by Bogers (2012) that managing knowledge sharing in OI requires more understanding. The blurring of organisational boundaries has been mentioned by participants as requiring management. This resonates with literature suggesting that successful OI practice requires that organisations share knowledge while protecting from unsolicited knowledge spill overs (Bogers, 2012). P6A resonates P1's cautious attitude which is highlighted in the following comment:

> There's a very fine line between what you can put out there, and what you can't. And that's a key challenge, I think, with this open innovation style (sic).

On IP issues, P1 stated,

> *It is unwise to start without proper agreements, that can be a problem in how you share the IP outcomes and that could be a barrier if you wanted to commercialise.*

On the importance of collaboration P1 commented,

> *Legal due diligence is important. Network of people that you know in other companies is important. It might just be exchange of ideas or useful conduits in other countries to meet people. The interaction change and evolves depending on what phase you're on.*

Further the fear of "*accidentally disseminating*" IP or "*inadvertently disclosing IP*" (as suggested by P1) when collaborating is seen as a challenge by most participants. Another aspect of this theme is that of balancing openness that is, being open enough but not too much. This is reflected in P1's comment "*in this sort of industry, there's sort of a point where sharing too much is not good*". P5 also pointed out that too much openness in innovation can be detrimental and stifle innovation in some cases. P2A, P2B, P4, P6A, P6B and P7 also share similar viewpoint. This further reiterates the importance of maintaining organisational boundaries while being open.

Loss of control on IP and confidentiality of company information

Data from B1, B2, B5, B6 and B7 shows that Biotechnology companies see loss of control in terms of IP and confidentiality of company information as a challenge towards successful OI practice. This is viewed as a challenge despite some of these organisations' internal R&D department and an employee dedicated to IP management. The reason might be due to the fact that traditionally organisations have believed that successful innovation requires control and protection of IP (Badawy, 2011; Chesbrough, 2003). In addition, organisations earlier have been more focused on innovation primarily through a well-funded R&D department (Chesbrough, 2003). Since OI challenges this earlier notion of successful innovation this might be the reason why organisations are still struggling with (fear of or actually) losing control of IP and company information. The magnitude of this challenge is high enough to deter organisations from forming collaborations. This is obvious in P2B's admission:

> Actually really most of the time, IP issues is one reason why we would not work with a university or another company, or whatever (sic). It basically comes down to IP because that's our core as a Biotechnology.

Biotechnology companies find working with universities in Australia particularly challenging due to IP issues. The sentiment is found common in B2, B5 and B7. It emerges that Universities sometimes want to own a piece of IP which can be an issue for a Biotechnology if something innovative is found. This can be challenging for Biotechnology companies as the intention is to license-out the technology at a later stage. This is because Biotechnology firms want full control of IP rights over the technology for revenue generation at later stages.

In addition to IP issues, the theme of lack of control over confidentiality of data when working with various external partners is also highlighted too. B2 and B5 shared that management of proprietary information can be challenging when working with different research groups. In case of P5 that has various alliances, managing company information seems to be an ongoing challenge. This is evident in the following comment by P5:

> That's what the challenges are when it's not in-house. When it's out there, you lose control of the confidentiality of your data….So it's kind of working together and managing, you know your proprietary information (sic) (P5).

This theme resonates with the findings of a study of 107 European SMEs and large organisations by Enkel et al. (2009) that showed loss of control as one of the major challenge. This sense of loss of control in IP and company information further leads to a sense of lack of control in the overall innovation process. For example, P7 when discussing the challenge of working with partners admits,

> Well I think it's great when we control it…..But as soon as you're under their control, you're in big trouble (sic).

Similarly, P4 suggests that,

> So that's why anything you can do internally, and have that control over is preferable.

There is strong emphasis that OI usually works if these challenges can be overcome by proper management. For example, in the case of B5 the company has a dedicated Senior Manager to overlook the management of alliances. Another way B5 is able to manage the challenges of lack of control is through taking time to set up a structure. As B5 partners mostly with universities and research institutes P5 found that setting up a structure at the beginning of the partnership avoids issues related to IP and loss of confidentiality of company information later on. Furthermore, relationship management along

with time management to maintain the overall focus and direction of the project is the extremely crucial when dealing with partners.

This theme emerges from B2, B5, B6 and B7 that are mostly similar with the exception of B7. B7 is a small virtual Biotechnology whereas the others are all publicly listed companies with an internal R&D. B2, B5 and B6 all have an IP manager in fact, the IP managers at B2 and B6 participated in this research study.

This finding is supported by the triangulation data, for example, in CRP1's opinion even with IP agreements in place for a small company it is difficult to trust people to adequately perform their job as well as not discuss their ideas with someone in their circle. Similarly, RIP2 mentions that every party wants to maintain as much control on the IP as possible. This issue of control leads to conflict if terms are not pre-defined at the onset of the project. IBP1 mentions too that IP issues are primarily the reason that partnerships disintegrate at early stages when Biotechnology partners want control over the IP and universities are not in agreement to their terms. IBP1 states that companies are very mindful of fencing their IP before engaging with partners in any manner as the risk of losing IP is huge.

The data in this matter points that lack of control whether it is in terms of maintaining organisational boundaries or IP issues or confidentiality of company information is viewed as a challenge in virtual and/or small Biotechnology irrespective of size and whether the organisation has a resource allocated to managing IP or not.

Overcoming ego, fear and distrust at the initial stages of the partnership

B1, B2, B4, B6, B7 and B8 face a common challenge while forming partnerships for OI purposes- that of overcoming distrust, fear and ego. An aspect of this discussed in literature as the "disclosure dilemma" or "Arrow's information paradox" (Bogers, 2011). According to Bogers (2011) the disclosure dilemma leads to problems caused due to organisations not revealing "the involved knowledge" when finalising contracts. To quote an example from the data, B6 that has recently started being more open in its innovation approach therefore, P6 was still in the process of understanding what to reveal and what not to at the initial stages of forming a partnership. The disclosure dilemma was highlighted by both participants P6A and P6B as a challenge.

Du Chatenier et al. (2009) have discussed this dilemma facing professionals in OI teams. Professionals struggle to maintain a balance between dialogue and protecting knowledge, opening up vis-à-vis closing in order to build a partnership as well as in establishing trust in "a non-trusting environment" (Du Chatenier et al., 2009, p. 358). This element of trying to establish trust in a non-trusting environment is exemplified in the following extract from the interview with P6B who experienced a roadblock with potential partners.

> It has happened to me. It was quite frustrating...We had a confidentiality agreement and everything, but it still didn't seem to open the other party up enough for us to be able to assess the invention….And we found that if you're open about where you think your innovation is, it seems to foster that relationship a bit better. But if you see it as a challenge to your invention, it's really hard to get beyond that barrier. They get a bit defensive, and

> we're not trying to attack it, we're trying to understand it. So all these questions we're asking, it's about understanding it, it's not discrediting it. But sometimes that's a difficult wall to pass over. (P6B)

This extract from the interview with P6B highlights the paradox of knowledge sharing and knowledge protection that has been discussed in literature. Organisations have been known to struggle with disclosing enough to benefit from openness while protecting the core knowledge in order to maintain their competitive advantage (Laursen & Salter, 2005; West & Gallagher, 2006). Therefore, it is suggested that OI professionals learn to balance between influencing and being influenced (Du Chatenier et al., 2009).

Another common aspect that emerges is related ego being a hindrance. While discussing the challenges in forming partnerships for OI P8 states, "*…sometimes they're just ego driven, if one partner wants to be more senior than the other in the agreement" (P8).* This is similar to what has been highlighted by Du Chatenier et al. (2009, p. 362) that professionals working in OI teams have "to deal with issues such as dominance of a partner" which may negatively impact sharing and negotiation in the knowledge creation process.

B6 and B8 are both listed Biotechnology companies with internal R&D expertise. Both organisations have internal resources allocated to IP management. Considering that both organisations have recently adopted a more open approach to innovation they are still learning from experience how best to work with external partners. The challenge is bigger for B6 because it is involved with a more diverse set of potential collaborators whereas B8 aims to primarily focus on collaborating with universities and research institutes. Furthermore, B1, B2, B4 and B7 too face the challenge of building trust in partnerships. It appears with time and displaying credibility through their actions and work organisations are able to form long term partnerships.

Differences in priorities and expectations of partners

Data from B2, B4, B5, B7 and B8 indicates that organisations find it a challenge to manage OI partners due to differences in priorities and expectations. Literature too has discussed the challenges faced by organisations in managing diverse partners with differences in motives and goals (Bogers, 2011). Data shows that managing timelines, delivery lines and quality of product while working with external partners requires considerable effort at times.

What has been highlighted by previous literature (such as by Von Krogh, 2011) is of relevance to this study too that, in case of OI organisations need a shared vision as well as innovation activities need to be planned deliberately with focus to achieve set objectives (Dougherty and Takacs, 2004). As an example, the following comment from P2A:

> Some of the challenge is actually to manage the timelines, and the delivery lines, and on top of that to still have a quality product, and to juggle what are their priorities as vision as a company, and what we need because apparently we are coming from two different perspectives in that sense (sic).

Additionally, organisations need to manage the differences in motivation and priorities of academic researchers and industry researchers. Smaller virtual Biotechnology (such as B1 and B7) that depend

heavily on external research collaborations have found that the motivation of researchers in academia is to get published and present at conferences whereas the motivation in industry is to get commercial results. For a Biotechnology there is no profit if it is unable to negotiate an out-licensing deal for its products whereas, university researchers still get paid and, in any case, can claim experience gained due to the research. Hence, it is of less significance to university researchers if a research collaboration fails after the Biotechnology has invested considerable time and money on it. This lack of business focus in university researchers is seen as a challenge by B2, B4, B5 and B8. For example, B8 found the pace of academic researchers to be slower than expected. This finding was supported by IBP1 that there is prejudice from the academic scientists towards industry science as it's looked down upon. On the other hand, industry science is cautious of interacting with universities in Australia due to IP issues.

Furthermore, B2 found it frustrating to deal with external research groups as these groups did not share the same vision and sense of responsibility to shareholders as the company did. This was similar to B4's experience as well that external partners lacked commitment towards company goals and were not as invested as internal stakeholders towards achieving targets and timelines.

It has been acknowledged in literature that when firms include external partners in the innovation process, often these partners are unable to meet the expectations or provide the necessary quality of a product or a service (van de Vrande et al., 2009). This is reflected in P4's comment:

> And you've put faith in them that they'll get the job done, and then it turns out that either they don't have the expertise to do the job, or they're not putting sufficient resources behind it. Which we've had as well. I mean, we've got involved with big guys overseas for what for us are big amounts of money, but for them are not. And they put the most junior Project Manager they have on it, and they just don't take your job seriously. And it's your company's life is really on the line (sic).

This experience is shared by P5 as well that different collaborators and/ or partners have different priorities. For example, as B5 works extensively with research institutes and universities it has been challenging to get the same commitment to company timelines and goals. This is highlighted in P5's following comment:

> It is a challenge because a lot of the collaborators want to do research, and they're really happy to start new things, but unlike a company who has timelines, and milestones, and objectives, they can get distracted…. So the idea is that it's a balance between the company meeting its own development objectives, versus the stimulating interest and the flexibility of the investigators to want to chase new leads.

P5 found that the key to managing this challenge is good time management and relationship management. Some companies by keeping a close track of progress of various projects with alliance partners and being more actively involved with their work as well as by displaying interest and passion for the results have been able to tackle the challenge to some extent.

Risk of time and money

The drawbacks related to time and money is a common theme emerging in data. For example, B8 an organisation that works extensively with universities finds their overhead costs an issue. Similarly, data from B2, B4 and B5, also highlight the challenge of time and money.

These organisations search for external expertise or knowledge when they are unable to source that knowledge from within the organisation. This puts them at risk because in some cases they are venturing into new areas that they have little or no knowledge about and therefore are not in a position to accurately judge the capabilities of a potential partner. This is evident from B4 and B7 where partners have promised more than they can deliver and mislead these organisations into believing that they have the required knowledge, skill and expertise to help deliver solutions.

Based on previous bad experience these organisations spend considerable time identifying and searching for partners and prefer referrals or well reputed partners. Investing time into identifying potential collaborators that are a good match to the company's strengths and interests seems crucial. This also reduces the risk of being drawn into collaboration with a partner that might not have genuine expertise.

Due to the challenges highlighted so far, it appears that companies prefer to have certain level of control while working with external partners or prefer to do as much as possible in-house.

Discussion and Summary

The issue of control as a challenge in OI has a link to the theme of risk of time and money as well as differing priorities and expectations. Organisations can minimise these challenges once there is a better sense of control on the innovation process. It appears from the data that OI would benefit from process control primarily due to the fact that though there is mostly a shared vision and/ or idea between organisations engaged in OI more often it is a "very loose idea or vision" (Lankila et al., 2005).

Due to the nature of OI and multiple party involvement it leads to more divergence in the innovation process thus, requiring better control and coordination (Lankila et al., 2005). Most organisations in this study did not have specific systems, processes and practices in place to manage and control OI practices specifically. Most organisations with the exception of B1, B3 and B7 had an internal resource allocated towards managing IP. On the other hand, B1, B3 and B7 emphasised the benefits of investing in good external patent attorneys. Controlling IP was one of the major challenges that most Biotechnology firms encountered especially when collaborating with universities within Australia and research institutes. This is clearly evident from the data from B2, B5, B7, and B8. It has been acknowledged in literature that IP concerns (as well as transaction costs) related to external knowledge can be deterrents towards practicing OI (Keupp & Gassmann, 2009).

The NIH syndrome as a challenge faced by organisations adopting an OI approach has been widely discussed in literature however; this was not evident in the data gathered. This might be due to the fact that most organisations that participated in this research study were Biotechnology SMEs. It was highlighted only by one participant that some employees struggle when the organisation adopts a more open approach. This was pointed out by P6B, who witnessed the organisation undergo a transition to a more open approach and observed employees' reactions as an insider. P6B observed that people who are not open to change struggle to work in an OI environment. This flexibility towards change can

be linked to the theme of lack of control that organisations face at the macro level in an OI environment. Working in an OI environment seems to demand a certain loss of control as well as flexibility whether it is at an individual or organisational level (as more actors are involved in the innovation process).

Overall based on these challenges emerging from the interview data Biotechnology organisations would benefit by learning to better control aspects of IP, data confidentiality, setting goals and expectations with new partners as well as learning to balance between disclosure and openness.

The Implications of OI

This research question related to this aspect has two parts the first part looks at the organisational level and second part looks at the individual level implications.

Organisational level implications of OI

This question was divided into few key themes (as referred to in Figure-4) that were addressed throughout data collection and analysis. Emerging patterns from across the data related to each of the key themes are discussed in the following sections.

Planning and preparing for OI

This section will firstly focus on understanding if there was a formal shift towards OI and what (if any) planning and preparation was undertaken by the organisations for it. Secondly, it will discuss how organisations find partners for OI and finally, how does the evaluation and selection of partners takes place in these organisations.

Most of the organisations that participated in this research did not formally plan and/ or prepare for OI that is, undertake “corporate wide re-organisation” as suggested by Boscherini et al. (2010, p. 1067-68) or undergo an organisational change process as described in the study by Chiaroni, Chiesa and Frattini (2011). Literature offers other examples such as P&G that used ICT and introduced new technologies to support OI as well as discusses the cultural changes that accompanied the shift to OI. The findings from the data for this study do not present a similar picture. The reason the findings differ from literature might be due to various reasons. The fact that the nature of Biotechnology industry and scientific work requires collaboration and these organisations lacked resources to invest in systems to support OI might be one reason. Furthermore, it needs to be taken into account that the shift in R&D practices in some organisations was transpired due to a change in management, strategy or due to the cyclical nature of Biotechnology business whereby the focus shifts as per stage of product/s. Hence the shift to OI for most Biotechnology firms (expect B6) in the sample was viewed not a conscious decision but a gradual shift due to strategic reasons.

Most organisations did not have to go through a change process to shift to OI, for example companies like B1 and B7 are virtual organisations who depend on external innovation for developing products, whereas B4 and B5 have used an open approach as part of the company strategy as well its ingrained

in the company culture due to the CSOs' belief in the collaborative nature of scientific work. On the other hand, B3 due to change in management works on a more competitive model whereby it does not look for collaborations anymore and its internal R&D is geared towards commercialisation instead of pure R&D. The data shows that there have been changes in the nature of R&D in organisations such as B2, B6, and B8 but these changes are not specifically related to a transition towards a more open approach.

Moreover, B2 and B8's R&D department underwent some changes due to change in company strategy and maturation process of company but not particularly due to company's shift to an OI approach. In case of B2, the company reduced its R&D team and decided to close down the R&D in Australia. The company has reduced its R&D capacity overtime and has increased work with external collaborators. This is partly due to the maturation process and products moving closer to the clinical stage. The data indicates that it was difficult for a Biotechnology SMEs to maintain the same level of R&D intensity at all times due to cost and resource constraints. Therefore, the change towards more a more collaborative approach is not particularly due to OI but due to maturity of company's products.

Another example of an organisation's change in R&D towards a more open and collaborative innovation approach due to change in management and strategy is presented in the case of B8. The company underwent a change in management and realised that it needed to revise its R&D strategy. This led to disbanding of the internal R&D function and realigning the team towards commercialisation of technology from external sources. The previous R&D team members were reassigned to other projects in house to avoid redundancy of scientific staff. B8's scientific team under Scientific Director, P8 now focuses on collaboration with universities for blue-sky research and ensuring its commercial viability at the end. At B2 and B8 it appears that there was no particular process for planning and preparing towards OI but it was a gradual shift. For B8 it was something that took place gradually over a period of two years whereas for B2 it was more gradual over a period of time as its products evolved.

What emerges from the data (B2, B3, B4, B8 and B6) is that it is the cyclical nature of Biotechnology business whereby companies have to be strategic in the way resources are used. Biotechnology companies at times have a heavier focus on commercialisation and at times are more focused on R&D. The discussion with P6A and P6B highlighted that even though the company made a conscious decision to shift towards OI due to its exposure to the concept through Innovation Exchange, it was also part of natural transition to move from R&D back to business development and so on. The shift at B6 was led by the CEO at the time. Since the company was at early stages of its innovation cycle it had a CEO with a scientific background and an innovation focus. As the company's products progressed through the innovation cycle towards commercialisation a new CEO who was more commercially focused joined the company. This again illustrates that the cyclical nature of Biotechnology and its product dictates the management and strategy for R&D adopted by the company at a particular point in time. This is similar to what has been earlier discussed in case of B2 and B8.

A different perspective is given by P4, the CSO at B4 about planning and preparation for OI. P4 suggested that in the Biotechnology industry scientists are trained to collaborate from early days. Hence there is no need for the company to go through any process to shift to OI as scientists in B4 already have a collaborative attitude. Collaboration and sharing knowledge appear to be part of the culture at B4 therefore, no planning and preparation was required for OI. Similarly, B5 did not undergo planning and preparation for OI as it is viewed as part of the company's business model and R&D employees are expected to look for solutions using an open approach.

One the other hand, B6 undertook planning and preparation for shifting to a more open mode of innovation after being introduced to the concept of OI by Innovation Exchange. This is evident in P6A's comment:

> Yes. There was a gradual shift towards it, because when I first joined the company in 2001, nobody had heard of OI, or exchange of information in that way.

The Senior Management at B6 shared the shift to OI as a part of the strategic planning process. This included getting staff involved in OI efforts through identifying various new ideas, knowledge and/ or technology that the company could be involved in. Since all employees at B6 were expected to be involved in OI practices therefore, training was conducted to help them understand and read patents properly. Additionally, cheat sheets were made available to ease the process to understand technical terms that non-technical and/ or non-scientific staff might not be used to. Employees at B6 were asked to not just identify an idea but also to be able to conduct a preliminary assessment of the idea before submitting it for review. As part of the organisation's OI initiative the organisation ensured that all employees were aware of the expectation to generate some new ideas as well as conduct research for identifying knowledge and/ or technology for the organisation's future pipeline of products.

Overall data indicates that most of the organisations did not undergo specific change to adopt an OI approach. It was a natural and/ or gradual transition for organisations due to various strategic and business reasons. Except for B6 that undertook a more structured approach to align its employees in R&D and other departments to a more open mind-set to identify the company's future product/s and technology others viewed it as unnecessary. For example, B4's culture and nature of business was based on a collaborative approach and B5's business model requires that R&D staff look for knowledge and solutions irrespective of source as and when required. Cooke's (2005, p.1147) observation that "there is strong supporting research to suggest Biotechnology merely pioneered open innovation" resonates with the data and explains the behaviour of most of the Biotechnology firms in the sample.

The data of this study reveals a different scenario from Van de Vrande et al.'s (2009) study that revealed an increasing level of adoption towards OI in medium sized enterprises as compared to small sized ones. Most of the organisations in the sample were SMEs and were practicing OI in some form and to some degree. Additionally, the data of this study presents a contrasting picture to the finding by Van de Vrande et al.'s (2009) that specific organisational and cultural challenges have to be overcome to adopt OI.

Furthermore, the reasons for the lack of formal shift to OI can be found in the earlier section on how key informants defined and understood OI. B1 and B7 are virtual enterprises therefore no formal change or shift could be expected in these organisations. However, other companies show the reasons for a shift towards a more OI approach to be the company's business model, change in management or simply a requirement due to the nature of scientific work or stage of product development. Based on the data there is no doubt that OI is prevalent in the Biotechnology industry however in most organisations no major changes were undertaken for it. Next section will discuss how organisations identify and find partners for OI.

Finding Partners

It is mentioned in the OECD (2008) report that organisations engage with a wide variety of partners for OI. The taxonomy of partners for OI suggested in the OECD report includes suppliers, customers, competitors, consultants, private R&D institutes, universities and other higher education, government and public research institutes. The data collected indicates that organisations in the sample engage with all of these partners as discussed in the subsequent section.

The reason these organisations need a wide variety of partners is well explained by Chiaroni and Chiesa (2006, p. 1075) who suggest that it is almost unmanageable for Biotechnology firms to successfully source all the technologies and scientific knowledge necessary for transforming "scientific ideas to final products". Thus making it is essential for these organisations to find partners to collaborate. The discussion on the search for partners can be divided according to the purpose that of, exploration and exploitation for knowledge. Exploitation of knowledge was related to using existing knowledge and capabilities in order to select, refine or execute the ideas for production (March, 1991). On the other hand, the sample organisations used exploration as means to find new opportunities and ideas. This involved searching, experimentation and risk taking to gain new knowledge that may lead to innovation (March, 1991). This section first discussed the analysis across cases of partners used for exploration of knowledge. This is followed by a brief discussion on the partners used for exploitation of knowledge.

It emerges from the data that most organisations did not have a formal process to identify and find partners for exploring knowledge. This is primarily because exploring knowledge was viewed as a varied process about identifying new knowledge in related areas of research that the company has (or wants) to further develop its competence in. For exploration purposes, different organisations in the sample use different methods to identify and find partners. Organisations such as B1, B2, B3, B7 and B8 use scientific literature to identify ideas that were of interest and find partners who had the required expertise. Other common methods used to find partners was through professional and social networking, cold calling, online search, brokers, intermediaries and professional recommendations. Each of these is discussed in the following paragraphs.

Data highlights that networking and meeting people regularly not just in Australia but also overseas is considered crucial to form partnerships. Networking and relationship building with existing partners seem to be predominant ways to find new partners.

P2A on the topic of finding partners stated,

> *If we are talking about the evaluation of different collaborators and companies that we do business with, we do evaluate it on a basis of their capabilities and knowledge. What we need, and whether they fit that picture to do what we need to do. And also the network is actually very important, and the personal relationships.*

B2 uses its existing network to ask for referrals, using the word of mouth approach. B4 has also found it useful to find partners through the organisation's existing relationships. Furthermore, B2, B4 and B8 have also found partners through recommendations. It seems that shared expertise as well as, good relationships with existing network of partners inadvertently leads to finding new partners. Triangulation data from CRO1 supports that the way they gain new clients is by word of mouth, that is, Biotechnology companies ask each other for referrals.

Most organisations (such as B1, B2, B4 and B5) in the sample indicated that no formal process was used to find partners. Although B8 follows a similar approach to B1, B2 and B4 however it has a more formalised process compared to the other firms. Similarly, B6 also has a more formalised process as compared to B1, B2, B4 and B5. What is similar among the sample is the use of network to find partners. For example, B6 uses local networks in the Biotechnology industry such as BioMelbourne and AusBiotechnology to identify potential partners. Other firms use other ways to network such as conferences or through professional networks.

In addition to networks organisations used knowledge brokers or intermediaries to search for partners that can meet their knowledge needs. B1 did not advocate the use of cold calling instead prefers to use brokers or intermediaries. These brokers help in partnering different organisations for projects of similar interest. Likewise, B4 uses scientific advisors, P4 who deals with these advisors found that most other firm use the same experts and therefore, these advisors have a bigger picture of who is doing what. These advisors have introduced B4 to partners due to being privy to knowledge of what different companies are working on. Correspondingly key investors also act as brokers (as in the case of B6) due to their knowledge of businesses that are looking to raise capital to develop a particular product.

There is no doubt that using established networks can reduce costs and save time as well as irregularities in information and knowledge sharing. However, reliance on established network of contacts can be detrimental and hinder the ability to discover and capture new opportunities which may ultimately lead to loss of profitable opportunities (Bianchi et al., 2011). Organisations need to be aware of this to get the most from their exploration and exploitation activities. It appears that not all organisations in the sample depended heavily on using networking and existing partner relationships to find partners. Alternatively using search engines, databases and then calling or sending an email to the partner organisation can lead to finding partners as well. B2 and B7 admit to using cold calling if they are unable to find the right person through the existing network. B2 and B7 use search engines and various databases to identify the top experts in the world in that area as well as identify institutes that have published papers in the area. B2 and B7 have had success finding partners through this approach. For example, B2 found an academic who is now collaborating with the company for one of

its products. Another example is, B7 identified a partner through this approach and eventually formed a partnership in the U.S. that led to it in-licensing the technology. One more useful tool is current scientific literature such as journal articles. B3, B6, B7 and B8 keep updated with new scientific research and finding experts in key areas of research through the use of scientific literature. Since scientists at RI1 have publications in academic journals, it is mentioned by RIP1 that sometimes Biotechnology companies interested in their work contact them directly.

In case of the sample organisations when exploring for knowledge and/ or technology it seems preference was to associate with universities and research institutes which is similar to what has been mentioned in literature by Tidd and Trewhella (1997). For example, B6 that is a spin-out from a university still has strong ties with that university and its partners and often engages in collaborations. Most organisations in the sample admitted to having a past or an on-going partnership/s or seeking to collaborate with universities and research institutes. The data support Lee et al.'s (2010) finding that SMEs form alliances with universities and research institutes for long term technology development that is focused on more fundamental research. The evidence of this can be found in case of: B1, B7, B5 and B8. Similarly, B3 engages with partners such as, universities more for knowledge and in the past has engaged with strategic partners more for market, distribution and commercialisation purposes. However, in some cases organisations engage with Pharmaceutical companies as well as other Biotechnology firms (small and large organisations) for development of products as in the case of B4, B5 and B6.

Sample organisations also illustrate what has been pointed out by Narula (2004) that at the exploration stage SMEs use external partners in order to maintain high level of competence in restricted number of key technology areas. An example is B4's association with a German company that had the expertise to transform the technology B4 has to other forms as well as find new development pathways.

When exploring for partners for OI, data indicates that there is a need for a variety of partners as Biotechnology SMEs do not have the internal capacity and capability to meet all its knowledge and technological needs independently. Thus, the data supports Chesbrough (2003a, p. 53) argument that "the cascade of knowledge flowing from Biotechnology…is far too complex for any one company to handle alone…so companies have to identify and build connections to excellent science in other labs".

On the other hand, in the exploitation stage, the sample organisations mostly preferred engaging with bigger Biotechnology and Pharmaceutical companies. This is reflected by most Biotechnology firms as the aim of most organisations is to sell their products to a bigger player (preferably large Pharmaceutical company). Moreover, at the exploitation stage Biotechnology firms need to work with external partners as they do not have the internal capability for production or the infrastructure to execute the commercialisation of the innovation. This is discussed further in the section on OI practices. Table-9 provides a brief snapshot of the ways the organisations in the sample found partners and the types of partners commonly used.

Ways of finding partners	Type of partners
Innovation brokers and/ or intermediaries, existing partners such as scientific advisors and key investors, professional and social network, Google search, scientific databases, cold calling, conferences, scientific literature, industry groups.	Universities (PhDs, academics, researchers), scientific advisors, research institutes, individual inventors, pharmaceutical companies, other Biotechnology companies, start-ups, technology transfer offices, Contract Research Organisations.

Table: 9- Overview of finding partners

Evaluating and Selecting Partners

Most organisations had the expertise to search and evaluate ideas however, it was indicated that there was no formal process for evaluating and selecting partners. This is primarily due to the fact that the reasons organisations associate with external partners is dependent on a wide variety of reasons such as the technology in question, stage of development and the problem the organisation is facing that needs a solution. For example, at B2 there is no formal process. The reason for this is explained by P2A as follows:

> …it's impossible to have a streamed process because it's so varied in a sense of what people are researching, and where the innovation is.

P4 stated:

> … looking for skill sets that are outside of your organisation that you either don't have internally or you don't have the capacity or equipment to do yourself or you don't have the time to do it yourself.

This is similar to the situation at B5, as indicated by P5's comment below:

> So there can never be a standardised process because… one, it can be opportunistic, and two, often there's only one or two groups around the world that actually provides the particular model or the area of expertise to answer a question that you have at the time.

This is supported by triangulation data too, there is no evaluation and/ or selection process that the CRO has to go through from the Biotechnology companies. As the introductions take place through networking and a certain level of trust is established due to it. Research by Lee et al. (2010) discusses how networking supports OI in SMEs. In addition, CRP2 highlights that the area they work in is extremely specialised, "*It's so specialised. On both sides, really*" (sic).

In case there are a few experts that are doing the same kind of research then data shows that contact is made with all and evaluation is done based on how well their work and working style would match the company's purpose. B1 and B4 follow this, as well as asking potential partners to define the scope of work, costs and timelines.

The needs-based evaluation approach is what is followed by most Biotechnology firms. For example: B3 and B7 also form partnerships based on who would meet the company's needs best and can provide the best possible solution. Although time and money are considered important aspects for Biotechnology SMEs, it appears that quality of work and working style takes precedence. For example, P1 and P4 both suggest that though money is an important factor however, it is not the basis of selecting

partners as quality of work as well as getting things right the first time are crucial to the business. As P4 suggests on this topic:

> So in this game you really want to do things, as much as you can, do it once, and do it properly.

The emphasis on relationships and quality of work is emphasised in the examples shared by B3 and B4 as well when evaluating and selecting partners. As P4 states:

> You build relationships where you find that their quality of work is really good, and you're happy with the quality of work, you're happy with the working relationship (sic)

B2 and B6 both organisations value partners that stand out amongst the competition. In P2A and P2B's experience sometimes potential partners eliminate the competition due to their approach towards the project. For example, B2 approached an academic for a project who offered to first evaluate if B2's technology was compatible with their technology before proceeding. This saved B2 time of drawing up agreements as well as money in case the technologies were not compatible to each other. This practice of doing a preliminary evaluation seems to be not uncommon. B5 when working with institutes decides whether to enter into an agreement by first entering into a short term pilot study with them. This enable B5 to evaluate the technology and make a decision based on data from the study.

Some organisations have internal groups dedicated to evaluating and selecting partnerships such as in the case of B5 and B6. B5 has a 'New Products Evaluation Committee' whereas B6 has 'New Opportunity Team(s)'. The purpose of these is to evaluate and select technology and/ or knowledge partners based on criteria such as technical feasibility, commercial feasibility, potential of the IP, money and time involved. These teams and/ or committees that evaluate new ideas are cross-functional teams and depending on the needs and expertise required for the project the team members change. B6 has a basic standardised checklist whereas at B5 it is less standardised. B6 has a clearer evaluation process than most others in the study. B6 not only looks at the commercial and technical feasibility it evaluates external partnership opportunities based on the stage the study is at, the weaknesses of the partner and technology, and what value can B6 add by getting involved in the partnership. This is supported from triangulation data, such as IBP1 states that Biotechnology organisations form partnerships based on who meets the need and requirements while being commercially viable.

Likewise, B8 evaluates and selects partners based on time taken to complete the pilot study; it would prefer the one that takes less time. Other factors such as reputation are also taken into account, a world expert would bring more credibility and attention hence companies (such as B8, B7) prefer them over others. This is similar to what B1 follows as well. However, this is in stark contrast to the way B7 operates. B7 being a small virtual Biotechnology organisation has no standard process at all. It depends mostly on cold calling and scientific research papers to identify potential partners. The evaluation process is based on both sides establishing credibility with each other through being interested and knowledgeable about the common research area. Sometimes response from the partner firm in forming the relationship can be criteria too, as the area is so specialised that there are limited choices available. As P7 explains:

> So this particular lab has got a cell expression system for the molecular target that we are interested in, and there's two labs in the world that have got. And I contacted both of them, and Toronto responded, the other one didn't. That's it.(sic)

Therefore, mutual interest and benefit forms the basis of partnerships rather than B7 evaluating and selecting partners.

Some of the criteria mentioned by the sample are similar to what has been followed by Roche Diagnostics that assesses technology based on market size, company fit, cost of opportunity and IP (among other criteria) (Fetterhoff & Voelkel, 2006). For example, B8 conducts market research to evaluate the potential of the opportunities; B2 looks at how well it matches/ fits the company existing portfolio. Most of the firms look at the cost of the technology and checking IP status on the technology of interest.

Summary

To summarise this section, data illustrates that organisations usually start with accessing their network to identify someone who can provide a referral; if no one in their network is able to provide a referral then usually an initial research is conducted. Some organisations may access databases or access scientific literature to identify and make initial contact. Others prefer not to cold call instead use intermediaries or broker companies to help act as referrals. However, it emerges from the data that although there is no set approach that these organisations follow and each organisation has their own unique approach to finding partners; what resonates with literature (such as Dahlander & Gann, 2010, von Zedwitz & Gassmann, 2002) is these organisations have the expertise to search and evaluate ideas that they intend to buy and/ or in-source.

Overall it appears that most organisations in the sample follow a more opportunistic and adhoc approach to the evaluation and selection of partners and opportunities especially for exploration purposes whereas for exploitation purposes it is primarily whoever offers the best deal. The exploitation part is discussed in greater detail in the subsequent section on OI practices (to avoid repetition it is not mentioned here).

OI Practices

Similar to Bianchi et al. (2011) findings the data shows that exploration for knowledge that is, inbound OI usually takes place at the drug discovery phase. Organisations in the sample use: research alliances, purchase of scientific services, joint ventures and in-licensing for inbound purposes. The only difference between findings of Bianchi et al.'s (2011) study of 20 large Bio-Pharma companies and the data from for this study (in terms of inbound aspect at drug discovery phase) is that these practices include joint ventures in addition to other modes at this stage.

On the other hand, data from this study shows that exploitation of knowledge (that can be referred to as Outbound OI) usually takes place similar to Bianchi et al.'s (2011) sample in the latter half that is, at the drug development process. The data in this study is in contrast with Bianchi et al.'s (2011) whereby alliances at this stage are not established but greater preference is shown for out-licensing as late as possible in the drug development process. Another difference found at the exploitation stage is that

organisations in this study involved non-R&D employees to exploit their internal knowledge to gather new ideas. The involvement of non-R&D workers in innovation initiatives has been found by Van de Vrande et al. (2009) in the study of OI in SMEs as useful for exploitation. In the sample only two organisations B6 and B8 used this to generate ideas and/ or identify products for the pipeline. These organisations considered it an important practice as it led to not only new ideas and products but also had other benefits such as improvement in employee morale and retention as well as increase in cross-functional knowledge. This is further discussed in the later section on exploitation of knowledge (inbound OI).

Overall in this study, inbound OI practices were more varied in comparison to outbound OI that was primarily through out-licensing. Organisations struggled with finding the right fit of technology for inbound OI as well as dealing with in-licensing partners that were untrusting and not revealing enough information about the potential technology. Few organisations in the study also engaged in joint ventures with universities and research institutes (these were B5, B6 and B8). The next section will discuss the predominant inbound OI practices that emerge from the data.

Inbound OI

Research Alliances

The sample organisations formed alliances with other Biotechnology companies, Pharmaceutical companies as well as universities, and public research institutes at an early stage (similar to Bianchi et al., 2011). Data from B2, B4, B5 and B6 shows that sometimes Pharmaceutical companies approach Biotechnology firms to work together in an alliance. This is usually for a specific program for example; B2, B4, B5 and B6 discuss participating in such alliances. Sometimes these alliances are initiated due to some problems that the other partner is facing. This allows the Pharmaceutical company to save cost while learning more about what the Biotechnology's technology can do. If the project seems promising the Pharmaceutical company can license the technology. Alliances with Pharmaceutical companies are beneficial for both Pharmaceutical and Biotechnology firms alike. It offers the Biotechnology firms access to Pharmaceutical companies' distribution channels, capital for clinical development as well as to gain more credibility for its research (Gassmann, Reepmeyer & Von Zedtwitz, 2008).

In some scenarios, (such as with B5 and B8 particularly) the alliances are formed with universities and research institutes for new cutting-edge research. In this scenario alliances are useful as universities get funding and small Biotechnology firms get access to a well-established infrastructure as well as experts and their reputation.

Purchase of scientific services

Purchase of scientific services is related to using specialised services that might be unavailable in-house. For this Biotechnology firms in the sample used innovation consultants, scientific advisors, universities, research institutes, and other Biotechnology, and CROs. Purchase of scientific services mostly happens at the lead identification and optimisation phase (Bianchi et al., 2011). All firms in the sample admit to using externalised service providers to ensure the viability of the research before taking

it to the next level. This is supported by data from CRO1 that usually helps Biotechnology firms at the early stages of development. The contracts are set-up before the commencement of work clearly defining the rights to new IP that might be generated during the process. All Biotechnology firms prefer to own the IP to avoid complications in case of licensing it out later.

Sometimes organisations just decide to use CROs to find solutions to certain problems that cannot be addressed with the internal expertise. In this case, it pays a fee for the service and the Biotechnology company owns the IP. CRP1 and CRP2 concur that the product and related IP that CRO1 works on is at the end owned by the Biotechnology client.

Joint Ventures

Joint ventures are used to bring in technological know-how into the organisation. B6 engages in a collaboration that is a 50/50 venture however, at the time of the interviews it was suggested that down the line a subsidiary might be set up. At the time of the interviews both companies worked as separate entities while collaborating. Also, B6 was looking at engaging in more joint ventures; it was evaluating two to three more such deals. B8 also engages in joint-ventures with universities and research institutes. These are considered win-win for both sides as the universities receives research funding and B8 acquires a good product development pipeline. IBP1, RIP1 and RIP2 all advocate that joint ventures between university, and industry are quite popular and mutually beneficial.

In-Licensing

Literature suggests that in-licensing usually takes place during pre-clinical test in bigger bio-pharmaceutical companies (Bianchi et al., 2011, Chiaroni et al., 2009). However, the data from the highlights that in-licensing can take place for some organisations that depend on outside R&D at an earlier stage. This is because these organisations (such as B5 and B8) have made a conscious decision to use outside partners such as universities, research institutes and innovators for new cutting-edge technology. B1, B2, B4, B5, B6, B7 and B8 also use in-licensing to bring new IP into the organisation from time to time.

Organisations seek out new opportunities, these can be a product in development or an idea or a technology that has potential. Different organisations in the sample use different criteria to identify the technology to invest in (as discussed in section on evaluation & selection of partners). Based on the evaluation the company may decide to either buy it or license it depending on the best way to be able to own the development program.

The data highlights that usually when in-licensing organisations look for a technology (or an idea) that is a good fit with the organisation's existing core expertise. However, organisations like B5, B6 and B7 are exploring different technology that they may not have considered before. For example, B6 has had a change in strategy it is not looking at confining itself to its core platform technology when looking at new ideas and development programmes.

This is similar to B4's and B5's efforts too of venturing and diversifying the product portfolio. Further, data highlights a slight change in perception towards in-licensing technology. Organisations were now more open to considering technology at an earlier stage than before. For example, B6 now is considering early stage technology from universities though earlier the organisation may have viewed these opportunities as high risk.

In-licensing is considered challenging by smaller Biotechnology firms. For example, though B7 engages in in-licensing, P7 finds it "*notoriously difficult*" and "*perilous*". P7 shares an example where one of B7's subsidiary companies spent "*about $300,000, and two years negotiating a license for the technology*". The technology has proven to be worth the investment and the company is now worth over $25 million. Due to challenges of negotiating in-licensing deals B7 now prefers to generate IP internally through consulting integrators and outsourcing work based on its project needs. This was found similar to all other Biotechnology firms who preferred to own all the IP at early stage till the technology is ripe to out-license.

Outbound OI

Organisations in the sample engaged in exploitation of knowledge and technology in order to better utilise and benefit from available internal knowledge. Two practices emerged from the data these are: involving employees in innovation initiatives and licensing-out.

Involvement of non-R&D workers in innovation initiatives

Organisations such as B6 and B8 involve all employees in the innovation process. This finding reflects what was suggested by Van de Vrande et al. (2009) that organisations can benefit from internal knowledge of employees outside of the R&D department through the use of suggestions boxes and internal competitions. B6 expects employees to spend a set amount of time every week looking for ideas and/ or products for the organisation's future pipeline. This is done through providing them with a checklist of what to assess when looking at a product, technology or idea. Employees at B6 are also trained on understanding IP, patents and provided with cheat sheets with names of websites and resources to help conduct a brief pre-assessment of the idea and/ or technology before submitting it. At B8 engaging employees in the innovation process is not as structured as at B6. At B6 employees are provided with training on how to find and evaluate ideas and it's expected of them whereas at B8 that does not seem to be the case. At B6, the organisation is more focused on employees exploring new product ideas and/or knowledge for the organisation and not focused on internal process improvement or change whereas at B8 internal improvement is considered important too.

There are benefits of this for the organisation; it can lead to organisational success in finding a solution and/ or new product. For example, in the case of B6 an employee in the finance department led to the organisation developing a product and became the first named inventor of the product. The data from B6 suggests that if training and basic knowledge is provided to employees outside of R&D then they can make a valuable contribution to OI efforts. This is different from van de Vrande et al.'s (2008) finding that employees cannot be relied upon to implement OI due to lack of skills or motivation or capability to

make significant contribution to the organisation's innovation process. As the data shows that with training and appropriate tools even non-R&D employees can help an organisation in its OI efforts.

Furthermore, Van de Vrande et al. (2009) argues that the ideas might be too many and not valuable or taken up by management. Organisation can take steps to avoid these pitfalls. For example, B6 has taken significant steps to help employees understand the organisation's innovation capability and needs to enable them to be able to make valuable contribution. Also, employees have been provided resources to evaluate ideas before submitting and are not judged on the number of ideas submitted. Employees are involved in cross-functional projects teams that help in knowledge sharing at B6 leading to a better understanding of the bigger organisational level picture. B8 on the other hand conducts cross functional training for employees this has also enabled employees to gain new knowledge and skills. These efforts of the organisations in turn translate into employees being able to make better suggestions and ideas for improvement as well as for its future product pipeline.

Out-Licensing

Literature on OI in similar industry suggests that for outbound purposes organisations engage in alliances for commercial exploitation, supplying of scientific services to other Biotechnology firms for leveraging the outcomes of the discovery through clinical tests or out-licensing (Bianchi et al., 2011, Chiaroni et al., 2009). The data shows that out-licensing is the predominant OI practice and alliances or supplying scientific services is not important to these organisations.

The Biotechnology firms do however; use various partners to make the product ready for licensing-out. Such as in case of B4 it engages with partners who have the capacity to turn B4's "*bench-sized recipe*" into a "*commercial-sized recipe*". There are other fees for service providers that are used along with CROs for clinical trials at the latter half of the innovation process. Since licencing-out emerges as the most common practice it is further discussed next.

Out-licensing is most popular practice with all Biotechnology firms in the sample. Organisations use it to exploit technology to generate revenues as well as enter new markets (Bianchi, Chiaroni, Chiesa & Frattini, 2011). There is consensus in the data that the best strategy is to take the product as close to market as possible before licensing it out. B2, B4, B5 and B6 prefer to license out technology as late as possible. There are some exceptions to this scenario. For example, in case the technology available in-house is not used by the organisation or it does not have the expertise to develop it further in-house it might be out-licensed earlier. B6 has out-licensed a technology to an animal health organisation as it does not have expertise in animal health and did not want to utilise the technology further.

Data suggests the reason for preference for out-licensing as late as possible is that there are better opportunities the closer the product is to market. However, the risks are considerably higher as well due to the requirement for higher investment into the product. This explains why smaller Biotechnology firms in the (sample such as B1 and B7) avoid this risk. Smaller virtual Biotechnology firms are unable to secure out-licensing with big Pharmaceutical companies. For example, B7 too out-licenses technology

it generates internally through collaboration with universities, research institutes, inventors etc.. The problem though is that small virtual companies like B7 are unable to raise the money required for progressing products further down the development line. This drives B7 to seek earlier smaller deals.

Out-licensing helps organisations market their products locally and internationally therefore, Biotechnology firms such as B2, B4, B5 and B6 usually out-license to large Pharmaceutical companies. Organisations want to get the best possible deal with the best possible partner. This is supported by reports from IB1 and interviews from IBP1, who states that in Australian Biotechnology industry out-licencing is the predominant practice. IBP1 states that Australian Biotechnology companies are able to sell their IP and technology to big Pharmaceutical companies overseas since the domestic sector is not yet well developed at that level.

Most organisations expressed the need to conduct due diligence before licensing out. For example, B5 and B6 use a more systematic process such as checklists and documented processes and procedures for out-licensing deals. However, virtual Biotechnology such as B1 and B2 do not have a process set-up though it is still conducted in a systematic manner due to the impact it has on the organisation's revenue. In case of B7 this differs as the licensing-out is conducted on an adhoc basis because it is dependent on finding a partner who is interested in what B7 has to offer. Although these organisations do not have a formal process for out-licensing they understand what is important to get a new licensing deal. Organisations such as B1, B7 and B8 that do not have an internal R&D department but work on a business model that uses external partners for developing products understand the importance of reputation. This is because reputation is important when it comes to licensing-out technology. This is reflected in their search for partners at the earlier stage of exploration who have good reputation and are well known or even top world experts. This enables these organisations to have better monetary and strategic returns at the out-licensing stage.

Data shows that the company strategy and business approach dictated the time for out-licensing the product and/ or technology as well as the type of partner/s it may find. For example, in the case of B8 at the time of the interviews, it did not seek out-licensing deals as it has its own sale force in its current target market (the U.S.). However, if the company was to expand or was presented with an opportunity in a new market then it would consider out-licensing its IP. The company intends to engage more in out-licensing as it grows.

Another exception is B5 that also engages in sub-license, for example it has provided a commercial license to a company in Japan. B5 transferred the technology to the Japanese company so that they are able to manufacture it and make changes according to their company expertise. No other company in the sample discussed sub-licensing except for B5. Out-licensing helps the organisations invest back into developing more product pipelines. Like other Biotechnology firms the objective at B5 is to license out some products while continuing to develop others and keep adding value.

Data illustrates that organisations have different OI practices and focus at different times. For example, at B6 the focus when P6B joined was on R&D that was primarily due to the fact that it was a young business and did not have many licensing partners. However, over time as new leadership joined, the company became more business orientated. The focus then shifted to business development and pushing the existing products into the market. At the time of participation, the company had a greater R&D focus. Thus, it appears that the nature of practices and focus is cyclical in nature as mentioned earlier too. This is cyclical nature of business is highlighted in the case of B2 and B4 as well. The company at the time of the study did not need a large number of internal R&D as its technology had matured.

To summarise, it emerges from the data that the nature of Biotechnology industry demands that organisations introduce technology as required to meet the development needs of its products. The final objective of all Biotechnology firms is to license-out to bigger companies in order to earn the highest possible revenue from its investment. Out-licensing thus, allows organisations to fully leverage their investments in R&D, through forming partnerships with actors who specialise in commercialisation that is, making innovation available to a wider market place (Dahlander & Gann, 2010).

Types of partners and practices

The data from this study reflects what literature (Bianchi et al., 2011 and Chiaroni et al., 2009) on OI in similar industry (that is, Bio-Pharmaceutical) suggests that firm size matters in case of OI. Larger firms engage with more partners through extensive use of inbound as well as outbound OI. The slightly larger and more mature firms in the sample (such as B4, B5 and B6) of this study suggested having more opportunities for commercially exploiting innovation which is similar to what Bianchi et al. (2011) found. For example, B7 a small virtual Biotechnology has not had many opportunities to exploit its technologies. P7 admits that most likely there will be no transactions with big Pharmaceuticals for B7 whereas the bigger organisations in the sample such as B4 and B6 have successfully out-licensed to well-known international Pharmaceuticals companies. Therefore, the data from this study supports Bianchi et al.'s (2011) assertion organisational size matters in case of OI in terms of the types of partners organisations engage with.

As discussed in the previous section, the data supports what has been mentioned by Rothwell (1991) and Lee et al. (2010) that SMEs tend to form partnerships with universities and research institutes. The data reflects what literature suggests (Rothaermel, 2001; Lee et al., 2010) that Biotechnology firms and SMEs form partnerships for exploitation at later stages. For example, B2 usually engages more with partners at later stages of development when more specialised expertise is required. In addition, according to P2A partners are not interested in the product at the early stages because the potential risk is higher. Therefore, P2A suggests that forming partnerships is more interesting at later stage of product development once Phase 1 is complete. Likewise, B4 also engages more with partners at Phase 2 and Phase 3. However, in the case of B5 it is shared that engagement with external partners is throughout although most of the collaborations are for pre-clinical studies. B5 looks at specific expertise that is required for the product development and seeks to find the top experts at universities

to form collaborations with them. It appears that at B5 collaborations are dependent on the product and its stage of development. In case of B6, it appears that the company engages with partners at various stages of the development process like B5. P6B however, admits that it is mostly at the later stages of the process. As B6 has a lot of internally generated ideas and has small scale manufacturing capability therefore when it comes to Phase 3 it is more heavily involved in external partnerships. However, like B2 and B4, B5 also engages with partners in Phase 2 and considerably more in Phase 3.

In case of small virtual Biotechnology like B1 and B7, it appears that engagement with partners is more need based. This is because these organisations' business model is based on collaborating with partners for developing a product. In the case of B1, the organisation looks at acquiring and combining technologies together to package a product therefore, it starts collaborations at an earlier stage of development compared to other organisations in the sample such as B2, B4, B5 and B6. Consequently, B1 uses partners throughout the innovation cycle. Similarly, in the case of B7 finding solutions to problems that it has identified through collaborating with external partners is more a requirement due the organisation's business approach.

The approach adopted by B1 and B7 is similar; this is primarily due to these organisations working as virtual organisations. Acquiring technology and/ or knowledge from outside is fundamental for these organisations. As mentioned by Hamel, Doz, and Prahalad (1989) SMEs adopt acquisition strategies due to their lack of R&D capability and limited resources. This makes the technology offered by the external firm the best option for these organisations. This is also true in case of B8 that does not have an internal R&D.

In case of B8, the organisation only brings technology in-house when it is commercially ready and the science has been demonstrated elsewhere as robust and proven so as to avoid any risk. Likewise, B5 also mostly associates with universities and research institutes for new research. Although B5 has an in-house R&D it uses external R&D like B8, B1 and B7 for research purposes. This deviates from what has been discussed in literature by Narula (2004) and Lee et al. (2010) that SMEs do not just use OI efforts for commercialisation as mentioned but for R&D as well. However, (as discussed previously in this section) other organisations in the sample such as B2, B4, B5 and B6 support the assertion by previous literature that SMEs tend to partner more towards later stages seems relevant. The common factor between these organisations is they all have some in-house R&D capacity as well as are listed Biotechnology companies. On the other hand, though B8 is listed company too unlike others in the sample no R&D is conducted internally this might be the reason that it differs from the other listed companies in the sample. Whereas in the case of B5 the reason might be that it has conducted most of its basic research earlier. Moreover, it has a platform technology that it aims to diversify. Hence simply depending on its internal R&D is not enough as B5 needs external partners for identifying new cutting-edge research that might be a good match to its core technology.

The types of partners and stage of partnership appears to be diverse at different stages of the innovation process. Data supports that partnerships are necessary as it is unlikely for SMEs to have widespread expertise in all areas such as “technology (ideas), funding (products), and marketing (distribution channels)” therefore their ability to commercialise technology is limited too (Lee et al., 2010, p. 298). The data from the study further supports Rothaermel’s (2001) finding that Biotechnology firms enter into considerably more exploitation alliances than exploration alliances. Most organisations discussed trying to limit the number of external partners in order to gain maximum revenue for their exploitation activities. In addition, exploitation of knowledge involved less risk and uncertainty for Biotechnology companies whereas exploring new knowledge with external partners required considerable time, effort and resources to manage. Furthermore, organisations needed to have the ability to transform the new knowledge internally to derive maximum benefit from partnering for exploration of knowledge.

Individual-level Implications of OI

To understand the implications on individuals two key questions were identified related to aspects of personnel management. These questions were:

- How have OI practices been linked to reward and incentive system for internal R&D personnel?
- What shift (if any) has occurred in terms of: career paths of scientists and roles, responsibilities and skills of internal R&D personnel due to OI?

Emerging patterns across the data related to each of the questions mentioned above are discussed in the following sections.

Reward Systems

Literature has suggested that OI leads to changes in norms and reward systems for internal R&D as well as risks dismissing of rewards and incentive systems (Bergman et al., 2009; Fu, 2012). The data from the eight Biotechnology SMEs indicates otherwise. There have been no changes due to OI in the rewards and incentives for the R&D staff.

In terms of reward and incentive systems data highlights that measuring performance for scientific work is a challenging process due to the complexity and inter-dependence of the work. Furthermore, company strategy and business goals are translated into team goals and corresponding individual goals and key performance indicators. Therefore, there is an indirect link betweein an organisation’s OI approach and individual goals. However, organisations in the sample have not undertaken change to transform and/ or align the reward and incentive system to OI practices.

Salge et al.’s (2012) suggestion that to capture value from openness both pecuniary incentives (in the form of link between salary, bonus or promotion and achieving innovation objectives) and non-pecuniary incentives (in the form of internal recognition, flexibiity and more desirable tasks) are important seems valid for the sample organisations. These organisations offer pecuniary incentives such as bonus, proft-sharing, share options as well as non-pecuniary incentives for R&D staff. This was discussed in the interviews and mentioned in their annual reports too.

As mentioned previously employees are expected to contribute ideas for OI in organisations such as B6 and B8. These organisations give employees due recognistion for good ideas. Given this scenario Buganza et al.'s (2011) suggestion that the reward and incentive system will have to include more open-oriented goals and metrics seems reasonable. Organisations in the sample show that non-pecuniary incentives such as recognistion by peers, sense of achievement, pride in solving problems to achieve scientific results as well as belief in the science and technology of the organisation are important. In addition, team work and team goals take precedence over individual goals and a collaborative attitude is the norm and culture in most organisaitons. A deep sense of loyalty and pride is evident in the interviews with P2A, P2B, P3, P4, P5, P6A, P6B as well as P8 in their team and their organisation's achievement.

It is not evident that organisations in the sample are struggling to transform employee perception from NIH. There appears to be no particular need in these Biotechnology firms to bring specific change to the reward system to include goals discussed by Chesbrough & Appleyard (2007, p.) such as giving attention to best ideas irrespective of source and encouraging NIH attitude. This might be due to the fact that in the Biotechnology industry collaboration and looking to fill knowledge gaps is part of the scientific nature of work as well as due to the size.

Data shows that though most firms had a dedicated HR department (except for the virtual organisations such as B1, B2, and B7), there was no clear effort made to link how employees performed in terms of OI to performance measurement outcomes. There was however an indirect link with how employees performed and contributed to the organisation's OI efforts. This was primarily based on the fact that organisations had a top-down approach to performance goals and objectives set for employees that were based on the firms' overall vision and strategic goals. It was not directly taken into account how well collaborations were managed by a particular staff member however, indirectly it was taken into consideration how efficiently collaborations were handled and whether an employee displayed a collaborative attitude. Data suggests that additionally organisations considered how much strategic thinking is applied, the effort made to think of novel ways of utilising existing collaborations as well as how much involvement is shown and passion displayed towards working to achieve common organisational goals. On the other hand, in some organisations how collaborations were managed is taken into account not at the employee level but at the senior managerial level (as in the case of B5 and B8).

Next few key themes related to rewards and incentive systems of R&D staff and linkages to OI practices are discussed.

Measuring Performance- A Challenge

Data shows that (B2, B4, B5, B6 & B8) performance measurement in the case of R&D is considered challenging by most due to the nature of scientific work. Scientific work involves a considerable number

of unknown factors. It appears that there can be equal amounts of successes and failures therefore, at times concrete outcomes are of less importance due to the unpredictability of R&D work.

B4 and B5 are one of the bigger organisations in the sample compared to others (with B5's capacity of 110 employees and B4's 40 employees) however, both participants had similar views as P2A and P2B from B2 (a small virtual Biotechnology) on this issue. Unlike B2 though, B4 and B5 had a performance review system in place. Overall what emerges from data is that scientific work is done in a collaborative team environment and work is interlinked and interdependent on other people achieving their targets on time. Therefore, performance is seen as subjective and it is more team performance than individual performance that matters. This leads to the next theme that discusses team work and the importance of achieving team goals.

Team work not individual goals and performance are important

In the sample organisations team work and team performance are very closely tied to the individual performance. Collaborating internally with other team members seems important for organisations such as B2, B4, B5, B6 and B8. For example, at B2 importance of team work is critical to business due to the fact that in small Biotechnology team work is the difference between success and failure of the company. Therefore, a feeling of camaraderie seems to exists primarily due to the realisation that if the work is unsuccessful it can lead to loss of their jobs.

Moreover, due to the collaborative and intertwined nature of scientific work, it is recognised by most participants that incentivising team works better than incentivising individual performance. Organisations (such as B4, B5 and B6 that have a formal system) are more focused on team-based objectives rather than individual ones. The collaborative nature of R&D work leads to preference for measuring team performance. This is highlighted by most organisations that have some internal R&D capacity such as B4, B5, B6 and B8.

Non-pecuniary rewards as important as pecuniary

This theme of non-pecuniary means to reward staff emerges from data of B2, B3, B5 and B6. At B3 there is a set performance review system for all employees including the R&D employees. At B3 there is a sense of loyalty and belief in the original technology that old employees have. Some have been with the company since its inception almost 25 years ago. This is similar to B5 where a sense of pride in scientific work is a driver and not necessarily incentives in the form of bonus. Instead it is mentioned by P5 that R&D employees are driven by resolving an issue, completing a task and being acknowledged for it.

Likewise, recognition for work well done not in terms of remuneration but through formal recognition awards in some form is part of reward system at B6. For example, the reward might be a simple luncheon to honour someone's work or have employee's name on the patent for a good idea. It appears that monetary rewards are important however, recognition and acknowledgement for achievement is important as well.

Profit sharing and bonus for R&D staff based on company's performance

The theme of incentivising staff with a bonus on achieving certain organisational goals is common in B5 and B6 whereas in case of B3, B4 and B8 profit sharing options were being considered at the time of the study. In B3 and B8 changes in R&D strategy led to an increase in revenue which has had a positive impact on employee entitlements whether in the form of profit sharing or company offering more training and better employment conditions to employees. The improved employment conditions are positively viewed by employees and have led to improved morale even though the role of R&D in these organisations has shifted from research to commercialisation. The annual reports of B4, B5, B6 and B8 discuss aspects of profit sharing for employees.

Emphasis on linking business goals to team and individual goals

Data from B2, B4, B5 and B6 illustrates that there is a direct link between individual goals and company goals and this encompasses company's OI approach. However, there are no specific objectives or key performance indicators set for R&D staff in terms of a direct link to how they perform on OI activities. For example, at B6 although all staff including the R&D team is geared towards participating in organisation's OI initiative through searching for ideas they are not rewarded on how many ideas they suggest. This is because it is part of the bigger picture that is, the company's strategic goals for next 5-10 years. At B6, strategic goals are set and the business is focused and aligned to that strategy, further based on the business goals staff goals are determined. Hence employees are expected to contribute to the company's strategic goals as it feeds into their individual goals. Similarly, B8 also does not incentivise staff on ideas they come up with for the innovation database.

The key theme in all the interviews when asked about the link between OI and how staff are recognised and rewarded for OI activities seems to be that it is part of the business goals. Therefore, it filters down to staff goals indirectly however; the organisations in the sample have not made a conscious effort or decision to align their reward systems due to OI.

The next section discusses if there was a shift in the career paths of scientists in these organisations due to OI.

Career Paths of Scientists

Petroni, Venturini and Verbano (2012) have suggested that finding, retrieving, and assimilating external knowledge changes career paths of researchers in organisations. This is reflected to some extent by the data such as in the case of B3 and B6 where the focus has shifted to commercialising science for the researchers in-house. Additionally, other environmental and industry factors seem to have played a role in the career paths of scientists in all the sample organisations. Most organisations in the sample have a flat organisational structure due to the small size leading to limited growth opportunities. Furthermore, the growth cycle of the products and stage of company's business determines the career paths of scientist as well. Each of these is discussed in the subsequent paragraphs.

The data on career paths suggest that there have been no major changes in this area for the R&D staff in their respective organisations. The changes pertain more to the nature of the business and industry. What emerges as a common pattern is that there is lesser job security for scientists and researchers have to move around more. For example, in B3 few R&D employees were made redundant as the company was not making enough profits and there was a change of management that further led to a change in the strategy. Likewise, in B2 as well the R&D department in Australia was closed and employees were made redundant. The common theme of lack of job security due to economic and environmental changes impacting career paths of scientists can be seen in the case of P1 and P7 as well. Both P1 and P7 are scientists by training with a Doctorate in their specialised fields however, due to lack of job security (among other reasons) chose to venture out on their own as entrepreneurs after working for several years in large Biotechnology firms and Pharmaceutical companies. The following words by CRP2 illustrate this point:

> We used to the scientists before, so we learn the hard way to switch off from the science into the business (sic)…. it was a risk we didn't want to take. [laughing] It was a very big change (sic).

Another aspect that emerges from the data is that there is a demarcation between industry and academic research. It is not easy for Biotechnology scientists to move back to academia as in the case of P2B who moved from academic science to industry. It was not an easy transition for P2B to pursue a business degree while working as a scientific researcher at a university. P2B had to hide pursuing a degree in business from university colleagues because it would have been viewed negatively and considered as lack of seriousness towards science.

As the sample organisations are SMEs data shows that mostly there are limited progression opportunities. There are however a few examples of career advancement in certain cases where organisations have grown. For example, P4 joined B4 as a Research Assistant and was the CSO of the organisation. However, for the R&D team at B4 currently the opportunities were limited as the company has reached a certain level of growth and a similar career progression for other scientists is unlikely. Another example, is that of career paths at B6, particularly of P6A and P6B. Both have had opportunities to grow in the business side though both have a scientific background. P6A progressed from a scientific position to the role of an IP manager and at present is the Commercial Director. On the other hand, P6B has moved from the position of R&D bench staff to an assistant to the IP manager, and finally to the position of IP manager as P6A was promoted. It needs to be noted here though that these are rare cases as B4 and B6 are one of the bigger companies in the sample.

Another pattern that emerges from the data is that career paths of R&D are connected to the stage of the company and growth cycle of its products. For example, it was mentioned that at one time B6 had around 30 people in the R&D department when the company was at its peak however at the time of the study the R&D team was around 11 members. The company goes through various cycles as its products develop and diverse R&D expertise is required based on which new roles are temporarily added to meet the needs.

Career paths of scientist seem related to the growth cycle of the company as well as business strategy. For example, the role of scientists in B3 and B8 has considerably changed due to a change in company's R&D strategy. B3 has scientists who have been associated with the company since its inception 25 years ago however now their role has moved from innovative science to commercialisation and production. Likewise, in B8 scientists are now aligned towards commercialisation of science and reallocated to various projects in-house as the company is no longer pursuing R&D in-house.

It appears from the data from B6 and B8 that there is a slight transition towards the 'knowledge ladder' formula as described by Petroni et al. (2012) whereby researchers are allowed to express their preference in terms of professional development. Since B6 and B8 both have cross-functional teams and are actively cross-skilling and training employees the knowledge ladder formula seems more suitable for these organisations. The emerging theme in this aspect from B6 and B8 seems to be that organisations are working towards matching employees career needs as there are limited growth opportunities in Biotechnology SMEs by offering other benefits such as: cross-skilling and lateral movement as the company evolves. Furthermore, this has a dual benefit of not only helping employees stay motivated and learn new skills and knowledge, the company also benefits by having a resource back-up and retaining knowledge in case an employee leaves. Sample organisations are highly driven to ensure that the business needs are met (by cross-skilling employees) and there is certain flexibility in employees and company towards meeting each other's needs.

Overall data reflects business needs and strategy have been factors impacting career paths for scientists and it is not the adoption of an OI approach that has led to changes. The data points to what has been observed by Petroni et al. (2012) too, that it is crucial for the R&D management to be linked to the organisation's business strategy as well as to the economic and cultural environment it functions in.

Roles, responsibilities and skills

There are few key themes emerging from the data in relation to whether the role and responsibilities for internal R&D has shifted due to OI in these organisations. These themes are as follows:

- Change in roles and responsibilities of R&D due to change in management and strategy
- Change in focus of R&D towards commercialisation
- Dedicated project managers
- Addition of new roles and divisions as product progresses
- Formation of cross functional teams and cross skilling
- Employees involved in knowledge exploration
- Reallocation of staff

Each of these themes is discussed next. Subsequently, the skills for R&D employees working in these organisations are presented.

Change in roles and responsibilities of R&D due to change in management and strategy

Organisations in the sample have had change in management that has steered transformation in the strategy. As can be expected this in turn involved further changes in other aspects of the organisation. For example, in the case of B3 over the years the change in management has led to a different R&D strategy that has not only caused alternation in some roles but also to redundancies. Likewise, at B2 there has been downscaling of R&D due to change in strategy. At B3, however there have been redundancies in the R&D department but increase in the sale staff. Additionally, B3 no longer has an IP manager and an IT team. Staff has learnt to handle day to day IT breakdowns on their own since the IT Department is outsourced. This inadvertently has caused up-skilling of staff in this area. In addition, B3's R&D has become more customer and sales focused (like B8) there is less focus on pure research. A similar shift has occurred at B8, where the change of management led to a change in R&D strategy. These involved scientists focusing on commercialisation of science instead of basic R&D.

The changes in role and responsibilities of R&D in these organisations are not due to the organisation's adoption of OI but due to strategic changes dictated by business needs identified. This is unlike what has been suggested by OI literature that has predominantly highlighted that it leads to changes in R&D's roles and responsibilities whereas these organisations' approach is more determined by strategic factors.

Change in focus of R&D towards commercialisation

The focus of R&D in some organisations has changed as they are using external partners. For example, R&D employees in B3 and B8 are no longer involved in pure innovative research. The role of scientists at B8 has seen a steep decline in basic R&D and a greater focus towards product development work that is, commercialisation of science emerging from an academic laboratory. Likewise, at B3 it is observed that scientists miss the excitement of pure R&D as their role has become more focused towards ensuring products are ready for the market.

As P2A stated:

> Innovation these days is actually to source out where are the experts and who can do the job the best.

This situation in the sample firms seems similar to what has been described by Petroni et al. (2012) that there is a decrease in the role of R&D as primary knowledge producers and an expansion of the role in terms of exploring and assimilating knowledge from outside into the firm. For example, P3 who has been with B3 for 25 years admits that the current role of R&D has become different from before. Previously the focus at B3 was looking for true innovation through research, a new technique or product but the situation was completely different now. This again highlights that there is decrease in R&D's role as knowledge producers.

At B8 scientists are just transforming the science from academic laboratory to meet commercial needs. Their role is more about assimilating and integrating technology and/ or knowledge emerging from outside the organisation in order to get a product out of the door. Scientists in these Biotechnology firms

play the role of knowledge integrators and assimilators instead of knowledge producers. This has been suggested by Petroni et al. (2012) that the role of scientists in OI is aimed at facilitating the adoption of external knowledge. However, unlike prior research by Huston and Sakkab (2006a, 2006b & 2007) and Petroni et al. (2012) suggesting the introduction of new roles for this known as “T-men” or “integration experts” the sample organisations have not created new role/s for this purpose but simply aligned current scientists towards integration of knowledge generated outside the organisation.

Dedicated Project Managers

Project manager role seems important in Biotechnology organisations when working with various diverse internal and external partners. In organisations such as B4 and B5 the role of the project manager seems to be to ensure that everything is on track and everyone is working together. The project manager oversees the contribution by each member and ensures that each team member is sharing the information in a timely manner. Similarly, at B6 there are project managers assigned to each product depending on the stage of development. Each of these is further discussed in the next paragraph.

At B5 to manage the growing number of alliances the company created an alliance manager role. However, in due time B5 realised that it did not work well to have a centralised and dedicated alliance management role due to the complexity, dispersed location, and diversity of relationships. Over time it was found that the alliance management role became more of an administrative function rather than a strategic role. Since B5 has cross functional teams and more of a matrix structure it realised that it worked better to have experts in the area to act as alliance managers at different stages. A subject matter expert who has passion for the area as well was more in direct relationship with the external partner was found to be better suited at managing the alliance. This is similar to what B4 follows as well to manage its partnerships. It seems project managers handle the project depending on the phase and expertise required. Likewise, B6 resources dedicated project managers for each product as and when required. The importance of project managers has been discussed by Gemunden, Salomo and Holzle (2007) as well that formally assigned project leaders and cross-functional teamwork play an important role in getting results from innovation.

Addition of new roles and divisions as product progresses

Data from B4, B5, B6 and B8 suggests that addition of new roles and/ or divisions is driven by the needs of the business and product that the company is developing. Roles that can fill the internal skills and knowledge gaps are sourced as the product progresses. For example, at its peak B6 had around 30 R&D focused employees whereas at time of the study it had only 11. This approach is similar to what B4 follows as well. For example, at B4 the growth of the company has led to new divisions been added to meet its business needs. B4 has recently added a Regulatory Division that was earlier outsourced to a consulting firm. At B8, although no new R&D related roles have been created however it venturing into the U.S. market led to the need for new market driven positions such as Quality Assurance Managers. These managers were needed to ensure that technical paperwork required in the U.S. is adequately completed. This is again based on meeting a business needs as in other cases such as B4,

B5 and B6. Hence, it seems not OI but company growth and/ or product development and/ or business needs are the reason for new roles and divisions in these Biotechnology firms.

Formation of cross functional teams and cross skilling

Cross functional teams have been formed in B5, B6 and B8 as these organisations continue to use external partners and involve employees in its innovation activities. The formation of cross-functional teams in all organisations is primarily needs based depending on the phase and demands of the project. These teams have allowed employees exposure to other business areas as well as has led to a higher involvement in the strategic vision of the company. For example, at B6 R&D staff is now looking at the business development side as well as the clinical side. This has allowed them to see the bigger picture and understand where their role fits in.

Employees involved in knowledge exploration

In organisations (such as B5, B6, B8) employees are involved in identifying and exploring new ideas and products. In terms of responsibilities at B6 all employees are expected to participate in the organisation's innovation process as part of its OI initiative. Employees have been trained to identify and assess ideas by following a checklist (as discussed in previous chapter). B6 has put certain protocols in place for employees to follow while contributing ideas. R&D staff (like all other staff members) are expected to contribute ideas, to enable them to do this B6 has reorganised their roles and responsibilities so as to relieve them of certain responsibilities. This has allowed R&D staff to have time to search for new ideas. Similarly, at B8, it is considered important that employees have an avenue to express ideas whether for internal business process improvement or otherwise. However unlike B6 it is not included as part of employee responsibilities but more as an initiative. At B6 employee involvement is more systematic and mandatory whereas in B8, it is a more adhoc process. Additionally, at B6 it is due to the organisation's alignment towards OI that led this initiative along with its business need and strategy however, at B8 it seems more a part of the company culture to keep improving business and its efficiencies.

Re-allocation of staff

Reallocation of staff members to better exploit time and resources seems to be a common practice in the sample organisations. For example, at B5, P5 was reallocated to manage operations as a staff member had left the organisation and the Head of Operations needed support to manage the operations. Data shows that resources are allocated according to the needs of the business. For example, at B6 a R&D staff member on maternity leave wanted to work from home therefore, another resource was given different tasks to allow the staff on maternity leave to do some other written tasks from home. At B8, when the company changed its R&D strategy there were no redundancies instead R&D staff was reallocated to other teams. Data illustrates that the sample Biotechnology firms endeavor to make the most of the available resources in order to effectively utilise employee skills, time and knowledge. Similarly, at B4 too staff are reallocated to different divisions or teams according to business needs.

The next section will discuss the skills highlighted in the data for R&D staff working in an OI type environment.

Skills for R&D staff in an OI environment

What emerges from data confirms Bigliardi et al. (2011) assertion that the R&D function is no longer solely responsible for technological innovation but shares responsibility with other departments to adopt external knowledge and technology into the organisation. For example, in the case of B6 and B8 R&D employees are interacting more with other departments as part of cross-functional teams to share ideas and exchange knowledge. This is similar to what has been discussed by Dahlander and Gann (2010) that unlike traditional R&D settings now staff are required to work as a 'broker' that is, possess the capability to re-combine ideas from inside and outside the firm.

R&D employees still need to be knowledge experts however; the additional responsibility of exploring and integrating external knowledge requires that they develop good coordination and communication skills. Data suggests that in Biotechnology SMEs one person's work is linked to another person's work and with the involvement of external partners it becomes imperative that employees communicate with each other about various interlinked tasks and projects. This is highly prevalent in B2, B3, B4, B5, B6 and B8. Interpersonal and communications skills seem to become more important in an OI environment as scientists work in a more collaborative manner with external as well as internal partners.

Being a good team worker is considered essential in a Biotechnology SME environment. The introduction of cross-functional project teams in organisations such as B5, B6 and B8 further highlights the importance of teamwork. Ability to liaison and take input from various stakeholders to achieve goals is considered to be essential for scientists in Biotechnology firms. This is apparent from the case of B2 where the team share tasks and regularly consults other members on their responsible areas to get inputs and ideas. Correspondingly, at B6 and B8 staff is involved in cross functional teams where non-R&D staff share ideas and give suggestions on innovation related problems and/ or issues that might exist.

In these firms, R&D staff is expected to have knowledge of more than one area while having specific expertise in their core field. Diverse expertise is required also due to the changing nature of work in SMEs. Data from B1, B2, B4, B5, B6 and B8 shows that scientists need to have knowledge expertise in at least two to three different areas in the scientific disciple. This is described by CRP1 as follows:

> It used to be, as a physicist, a chemist, a biologist. Now you have to be physicist, chemist and biologist! [laughing] (sic).

Ability to be flexible, adapt to change while being able to organise and prioritise tasks based on business needs is highlighted as critical in all firms. The importance of being flexible for these scientists is especially emphasized. Biotechnology firms (B2, B3, B5, B6 and B8) have undergone transformation due to change in management and/ or business strategy. Therefore, flexibility and adaptability to change is seen as critical for these employees. In addition, time management emerges to be important

(particularly from B5, B6 and B8). R&D staff have to contribute to searching for external ideas and/ or products in addition to their day-to-day duties this requires good time management.

The data clearly highlights that scientists need to be more commercially oriented as well as be more entrepreneurial in outlook. In addition, scientists are expected to think like leaders in their own area, organisations such as B6 in the sample have taken steps to empower the scientist to take greater initiatives. Petroni et al. (2012) also have highlighted that scientist are required to have managerial skills in addition to their knowledge expertise.

Moreover, importance of knowledge and awareness of IP and confidentiality issues for scientists is highlighted by participants such as P1, P2B, P5, P6A and P6B. Over all it appears that there are some skill requirements that have changed over the years for R&D. Similar to research by Du Chatenier et al. (2010) this study also found interpersonal skills, project management and ability to manage the collaborative innovation process important for OI professionals.

There is no doubt that some skill requirements have changed for R&D staff however, there are few that were important before but have become slightly more significant given the OI scenario. Some basic skills for scientist such as attention to detail and being knowledgeable remain important. For scientific staff it is crucial to get things right the first time and there is not much room for error. Hence attention to detail as work in Biotechnology requires scientists to be precise and accurate is another fundamental skill that is still required.

To summarise, some of the key skills highlighted in the interviews are as follows:

- Time management
- Awareness of IP and confidentiality issues
- Team worker
- Ability to be flexible and adapt to change
- Attention to detail
- Ability to share knowledge
- Commercially savvy and business oriented
- Good interpersonal and communication skills
- Multi-skilled and have knowledge across scientific disciplines
- Sales oriented
- Entrepreneurial in outlook
- Openness to learn and take suggestions from other stakeholders
- Problem solving attitude
- Ability to work as a ‘broker’ to recombine ideas from inside and outside the firm

Discussion and Summary

It is evident from the data that the scenario has changed for internal R&D personnel and the requirements in terms of knowledge, skills and responsibilities. This in turn would be expected to influence the performance management and career paths of these personnel. However, it remains questionable if these changes are due to OI or more due to the progression of business, and change in strategy and goals.

Data suggests that no particular roles such as for technological monitoring and/ or gatekeeping as mentioned by Chen et al. (2004) are added due to OI. Excluding B6 that employed a HRD consultant for a short period of time to form cross-functional teams most organisations added roles based on product and business demands. For example, at B5 other than the introduction and then annulling of the Alliance Manager role there seems to have been no particular changes due to OI in roles. This is similar in case of other organisations such as B2, B4 and B8 that there are no new R&D roles that have been created due to OI. Nevertheless, organisations (e.g. B3, B4, B6 and B8) have added new roles whether it is in sales (B3), regulatory division and other divisions (B4), project managers for specific phase of product (B6), and/ or quality assurance managers (B8) more for strategic reasons to meet business needs than due to OI particularly.

The arguments made by Petroni et al. (2012) that R&D has changed has value for the sample organisations but not as drastically as in some larger organisations such as found in studies by Huston & Sakkab (2006) and Bianchi et al. (2011) among others. However, Nobelius's (2004) assertion that R&D role has shifted from being more technology centred to interaction focused perspective also appears to be the case as Biotechnology firms are interacting with the external partners to generate ideas or/ and develop their next products. To conclude, it appears that aspects of R&D have changed however, this cannot be attributed to OI but due to strategic business reasons and goals.

Management of OI

Management of OI requires time, resources, communication and flexibility. In terms of resources, companies in the sample had internal resources such as alliance managers, IP managers or engaged with external Patent Attorneys to manage various contracts and arrangements with licensing partners. Companies such as, B2, B3, B4, B5, B6 and B8 had a resource at some stage dedicated to IP management. B3 and B4 no longer had an internal IP manager at the time of the study.

B5 at one time had an Alliance Manger specifically focused at managing and keeping track of its collaboration with various partners. Alliance Management in some form is considered important as it is focused on following up and keeping close watch on all the alliances, royalties, licensing deals and contracts with external partners. In most organisations this is not a centralised role but responsibility of allocated Project Manager. This is further discussed later in this section.

For the Biotechnology firms OI required coordination of various activities and managing logistics. Talking about the overall experience of managing OI P3 said:

> Pretty good open sharing and things like that. Sometimes when it gets…when it's not working well it becomes more difficult, but when things are working, it's fine.

Internal as well as external communication channels seemed to be important between internal and external stakeholders. RIP2 too highlights that since OI is all about people working closely together from time to time there are communication and inter-personal issues that can be managed if proper communication channels are built and maintained throughout the relationship. It emerges that most of the sample organisations (with exception of B3) had porous boundaries that is they interacted and engaged with the external partners proactively and willingly to allow for inflow and outflow of information.

Most organisations did not have one single point of contact for managing all OI activities but had Project Managers who were responsible for the project at different stages depending on their area of expertise. It was important that each team member managed and maintained their contacts and directed external partner communication to achieve project deliverables. A sense of team work within the organisation was highlighted by most participants such as P2A, P2B, P4, P5 and P6A and P6B to be advantageous in working in an OI environment. At RI1 too a project management approach is undertaken to manage various Biotechnology clients. Scientists may work simulatenously on more than one project depending on the availability of personnel, timelines and project requirements. Therefore, forming temporary project teams and allocating resources as required is something that all organisations in the sample used to manage OI activities.

Relationship management was considered important in order to work successfully with external partners. Most Biotechnology firms preferred long term relationships with on-going partners as it required considerable investment of time to build the relationship and understand each partner's expectations and working styles. This is supported by RIP1 that building a good relationship with the client (that is, Biotechnology firm) is critical as it helps to override any problems that might appear during the course of the project.

Literature has mentioned that systems are important for OI management (Huston & Sakkab, 2006) however, it appears from the data that most organisations even the larger ones in the sample with good infrastructure such as B5 and B4 were not using specific systems for OI management. B5 was the only organisation that admitted to examining the possibility of using a proper project management system and software such as Stage Gate to ease the management of alliances and collaboration. However, due to cost issues the company decided against it. B6 and B8 (to some extent) unlike other Biotechnology firms in the sample had internal processes and systems in place to utilise internal knowledge of its employees.

All organisations in the sample seem to have a project management approach to managing OI. Controlling the innovation process through close monitoring of timelines and budgets seems essential

to the success of OI. Flexibility in approach towards what kind of partners as well as openness to where the idea for the next product and technology for the company's future may come is a common factor among the sample organisations. The stage of development of the product was a deciding factor for the company's OI approach.

It emerges that these organisations did not use any specific systems, processes or procedures for managing OI rather a more fluid approach in processes and procedures to adjust as required to meet project needs was taken. These organisations demonstrated maintaining control over the innovation process through close monitoring using a project management approach. Moreover, forming temporary project teams and maintaining open communication channels with partners was illustrated. A focus on good relationship management along with a flexible attitude was displayed in the approach towards OI partners.

Conclusion

This chapter has presented a cross data analysis that refers to comparison of patterns across all data units and group analysis that is, about grouping similar data of the cross-data analysis. This level of analysis has allowed the research to understand the collective evidence that supports or refutes the theoretical expectations and evidence from the literature. This chapter has identified the similarities and differences across diverse data in the sample.

As mentioned earlier (in Chapter-3) to understand the complexity and uniqueness of data this level of analysis too has focused on providing ample contextualised details of the data while understanding the commonality across. This chapter further illustrates that attention was given to the overall aim of the study while examining data for comparisons until the researcher was no longer able to identify new insights thus, suggesting a theoretical saturation was achieved.

The succeeding chapter presents the next level of analysis where the underlying explanations for emerging patterns from primary, secondary and triangulation data have been reflected on by the researcher to draw general conclusions that explain contrasting and compatible themes in data and propose an emerging approach for managing the implications of OI.

Chapter 6

Discussion and Conclusion

This chapter presents the final analysis of the data whereby, the researcher looked for underlying explanations for the emerging patterns. On further analysis of the themes from the earlier levels of analysis a few patterns were evident across the data. These patterns were grouped together and a summation of all levels was conducted to formulate the final findings of this study. This chapter presents a final discussion of the key findings.

The data highlights a few common patterns. These patterns are indicative of the following key findings from this study:

- OI is suitable for industries with certain characteristics
- Size, entrepreneurial thinking and team work of Biotechnology SMEs supports OI
- OI requires contending with dualities and paradox
- Dual demands of OI are supported by certain characteristics of organisational fluidity and agility such as: porous boundaries, fluidity in processes & systems, resource mobility and temporary project teams

This chapter is dedicated to discussing these key findings in detail.

OI is suitable for industries with certain characteristics

Findings from this study show that OI is influenced by the characteristics of the Biotechnology industry that radically operate in a landscape that is under constant scientific progress and require a greater reliance on many partnerships between Biotechnology and external partners such as Pharmaceutical companies, universities, and research institutes among others. This finding confirms Nigro et al. (2013) point of view that Biotechnology companies operate in fast changing environments and with numerous partners. Findings also confirm that the basis of scientific work is knowledge, which is continuously required by organisations operating in the Biotechnology industry to learn, absorb and exploit new and additional knowledge. This study confirms that OI in the Biotechnology organisations helps to explore and exploit internal and external knowledge, overcome resource limitations and restrictions, as well as capital constraints. Also, OI facilitates learning from various sources increasing the knowledge base within each entity. It enables exploitation of intellectual capital internally as well as externally that are specifically relevant to the organisation. Biotechnology organisations require a broad range of skills and expertise for which knowledge sharing and exchange is a common practice. In this industry, scientists add their knowledge and reputation to the organisation's capital as they interact within and outside the organisation in a collaborative manner (Arora & Gambardella 1990; Liebeskind et al. 1996; Oliver & Montgomery 2000; Powell et al. 1996; Senker & Sharp, 1997).

The use of various practices to enhance collaboration for knowledge and inter-organisational networks for commercialisation have been part of the Biotechnology industry for a long time and not something that has been adopted recently in these organisations. Hence the notion of incorporating changes to adopt or practice OI into the organisation was not valid for most of the sample organisations.

This study shows that for organisations operating in the Biotechnology industry adoption of OI is a natural response to working effectively. This is because these organisations operate in a dynamic economic environment and changing business conditions. Although an amalgamation of OI practices into the overall innovation approach was noted, no eminent organisational changes were apparent. The outcome of this study in terms of changes made to adopt OI differs from previous research such as by: Bigliardi et al. (2011), Boscherini et al. (2010) and Chiaroni et al. (2009 & 2010) to name a few, who suggested substantial organisational changes are required for OI.

The time and cost involved in R&D has grown considerably making new drug development more challenging as well as reducing its success rate (Nigro et al. 2013). Additionally, lack of marketing capabilities and financial resources makes Biotechnology firms inherently more inclined towards being open to collaborate for innovation (Nigro et al., 2013). This study likewise provides evidence that OI practices are an integral part of how Biotechnology organisations explore and exploit internal and external knowledge. OI allows these organisations to problem solve and diversify their knowledge capital using various means and methods. This enables overcoming limitations and restrictions such as resource and capital constraints.

Size, Entrepreneurial Thinking and Teamwork of Biotechnology SMEs supports OI

This study indicates that company characteristics such as size, entrepreneurial thinking and culture of teamwork impact OI, which was not well established from earlier research. Bogers (2011) suggested that OI attributes for SMEs was not well understood. This research, however, resonates with the finding by Van der Meer (2007, p 201.) that innovative SMEs are “naturally” more suitable for OI. This is evident from themes such as: OI is essential for small and virtual Biotechnology organisations; limitations of small listed firms make it necessary to collaborate to meet the diverse expertise requirements at different stages of innovation, as well as to save time and money. Opportunistic motives and lack of capacity necessitate these Biotechnology SMEs to collaborate, engage in exchange of knowledge and in joint exploitation of knowledge. These findings are commensurate with Van der Meer (2007, p. 200) who said that in cases where there is limited R&D capacity, “borrowing, hitchhiking and combining” of external knowledge is normal.

A common theme that emerged from the data analysis is the important role of project teams and the significance of team work for OI in Biotechnology SMEs. These research findings suggest that due to the interconnectedness required in scientific work, team work is of great significance, more than individual work, at times making it a challenge for measuring individual performance. Due to the small

size of Biotechnology SMEs there is a need to work closely and have a strong sense of camaraderie for cross-skilling and knowledge. The value of teams combing diverse personalities, knowledge and skills as in the case of the project teams in the Biotechnology firms is known to more likely accomplish an innovation than homogeneous teams (Antikainen, Makipaa & Ahonen, 2010; Forrester, 2000).

OI requires contending with Dualities and Paradox

This study highlights the dichotomy of saving time and money due to OI, as well as the challenge of risking time and money when working with external partners. This indicates the paradoxical nature of OI as well as Biotechnology work whereby the unpredictability of working with external partners who might have different priorities needs to be managed while maintaining company goals and timelines (Ford & Backoff, 1988). These organisations needed to maintain order and structure while dealing with the possibility of disorder and change caused by external liaisons as well as trying to maintain organisational boundaries while attempting to expand it at the same. The contradiction pointed out through the benefits and challenges inherent in OI highlight that the Biotechnology organisations had to contend with tensions and balance opposites in order to thrive. Over the years this organisational challenge caused by maintaining a balance between contradicting demands has been discussed under various labels such as: tensions (English, 2001), paradoxes (Poole & Van de Ven, 1989), dualities (Peters, Waterman & Jones, 1982), dilemmas (Hampden-Turner,1990) and Janusian thinking (Sjöstrand, 1997; Quinn & Kimberley, 1984) (as noted by Achtenhagen & Raviola, 2007). This challenge was apparent for the participating organisations in the manner they responded and adjusted continuously to dynamic, evolving business needs and environment while maintaining a certain level of stability and conformity to survive and to be effective. For example, organisations such as B2, B4, B5, B6 and B8 were exploring the possibility of expansion into new knowledge and technology while maintaining their core area of competence. This dilemma has been recognised in literature that modern organisations need to cope with heterogeneous environment that includes simultaneously dynamic as well as stable sectors (Sutherland & Smith, 2011).

The data points towards the concept of dualities that has been long recognised to illustrate the concurrence of contractions in organisations (Sutherland & Smith, 2011). This is illustrated not only in the key themes emerging from the challenges and benefits of OI in these organisations but also in the practices of exploring and exploiting knowledge. Furthermore, the Biotechnology organisations demonstrated the characteristics adopted to harness the benefits of opposing forces such as: balancing revealing and being open enough but not too much, efficiency and innovation, hierarchy and networks, teamwork and individual accountability, maintaining cost control and ensuring quality, providing strong leadership while supporting employee empowerment, as well as a centralised vision while practicing decentralised autonomy (Biloslavo, Bagnoli & Figelj, 2013). These characteristics emphasise the dual and contradictory approach of these organisations towards their continuously evolving business needs and innovation practices. For individuals this paradox has been highlighted in the data as they struggle to manage timelines and resource constraints while striving for quality, learning to balance between disclosure and discretion when interacting with external partners, retrieving internal knowledge while

gaining new knowledge, working collaboratively internally and externally while being individually responsible. In addition, scientists especially needed to have flexibility to switch between science and business in these Biotechnology firms.

Since this research is based on the KBV, and the Biotechnology organisations are knowledge intensive entities that are involved in developing, transferring and commercialising intellectual capital, duality of knowledge has to be considered. These organisations have aimed to maintain some form of internal R&D knowledge whether it is in the form of top management (CEO, MD and CSO) being scientists (as in case of B1, B3, B7) or as in B2 maintaining a small R&D department, and/or in B8 and B3 where internal R&D personnel were also involved in commercialisation to minimise redundancies. These organisations display the awareness to maintain internal knowledge levels to benefit from external knowledge. Maintaining AC allowed them to balance and reconcile contradictory tensions arising from the simultaneous pursuit of internal and external activities (Rothaermel & Alexandre, 2009).

The dilemma facing these Biotechnology firms that of sharing knowledge to form partnerships for OI while maintaining a certain level of caution and discretion to not hamper their IP has been highlighted throughout by the participants. This challenge in some form or another has also been discussed in previous OI literature too (e.g. by Du Chatenier et al. (2009); Laursen & Salter (2005); West & Gallagher (2006)).

Bogers (2011) has discussed the paradox of OI in terms of knowledge sharing and protection in R&D collaborations. Licensing has been suggested as a way of implementing a knowledge exchange strategy that encompasses both knowledge sharing and protection. The Biotechnology firms in the sample (all except B3) were highly dependent on licensing at both exploration and exploitation stage. What needs to be noted here is that unlike Bogers (2011) the data from this study is further able to highlight the challenges for individuals involved in evaluating and organising these licensing agreements. Distrust, control issues, and ego emerge as human factors hindering the knowledge exchange. Future research can explore other human elements and skills that hinder or facilitate personnel involved in knowledge exchange while maintaining the fine balance of protecting knowledge and revealing enough especially at early stages of partnerships. In relation to OI and KBV of the firm the question how paradoxical demands of protecting and sharing knowledge, collaborating and being competitive for knowledge, maintaining core knowledge and exploring new knowledge can be managed especially within the Biotechnology firms from individual manager's perspective has been sparsely addressed in literature so far.

Dual demands of OI are supported by Organisational Fluidity and Agility

Further analysis of the data themes displayed a common pattern among the Biotechnology firms for managing the implications of OI. Characteristics of organisational fluidity and agility were displayed by these firms to facilitate and support the management of dual demands and paradox created by OI. The

characteristics of organisational fluidity and agility provided the underlying explanations for the emerging patterns in the data as to how these organisations and individuals managed the implications of OI. The subsequent section discusses the characteristics of organisation agility and fluidity as displayed by the sample Biotechnology firms to manage the implications of OI.

Themes discussed in the previous chapter related to: shift towards OI, OI practices, management of OI, shift in roles and responsibilities point towards a link between OI and the concepts of organisational fluidity and organisational agility. Some characteristics that are common to flexible and agile organisations were displayed by the sample such as: porous boundaries, fluidity in processes & systems, resource mobility, temporary project teams. Data highlights a link between these characteristics and OI. The next section discusses the two major findings of this research that are: organisational fluidity facilitates OI; and there is a close link between organisational agility and OI. The significance of these findings is that it has enabled these Biotechnology SMEs with limited resources and infrastructure to manage the implications of OI without huge investments of time and money.

Organisational Fluidity facilitates OI

Organisational fluidity was recognised as a factor for facilitating the management of dual demands and paradox created by OI. Most Biotechnology SMEs did not have a formal process to identify and find partners. These organisations generally preferred an opportunistic approach for evaluating and selecting their partners, which required flexibility and agility towards new partnership opportunities. The fluidity of processes and practices in each organisation for collaboration indicates an adaptable approach. Furthermore, B4, B5, B6 and B8 added divisions and R&D staff based on the stage of development requirements. Organisational fluidity in these organisations highlight not only their flexibility in absorbing knowledge but also shows agility in moving towards new opportunities.

The Biotechnology firms displayed to have flexible and fluid organisational forms with continuously changing templates, depended on speedy improvisation, as well as ad hoc responses. Furthermore, the formation of temporary project teams and identifying project managers based on who has the relevant expertise and best meets the project needs at a particular stage also supports the notion of fluidity as discussed in literature (Brown & Eisenhardt 1998, Kenis et al. 2009, Schreyögg & Sydow, 2010, Siggelkow & Rivkin, 2005). For example, temporary project teams were formed at B4, B5, B6 and B8. As, P5 said "*we're all fluid across the organisation*". Additionally, as mentioned previously B4 and B6 added divisions and R&D staff based on the stage of development of the product and other business needs.

Data further points to another link between OI in these Biotechnology firms and their organisational fluidity. This common aspect is that of porous boundaries. As has been discussed previously, the Biotechnology firms in their OI efforts collaborate with a diverse set of partners for a wide range of business needs at different stages of innovation. This required the blurring of organisational boundaries for the inflow and outflow of knowledge. These organisations displayed awareness that boundaries can constraint an organisation's activities and restrict the possibilities due to hindering the flow of information

and knowledge (Ashkenas, 1999). Evidence of this is available as most firms already had partnerships for R&D and indicated the challenge of lack of control due to the blurring of organisational boundaries (as discussed in Chapter-5). Moreover, the ease with which these organisations formed relationships with changing partners also points to the existence of porous boundaries. In addition, there were no major issues noted with R&D employees due to NIH syndrome as these organisations already had a flexible approach towards knowledge exchange. As Chesbrough (2003) has suggested that the blurring of organisational boundaries is required for OI, in these Biotechnology firms the organisational fluidity facilitated OI.

Organisational fluidity of these Biotechnology firms also enables the agility of these organisations. The concepts of organisational fluidity and agility have been linked in previous literature (Harraf, Wanasika, Tate & Talbott, 2015). The next section explores the link data points to between organisational agility and OI in the sample.

Organisational Agility and OI

The relevance of organisational agility to the concept of OI is highlighted as the sample were mostly SMEs and displayed the structure and style of agile organisations. B1, B2 and B7 were defined by participants as virtual organisations. Virtual organisations are known to use collaborative partnerships to meet agile goals. According to Goldman, Nagel and Preiss (1995) a virtual organisation uses physically distributed and complementary competencies that may be broadly dispersed around the world to create a coherent output. Therefore, the idea of collaboration and openness is inherent in the foundation of virtual organisations. Virtual organisations are also known to be agile (Barrand, 2010 cited in Audran, 2011). Adaptability and flexibility are usually related to new forms of organising that include the concept of virtual organisations, a characteristic of B1, B2 and B7 (Davidow & Malone, 1992; DeSanctis & Monge, 1999).

The other organisations (such as B3, B4, B5, B6 and B8) in the sample were all flat, non-hierarchy driven with (more or less) a matrix style organisational structure. Literature (such as Youngblood, 1997; Dyer & Shafer, 1998) acknowledges that agile organisations tend to be flat, semi-structured, team based that are not locked into fixed structures in order to encourage speedy formation and reformation within (e.g., the formation and reformation of temporary teams such as in case of B4, B5, B6, B8) and across organisations (e.g. moving in and out of temporary alliances as displayed by all Biotechnology firms).

In addition, these Biotechnology firms showed characteristics of agility such as using resources in a flexible/fluid manner so that they can be organised, reassembled, and redeployed to meet different business needs (Doz & Kosonen, 2007). An example of this is how B4, B5, B6 and B8 added new roles and divisions as product progresses as well as brought changes in roles and responsibilities of personnel along the pipeline of product development. Agile organisations are known to have resource mobility that refers to the ease and speed with which financial, physical, intangible, and human resources can be re-allocated according to opportunities (Doz & Kosonen, 2007). This is demonstrated

in the Biotechnology firms use of human resources and financial capital in a manner that is more beneficial to the business. This is evident from the themes (discussed in the previous chapter) related to: change in roles and responsibilities of R&D due to change in management and strategy; and change in focus of R&D towards commercialisation, and reallocation of staff.

Furthermore, these organisations displayed the capacity to be adaptable without having to change (which is synonymous of agile organisations) (Dyer & Shafer, 1998). The way these organisations evolved towards OI is demonstrative of agility too. These firms displayed the characteristics of agile organisations that attempt to incorporate a capacity to modify, and adjust, whether on their own or with their alliance partners, as conditions change, and do so over a period of time (Dyer & Shafer, 1998; Harraf et al., 2015). This is suggestive of the fact that agility was an ongoing process in these Biotechnology organisations. These organisations appeared to be static but changing at the same time by small degrees. This is how the non-virtual B4, B5, B6 and B8 evolved slowly towards OI whereas the virtual ones B1, B2 and B7 were inherently inclined towards openness for innovation. Hence, the agility of the Biotechnology firms made the participants view OI as a natural response to wider environmental changes and/ or easy to adopt without requiring major changes to incorporate it.

These firms managed high involvement in external technology acquisition and external technology exploitation for OI without a dedicated resource and/ or set systems or processes, instead preferred using a project management approach, which required internal flexibility to form temporary project teams, resource mobility, as well as porous boundaries to interact with external partners with ease. Thus, displaying characteristics of organisational agility and fluidity.

Significance of these Findings

This study highlights that OI is positively influenced by certain industry and business entity characteristics. Since the Biotechnology industry entails knowledge intensive scientific work, collaboration, alliances and networks play an important role to fill the knowledge gaps in each business entity in the industry, most of which were SMEs. Due to the small size a lack of resources was noted to be imminent, making it imperative for the Biotechnology organisations to work collaboratively with external partners. This was enabled by fluidity and agility of the organisations.

The finding that OI is influenced by company as well as industry characteristics is of significance as it explains the on-going debate in OI literature about whether it is a new concept or not. It appears that for knowledge intensive Biotechnology industry OI is not an entirely new concept. Furthermore, what emerges is that an entrepreneurial outlook, team work, and temporary project teams facilitate OI management in these Biotechnology firms. This finding suggests that OI is influenced by external industry factors in addition to internal company factors.

Overall two key points emerge from the data: one that OI is in part a company's strategic response as it works in conjunction with its changing environments; and second, the size of the organisation in

addition to, the nature of Biotechnology industry requires optimum exploitation of internal and external intellectual capital. How these organisations respond to external environment as well as enhance the use of human and intellectual capital is through maintaining flexibility and by being agile. These firms' organisational fluidity and agility have enabled the ability to contend with the dualities and paradoxes presented by OI.

This study shows that there is a link between OI and organisational fluidity and agility of Biotechnology SMEs. The findings support the argument for a change in the way literature has perceived the concept of OI as something novel that requires change management. SMEs are not able to invest time, money or human resources to change. These organisations are nimble and flexible in their approach hence, are able to survive in dynamic times. By the same account these organisations are able to use an OI approach. These organisations' flexible and agile approach has enabled their ability to manage OI and its implications without heavy investment in resources and without challenges of NIH syndrome. Flexibility and agility facilitated these organisations to manage the organisational and individual implications of OI. Thus, suggesting that organisational flexibility and agility may be important factors in OI adoption and successful management for other industry and organisations.

At an individual level the implications of OI were managed by individuals due to their ability to be flexible and adapt to change, work in teams, share roles and responsibilities, maintain an entrepreneurial attitude, ability to be multi-skilled and balancing dualities by remaining agile. This study differs from Salter et al. s' (2014) in its scope as it focuses on understanding the perspectives and experiences of individuals on the implications and management of OI in all its forms not just inbound (inbound, outbound and/ or coupled) as well as it has evaluated OI in SMEs.

OI in Biotechnology SMEs is facilitated by organisational fluidity and agility at an individual and organisational level. Organisational fluidity and agility provide support for OI through flexibility in processes, systems, roles and responsibilities. At the individual level, this allows employees a certain ease to switch between the dual demands placed on their time, knowledge, and skills to participate in organisation's OI practices.

Considerations for existing theory

OI is a powerful framework encompassing the generation, capture, and employment of intellectual property at the firm level (West and Gallagher, 2006, p.1). OI models stress the importance of using a broad range of knowledge sources for a firm's innovation and invention activities, including customers, rivals, academics, and firms in unrelated industries while simultaneously using creative methods to exploit a firm's IP.

The dichotomy is that these organisations overall orientation to maintain strategic agility dictated continuous adjustment in their strategic direction that enabled sustained flexibility towards new developments and allowed value creation through innovation (Weber and Tarba, 2014). It is well

recognised in literature that as the broader environment changes the actions and procedures, policies, etc., of organisations need to change to respond to changes in the environment (Mitleton-Kelly, 2003). These biotechs seem to display a similar characteristic. Consequently, the findings of the present research demonstrate that the current KBV needs to be modified and extended to reflect current KM practice within Australian biotechnology firms through examining their use and management of intellectual property.

Contributions to Practice

For managers, the results of this study indicate that taking an adhoc approach to adopting and implementing OI is worth considering especially if there is an inherent flexibility and agility present in their teams. Training employees to maintain an open attitude in their approach towards their roles, responsibilities and collaboration can have a positive impact on the organisation's OI practice.

For public policy, the findings of the study are significant to help industry leaders understand that there needs to be training and platforms for open dialogue between university researchers and industry research teams to overcome some mental barriers in working together. Other industries can learn from these biotechnology firms that adopting and practicing OI need not be a monumental change management initiative that requires large investment of money or other resources. If the organisation already has a matrix style organisational structure then the formation and reformation of team and reallocation of resources is already something that employees are used to. This would enable OI practice. By focusing on maintaining porous boundaries, fluidity in processes and systems, resource mobility and temporary project teams, organisations can successfully practice OI especially in knowledge-based organisations.

Limitations of the Study

The research is a qualitative case study of the Biotechnology industry. Performance in terms of efficiencies and effectiveness of the business entities investigated were not established due to the scope of the study. The sample for this study comprises of eight Biotechnology organisations plus one research institute, one industry body, and one CRO all within the Biotechnology industry in Victoria, Australia. Given that the principles of theory saturation were followed this sample can be considered appropriate in terms of the internal validity of the study. However, it is recognised that the study may have limited generalisability. The sample size as expected has reduced the representational power. However, when evaluating this study's limitations, it is worth considering Malterud, Siersma, and Guassora's (2016) argument for exploratory qualitative study, such as this. These authors suggest that it is not necessary to find a complete description of all aspects of the phenomenon studied rather it is sufficient when the study proposes new understanding that adds value to or challenges existing considerations. This study has challenged aspects of the way literature views OI and enhanced understanding of how implications due to OI can be managed. Furthermore, the sample of individuals included in this study hold experience that is marginally explored so far; thus, increasing this study's information power as described by Malterud et al. (2016). Additionally, Marshall, Cardon, Poddar, and Fontenot (2013) have suggested a number between 15 to 30 interviews for qualitative case studies.

Considering these viewpoints, the sample for this study was considered adequate to answer the research questions as it enabled a novel and in-depth understanding of the experience of the participants in context of the OI phenomenon.

Recommendations

Literature has been more focused on OI as a new concept that needs to be adopted and requiring major change in the practices, processes, and systems in organisations to be successful. This study highlights that previous literature may have overstated the implications of OI especially due to the 'NIH syndrome' that leads to challenges created by employee attitude and resistance. The findings of this research indicate that employees in Biotechnology SMEs are orientated towards collaboration (internally and externally) due to it being a necessity for drug development and scientific work. Moreover, the small size and resource constraints of these organisations further enhances individuals working in this industry to adopt a more open and collaborative attitude towards innovation.

The data from this study indicates that there are other implications on individuals that need more attention in future literature. OI can lead to greater learning, improved staff morale, team work at an individual level as indicated in these organisations. On the flip side, it can require individuals to overcome ego, fear, and distrust while attempting to form external partnerships. Practitioners as well OI theorists need to consider other implications of OI for individuals that may differ across industries. Future research by focusing on these implications can offer a more holistic picture of OI.

What this study contributes is that OI and organisational agility and flexibility are closely linked however, what this study is unable to determine is how due to the limitations of scope. The characteristics of agile and flexible organisations (such as: porous boundaries, fluidity in processes & systems, resource mobility and temporary project teams) facilitated OI management in the Biotechnology industry. Thus, suggesting that there may be a relationship between these concepts and OI. Future research should explore how OI interacts with various aspects and characteristics of organisational agility and flexibility more closely.

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Appendices

Appendix 3.1A Invitation Letter

Date

Invitation to participate in a Doctoral research project on 'Open Innovation in the high-technology sector in Victoria

Dear Participant,

I am Hitu Sood, a PhD student at the School of Management, RMIT University, Victoria. I would like to invite one employee and one manager from your organisation's R&D department to participate in my research project that aims to investigate the practice and implications of Open Innovation (OI) in the high-technology sector in Victoria. My research is supervised by Associate Professor Dr David Gilbert and Dr Afreen Huq.

Participation will involve an interview that will not take more than 60 minutes. During the interview participants will be asked a set of questions regarding their perceptions of Open Innovation (OI) practices and systems. They will be able to answer the questions based on their experience of working within an environment that encourages an open approach to innovation. Your organisation might be practicing some form of openness towards innovation this might for example, involve allowing internal knowledge out of the organisation to form partnerships or utilising external knowledge internally to better your innovation performance.

The interview will be recorded (audio only) and participants will have the right to request that recording cease at any stage during the interview. They will not be asked to provide any personal information and personal records. There are no apparent or hidden risks in participating in this research as it only involves a set of questions about their opinion of using an open approach to innovation. They may choose not to answer any particular question and participation in this research is entirely voluntary. They may withdraw from participation at any time. The data collected in the interview will be analysed for my thesis and the results may appear in publications. The results will be reported in a manner that does not enable participants or organisations to be identified. Thus the reporting will protect participants' confidentiality.

Research findings will be helpful to advance theory on open innovation adoption and implementation. Your employees' contribution is important since they are a major stakeholder in meeting the innovation needs of your organisation. Participating in this research is a valuable opportunity to express how Open Innovation (OI) can be improved and any negative implications overcome.

If you have any queries regarding this project please feel free to contact me (phone: 03 9925 1489, email: hitu.sood@rmit.edu.au) or my supervisors Associate Professor Dr David Gilbert (phone: 03 9925 5196, email: david.gilbert@rmit.edu.au) and Dr Afreen Huq (phone: 03 9925 5198, email: afreen.huq@rmit.edu.au). The research is approved by the RMIT Business College Human Ethics Advisory Network and if needs be the Chair can be contacted at GPO Box 2476V, Melbourne, 3001. Phone: 03 9925 5596 or email: bchean@rmit.edu.au.

I would highly appreciate your support in making this research project a success.

Yours sincerely,

Hitu Sood

Appendix 3.1B Participant Information Sheet

INVITATION TO PARTICIPATE IN A RESEARCH PROJECT

PARTICIPANT INFORMATION

Project Title: Implications of Open Innovation (OI) in high-technology sector in Victoria

Investigators:

- Ms. Hitu Sood (PhD Candidate, School of Management, RMIT University, hitu.sood@rmit.edu.au (03 9925 1489)
- Associate Prof. Dr David Gilbert (School of Management, RMIT University, david.gilbert@rmit.edu.au (03 9925 5196)
- Senior Lecturer Dr Afreen Huq (School of Management, RMIT University, afreen.huq@rmit.edu.au (03 9925 5198)

Dear Participant,

You are invited to participate in a research project being conducted by RMIT University. Please read this sheet carefully and be confident that you understand its contents before deciding whether to participate. If you have any questions about the project, please ask one of the investigators.

Who is involved in this research project? Why is it being conducted?

- Ms Hitu Sood, the primary investigator of this research study, is a PhD student at RMIT University. She is doing this study as a part of her PhD degree under the supervision of Associate Professor David Gilbert and Dr Afreen Huq.
- This project has been approved by the RMIT Human Ethics Committee and adheres to the strict guidelines set by the Ethics Committee.
- The research study is conducted to investigate the implications of Open Innovation (OI) in high-technology sector in Victoria.

Why have you been approached?

You have been approached as Research and Development (R&D) manager and personnel in a high-technology company in Victoria. Your organisation's details have been obtained from various Victorian government and public websites that list top high-technology organisations in Victoria. Your participation invitation is based solely on the criteria of your organisation being in high-technology industry practicing Open Innovation (OI). Your participation in this research is voluntary and random.

What is the project about? What are the questions being addressed?

- The proposed research aims to investigate the implications of Open Innovation in high- technology sector in Victoria with focus on internal R&D and organisation's processes, systems and structures.
- About 10 different organisations in Victoria are expected to participate in this study.

If I agree to participate, what will I be required to do?

- You will be invited to participate in a semi-structured interview comprising of questions relevant to innovation and specifically open innovation practices in your organisation. You will be able to answer the questions based on your experience of working within an environment which encourages an open approach to innovation. Your organisation might be practicing some form of openness towards innovation whether it is related to allowing internal knowledge out of the organisation to form partnerships or utilising external knowledge internally to better your innovation success rate.
- The interview will be recorded (audio only) and you have the right to request that the recording cease at any stage during the interview.

- The interview will take a maximum of 60 minutes. Two sample questions are given below.
  Q. Please give us a generic overview of the OI practices in your organisation.
  Q. What are some of the positive and negative examples of the implementation of the OI approach within your organisation?
  (Source: Mortara and Minshall, 2011, p. 596).

What are the possible risks or disadvantages?

- There are no apparent or hidden risks in participating in this research as it only involves a discussion of the implications of Open Innovation for internal R&D and the organisation's processes, systems and structures.
- If any question may cause you concern, you are free not to answer them.
- You will not be asked to provide any personal information and personal records.
- If you are unduly concerned about your responses to any of the interview questions or if you find participation in the interview distressing you should advise the researchers that you either want to strike that discussion from the record or discontinue the interview. The researchers will discuss your concerns with you confidentially and suggest appropriate follow-up if necessary.

What are the benefits associated with participation?

- This research will encourage and help Australian businesses to establish best practices in Open Innovation and manage it more effectively.
- There are no direct benefits of participating in this research. However, research findings will be helpful to develop and validate a framework on how organisations can better adopt and practice Open Innovation in high-technology sector in a structured and effective manner.
- Your contribution is important since you are a major stakeholder in meeting innovation needs of your organisation. Participating in this research is a valuable opportunity for you to express how open innovation (OI) can be improved and any negative implications encountered.

What will happen to the information I provide?

- Digital voice recording will be used when the participant have given consent prior to the interview. The audio files of interviews will be encrypted and stored securely in the Server for five (5) years. Only the researchers will have access to these encrypted files. After five (5) years the data will be completely destroyed.
- Any information provided by the participant would be safe guarded in accordance to the strict guidelines of the RMIT University Human Research Ethics Committee.
- Any information provided by the participants can only be disclosed if 1) it is to protect the participant or others from harm; 2) a court order is produced; 3) with written permission from the participant.
- Any outcomes from this research will be of a general nature without any details of specific participants disclosed. Where participant's words are directly quoted in a publication, the participants' identity will remain confidential.

What are my rights as a participant?

- The right to withdraw from participation at any time
- The right to request that any recording cease
- The right to have any unprocessed data withdrawn and destroyed, provided it can be reliably identified, and provided that so doing does not increase the risk for the participant.
- The right to have any questions answered at any time.

Whom should I contact if I have any questions?

If you have any questions regarding this research, kindly contact:

1. Ms Hitu Sood
   Phone: (03) 9925 1489

Email: hitu.sood@rmit.edu.au

2. Associate Professor Dr David Gilbert
   Phone: (03) 9925 5196
   Email: david.gilbert@rmit.edu.au
3. Dr Afreen Huq
   Phone: (03) 9925 5198
   Email: afreen.huq@rmit.edu.au

Yours sincerely

Hitu Sood
PhD Candidate

Associate Prof Dr David Gilbert
Supervisor

Dr Afreen Huq
Co-Supervisor

If you have any complaints about the conduct of this research project, please contact the Chair, RMIT Business College Human Ethics Advisory Network, GPO Box 2476V, Melbourne, 3001, telephone +61 3 9925 5596, email bchean@rmit.edu.au .

Appendix 3.2- Case Study Protocol

1. Overview of the Case Study

- Background information
  - Collected on the case through various sources (company website, government website, industry bodies, ASX, newsletters etc.)
  - Prepared for each data set and included in the first level case-analysis
- Issues to be investigated
  - Research Problem and Questions: Presented in Chapter- 2
- Previous research and relevant literature
  - Presented in Chapter- 2

2. Case Selection

Criteria for case selection for primary sample

- Industry: Biotechnology
- Company characteristics:
  - Active in R&D, uses or has used partnerships and collaborations for innovation and R&D
- Participant characteristics:
  - Involved in innovation, cooperation, and R&D in the case companies, interest in research aim and willingness to contribute to investigating the research questions

Criteria for case selection for triangulation data

- Industry: Biotechnology
- Company characteristics
  - Interacts with Biotechnology companies as partners or clients and/ or are industry experts overseeing how the Biotechnology firms in Australia/ Victoria practice innovation.
- Participant characteristics:
  - Experience working with biotech companies in Victoria, knowledge of innovation practices of Biotechnology companies, interaction with biotech companies on a regular basis.

3. Roles and Procedures

Roles

- PhD candidate to actively collect all data and relevant case information
- Supervisory team to oversee and audit that data is collected ethically and proper procedures are followed at each stage

Procedures for data collection

- Prepare Instrument
  - Prepare interview guide
- Prior to initiating interviews a mock interview was conducted with the supervisory team to prepare, train and guide the researcher for field

4. Conduct data collection

- Send email invitation to companies to participate
- Follow up with phone call or email
- Send participant information sheet once company indicates some level of interest in participating
- Schedule date and time for the interviews
- Prepare all documentation for interviews: consent form, interview guide, voice recorder and notebook for note-taking
- Ensure participant signs the consent form prior to recording the first interview
- Ensure participant is aware that they can stop the recording and/or refuse or skip a question if they want to
- Ensure participant is made aware that data collected will be stored securely and proper confidentiality procedure will be followed when reporting the data.

5. Post-data collection

- Transcripts of interviews were stored securely.
- Transcribed interviews were sent to participants as soon as possible after the interview and changes made as per participant's recommendations.
- The data collected was securely stored and password protected with access granted to only the investigators involved in the study.

6. Analysis and quality test of data

- Data analysis procedures were determined prior to data collection.
- Data analysis strategies and techniques as discussed in Chapter- 3 to be followed.
- Design tests to improve the quality of the research were followed as illustrated in Chapter-3 of the study.

7. Reporting

- Each data report was reviewed by the supervisory team.
- Draft data reports were sent to five primary participants.
- Member checks with two primary participants were conducted for finalised data reports and findings discussed in detail.
- Final report was prepared to reflect and include multiple sources of data collected for each study and secondary sources of data was incorporated to improve robustness of final data presented.

Based on:

Brereton, P., Kitchenham, B., Budgen, D., & Li, Z. (2008, June). Using a protocol template for case study planning. In *Proceedings of the 12th International Conference on Evaluation and Assessment in Software Engineering. University of Bari, Italy*.

Appendix 3.3 Triangulation Interviews

CRO1

The participants (CRP1 and CRP2) both had similar backgrounds as research scientists. They founded the company in 2011 after losing their jobs in a Biotechnology company they were employed in for over nine years. Both participants were scientists by training who previously worked in academic science in the area of Biomolecular Modelling and Computational Drug Design. At the time of the interviews both held Adjunct Associate Professorial positions at well renowned universities in Australia. Both participants were well published in peer reviewed journals. After the Biotechnology company closed down both participants decided to collaborate. Their collaboration led to establishing a Contract Research Organisation (CRI1) to offer scientific solutions based on their expertise. The work that CRI1 offers is specialised and a niche area. The experience that the participants offer is rare and the scientific solutions they provide can be expensive to develop in-house. The participants regularly work on improving their scientific capabilities and develop new scientific methods that they can offer to their clients. In terms of their R&D the CRO is self-reliant.

The company works with clients worldwide in fact, 50% of its client base is overseas. CRI1 has clients is the U.K., Germany, China, Hong Kong and the U.S. At the time of the interviews CRI1 was focused on establishing itself in the current market with plans to expand the market base in due time. The office is located in South Eastern suburbs of Melbourne.

The basis of the service they offer is computational design methods for molecular science. CRI1 offers customised solutions to small to medium sized Biotechnology companies across the globe. Biotechnology SMEs that have no internal R&D particularly required the services of CRI1. However medium sized Biotechnology firms that have an internal R&D department still use their services due to resource and/ or capability constraints. CRI1 has also worked for universities and research institutes as well.

Conceptualising OI

The participants related the term open innovation with ‘open source’. Open innovation for CRP1 was a mutually beneficial exchange where both parties benefited from each other’s experience and expertise. By helping one party find the solution for a particular problem (as in the case of CRI1) it enabled the company to develop methods that may lead to solutions that might be useful to other companies in the industry.

Most Biotechnology firms approach CRI1 at an early stage that is, the development stage when faced with a R&D challenge. CRP1 and CRP2 view the work of CRI1 conducts as both a substitute as well as a complement to the R&D of the organisation. However, it is more of a substitute in case of the SMEs as most have either limited R&D resources. Also, in case of companies with an internal R&D the skills, software and capability offered by CRI1 are hard to develop. So companies with R&D try to find solution

with their own resources first and when they cannot resolve it they approach CRI1 to accelerate the process.

Individual-level Perspectives on OI

Benefits of OI

The reason companies employ CRI1 is because it helps save time and money as well as to meet skill, technology and resource gap. It leads to expertise and experience sharing and both parties learn something new.

Open Innovation has made access to technology and resources previously unavailable to small companies and entrepreneurs possible. Entrepreneurial firms and individuals can benefit from OI as it helps conceptualise an idea without requiring considerable investment and resources. OI is considered by the participants to have made converting ideas into products much easier.

Open innovation has made it more convenient for scientists like CRP1 and CRP2 to work on their own. As CRP2 states, “It’s also easier to start on your own because of open innovation”. More and more companies are opening up to finding solutions to their innovation challenges irrespective of distance and source companies like CRI1 are able to survive.

Challenges of OI

Working in an OI environment has its challenges for CRP1 and CRP2. One major challenge is the management of international client base. CRP1 finds that being a small organisation time management becomes crucial as both participants have to travel to meet clients and network while maintaining the standard and quality of their work.

Trust is another issue that is a challenge. The CRI1 maintains the IP while the client acquires the product. However in the process CRI1 has to sometimes employ contractors and disclose the methodology in order to prepare reports so that the results can be reported adequately. This can lead to trust issues even though there is a proper agreement between parties beforehand. In CRP1’s opinion even with IP agreements in place for a small company it is difficult to trust people to adequately perform their job as well as not discuss their ideas with someone in their circle. The issue of trust is crucial for CRI1 as the company does not have the resources to actually enforce the IP protection in case of an issue.

CRI1 employs companies who perform tests to ensure that the methodology developed by the company meets the client’s requirement. To find companies that can be trusted with maintaining confidentiality as well quality of work is a major challenge for a small CRO in the Biotechnology industry. CRP1’s following example illustrates this:

> We had somebody but then it turned out that the resources they wanted to put on that project was just ridiculously small. So we came to the stage when they had to actually test it and they just didn’t reply for weeks and it was just half a person working on that project once a week and so, I mean, that’s...that type of thing, and

> I think you can trust people to.....to say what they do, but in the end you can't…And we had to find quickly somebody else because you're halfway in the project and since it was a grant, it's time-limited, so problems to finish the grant on time. If we wouldn't have found somebody who could help us, then we would have lost the sum that we had to pay already for everything up to that….But luckily we found somebody so it worked out okay. But that's an example. (sic)

The example shared by CRP1 illustrates that working with external companies where knowledge needs to be shared can not only lead to IP and trust issues but also be a challenge as these might in turn cost time and money.

Another challenge that is faced in an OI scenario is that networking becomes vital and for scientists who have turned entrepreneurs this is a skill that they need to acquire. Since most of the clients that work with CRI1 have been through introductions or referrals networking is crucial to the business. However, it can be a challenge as CRP2 admits that it is a challenge to find contacts especially "meaningful contacts". Even at networking events it is hard to meet the right people who are decision makers. Finding ways to network is a constant effort. Networking though a challenge is crucial as it can lead to more business opportunities for CRI1 and can accelerate the growth.

For these scientists selling is also a challenge. CRI1 has to find clients and represent their company at different networking events. Both participants find selling to be a challenge as it's a skill they are still learning. As the area CRI1 operates in is niche the market is small too hence selling when the opportunity is there becomes critical for the business.

Organisational Implications of OI

Finding partners

In terms of how the Biotechnology companies find or approach CRI1 it is essentially through networking. Introductions are made through contacts which leads to trust on a personal level. Introductions through a common contact who the cient trusts helps improve initial trust between CRI1 and the client.

In addition, both participants are well published scientists which enhances to their credibility. As CRP2 states, "And we do have our references from publications and things like this." (sic).
CRP1 and CRP2 attend conferences, sit on advisory committees and attend networking events. As the work performed by the CRO is a niche area hence the company has a comparatively small market base. For CRI1 the business is dependent on networking therefore, its considered essential by both participants. Networking and referrals are the best approach to find new clients due to the specialised expertise offered. Further, word of mouth considered to be the only advertising that CRI1 can benefit from.

Evaluation and selection of partners

There is no evaluation and/ or selection process that CRI1 has to go through from the client's side that is, from the Biotechnology companies. This is as mentioned in the previous section primarily as the introductions take place through networking and a certain level of trust is established due to it. In

addition, CRP2 highlights that the area they work in is extremely specialised, “no from their side none from client side. It’s so specialised. On both sides, really” (sic).

As the relationship progresses though there is certain level of evaluation to judge if there is long term compatibility between the working styles based on how CRI1 meets client’s needs and accomodates any changes and demands from the client as the project progresses.

Word of mouth from previous clients helps CRI1 to gain new clients. As CRP1 mentions “There’s a group who says, ‘These people, they’ve helped me so much,’ and that’s really the best thing” (sic).
The Biotechnology companies ask each other for referrals, CRP1 mentions that their clients ask them for “reliable companies” in other areas. Hence referrals from other clients and word-of mouth in the industry works as how Biotechnology companies evaluate and select the CRO.

OI at CRI1

Different forms of OI

CRI1 usually helps clients at the early stages of development. The know-how and technology that CRI1 uses is developed by the participants based on their research experience and knowledge. The technology offered by CRI1 was developed by the participants during the time they worked in academic research. The IP used by the company to provide solutions to Biotechnology companies is developed and owned by the participants. CRI1 has not bought any IP.

At times CRI1 works on collaborative projects whereby it develops new methods while working on solving the needs of its clients. The product and related IP in this case is owned by the Biotechnology client and the methodology to deliver the product belongs to CRI1.

CRI1 out-licensed its IP once. However, the business model that the company follows as explained by CRP1 is:

> Contract research, so we use our experience, our methods, our tools to give our clients the outcome they want, basically, which is not better tools but which is a product in the end.”
> In terms of licensing CRP1 explains “….We certainly tried it once but we see that for people it’s hard to apply really our methods (sic).

Since the R&D work performed by CRI1 is “very specialised” (CRP2) there is a demand for the service it provides. Hence CRP1 and CRP2 appear content with focusing on contract research work and consider licensing their technology complicated. This is because it might require them to first train people in the company buying it to use the technology and that would involve writing manuals, standardising their methodology and packaging it etc.. The participants express that they have considered it but it’s not a business model they want to follow as it will require different skills, resources and investment of time as well as money to achieve it.

Management of OI

At intial stages of engagement with new clients initially the CEO of the Biotechnology company is involved in order to understand the work CRI1 would be able to perform and know the company better. Later the R&D head is involved to discuss the project details. At various stages of the project different people and/or departments at the Biotechnology company interact with CRI1. For example, administration and finance are involved at the setting up of the contract and the payment stage. The final report that is prepared is reported to the R&D head and the key R&D personnel as well as the CEO in case of SMEs. A R&D manager or a project manager is involved to handle the technical aspect of the project throughout whereas all decisions and negotiations are made at a senior level by the CEO at the inception of the project.

Individual-level Implications of OI

The scenario in Biotechnology firms appears to have changed in the perspective of the participants. As CRP2 expresses, “It’s changed a lot. It used to be very much more closed. I mean, it used to be more or less closed” (sic). This assertion is supported by CRP1 who explains that earlier Biotechnology companies had to have everything within due to the concern for IP as well as the quality of work. Drug discovery companies previously had their own design team, chemists and biologists etc. However now there are Biotechnology companies consisting of just a few people that develop drugs due to a more open and collaborative approach. A company like CRI1 would not have been possible ten or fifteen years ago in the participants opinion primarily due to infrastructure issues.

Career paths of scientists

As the scenario has changed in Biotechnology industry due to greater access to technology, knowledge and resources irrespective of location, scientists like CRP1 and CRP2 can become entrepreneurs. The career paths of scientists has changed due to more opportunities being available. However the growth is slow and has challenges such as learning new skills like selling, networking and financial management. Further growth prospects for companies like CRI1 can be limited as the market might be small due to the niche technology that is offered.

According to the participants the financial crisis of 2008, has changed the scenario for the Biotechnology industry in Australia and has led to a change in perspective. The challenge facing the scientists today is that the traditional way is disappearing. Therefore an adaptable approach towards change and the dynamic business environment are crucial. Openness to change in all forms is emphasised as critical by the participants. This is primarily because scientists in the Biotechnology industry nowadays have no set career paths (according to CRP2) and have to be proactive in terms of finding their own way and creating their own career path.

Role, responsibilities and skills

Being entrepreneurs the roles that the participants have to play changes on a regular basis as they have to manage myriad aspects related to their company. At CRI1 the scenario is that CRP1 and CRP2 share managing various responsibilities although CRP1 is primarily responsible for client management and CRP2 oversees financial side of the business.

On being asked if the participants had observed any changes in the roles and responsibilities of scientists due to a more open and collaborative approach to innovation, the participants suggested that it has. In CRP2's and CRP1's opinion for academic scientist the emphasis on publishing has meant that the quality of research has suffered. CRP2 asserts that, "people are producing rubbish". Academic science in an attempt to be more outcome focused is measuring performance based on the number of publications and not on the quality of research. Earlier academic research in CRP2's opinion was based on more extensive experience whereby a bigger picture was presented in the paper.

In industrial research the focus is still on the end product and securing IP. However, as the current Biotechnology industry is facing "huge pressure" scientists have to constantly worry about their careers. Scientists in the industry are facing a major challenge due to lack of job security as Biotechnology companies have been closing down in the last few years. Hence scientists such as the participants have to find new avenues of employment. The transition that CRP1 and CRP2 have faced is described astutely in the following words by CRP2:

> We used to the scientists before, so we learn the hard way to switch off from the science into the business (sic)…. it was a risk we didn't want to take. [laughing] It was a very big change (sic).

As is evident from the quote above the shift from science to business was not easy for the two participating scientists. In light of the shift that they had to undergo the participants view that scientists today need to develop business skills as well as interpersonal skills in terms of managing human relationships and dealing with different stakeholders. Knowledge is still important but diversity of knowledge is required in the current scenario. Scientists still have to be experts in their area but are now required to have knowledge of other areas too. This is described by CRP1 as follows:

> Because it used to be, as a physicist, a chemist, a biologist. Now you have to be physicist, chemist and biologist! [laughing] (sic).

In addition, flexibility to switch between science and business is important. An entrepreneurial outlook is required as well as an open attitude towards learning and adapting to change. Industrial scientists need to have a more risk taking attitude and let go of their fears of venturing into the business side of science. Scientists have to be able to network and work with other people to find practical solutions. Scientists now have to focus more on applied science instead of "pure science" *(CRP2)*.

Earlier industrial scientists were considered to have transition to the "dark side of the world" and associated with an "evil image of the guy who sells the world" (CRP1) whereas now this image is not valid anymore. Now industry science is considered more practical and associated with "helping people" (CRP2). The participants find that collaboration in industry is a mutually beneficial exercise whereas in academic science though there are collaborations everyone is working for their own purpose and exploiting each other.

CRP1 and CRP2 have found the experience to be working on their own entrepreneurial venture in the biotech industry to be rewarding though it was "scary" (CRP2) and not without its challenges. Summing

up their experience CRP1 and CRP2 concur that they would think twice now even if they were offered a professorial role with a fixed monthly salary. They appear to be content with their entrepreneurial venture and the journey they have made from being only scientists to being entrepreneurs and scientists with business acumen.

IB1

IBP1's first job was as an academic. IBP1 then worked as a scientist and served as a Director on various boards. For the last eleven years IBP1 has held the positon as the CEO of IB1. IBP1 has received recognition internationally as a global Biotechnologynology visionary.

IB1 is Australian Biotechnology's peak industry body association. It is a public company that has grown from four staff members ten years ago to fifteen full time employees. It has seven non-executive Directors plus the CEO. It receives no government funding and operates like a small self-sustainable business. Most of the revenue is generated through incoming memberships. It has around 500 corporate members. Its members are Biotechnology companies in Australia. IB1's membership is representative of a broad spectrum of interests across the Biotechnology industry encompassing almost all aspects of the value chain from inception through to commercialisation as well as policy. Further IB1 organises events for the industry which are another source of its incomes. In addition, sometimes by winning government tenders and projects it is able to further gain income. It has been able to operate on a sustainable business model for over ten years now.

Conceptualising OI

IBP1 is familiar with the term though it is not used by IB1 due to mixed views. However, IB supports what OI represents that is, collaboration for innovation, as IBP1 expresses:

> It's a team game now. The individual genius, those days are pretty much over… There's a lot of moving parts, there's a lot of stakeholders involved, it's a very complex patchwork quilt.

In IBP1's opinion for successful outcomes from science different partners have to collaborate and work together towards a common goal that will not only reap individual rewards and satisfaction but enable beneficial social and economic outcomes for the society too.

According to IBP1, Australia is known to have world class research capabilities however; it's not as adept at translating it science into commercial outcomes. The reason is that university academics are not rewarded for engaging in industry but only for basic research and education. Academic scientists who work on patenting or engaging with industry do not get adequate support. Therefore, IBP1 asserts that the system is set up in a manner that opposes collaboration. Due to this IBP1 says it is counter productive that the government on one hand encourages collaboration however, there is no supporting system in pace to actively support it.

As academic scientists are not encouraged through financial reward to engage with industry they do not do it. This has led to frustration within early to mid-stage career academics as they would like to actively engage more with industry but are unable to due to pressure to focus on publications. The

younger scientists are finding it more of a challenge than the older scientists as they are more engrained in the system.

When IBP1 moved from science to the business side she had to encounter discouragement and remarks warning her of moving to “the dark side” (IBP1). The view previously was science for profit motive was considered evil though this is no longer the case it is still prevalent in the public sector. IBP1 therefore advocates that there is a need for exposure and education in order to help people get more comfortable with the idea of working in an open collaborative manner as it is different from a purely academic situation.

In IBP1’s opinion there is a need to bridge the gap further between industry and the academic sector to advance innovation within the Biotechnology sector.

IBP1 does not view OI to substitute internal R&D. Engaging is OI is unavoidable due to the need for diverse expertise. However, Biotechnology firms are aware of the risk as well as the scope of error it can create to spread their R&D.

Individual-level Perspectives on OI

Benefits of OI

In IBP1’s opinion, OI allows different parties such as academic science and industry to work together towards commercially viable outcomes for science. In IBP1’s view it allows the community to benefit from a good return on investment by turning basic research that may never otherwise be applied into science that is useful for the community.

IBP1 draws attention to the “economic and a social argument” of transferring quality research into commercial pathway that will benefit people in a range of ways and lead to economic development. According to IBP1, the social benefit is that the application of science for various purposes by diverse partners with different points of view coming together in a collaborative manner will lead to better outcomes for the society that is better healthcare, climate change remediation and better energy arrangements to name a few.

IBP1 states that academic scientists need to step out of the “the fantasy of the gentleman researcher and start looking at modern life” so that society and economies can benefit more from science. Scientists have to put their knowledge to use for practical solutions otherwise it is a huge wastage. This can be achieved when science and business interact and collaborate more.
Problem directed science that is encouraged by the industry can lead to better solutions for community. OI is a way of bringing together two halves of “the apple” for achieving commercially viable outcomes for science in Australia. IBP1’s expresses her opinion about the necessity of OI as follows:

> So you have to have both halves of the apple working together. They have to work optimally together to make the outcomes for Australia and for the individual parts better. There’s no one group that can survive without the other group. So it’s a community effort. And the sooner people grasp that, the better off we’ll be.

IBP1 shares that OI allows different partners to collaborate. No university or medical research institute in Australia has funds to take product to market. There is need for private money and investment for that to be possible. OI in IBP1's opinion allows collaboration that is necessary for science to turn into commercially viable outcomes for the community.

Challenges of OI

The lack of enthusiasm from academics in participating in events organised to interact with industry partners is viewed by IBP1 as a challenge. There is prejudice from the academic scientists towards industry science as it's looked down upon.

On the other hand, industry science is cautious of interacting with universities in Australia due to IP issues. This is illustrated in the following quote:

> And they say, 'We won't go to X, Y University, we won't touch them with a bargepole, because we had this negative experience with them.' You know they think their IP is worth X and it's not worth anything, until it's commercialised, it's just an idea, it's a good piece of science, but it actually isn't worth anything….

IB1 is working towards breaking down these prejudices and help both parties overcome their judgements. The goal is to help both parties understand that both need each other and both play a crucial role in advancing science.

IBP1 has observed that IP issues are primarily the reason that partnerships disintegrate at early stages when industry partners want control over the IP and universities are not in agreement to their terms. Companies are very mindful of fencing their IP before engaging with partners in any manner as the risk of losing IP is huge.

Another challenge that IBP1 highlights is that Biotechnology companies engage more in research collaboration with offshore partners. The reason for this is familiarity, availability, attitude, culture and practicality. Another reason is that Biotechnology companies find that in some other countries such as the U.S. and the U.K. they have much better arrangement as well as a more sophisticated understanding of working with industry. As IBP1 points out:

> Professors in Cambridge just about every one of them has a start-up company as well. That's not the situation in Australia. Again, Professors in many US institutions have start-ups or have had a company and made money out of it or are part of one or two other companies or sitting on their scientific advisory committees or as a director. It's a very usual thing to do. That is not the case here. So if you've found an expert who is familiar with this, and has done it before, then that might be more attractive to you than arguing with somebody about who's going to own the IP. [laughing]

This highlights that Biotechnology companies require a cultural and attitude change from academic scientists in Australia in order to form more mutually beneficial partnerships. This is highlighted in the following comment:

> I just think it's a crying shame we've got all the elements here…but we just can't seem to get past this old-fashioned notion that public research is good and wholesome and there's something smelly about making money.

This cultural barrier that IBP1 points towards is a key challenge for promoting collaboration and partnerships within industry and academia. There is a communication barrier where both parties use different language and words that leads to misunderstanding and disagreements even when what is being discussed is the same but just representing different points of view. This is expressed in the following quote from the interview:

> Even the same words have different meanings for people. So when they meet and they talk to each other, that's why they don't understand each other very well. And that's where we need a breakdown in more sophisticated engagements.

Another challenge that has been observed by IBP1 is that networking is viewed as uncomfortable and a hard task by most scientists but more and more realising the importance of overcoming their internal barriers. Furthermore, developing trust with new partners is found to be challenging as well.

Organisational Implications of OI

Finding partners

Biotechnology firms partner with universities and medical research institutes for contract R&D, and sub-contract work to consultants. When seeking partners Biotechnology companies spend time considering potential partner's patent positon, look at competition and keep track of publications. They search for knowledge leaders globally, keep track of their publications, find out their experience in the sector and working with industry.

IB1 makes referrals to Biotechnology firms as it knows the sector well; knows who is good in a certain area. Also, IBP1 has noticed that, Biotechnology companies help each other with information as it's a small and highly networked sector. Hence if someone needs information that is not directly competitive then companies help each other. For example, if a company is seeking an introduction to a lawyer or someone in regulation or someone with a specific scientific expertise then IB1 makes recommendations as well as other Biotechnology firms help provide information. As pointed out by IBP1 "it's like a market place and there's a lot of that internal activity that takes place in the sector. That's not the problem".

IBP1 describes the role IB1 organisation plays as follows:

> So we act as marriage brokers and make referrals and suggest partners and then it's up to them…we provide the engagement ring and whether they get married or not is up to them.

There are different aspects that determine if the partnership is established these are aspects related to science, availability, cost and IP. Some of the introductions that were made by IB1 turned into long standing partnerships.

Evaluation and selection of partners

IBP1 has noticed that partnerships are needs based mostly as some expertise is unavailable elsewhere. Number and type of partnerships formed are dependent on the size of the company, money available, expertise required, level of difficulty and competition. Sometimes in research things evolve in another area where the organisation might require new capabilities that it might not have. Biotechnology organisations form partnerships based on who meets the need and requirements while being commercially viable.

OI at IB1

Different forms of OI

IB1 organises various events to promote collaboration and networking in the industry. For example, an annual event is a Technology Transfer Conference. Technology officers from universities and research

institutes are invited to attend the event as well as business development personnel from Biotechnology companies. This conference not only encourages collaborations but also is a platform to learn best practices in the area from other countries.

Another event IB1 organises is an Annual National Industry event which is open to academics as well. Furthermore, it organises an investment event for the industry. These events are aimed to bring together academics, industry and investors in one place from across the globe as well as nationally.
Additionally, IB1 actively participates in State and Federal Government discussion at a policy level in order to encourage collaboration.

An example shared by IBP1 of the way the Victorian Government advocated OI was by offering a voucher system whereby a public institution facing a problem that it could not resolve on its own would issue a tender that allowed various companies to bid to solve the problem. This system was positively received by Biotechnology industry and it was a clever way to ensure that public money was applied to good use in finding solution for the public sector. IBP1 laments that this system no longer exists.

Most of the Biotechnology companies are capital lean and/ or virtual companies. As they are under-capitalised sometimes these Biotechnology firms are unable to speed up the innovation process and fall behind the competition.
Biotechnology sector in Australia is highly networked, as IBP1 explains

> It is so knitted together that you can't do much without everybody else knowing about it. It's like a village. And they've done this to hang together to give each other succour, because it's tough. It's a really hard gig, you've got everybody up against it. They're got a high failure rate, they've got very little capital.

IBP1 states that out-licencing is the predominant practice. Australian Biotechnology companies are able to sell their IP and technology to big Pharmaceutical companies overseas since the domestic sector is not yet well developed at that level. The shift that has taken place is that Biotechnology companies are able to out-licence their technology and/ or IP at an earlier stage. There are different deals that Pharmaceutical companies engage in with Biotechnology firms sometimes by financing research and this allows them first right to examine it or first rights refusal. Sometimes Pharmaceutical companies invest in a technology to either secure first rights or secure certain portion of the business later. Biotechnology companies are now able to engage with Pharmaceutical companies in various ways now as the pathway is not as linear as before and there is more flexibility for both parties to engage.

Management of OI

According to IBP1 trust, people skills and relationship management appear to be crucial for managing partners in an OI scenario. IBP1 insists that the culture of the Biotechnology organisations in terms of attitude towards collaboration and partnership for R&D is dictated by its leadership. Biotechnology companies with CEOs who have a scientific training vis-à-vis ones with a finance or business background operate differently. People skills are crucial along with a scientific aptitude are essential for managers in Biotechnology firms. Further, someone who has a diverse experience has knowledge of

not just one stream but has a broad experience and understands people not just scientists but also how sales or finance or marketing people think and respond is beneficial in IBP1's viewpoint.

Individual-level Implications of OI

Reward systems

IBP1 expresses that how academics are remunerated is holding back their ability to engage more with industry to translate research into meaningful commercial outcomes for the society.

Career paths of scientists

Career paths of scientists have changed over the years. When IBP1 started her career as an academic business was viewed as the "dark side". However, now it is accepted that science and business need to amalgamate for achieving commercially successful scientific outcomes.

The gap between academic science and industry is less wide and public and private sector are being encouraged to work together and understand the role the other plays. Now there are successful scientists who are CEOs and leading companies. The career paths of scientists have evolved there are high number of scientists who are open to entrepreneurial ventures of their own.

Role, responsibilities and skills

Scientists are required to develop business skills in conjunction scientific knowledge and expertise.

The change that has taken place over the years is described by IBP1 from her personal experience as follows:

> When I was a younger academic, we had a talk in the department from the first Biotechnology company that was around at the time. And I remember saying to the Managing Director, who presented, afterwards about I was a scientist and I was thinking of doing a MBA and I was thinking of developing business skills and he said to me that will never be required. Scientists will always do science and business people will always do business and how wrong was he (sic).

According to IBP1, the perfect balance for a scientist is someone who is technically competent while possessing business competencies. In order for the organisation to succeed its mandatory for the managers in Biotechnology firms to not only understand the science but also the business aspect.

Graduates now are more curious about business development aspect of the business. There has been a gradual shift that IBP1 has observed that the young aspiring scientists are actively seeking out business skills once they have basic science literacy and understand how a R&D laboratory operates.

IBP1 foresees a new breed of entrepreneurs for the Biotechnology sector who have well developed scientific and business acumen. There is a growing understanding that both are required for scientists. According to IBP1, also at the senior level that is, the Board of Directors there is an over emphasis on financial literacy that is essential however, given the changing nature of business there needs to be more awareness and strategy around digital footprint of the company and cyber security issues. This is primarily because for Biotechnology firms securing technical boundaries is critical in order to mitigate

the risk to IP that is the prime asset. Therefore, there needs to be greater knowledge and awareness about issues related to cyber security and IP protection. This is illustrated in the following comment:

> At the board level – do they actually understand the protections that they have built around their intellectual property, which is the heart, the beating heart of the company. If that stops beating, you have no company…the boards need to look more at their diversification…in terms of valuing more people that have that technical ability, have content knowledge and seeing them as valuable and as important as people who have legal backgrounds, that have financial backgrounds.

Scientists need more awareness of legal constraints and requirements. According to IBP1, most Biotechnology firms in Australia are small to medium sized therefore scientists are required to be "jack of all trades". Further, IBP1 states that scientists in Biotechnology need to be mindful of the "IP clock" as well as have visibility of other elements of the business not just R&D laboratory work. Scientists have to work under certain constraints of time and money especially in the Biotechnology sector in order to achieve successful commercial outcomes before competition. They have to have good time management as well as ability to work under pressure. Scientists in Biotechnology firms are getting more aware of competition and ensuring IP and information security issues.

RI1

Interviews were conducted at a premier research organisation (RI1) in Victoria with two participants. RI1 has 5000 experts based in fifty five centres. RI1 collaborates with around three thousand customers every year. It has around 150 international partners.

At the time of the interviews RIP1 held the position as a Lead Scientist, Biotechnology and RIP2 was the Director of Commercialisation. RIP1 led various projects at RI1 mostly for the Biotechnology industry. He was responsible for identifying and forming a team of scientists based on client's needs and expertise required. He has over two decades of experience as a scientist. He has worked in academic science prior to being a scientist at RI1. RIP1 has worked at RI1 for more than twenty years in various roles such as: senior research scientist, research program manager, project manager and commercial manager.

The other participant RIP2 managed the interaction between RI1 and industry. He was primarly responsible for business development function and leading a team focused on finding more industry engagement projects. He had formed good relationships with senior business leaders in the Biotechnology industry. He was familiar with the Biotechnology industry in Victoria as well as Australia overall.

Conceptualising OI

RIP1 defines OI as a way of dealing with a complex problem that does not have an obvious solution through the use of a number of different points of view or different sets of experiences. RIP1 offers a simple explanation for using OI that more heads are better than one. Accessing different resources and perspectives is the easiest and simplest way to sometimes begin to solve a problem or address a need

for knowledge or expertise. OI is viewed as positive by RIP1 as it allows various inputs into solving a problem. It is viewed as finding a way to solve a problem that needs to be resolved by both participants.

On the other hand, in RIP2's experience no one who practiced OI ever called it by name. To understand OI one has to understand that "technology transfers on two legs". For transferring technology it was important that people interact and understand each other therefore, OI therefore was more about "people exchange and people working closely together" in RIP2's opinion than just technology transfer. Furthermore, according to RIP2, OI was based on understanding the premise that it was a mistake to consider that all knowledge resides in a small group of people. By drawing on a different location of skills businesses are able to avail opportunities from a whole different set of skills. Using and amalgating skills and knowledge from a variety of disciples enables better innovation. RIP2 explains this as follows:

> We're increasingly finding that at the intersections of different disciplines, so chemists, and scientists, and biologists working at the intersection of where those problems that are on the boundaries but intersect with one another, you start to get much more interesting ideas when the disciplines……start to interact.

RIP1 points out that most Biotechnology firms are "ideas-rick but money-poor, capability-poor or resource-poor". RIP1 has worked for Biotechnology firms of all sizes from the smallest to the largest at RI1. Usually Biotechnology firms approach RI1 thinking that they know what they want to do but don't know how to do it. RI1 works as a "de facto R&D unit" for a large number of Biotechnology firms. However, RIP1 views OI as both a substitute as well as a complement to an organisation's R&D. According to RIP1 this is dependent on the size of the company, for a two-man or virtual company using external sources for R&D is the only option whereas for a larger organisation OI complements internal R&D. What organisations lack is complemented by using various other sources. In RIP1's view OI is not a substitute overall because organisations of all sizes usually look for solutions to fix some problem that cannot be resolved using internal resources.On the other hand, RIP2 expresses OI is more to complement the exisiting R&D efforts. There is a need for both sides to have technical expertise and skills in order to use the knowledge effectiving. This is expressed by RIP2 as:

> So you need to have internal capability that allows RI1 to effectively engage, or any other organisation to engage. So I think for open innovation to work, it's great to have technical skills…have technical skills on either side. So yeah, I wouldn't be using one as a substitute for the other. I think they need to complement (sic)

Individual-level Perspectives on OI

Benefits of OI

For RIP1, OI is beneficial as it allows a variety of avenues and inputs to explore and approach a problem. By allowing a wide diversity of inputs OI can lead to new ideas and outcomes. OI open ups ways for different experts to collaborate together leading to better science. This in turn leads to better solutions that eventually results in science making a positive difference in people's life.

OI enables organisations to draw ideas and knowledge from their customer, supplier and even competitors leading to better solutions and outcomes. RIP2 expresses this benefit of OI in the following comment:

> The more open the innovation system is, the better ability we have to invent and solve really massive problems, really big challenges.

Challenges of OI

RIP1 finds that when working with Biotechnology firms initially it is important not to take a prescriptive approach to problem solving as each client and problem is unique. The hardest part is to know when the problem cannot be solved and when to carry on. Also it can be challenging to ensure that the client is informed every step of the way about the progress on their work. Client management is viewed as a challenge at times as it can be “a draining process”.

It is important to maintain communication channels and a good relationship. Communication within the team working on the project as well as with the client is the most crucial part. In order to ensure that problems are resolved quickly. To avoid communication problems RIP1 asserts it is important to set up “porous communication”.

Another challenge can be IP ownership if not addressed properly. RIP2 mentions that every party wants maintain as much control on the IP as possible. The issue of control leads to conflict if not pre-defined at the onset of the project. In RIP1’s opinion it is less about the ownership but more about the exploitation of IP. In some cases clients do not “care about the IP” as long as they are able to access it. Effective communication about options related to IP is important to ensure all parties understand the implications this helps in avoiding problems at later stages.

Organisational Implications of OI

Finding partners

Biotechnology firms usually approach RI1 as it is highly reputed. There is a business development team at RI1 which liases with the industry and participates. RI1 participates in various industry events to create awareness about the technology and solutions offered. Also, scientists within RI1 have various publications about their work in academic journals, this enables Biotechnology companies interested in their work to contact the them. RIP2 and his team are active in creating relationships with the industry. The business development team is proactive and is usually the first point of contact for Biotechnology companies seeking R&D solutions from RI1.

OI at IB1

Different forms of OI

There is an evolution at RI1 towards more engagement with external partners to generate scientific solutions that impact and make a positive difference to people’s lives.However, in the area that RIP1 oversees there seem to be no specific processes and/ or systems that are followed in terms of interacting with its external stakeholders. RIP1 identifies and forms a team to work on the project based on the client’s needs and knowledge requirement of the project. The way RIP1 and his team approach the problem is unique to the client and their problem and expectations. Team members are encourage to think outside the box and be creative when approaching client’s problems. RIP1 describes how the process as follows:

> Entirely organic… It’s entirely, I mean, it’s about thinking, it’s about being creative, being innovative, thinking outside the squares, all those things. It’s about grasping an opportunity or, you know, pursuing an

> idea…opportunism, being reactive, being proactive, there is no one way. And it's a judgement as to what the team looks like, and what it requires, and who will do it, and how it's done.

RIP2 and his team work closely with the scientific team to understand the technology and expertise offered. This allows them to share with prospective clients what can be offered and to help match the correct expert with the client. Forming a team for a Biotechnology client requires judgement on part of the manager heading the project. Hence identifing the right expert to be the project leader is important to the final outcome of the project. The team is selected dependent on who knows what, what the project requires and how it will be done. In RIP1's experience sometimes Biotechnology clients don't know what they need but just have an idea and part of the job is to decipher the exact need of the client.

Further, things change as the project progresses hence in RIP1's opinion there is no one way of doing things. The participant insists that how it is practiced cannot be quantified in any way. The focus is to achieve the outcome that the client wants by using whatever resources possible.

Management of OI

IP agreements need to be structured properly at the inception of the relationship. Communication and building good relationship with the client is critical as it helps to override any problems that might appear during the course of the project. A project management approach is undertaken to manage various clients. The organisational has a matrix style strucutre that allows for movement of personnel across the organisation depending on the project requirements. Scientists may work simulatenously on more than one project depending on the availability of personnel, timelines and project requirements.

Individual-level Implications of OI

Reward systems

It appears from the interviews that the nature of overall R&D has not significantly changed in RI1. However what is being realised is that how organisations "tap into R&D" is not the same anymore. R&D personnel are required to work across boundaries with others. For RIP1 the two measures of performance are client's feedback and delivery on the outcomes of the project however in terms of how it is measured in the organisation it is not the same. RI1 was undergoing a change in terms on its purpose in some ways. The focus for a long time had been on academic pursuits by scientists within the research organisation however, the organisation was encouraging more engagement with industry and outcome focused science. The focus should be to use good science to solve problem that makes a difference in people's lives instead of a long list of publications. This slow transition is described by RIP1 as follows:

> Good science as opposed to relevant science... which doesn't sort of mean it's not good science. But, you know, if you don't publish something, it doesn't mean it's not good (sic).

The reward systems measures what is acknowledged through publications as well as patents however; RI1 was grappling with how to measure performance of its scientists. The organisation is trying to understand performance in terms of client engagement and external revenue vs. number of publications as a measure of performance. RI1 was working on reflecting this shift in the way the scientists within are rewarded. The participant laments that the transition is slow and there is still considerable focus on

pubishing as opposed to industry engagement. The challenge was how to acknowledge scientists for “industry facing work as opposed to academic facing work (sic)”.

RIP1 asserts that the emphasis on external engagement would grow and there would be more clear strategies to achieve and acknowledge it. At the time of the interviews RI1 was undergoing a cultural change in some ways whereby there was a realisation about the importance of industry and external engagement and, external revenue being critical for its survival. This in turn would impact performance measures and reward system.

The organisation is realsing that the work scientists do can have a bigger impact by engaging more with industry and it would lead to positve outcomes for society in terms of jobs, new industries and solutions for society instead of just publications. Measuring this impact would need to somehow be captured in the performance system.

Career paths of scientists

Scientists at RI1 are facing a shift towards applied science. However, as the organisation was undergoing a change it was not clear what would emerge. RPO1 suggested that there might be a dual stream in terms of being either a Research Consultant or a Research Scientist. The difference between the two would be that the Research Scientist woulld be the tradition scientist engaged in academic programme whereas the Research Consultant is an “industry facing scientist” who is not focused on publications but outcomes and impact to industry and society through it. Therefore, the organisation would have to deduce different career paths based on the inclination of the individual as well the organisation’s objectives.

Role, responsibilities and skills

It appears from the interviews at RI1 that scientists are required to possess not just scientific skills but also the ability to enaged with others. The “Emotional Quotient element” is highlighted as being important to work in an OI environment (RIP2). Entrepreneurial skills and export orientation are skills displayed by most organisations that approach RI1 for colloration or project engagement.

RIP1 insisted that the role of internal R&D has changed overall. At research organisations, institutes and universities too there has been a shift in the role and responsibilites of R&D as grants are harder to acquire. At RI1 this has led to greater external engagement. Further in Biotechnology companies too using external sources is now part of the norm as the industry has become leaner after the financial crisis. The shift at RI1 is described as becoming more commercial and business focused instead of operating as a research organisation.

Scientists are required to work in a more open and networked innovation space. This means that they need to acquire people skills and a change in attitude. Scientists have to be open to what they would be willing to do in order to help someone solve their problem. Further, there is a need to understand the importance of forming good relationships and communicating effectively with different stakeholders

internal as well as external. Soft-skills are becoming more critical for scientists. Scientists need to “de-silo-ize” themselves.

Engaging with external partners instead of focusing on publications is a change that scientists at RI1 would have to face. RIP1 highlights the reason for this in the following comment “to do what it takes to address the needs of those who pay the bills”. It is reiterated throughout the interviews that due to the increase in collaboration for innovation whereby industry and academic and/ or research scientists are required to work together a certain change in perspective would be essential. Scientists would need to focus on the impact and outcome of their science and not just number of publications.

RIP1 started as an academic who has undergone a shift towards commercially focused science and finds it more fulfilling due to the impact it has on people’s live. In addition, scientist traditionally view applied science as “it can’t be cutting edge” and consider it to be “low-rank science” this requires a change in attitude for scientists working in an OI environment in research organisations and institutes. Scientists when working with industry are given a task to solve a problem and it requires them to be competitive in the market against other players. There is a need to be ready to accept that what is required now is to use the best possible science to help solve a problem for a client whether it is acknowledged by experts or published is not as important as its impact.

Appendix 3.4 Consent Form

CONSENT FORM

1. I have had the project explained to me, and I have read the information sheet

2. I agree to participate in the research project as described

3. I agree to be interviewed and that my voice will be audio recorded

4. I acknowledge that:

   (a) I understand that my participation is voluntary and that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied (unless follow-up is needed for safety).

   (b) The project is for the purpose of research. It may not be of direct benefit to me.

   (c) The privacy of the personal information I provide will be safeguarded and only disclosed where I have consented to the disclosure or as required by law.

   (d) The security of the research data will be protected during and after completion of the study. The data collected during the study may be published, and a report of the project outcomes will be provided to participants on request. Any information which will identify me will not be used.

Participant's Consent

Participant: _____ Date: _____

(Signature)