Appropriation of Intellectual Property: A Multiple Cross-Case Analysis of SME Practices in Technology-intensive Industries

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Intellectual property (IP) is critical to the development of competitive advantage. Anecdotal evidence and the literature suggest that SMEs find it difficult to appropriate their IP, due to high legal costs. This study examines the key determinants of IP appropriation strategy in technology- intensive SMEs. We examine the relationships between the factors that facilitate IP appropriation and innovation performance with a qualitative analysis of five case studies in the biotechnology and ICT industries. The results reveal that SMEs in both sectors rely on organizational resources, specific IP acquisition practices and various IP protection practices to facilitate IP appropriation.

INTRODUCTION

The nature of competition has changed due to the emergence of the knowledge economy, in which intellectual property (IP) has become critical for the development of competitive advantage. IP encompasses intangible assets such as knowledge, inventions and designs. IP can be generated either through internal research and development (R&D), R&D partnerships, or from other external sources, such as patent publications. The protection of IP can be achieved via formal legal mechanisms, such as patents, or alternative informal practices, such as trade secrets. The benefit of strong IP protection is that it allows owners of innovations to appropriate more value, for example, by licensing the IP to other firms.

Since knowledge is one type of IP and sustained competitive advantage stems from the ownership of and access to knowledge, IP can be called 'knowledge-based advantage' (McEvily & Chakravarthy, 2002). The owners of IP have exclusive rights to the property, allowing them to extract financial benefit (Reitzig & Puranam, 2009; Narayananan, 2001). IP is of such value to the firm, that it needs to be secured, and protected from imitation, obsolescence, and infringement (Levin et al., 1987). Imitation of innovation saves competitors the time and expense of true innovation (McEvily & Chakravarthy, 2002; Nieto & Perez-Cano, 2004).

The innovating firm incurs costs in protecting this knowledge from imitators. Instead of simply protecting their IP, some firms, particularly SMEs choose to share and exploit their intellectual assets in the market for competitive advantage and thus, profit. However, this exploitation exposes the firm's IP to the threat of imitation by competitors. Therefore, firms must 'find ways to balance the need for knowledge protection and the need to replicate and share their knowledge' (Hurmelinna et al., 2007,

p.137).Review of the literature, which predominantly focusses on large firms, suggests that IP appropriation strategy involves a multi-dimensional approach by engaging in continuous innovation of organizational resources, IP protection practices and IP utilization strategies, to gain overall value for the firm. Anecdotal evidence suggests that SMEs find it difficult to allocate scarce resources on expensive patent-attorneys.

This study is important to gain an understanding of the type of appropriation practices SMEs engage in to gain value from their innovations. Further investigation is therefore required to gain a better understanding of SME practices, which would build on theoretical examinations of appropriation strategy (Grindley & Teece,1997; Chesbrough, 2008) along the IP value chain: IP generation, IP protection and IP utilization. Consequent to the above, the study addresses the question: *What are the most significant facilitators of IP appropriation in SMEs in the biotechnology and ICT sectors?'*

In order to provide qualitative answers to the research question, we apply the well-known VRIO framework (Barney, 1991) to the IP value chain, which comprises of three stages: IP generation, IP protection and IP utilization. The study examines the key factors that facilitate IP generation, IP protection and IP utilization. More specifically, this study asks the following questions*: 'What are the key factors that facilitate IP appropriation in firms in the biotechnology and ICT industries? What are the best IP appropriation practices used by firms in the biotechnology and ICT industries? Why are they important? How are they applied?'* The biotechnology and ICT sectors were chosen as case study companies because R&D is crucial for rapid and continuous innovation, which enables growth and survival in these innovation-based industries (Cohen et al. 2000).

LITERATURE REVIEW & THEORETICAL DEVELOPMENT

The purpose of the literature review is to establish a theoretical foundation for the qualitative study by developing a theoretical framework that represent IP appropriation by the firm. Organizational resources are those attributes of a firm's physical, human and organizational capital which can lead to efficiency and effectiveness (Wernerfelt, 1984). Bundles of resources, such as knowledge and physical assets, complement each other and provide the firm with a sustained competitive advantage (Porter, 1996; Steiglitz & Heine, 2007). Thus, firm resources can be considered as strengths for enabling strategies to be generated and implemented (Porter, 1981). Grant (1996) refers to the Knowledge-based View (KBV) and argues that the competence of a firm depends on organizing its existing knowledge, the most significant competitive asset that it possesses (Wiklund & Shepherd, 2003).

IP appropriation occurs when value is extracted from the firm's IP. Reitzig and Puranam (2009) state that the value appropriation chain is comprised of generation, protection and utilization of IP. Furthermore, the VRIO framework (Barney, 1991; 1995), states that an organization's resources are valuable, rare, and inimitable and can be organized. Earlier studies of the resource-based view (RBV) and knowledge-based view (KBV) support the VRIO framework, which suggests that IP appropriation strategy can enable the firm to take advantage of organizational resources, including the firm's IP, that add value, are rare, inimitable and organized. The VRIO framework can be applied to the IP value chain, as explained in the following discussion.

Generation of IP

The literature suggests that the acquisition of IP via sources internal to the firm, such as internal R&D activities, involves intra-firm knowledge transfer, and R&D is positively correlated with innovative output (Rogers, 1998; Mansfield, 1964; Hall, 1998), and R&D spending leads to increased profits and market value for the firm (Rogers, 1998; Greenhalgh & Rogers, 2006; Pakes, 1985; Greenhalgh & Longland, 2001). Similarly, the external acquisition of IP, a form of inter-firm knowledge transfer, via alliances, in-licensing agreements, acquisitions and imitation, has also been argued to lead to sustained innovation performance, since it is costly to discover and develop a new product internally than to imitate it or purchase it via partnerships agreements or acquisitions (Lanjouw, 2003).

Protection of IP

The literature indicates that firms are faced with the strategic decision to either protect their IP with either legal or informal practices, or exploit their IP to gain competitive advantage, or do both. Firms 'should find ways to balance the need for knowledge protection and the need to replicate and share their knowledge' (Hurmelinna et al. 2007, p.137). Competitors may choose to imitate an innovation as it saves them the time and expense required for identifying and experimenting with new sources of innovation (McEvily & Chakravarthy, 2002; Nieto & Perez-Cano, 2004). Imitation depends on the motivation to imitate, the ability to imitate, and the ability to overcome legal restrictions protecting the IP (Zhao, 2004). The technical knowledge required by competitors to imitate can be acquired through reverse engineering by examining patent applications and publications, engaging in informal conversations with employees, hiring competitors' employees, and informal discussions with suppliers and customers (Levin et al., 1987; Appleyard, 1996).

Since IP is a type of knowledge, some studies have applied the RBV to argue that IP itself raises barriers to imitation, making itself inimitable (McEvily & Chakravarthy, 2002; Nieto & Perez-Cano, 2004). Since the inter-firm transfer of knowledge is affected by the nature of the firm's IP, the KBV explains this. With regards to the attribute of codifiability, explicit knowledge can be imitated, and thus transferred out of the firm, more easily because it can be codified. Examples of explicit knowledge include the knowledge contained in documents, plans or databases, production machinery and equipment, and pharmaceutical products or special alloys, etc. (Badaracco, 1991).

The higher the degree of codification of an item of knowledge, the more efficient the legal means of protecting it (Nieto & Perez-Cano, 2004). Since IP is vulnerable to expropriation by competitors, it can be made inimitable if protected by IPRs or informal mechanisms (Grindley & Teece, 1997; Nieto & Perez-Cano, 2004).

Legal Protection Mechanisms

The literature generally describes IPRs as legal or formal IP protection mechanisms, such as patents (Nieto & Perez-Cano, 2004). When IPRs are available to the firm, IP based on explicit knowledge can be protected with patents, copyrights, trademarks or confidentiality (secrecy) agreements. Nieto & Perez-Cano (2004) find that for IP based on explicit and highly codified knowledge, firms tend to use patents, which are more effective. Patents grant innovators legal protection of their innovations against imitators through assigning ownership rights (Nieto & Perez-Cano, 2004), and have been shown to have a significant impact on the value of an innovation (Levin et al., 1987). The overall benefits of patents include providing a proprietary market advantage (shorter time to market); improving financial performance (reducing R&D expenditure); and improving overall competitiveness (Rivette & Kline, 2000; Terziovski & Corbel, 2012). Other formal methods of IP protection include copyrights, trademarks and secrecy agreements, which are often implemented before the firm engages in the process of obtaining legal patents (Chesbrough, 2008). IPRs play an important role in appropriating innovation rents in technology-based industries (Cohen et al. 2000), so firms in such industries are more likely to be continuously innovating (Hussain, 2015).

Informal Protection Mechanisms

SMEs may not be able to afford IPRs for the protection of their IP., therefore they need to rely on continuous innovation of their limited resources. In contrast to explicit knowledge, tacit knowledge is that which cannot be articulated and cannot be codified because it contains all the procedures and principles that people know but cannot articulate in words or other means (Terziovski, 2010; Nelson & Winter, 1982; Nonaka & Takeuchi, 1995; Nieto & Perez-Cano, 2004).Since knowledge of organizational routines is acquired through experience within the firm (Nelson & Winter, 1982; Cohen & Levinthal, 1990), most technological knowledge has a significant tacit component (Nieto & Perez-Cano, 2004).

These features of tacit knowledge raise natural barriers to imitation for the SME, and is, for example, more difficult for employees to communicate to external parties such as customers, suppliers or peers, who might share this information with the firm's competitors (Mansfield et al., 1981; Teece, 1986).

Although tacit knowledge is difficult to imitate, it is also more difficult to preserve. Therefore, informal protection mechanisms such as trade secrets, lead-time advantage, and customer lock-in are relied upon to protect IP based on tacit knowledge to make it inimitable (Nieto & Perez-Cano, 2004; Hurmelinna et al., 2007).

Anecdotal evidence suggests that SMEs use informal IP protection mechanisms, which refer to the protection of proprietary knowledge by methods other than legal or formal IPRs. When IP is based on tacit knowledge, informal IP protection mechanisms can be utilized. These include exploiting lead-time, moving rapidly down the learning curve, organizing knowledge such as complementary manufacturing capabilities, increasing product complexity, locking-in customers, and advertising the brand (Cohen et al., 2000; Lanjouw, 2003). Informal mechanisms can not only protect IP, but also develop competitive advantage for the firm. For example, in countries without patent laws, innovators have become technology leaders by pursuing innovations in industries that are not dependent on patents for protection and in which secrecy provides an alternative mechanism for protection (Moser, 2005), and this is more often feasible with process innovations than with product development. It is important to note that, although trade secrets are an informal mechanism for IP protection, usually applicable to tacit knowledge, they should be differentiated from confidentiality (secrecy) agreements, which are a formal legal method of IP protection.

Utilization of IP - Innovation Regimes

It is insufficient for the firm's IP to be rare and be made inimitable with the implementation of legal or informal protection mechanisms. According to the VRIO framework, it must also be valuable and organized to enable superior competitive advantage (Barney, 1991; 1995). The firm's utilization of IP via open or closed innovation practices, which organize the firm's IP in such a way that the firm can extract value from the IP, while mitigating the threat of expropriation by competitors (Kelly & Kranzburg, 1978; Chesbrough, 2003; 2008; Pisano & Teece, 2007).

Hence, IP utilization practices, such as open or closed innovation regimes are also determinants of IP appropriation. Chesbrough (2003, 2008) categorizes IP management strategies as, either open or closed innovation regimes.

Open Innovation Regimes

In an open innovation business model, the firm uses its unused internal ideas to capture value in the market via external channels, while using ideas external to its own business to generate additional value (Chesbrough, 2003; 2008; Pisano & Teece, 2007). Examples of strategies for utilizing IP in an open innovation regime include obtaining IPRs, such as patents, which can be out-licensed, as well as publishing new discoveries, making them open to the public and encouraging standardization, which shapes the landscapes of industries.

Firms can earn financial benefits by licensing out their patents to other firms. In fact, many firms manage portfolios of patents, which earn them significant revenues (Chesbrough, 2008). In the biotechnology and ICT sectors, firms make substantial investments in R&D. Therefore, possessing a portfolio of patents allows such firms to adopt an open innovation regime with the aim of recouping their investments and increasing their profits, which can be used as additional operating capital to support further R&D or value-adding activities such as hiring new employees (Shapiro & Pham, 2007). Furthermore, some firms choose the open innovation regime to manage patented IP in the hope that other firms with access to their patented knowledge can make further improvements to the technology and perhaps set standards (Chesbrough, 2008).

To be successful in open collaborative innovation, firms need to share valuable knowledge, while they protect that same knowledge against unwanted spill-overs (Grindley & Teece, 1997; Gulati & Singh, 1998). However, since they provide articulated and codified information, patents are an easy target for competitors wishing to obtain information at less cost than if they were to conduct the R&D activities themselves. Grindley & Teece (1997) argue that currently an increase in R&D and manufacturing costs has led to the increased risk of infringement of IP. Therefore, the market response by firms has been to

aggressively protect their IP with a dual strategy for capturing value from that IP, whereby the IP in question is out-licensed in R&D partnerships and in product manufacturing in manufacturing joint ventures.

Closed Innovation Regimes

Implementing a closed innovation regime means that although the IP is protected, the firm could be losing out on potential rents, especially when the firm must recoup its investments in R&D (Nieto & Perez-Cano, 2004). In their theoretical paper, Pisano & Teece (2007) examine appropriability regime and industry architecture, and how they can be shaped for successful IP appropriation. They find that greater levels of IP protection and stronger barriers around innovation are not necessarily conducive to capturing value from the firm's IP.

According to Chesbrough (2008), closed innovation regimes were common in the past, with firms keeping control of internally generated ideas and being self-reliant for the commercialization of these ideas. Managing IP by maintaining informal industrial secrecy (trade-secrets) or making use of legal confidentiality (secrecy) agreements to exclude competitors from this proprietary knowledge is an example of a closed innovation model, where the innovator can appropriate returns indefinitely as long as the knowledge does not spill outside the firm (Levin et al., 1987; Cohen et al., 2000; Nieto & Perez-Cano, 2004; Hurmelinna et al., 2007).

However, the literature does not fully support these views, as there are several studies that suggest that secrecy provides better protection of IP than patents (e.g., Cohen et al., 2000; Arundel, 2001). In their quantitative paper, Kultti et al. (2007) compare the impact of secrecy and patenting on the incentive to innovate, information disclosure and welfare. They find that patenting has positive effects on both innovative activity and information disclosure, which in turn have a positive impact on welfare. The study also reveals that secrecy is beneficial in protecting from the risk of infringement when the probability that a competitor develops the same innovation and patents it is small.

Application of the VRIO framework to the IP Value Chain

A review of the literature review has identified some key constructs representing factors that facilitate IP appropriation by the firm, as is presented in Table 1. Both the RBV and the KBV provide a theoretical basis for the relationships between these factors and firm performance, as they can propose how the presence of organizational resources and capabilities, IP management practices and organizational learning can facilitate the firm's IP appropriation strategy.

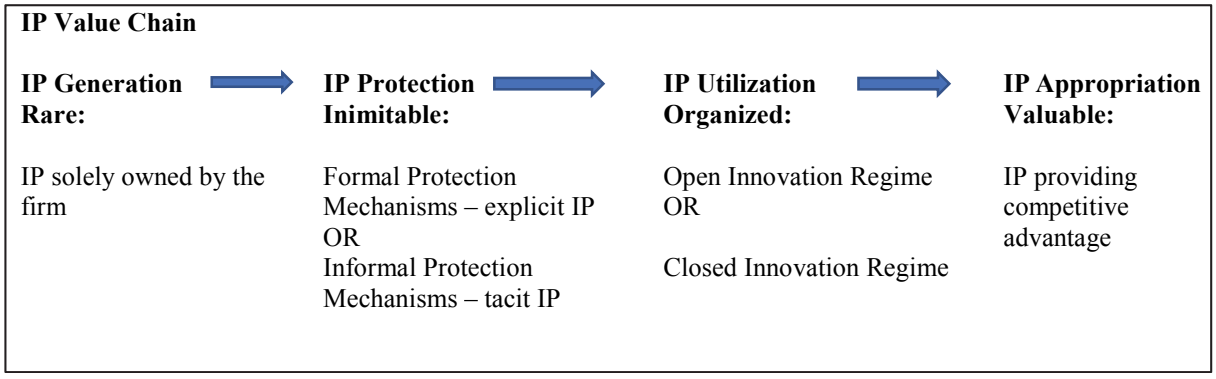
TABLE 1
KEY IP APPROPRIATION STRATEGY DIMENSIONS
IDENTIFIED BY THE LITERATURE

Model Construct	IP Appropriation Facilitating Factor	Reference to Theory
Organisational Resources	Exploitation of organisational resources	Christensen and Bower, 1996
	Internal acquisition of IP via R&D	Rogers, 1998
	External acquisition of IP	Lanjouw, 2003
IP Management Practices	Implementation of Formal IP protection measures	Nieto & Perez-Cano, 2004
	Presence of informal IP protection enablers	Keupp et al., 2010
	Out-licensing	Grindley and Teece, 1997
	Policy of maintaining trade secrets	Arundel, 2001
	Motives for the organisation's current IP management strategy	Narayananan, 2001
	Use of revenues from innovation	Jacobides, 2008
Organisational Learning	Organisational Learning	Terziovski and Corbel, 2012

Based on the KBV, the degree of codifiability of knowledge determines the type of IP management practices that can be efficiently implemented (Nieto & Perez-Cano, 2004). Explicit knowledge can be codified relatively more easily and thus can be protected more effectively with IPRs.

According to the VRIO framework, a resource, in this case proprietary knowledge or IP, must be valuable, rare, inimitable and organized to provide competitive advantage (Barney, 1991; 1995). Figure 1 shows how the VRIO framework can be applied to IP value chain to explain the impact of organizational resources, IP protection practices and IP utilization on IP appropriation.

FIGURE 1
APPLICATION OF THE VRIO FRAMEWORK TO THE IP VALUE CHAIN



RESEARCH METHODOLOGY

We undertook case study research to examine the IP management practices along the IP value chains of five firms in the Biotechnology and ICT industries. The purpose of this multiple-case study design is to identify practices during IP generation, IP protection and IP utilization that facilitate IP appropriation which are affected by the following:

- Organizational resources and capabilities which facilitate IP appropriation by the organization (IP Generation);
- IP protection practices which facilitate IP appropriation by the organization (IP Protection);
- Innovation regimes which facilitate IP appropriation by the organization (IP Utilization);
- Firm performance in terms of measurable performance outcomes (IP Appropriation).

These constructs should be considered as part of an integrated IP appropriation strategy. Therefore, a holistic, comprehensive, integrated and cooperative approach is adopted for researching IP appropriation strategies. This requires collecting data not only about IP appropriation but also about leadership, systems, people, customers, key stakeholders, project management and commercial orientation. Processes in the innovation cycle were also examined from research, development and production through to marketing and commercialization of research to ascertain how basic research is related to applied research, development and production through to marketing and commercialization of research.

Multiple-Case Study Design (MCSD)

Multiple-case study design was adopted for this study, which has the advantage of capturing more information than single case study designs. According to Yin (2003), an important methodological aspect of multiple-case study design is the application of replication logic. This is the logic of treating a series of cases as a series of experiments, where each case study confirms or refutes the conclusions drawn from previous ones. McCutcheon & Meredith (1993, p.244) explain the role of multiple-case studies in hypothesis testing by stating that: *"...since only one well-documented contrary instance can disprove a hypothesis, a case study can be a powerful tool to delimit a theory's generalizability or to discount it altogether."*

Case Study Interview Protocol

The face-to-face interviews were conducted on a one-to-one basis at the premises of the participating companies. In all cases, the interviews were recorded on an audio recording device after permission was sought from the interviewees. The interviews typically were of one to one and a half hours duration.

Interview Questions

The questions addressed by the qualitative case study analysis were based on the constructs identified in the literature review to form the primary data for the qualitative data analysis. These were presented as general questions in the case study interviews, allowing for elaboration with details, for example of strategies implemented by the organization. We addressed the following questions to develop the case studies:

- What resources does your organization rely on for the appropriation of its IP?
- Does your organization rely on the internal acquisition of IP via R&D for the appropriation of its IP?
- Does your organization rely on external acquisition of IP for the appropriation of its IP?
- Does your organization implement formal IPRs for the protection of its IP?
- Does your organization rely on informal IP protection enablers?
- Does your organization rely on out-licensing as a form of open innovation regime for the appropriation of its IP?
- Does your organization rely on maintaining trade secrets as a form of closed innovation regime for the appropriation of its IP?

Participant Industries

SMEs from the Australian Biotechnology and ICT industries were selected for developing the case studies. Since IP rights play an important role in appropriating innovation rents in technology-based industries (Cohen et al. 2000), and since open innovation regimes involve out-licensing of patented IP, SMEs in these industries are more likely to be innovating continuously.

The development of the biotechnology industry and its achievements in genetic research have made the industry more dependent on IPR protection (Eisenberg 1987). Since new advances in technology have made is easier to copy chemical compounds, the pharmaceutical and chemical industries are also highly reliant on patent protection (Nogues 1990; Noonan 1990; Sherwood 1990; Comanor 1986; Besen & Raskind 1991). Recently the biotechnology industry seems to be becoming less innovative because, although there has been a rise in R&D expenditure, there is a decrease in the number of new drugs coming to market (Drews 1998).

Specific IP Appropriation-related Issues in the Two Sectors

The commercialization of any innovation must address two key areas: i) market risk and ii) technical risk. Biotech companies are required to invest large sums to conduct R&D and develop the innovation to the point where it can go to market. Once the right innovation is commercialized, there is little market risk.

On the other hand, ICT innovations are more likely to face low technical risk and high market risk. Business start-up accelerator programs are usually good at screening out the weak and advancing the strong ICT projects. Technically, their products can be developed quickly and any success is typically contingent on then getting to market first and establishing a lead-time advantage.

However, biotech companies require long product development times and hence, face more technical risk than market risk. This has implications for the way they deal with IPRs and the formal versus the informal management of 'isolating mechanisms". The current study finds this difference in the qualitative case study analysis.

Participant Firm Size

Differences between small and large firms can demonstrate the impact of firm-specific factors, such as resources and capabilities, on innovation appropriation by impacting the choice of IPRs for IP management, including for inter-firm partnerships. For example, small firms may not have the financial resources to apply for patents to protect their innovations or for law suits against infringements of IPRs. As a result, small firms may not find patenting a valuable IP management strategy and choose to protect

their IP with informal protection measures such as secrecy (Arundel 2001). On the other hand, large firms often have resources devoted to the protection of their IP, such as a legal department, which leads to a higher propensity to patent innovations (El-Haj-Hassan 2012), which can then be out-licensed by the firm to produce rents.

Unit of Analysis

The main consideration in selecting the unit of analysis is that it logically binds the phenomena that produce the relationships between inputs (e.g., people, systems, resources), processes (e.g., developing capabilities, transferring knowledge, forming strategic alliances) and outputs (e.g., innovation performance, marketing outcomes). The unit of analysis selected in this research is the organization. An organization can have any number of divisions that implement IP appropriation strategies that contribute to the innovation performance of the organization. For example, research laboratories focus on quality, disciplined practices, and tested procedures.

Primary Data Collection – Interviews

The primary data for the case study analysis was sourced by conducting interviews with the five case-study firms. The transcripts of these interviews, along with supplementary data, were used to develop case studies on these five firms. Table 2 shows the companies which participated in the case study research.

TABLE 2
COMPANIES THAT PARTICIPATED IN THE RESEARCH

Company	Interviewee's Position	Industry
Biota Holdings (Biota)	VP Research	Biotechnology
Walter & Eliza Hall Institute (WEHI)	Head of Business Development	Biotechnology
Cell Therapies	CEO & MD	Biotechnology
PHM Technology (PHM)	CEO	ICT
Hansen Technologies (HSN Tech)	General Counsel	ICT

Correspondence in the form of a covering letter was sent via email by the researchers directly to the CEO of the companies, who chose either to participate in the interviews themselves, or to refer the researchers to another staff member. The covering letter introduced the researchers to the organization and detailed the key issues to be discussed.

Respondent Profile

The respondents can be generally described as middle to senior managers, with thirty per cent of the respondents at chief executive officer level, directors and managing directors.

Seventy per cent of the respondents are in middle management positions, which included IP commercialization managers, business development managers and functional managers. This is expected, since upon administration of the survey, it is difficult to contact senior managers directly, but often mid-level managers are available to participate in the survey.

Secondary Data Collection

The SMEs that participated in the case studies also provided documentation to support the information provided during discussions, including organizational charts, detailed project information at various stages of development, marketing information for prospective clients in global markets, and annual reports. We supplemented this documentation with publicly available information from the Web sites of the respective firms.

Multiple Cross-Case Analysis Method

The software application NVIVO 10 is used to conduct a qualitative data analysis of the five case studies to identify the emergent themes relating to IP appropriation strategy along the various stages of the IP value chain to identify factors that are important for the appropriation of IP. The interviews were firstly transcribed. NVIVO was then used to manually code these transcripts for content relating to the various constructs and related IP appropriation factors. This resulted in a hierarchical collection of "nodes" in NVIVO with sub-nodes relating to finer-level factors within each IP appropriation factor.

RESULTS

The multiple cross-case analysis revealed that IP appropriation in the biotechnology and ICT industries is challenging, lengthy and complex. If the IP appropriation process is to be managed effectively, it requires the confluence of activities along the IP value chain, which need to be managed simultaneously. Table 3 provides a summary of the findings of the cross-case analysis, indicating what the key facilitators of IP appropriation are at each of the stages of the IP value chain.

TABLE 3
SUMMARY OF ANALYSIS OF IP APPROPRIATION FACILITATORS ACROSS BIOTECHNOLOGY AND ICT INDUSTRIES AT VARIOUS STAGES OF IP VALUE CHAIN

IP Value Chain Phase	Biotechnology Industry	ICT Industry
IP Generation	Organizational Resources	Organizational Resources
	External IP acquisition	External/Internal IP acquisition
IP Protection	Legal IP Protection	Informal IP Protection
IP Utilization	Open Innovation Regime	Open/Closed Innovation Regime

Findings Relating to IP Generation

Based on the multiple cross-case analysis, we found that organizational resources which are valuable, rare, inimitable and organized are critical to IP generation and achieving IP appropriation. The analysis revealed that the presence and exploitation of organizational resources is a key factor that facilitates IP appropriation. For example, Biota Holdings has implemented a project management system for all drug discovery and development projects, including a project charter, stage gate reviews, standard language and templates. WEHI values its human capital, which includes postdoctoral fellows and technical staff, who are provided with opportunities for professional development. Cell Therapies' expert knowledge on the TGA's regulations on cell manufacturing has given it the opportunity to provide consulting services to other firms.

Despite the obvious importance of the presence of organizational resources, the external acquisition of IP (an organizational resource itself) is the next most important factor relating to organizational resources across all the case study companies. The external acquisition of IP can take place via acquisitions, R&D alliances, licensing partnerships, etc. The importance of alliances in the external acquisition of IP is particularly strong for WEHI and Cell Therapies. For HSN Tech, sourcing technology is a large part of the firm's growth strategy. The company often acquires technology, such as software, which is required to grow the company's capabilities. Unlike the other firms in the study, PHM relies more heavily on the internal acquisition of IP than on the external acquisition. R&D to develop and source technology is the firm's key activity. This is because, as a small firm, PHM is unable to partner with industry giants, such as Boeing.

Findings Relating to IP Protection Practices

The case study research found that IP protection is also critical to IP appropriation strategy. The analysis reveals that two of the biotechnology firms, Biota and WEHI, make extensive use of patents. Biota's patent portfolio currently includes some 350 patents. The firm relies on patents to protect its IP, namely drug compounds. This is because, although obtaining patents is a costly and lengthy process, it provides the innovator with a period of exclusivity in the market. WEHI usually lodges about one patent per month and it is one of the few Australian organizations to have two in-house patent councils. This allows for close contact between the patent attorney and the 80 laboratory heads, assisting better research translation, and leading to a better fit between the actual research program and the IP strategy.

On the other hand, both ICT firms rely on trade secrets for protecting their source codes, which are the key IP components of their products. HSN Tech's products have a long life cycle and they are constantly evolving. The nature of firm's products means that they are naturally protected from imitation.

Among the company's suite of products, although there is usually a common core product, it is constantly being modified and customized as per customer requirements, making it complex and difficult to replicate. Hence, HSN Tech does not feel the necessity to patent its products. Similarly, PHM's products are complex and cannot be easily replicated. This is because the company understands its customers and their needs, so it is able to develop a standard solution that can be customized by the client for their specific workflows.

ICT services sector presents a different situation to that in the biotechnology industry, which seems to reinforce anecdotal evidence that SME's IP is constantly evolving as it forms the product or solution itself. Since the product is implemented as a solution to customers, it needs to change with the changing nature of customers and their needs. As firms grow, so do their needs, where SMEs are pressured to align with these changes by becoming more formalized with systems, processes and procedures.

The market conditions change as well, so deregulation of industries also lead to changing requirements of customers. For biotechnology firms on the other hand, they have set goals to discovering solutions through lengthy research programs. For example, a biotechnology firm may have a disease in mind for which it would like to find a cure for. It knows its target, and it will endeavor to discover compounds aimed at the target to either prevent or treat the disease.

The difference in results for the Biotechnology and ICT firms may be due to differences in the technical and market risk faced by firms in the two industries. For example, biotechnology firms face high technical risk, since they are required to invest large amounts to develop and market innovations, and low market risk, since they can easily reap financial gains from novel technologies. Therefore, biopharma companies rely heavily on IPRs such as patents for the protection of their IP. On the other hand, ICT companies face higher market risk, so they may choose to save on the cost of obtaining IPRs, and protect their IP with trade secrets as discussed earlier, as part of continuous innovation.

Findings Relating to IP Utilization

With regards to the utilization of IP for open and closed innovation, all firms in the study demonstrated open innovation regimes of various forms. For example, Biota's business model to date has been to license its IP to pharmaceutical companies. This is how the company earns revenue from its portfolio of patents. Biota's licensing strategy involves licensing a whole package of IP, which includes know-how. Both PHM and HSN Tech have also entered into out-licensing agreements. However, PHM has entered into a licensing contract on two occasions and HSN Tech has done so under strict controls around what the licensee can and cannot do with the software.

On the other hand, WEHI uses a different tactic for open innovation. As a not-for-profit organization, WEHI's mandate is to create world-class knowledge on medical research and to disseminate it. This knowledge is usually shared through publication, but also by training the next generation of researchers to do the same. However, the ICT firms do not rely on formal legal IP protection practices due to the nature of their IP and they rely on informal protection mechanisms such as trade secrets. Therefore, the case study analysis is inconclusive with regards to the impact of open innovation regimes, as opposed to closed innovation regimes, on IP appropriation.

CONCLUSION & IMPLICATIONS

With regards to the research questions, *'What are the most significant facilitators of IP appropriation in SMEs in the biotechnology and ICT sectors?'* the multiple cross-case analysis revealed that SMEs in the biotechnology and ICT sectors rely on organizational resources, certain IP acquisition practices and various IP protection practices to facilitate IP appropriation.

On the other hand, we found differences between the IP protection strategies of biotechnology and ICT SMEs. Biotechnology SMEs rely on Intellectual Property Rights (IPRs), such as patents for the protection of their IP, while ICT SMEs do not rely on IPRs.

Based on the intra-industry analysis, we conclude that organizational resources and formal IPRs are important IP appropriation factors, common to all three biotech companies. The intra-industry analysis also revealed that acquiring IP internally via R&D and maintaining trade secrets are not key IP appropriation factors for the biotech companies. On the other hand, the intra-industry analysis reveals that, the ICT firms rely on both open and closed innovation by using trade secrets.

The implication of our research is that SMEs in innovation-intensive sectors should consider an integrated strategy of the IP value chain, i.e., IP generation, IP protection and IP utilization, to ensure successful IP appropriation. The article adds to the findings of Hussain & Terziovski's (2016) and Ceccagnoli's (2009) studies, which investigated the relationship between appropriation strategy and firm performance (Pisano & Teece, 2007; Chesbrough, 2008; Ceccagnoli, 2009; Terziovski & Corbel, 2012). The article supports the notion that SMEs facilitate the efficient exchange of knowledge (Arrow, 1974; Kogut & Zander 1992; 1996; Nahapiet & Ghoshal, 1998).

Limitations and Future Research

The IP Value Chain model does not explore lead time which can be used to maintain a leadership position in combination with other IP protection measures, such as patents and secrecy agreements, which can act as a safety net and are more effective in sustaining a competitive advantage (Hall & Ziedonis 2001; Terziovski & Corbel 2012).

Furthermore, different protection mechanisms can also be implemented at various stages of the IP value chain (Harabi 1995). For example, firms might first depend on secrecy before the commercialization of a new product, but follow this with patent protection, as well as marketing and lead-time strategies. However, patents eventually expire, and trade secrets may be exposed. These limitations suggest that further qualitative and quantitative research is required to examine combinations of IP management practices on innovation performance in innovation-intensive industries.

A set of hypotheses could be developed and tested relating to the relationships between IP generation, IP protection practices and IP utilization and IP appropriation. For example, the study could focus on the use of informal IP protection mechanisms for both explicit and tacit knowledge on IP appropriation. A survey instrument using a Likert scale would enable levels of the impact of various factors facilitating IP appropriation to be ranked and compared.

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