

Extending the Knowledge-based View: An Examination of Intellectual Property Strategies in Australian Biotechnology Firms

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ABSTRACT Knowledge management (KM) approaches have developed traditionally from the knowledge-based view (KBV), a derivative of the resource-based view (RBV). Drawing on the relational and industry structure views, this paper presents a framework for analysing knowledge management practices in the biotechnology industry. These firms exhibit sophisticated and strategic KM practices and deploy a range of strategies in leveraging competitive advantage through their intellectual property practices. The paper demonstrates 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.

Keywords: knowledge management, intellectual property, competitive advantage, biotechnology industry, SMEs.

Introduction

In the last decade, knowledge management (KM) has generated considerable interest in both the academic and business communities. Knowledge management has become the focal point of debates on mechanisms for acquiring a competitive edge, particularly in the context of the new economy. For most writers on the subject, a firm's competitive advantage is seen to flow directly from its unique knowledge and how it manages that knowledge.¹ Indeed, Drucker² has argued that in the post-industrial information economy it is 'knowledge' that will replace natural resources, capital and labour as the basic resource from which to generate economic wealth.

KM is the process of identifying, managing and leveraging individual and collective knowledge to support the firm becoming more competitive.³ In studying KM, the dominant perspective adopted by writers from within the management and information systems (IS) literature is referred to as the knowledge-based view

(KBV). The KBV has itself been derived from the resource-based view (RBV) on sources of competitive advantage developed within the strategic management literature.⁴ Both the KBV and RBV approaches emphasise the role of the firm and its use of its resources/knowledge as a discrete entity. These approaches have also relied almost exclusively on research conducted on large organisations.

Recent studies on young high technology firms have highlighted how in practice many SMEs do not restrict their KM strategies to in-house resources and activities but also seek competitive advantage through inter-firm alliances involving knowledge sharing⁵ and through industry-based activities involving knowledge blocking. These research insights suggest limitations to the dominant RBV and its derivative the KBV. More specifically, this paper discusses KM strategies amongst Australian biotechnology small and medium sized enterprises (SMEs) focusing on their management of intellectual property (IP). IP, in particular patents and trade secrets, has become a key element of competition in all high-technology industries.⁶ The paper examines the utility of the conventional KBV for understanding the knowledge management practices of knowledge-based SMEs in the biotechnology industry. It explores some of the strategies employed by these firms in managing a specific type of explicit knowledge, their IP, to demonstrate some of the limitations of the current KBV. Although the KBV is useful as a starting point, it also requires extension to encapsulate the full range of knowledge management practices exhibited by these knowledge-based SMEs, including the relational and industry-structure based views. The paper develops a framework for analysis, which will be deployed in future research that will examine how Australian knowledge-based SMEs use their IP to source competitive advantage in the biotechnology industry.

Development of the Knowledge-Based View and its Limitations

Refining and extending resource-based arguments, the emerging knowledge-based view focuses upon the role knowledge plays in development of capability based competitive advantage.⁷

Knowledge management has been explored in several disciplines such as economics, management and information systems (IS). Each discipline holds distinctive views of knowledge that have led to different perceptions of knowledge management.⁸ Consequently this has led to a lack of clarity within the literature regarding terminological, methodological and conceptual dimensions of knowledge management.⁹

One of the fundamental problems with knowledge management theory is the definition of knowledge and its level of analysis.¹⁰ Knowledge has a variety of dimensions or characteristics to it.¹¹ These various aspects of knowledge make it almost impossible to define types of knowledge unambiguously.¹² The knowledge concept reveals that firms have different types of knowledge: explicit versus implicit; individual versus organisational.¹³ Each of these types of knowledge can provide the basis for a competitive advantage.¹⁴ In the literature, organisational knowledge has been defined as being both explicit and tacit.¹⁵ However, this paper only utilises a specific type of explicit knowledge, IP, to illustrate the inadequacies to KBV and create an awareness amongst researchers of its underlying assumptions and limitations.

Within the IS and management disciplines, KM has traditionally been linked to the development of strategic management theory. The current dominant approach

to KM, which has emerged from within these disciplines, has been the knowledge-based view (KBV). The KBV itself is derived from the broader RBV on sources of competitive advantage.¹⁶ The RBV proposes that an organisation's competitive advantage is derived from those valuable and unique resources that are costly for competitors to imitate. In the case of the KBV, the resources are knowledge-related elements.¹⁷

A limiting factor of both the KBV and RBV is that they only emphasise firm-specific capabilities. More significantly, whilst both viewpoints acknowledge that firms have 'dynamic capabilities' that enable them to sustain their competitive advantage, these approaches are incapable of explaining these capabilities or how they operate.¹⁸ As a consequence, knowledge management research has begun to focus on other sources of competitive advantage that can be generated from a firm's network of external relationships.¹⁹

In this context, questions are raised about how adequately the KBV reflects knowledge management practices. The KBV appears to neglect knowledge acquisitions, which may occur from inter-organisational relationships, as a source of competitive advantage. This indicates that the current KBV may be problematic for investigating environments where the growth, development and survival of young technology-based firms are particularly dependent on how they innovatively combine firm-specific and external partners' knowledge.²⁰ Given that the focus of this paper is a particular type of 'young technology-based firm', Australian biotechnology firms, this suggests some inherent limitations in applying the KBV for examining their knowledge management practices. The Australian biotechnology industry provides a unique context in which to examine knowledge management, consisting primarily of SMEs whose primary function is research and development (R&D). Although knowledge management research in the area of R&D organisations²¹ and SMEs is underdeveloped, there would appear to be grounds for developing a framework that extends the KBV beyond its current boundaries.

Knowledge Management and SMEs

To date, the focus of the majority of knowledge management research has been on large firms.²² Research into knowledge management practices in SMEs has been limited and has not questioned the adequacy of the KBV or RBV or customised the models accordingly. The unique characteristics of SMEs, however, suggest a strong need to customise models developed for large firms. SMEs tend to have limited resources,²³ often do not generate explicit business strategies,²⁴ and tend to have an operational rather than strategic view of IS,²⁵ which lead researchers to question their need for KM.

On the other hand, the non-bureaucratic nature of SMEs tends to make them knowledge generators.²⁶ The less formal strategies apparent in SMEs possibly facilitates easier communication of knowledge, improves informal networks, increases speed of decision-making and level of innovation, improves the degree of employee commitment and receptiveness of novelty.²⁷ These characteristics tend to suggest KM in the SME context does have relevance. Paradoxically, however SMEs possess many features that make them unable to sustain competitive advantage from this innovation. Indeed, it is often access to resources that restricts SMEs.²⁸ To overcome these difficulties, many SMEs collaborate with other firms.²⁹ This approach again resonates with Dyer and Singh's³⁰ relational view.

It appears that any investigation into knowledge management practices amongst SMEs and in particular young high technology SMEs will require extension to, and a customisation of the conventional KBV. The following sections will explore how the KBV may need to be augmented.

Extending Knowledge Management beyond a RBV

Emerging from the strategic management literature are two other prominent perspectives in addition to the RBV, industry structure and the relational views. Industry structure competitive advantage became the dominant view in the 1980s and refers to an organisation's competitive advantage through membership of an industry with favourable characteristics. Associated with the work of Porter,³¹ characteristics may include relative bargaining power, barriers to entry, lowering costs and tying in suppliers and customers.³²

Subsequently, and in parallel with the development of the RBV, a third view on sources of competitive advantage emerged—the relational-based view.³³ This refers to idiosyncratic inter-firm linkages as a source of competitive advantage, i.e. where competitive advantage cannot be generated by either firm in isolation but only through collaboration. These collaborations involve substantial knowledge exchanges and the combination of complementary resources or capabilities. This enables firms to create unique products, services and technologies, and to lower transaction costs compared to their competitors.³⁴

From a knowledge management perspective, while the industry view has generated little interest, the relational-based view has become a focus for researchers examining learning and knowledge transfer in strategic alliances.³⁵ Through building relation-specific assets, knowledge sharing routines and effective relational governance mechanisms firms have been able to leverage their relational resources for knowledge acquisition and to acquire competitive advantage.³⁶

In the context of SMEs in the biotechnology industry this paper will highlight the appropriateness of extending the KBV to include both relational and industry structure views and will be explored through their use of IP.

Overview of the Australian Biotechnology Industry

The biotechnology industry is an example of a knowledge-based industry³⁷ with its main function being research and development and its primary asset being its IP. It is characterised by long and complex product development and approval cycles, a heavy reliance upon basic scientific research and a set of very heterogeneous technologies. Australia's involvement in biotechnology is considered vital for its competitiveness in the knowledge economy.³⁸ The Australian biotechnology industry is small by international standards, consisting of a number of large companies, including subsidiaries of multinational corporations and approximately 190 small companies.³⁹ In comparative terms, the Australian industry is most similar to the Canadian biotechnology industry where SMEs also account for a large proportion of core biotechnology companies.⁴⁰ However, Canada has over 300 core biotechnology companies, and the success of its industry places it second only to the USA.

Australian biotechnology firms provide an unusual context in which to explore KM. These biotechnology SMEs exhibit distinct characteristics that differentiate them from conventional SMEs. These characteristics include:

- no resource poverty—many have multi-million dollar R&D budgets;
- highly specialised and skilled workforce aware of the importance of IT/IS and IP management; and
- tendency to have explicit strategies, with particular foci on the strategic management of IP. These business plans are frequently the only way that these start-up SMEs gain access to finance.

In some respects these characteristics make biotechnology SMEs appear more like large organisations. This suggests that theories on strategic advantage developed for large organisations, such as the industry structure and relational view, might also have some relevance for these types of SMEs.

Intellectual Property in the Biotechnology Industry

In terms of KM strategies, it is evident that a biotechnology firm's scientific knowledge base forms a critical component of its competitive position.⁴¹ IP, and in particular patents have become a key element of competition in high-technology industries because they are the most tangible of the IPRs available and provide the strongest legal protection.⁴² The heightened importance of patents is the result of the transition to the knowledge-based economy and the rising role of intangible assets.⁴³

A firm's potential earnings and competitive prospects are often evaluated on the basis of its IP capabilities. Furthermore, small biotechnology firms often rely on patents as evidence of their expertise to attract research partners or investment.⁴⁴ Significantly, biotechnology SMEs have proven themselves adept at managing and deploying their IP to source competitive advantage using KM strategies at firm, inter-firm and industry levels. The following section examines how these innovative KM strategies highlight limitations of the KBV and utility of relational and industry-based strategic management theories to the study of KM amongst SMEs. This paper focuses on a type of explicit organisational knowledge pertinent to the biotechnology industry, its IP. IP was chosen as a lens through which to illustrate the current inadequacies of the KBV in some contexts and its need to be extended beyond a RBV. The RBV has too much of an internal focus on the firm.⁴⁵

Sourcing Competitive Advantage through IP

IP forms the core of a biotechnology start-up.⁴⁶ R&D priorities are determined by the strength of patents⁴⁷ and biotechnology business plans seek to optimise IP asset potential.⁴⁸ Therefore the adoption of RBV approaches to manage IP assists biotechnology firms in developing their strategic direction. Knowledge-based and resource-based approaches, such as core competencies, offer much to biotechnology firms in developing IP strategies. Increasingly patents are being exploited as an organisational resource. The use of patents is being extended beyond the initial intentions of preventing competitors copying a firm's innovations. Knowledge intensive industries are generating alternative revenue streams through licensing their technology patents. As with other organisational resources, it is increasingly common practice for firms to conduct audits, analysis and even patent mining. Biotechnology firms employ these techniques to ensure they have freedom to operate in the global markets, to identify patents from which the firm can obtain revenue, and to stimulate the development of new ideas.⁴⁹ This further

demonstrates the importance of the KBV view with respect to IP management. However, the Australian biotechnology industry provides a context where competitive advantage through IP is sought within and beyond the firm's boundary. Indeed amongst biotechnology SMEs it appears that competitive advantage derived through industry structure and relational based sources are equally as important as those derived from the firm's own resources.

Relational View and Biotechnology Firms

One of the most salient characteristics of the biotechnology industry is the use of collaborative relationships to conduct exchanges between new biotechnology firms, established pharmaceutical firms, universities and other non-profit research organisations.⁵⁰ Indeed past research has shown a desire to innovate and learn in a network of industry partners has already motivated several inter-firm alliances in the biotechnology industry.⁵¹ There are very few firms that have the internal capacity to undertake all the R&D necessary to create a marketable product.⁵² Therefore firms are forced to reach out beyond their boundaries to access complementary knowledge,⁵³ particularly through arrangements of technology licensing. Alliances and inter-firm relationships are used to connect firms to information and capabilities necessary to support them through costly patent races and time-consuming product development and testing.⁵⁴ Vertical alliances more so than horizontal alliances provide firms with access to scientific inputs and research knowledge.⁵⁵ Alliances can assist firms in overcoming market entry barriers.⁵⁶ Furthermore, these external linkages may evolve into important sources of new product ideas.⁵⁷

The role that scientists played directly in the success of IP strategies is somewhat underrated in the technology licensing process. The success of formal technology licensing can be increased when tacit knowledge is also transferred at the same time.⁵⁸ Therefore transferring a researcher from the parent company to a spin-off firm ensures that some of the technological complementary assets are appropriated by the spin-off.⁵⁹ A similar conclusion was reached by Amburgey and Al-Laham⁶⁰ in their study of alliances within the biotechnology industry. They examined whether biotechnology firms could circumvent the need to participate in collaborative research by acquiring the IP instead—e.g. licensing patents. Amburgey and Al-Laham⁶¹ found that there were problems with this approach as firms gain access to knowledge that is not linked to its current knowledge base and therefore not useful. Therefore they concluded that utilisation of acquired knowledge by the acquiring firm requires the transfer of routines as well as codified knowledge from the seller.⁶²

Another example of relational-based competitive advantage is the industry clusters.⁶³ These clusters include research organisations, companies involved in development and application of biotechnology, companies providing specialised inputs, equipment and services, and supporting legal, financial, business service organisations.⁶⁴ Clustering leads to increased knowledge flow with the close proximity to competitors and suppliers enabling and facilitating information flow and social interactions, both formally and informally.⁶⁵ Powell⁶⁶ found that in the biotechnology industry innovation was the result of networks, not individual firms. Therefore it was concluded that biotechnology firms are competitively disadvantaged if they are unable to create or be positioned in these learning networks.⁶⁷

Industry Structure View and Biotechnology Firms

Biotechnology represents a sector of the industry that is reliant upon new knowledge and basic research, long industrial lead times and investment requirements, all factors that are shaping the industry structure.⁶⁸ Consequently, biotechnology firms seek to control and stabilise their industry by developing aggressive business strategies aimed directly at impacting their competitors' core business process, their research and development. These strategies generally involve cunning management and application of their intellectual property and manipulation of the marketplace.

Porter's⁶⁹ industry structure model strategies provides a good model for illustrating these various IP practices. These firms develop strong patent portfolios to use as *bargaining power* in cross-licensing agreements. A quality portfolio is a powerful lever in negotiating required technology.⁷⁰ *Tying in customers and suppliers* is achieved through supply chain linkages, in particular vertical linkages with upstream/downstream companies. Furthermore, these linkages can help *lower costs*. For example, upstream linkages are a way to acquire access to knowledge without having to hire a large and costly staff of scientists.⁷¹ Downstream linkages highlight ways to commercialise a product without having to invest in costly assets distribution networks, marketing departments or sales forces.⁷² However the most dominant source of industry structure competitive advantage is creating *barriers to entry* through the formulation of patent blocks.

A number of biotechnology firms use their IP, especially patents, to create blocks to further R&D in specific areas. Although patenting is necessary to ensure that companies are able to recoup substantial research and development expenditure, some trends in IP management are resulting in the creation of barriers to entry. Blocking patents arise where the excise of one patent would infringe claims of another.⁷³ Patent blocks prevent access to essential research tools and can inhibit patenting further downstream. Given that most Australian biotechnology firms are downstream companies, it is clear that blocking patents and stacking licences could well be a barrier to entry for the Australian biotechnology industry.⁷⁴ In Australia, this issue of patent blocking is a significant issue to SMEs, particularly as non-Australian companies and institutions hold most of the biotechnology patents granted in Australia.⁷⁵ It is suggested that patents, held by foreign companies, are for blocking purposes and will lie dormant. In fact, a study by Cohen *et al.*⁷⁶ revealed that preventing rivals from patenting related inventions was the most pervasive motive for patenting after prevention of copying.

Patents no longer have a passive role in the biotechnology industry, to merely protect a firm's own technology. A study by Calabrese *et al.*⁷⁷ proposed that a biotechnology firm's IP accumulation and its strategic alliances are designed to stabilise and control the competitive environment. Firms are using their patents more strategically and through the development of policies are beginning to realise the full potential of their IP.⁷⁸ A number of concerns have been raised about the impact of licensing practices for gene patents on the research environment, on market dynamics for new product development, and on clinical uptake of new tests and treatments.⁷⁹ The patenting and licensing efforts enhanced utilisation of academic discoveries in the short term, but in the long term innovation may be stifled through limited access to this knowledge.⁸⁰

Although a number of these patent strategies explored have been employed by large firms, the unique characteristics of biotechnology SMEs suggest that they

must not only be able to react to the strategies but also use and exploit them. These sources of competitive advantage are derived from several perspectives, which demonstrate some limited interconnectivity. This may suggest that in some knowledge-based SMEs, it may be appropriate to explore extending the KBV beyond the RVB and to include both industry and relational extensions. The following section develops a framework for analysing possible sources of competitive advantage using IP in Biotechnology SMEs and will form the basis of future work in this area.

Framework for Analysis

The analysis knowledge management practices amongst knowledge-based SMEs in the biotechnology industry requires multiple perspectives on sources of competitive advantage. The literature review revealed that these sources are resource, relational and industry structure. From a research perspective there is a growing realisation that the knowledge economy is dictating that firms must also try to source competitive advantage from beyond the firm boundary.⁸¹ Significantly knowledge management research per se has yet to adequately explore these complementary sources of competitive advantage.

From a preliminary investigation, a framework for analysis (refer to Table1) has been developed that will form the basis of future work on knowledge management in knowledge-based biotechnology SMEs. The framework identifies various foci relevant to investigating sources of competitive advantage in biotechnology SMEs and indicates previous research which has either identified or used these foci for investigation.

The framework was developed mainly as a result of the literature review, drawing on the major themes, discussions and past research methodologies. It draws particularly on the work of Powell,⁸² DeCarolis and Deeds⁸³ and Calabrese *et al.*⁸⁴ Their research is derived from a variety of disciplines and each provides differing perspectives on the biotechnology industry. The work of Calabrese *et al.*⁸⁵ provided insight and awareness of limitations in a similar biotechnology industry—i.e. the Canadian Biotechnology Industry. Thorburn's⁸⁶ research on knowledge management in research spin-offs allowed the framework to be attuned to the particular characteristics of Australian R&D organisations. The framework was further refined based on recurring themes apparent in informal directed discussions with company managers, government representatives and IP lawyers who have worked in the biotechnology industry and researchers in other disciplines, predominantly law. These informal discussions have enabled the researchers to gain an overall understanding of the biotechnology industry and some of the issues facing companies, particularly from an Australian perspective. In addition, documentary analysis of industry reports, company annual reports and websites has also assisted in this initial research and framework development. The framework for analysis will form the basis of future research investigating knowledge management in biotechnology SMEs.

Discussion and Future Work

The biotechnology industry is an example of a knowledge-based industry, which is heavily reliant on knowledge generated from R&D and their IP. In an industry characterised by long product development time, uncertainty and large down-

Table 1. Developing a framework for analysis of KM in Australian biotechnology SMEs

Sources of competitive advantage levels	Preliminary identified KM strategies	Foci for future data collection/analysis
Resource (Wernerfelt, 1984) Organisational	Knowledge creation (R&D)	<ul style="list-style-type: none"> ● R&D strategy (Rivette and Kline, 2000; Bent, 2001; Spruson and Ferguson, 2001) ● Corporate strategy (Rivette and Kline, 2000; Bent, 2001; Spruson and Ferguson, 2001) ● IP strategy (Rivette and Kline, 2000; Bent, 2001; Spruson and Ferguson, 2001) ● Relationships between IP, R&D, Corporate strategy (Rivette and Kline, 2000; Bent, 2001; Spruson and Ferguson, 2001) ● Other resource management strategies and their relationships—people, technology (Thorburn, 2000) ● Types of IP (patents, trade secrets, plant breeder's rights) ● IP management (Bent, 2001) ● Patenting process (US differs from Australia and Canada) ● Finance-venture capitalists (Spruson and Ferguson, 2001) ● Awareness of the external environment and competitors (Rivette and Kline, 2000) ● Patents (DeCarolis and Deeds, 1999) ● Firm citations (DeCarolis and Deeds, 1999) ● Products in development and market (DeCarolis and Deeds, 1999) ● Government assistance programs—Biotechnology Australia, AusIndustry, each State govt. Dept of State Development (Ernst and Young, 1999) ● Look at international trends (as the firms are part of the global knowledge economy)

Table 1. (Continued)

Sources of competitive advantage levels	Preliminary identified KM strategies	Foci for future data collection/analysis	
Relational (Dyer and Singh, 1998) Interfirm	Knowledge sharing (industry clustering)	<ul style="list-style-type: none"> ● Industry associations (AusBiotech Association) ● Government assistance programs (as above) ● Linkages with government departments, research institutions, universities (Ernst and Young, 1999; Thorburn, 2000) ● Management and sharing of other resources (Thorburn, 2001) ● Geographic location (Decarolis and Deeds, 1999) ● Strategic alliances (Powell, 1996; Decarolis and Deeds, 1999; Calabrese <i>et al.</i>, 2000) 	<ul style="list-style-type: none"> ● Joint ventures (Powell, 1996; Calabrese <i>et al.</i>, 2000) ● Clusters (Powell, 1996; Calabrese <i>et al.</i>, 2000) ● IP management strategies in IP sharing and licensing agreements (Grindley and Teece, 1997) ● Ad hoc, temporary and informal links and networks (Decarolis and Deeds, 1999; Steen and Innes, 2000) ● Themes of discussion in these alliances ● Look at international trends (as above)
Industry structure (Porter, 1980) Industry	Knowledge blocking (patent blocking)	<ul style="list-style-type: none"> ● Laws on IP (Nicol and Nielsen, 2001; Spruson and Ferguson, 2001) ● Laws on anti-competitiveness (Nicol and Nielsen, 2001) ● Value chain—upstream versus downstream biotechnology companies (Calabrese <i>et al.</i>, 2000; Nicol and Nielsen, 2001) ● Strategies for overcoming patent blocking (Rivette and Kline, 2000) 	<ul style="list-style-type: none"> ● Issues associated with blocking (Rivette and Kliene, 2000) ● Patent practices and reasons for patenting (Cohen <i>et al.</i>, 2000) ● Relationship like between firms, between larger and smaller companies (larger MNEs have access to more resources and markets) ● Issues associated with blocking (Rivette and Kline, 2000) ● International trends (as above)

stream investments, intellectual property protection plays a key role in its development and fosters a business model based on technology licences.⁸⁷ The result has been a significant change in how firms use and perceive their IP.

Patents no longer play a passive role in the biotechnology industry. Firms are using their patents more strategically and through the development of policies are beginning to realise the full potential of their IP to enhance their global competitiveness.⁸⁸ These sources of competitive advantage are derived from several perspectives. Calabrese *et al.*⁸⁹ proposed that a biotechnology firm's IP accumulation (firm-level strategy) and its strategic alliances (inter-firm strategies) are designed to stabilise and control its competitive environment (industry-level strategies). It is suggested that for some knowledge-based SMEs, it may be appropriate to explore extending the KBV beyond the RVB and to include both industry and relational extensions. This may be a reflection of the influence globalisation is having on their business practices.

The KBV appears to neglect knowledge acquisitions, which may occur from inter-organisational relationships, as a source of competitive advantage. This suggests that the KBV is problematic for examining environments where the growth, development and survival of young technology-based firms are particularly dependent on how they innovatively combine firm-specific and external partners' knowledge.⁹⁰ Given that the focus of this paper is a particular type of 'young technology-based firm', Australian biotechnology firms, this suggests some inherent limitations in applying the KBV for examining their KM practices.

Furthermore the inadequacies of the KBV may be reflective of a deeper underlying problem. The KBV has tended only to be examined as a derivative or extension of the RBV rather than its own theory or sub-component of strategic management. As Grant⁹¹ noted the knowledge-based view is not, as yet, a theory of the firm. There is insufficient consensus as to its precepts or purpose, let alone its analysis and predictions for it to become recognised as a theory.⁹² However, the inadequacy of the KBV to explain current KM practices may suggest that the KBV needs to be considered a separate perspective from the RBV and developed in its own right within strategic management theory.

The purpose of this framework is to provide researchers with an awareness of the context-dependency of KM and heighten their sensitivity towards other levels of analysis needed for exploring KM. Organisational knowledge is a prominent concept in the resource-based perspective⁹³ and as indicated this has resulted in a firm-level focus which has meant perhaps the importance and relevance of other levels have been ignored. Current models of organisational strategy and structure fail to meet the challenges of today's knowledge-oriented competition.⁹⁴ As Narasimha⁹⁵ notes, the multi-dimensional nature of organisational knowledge must be understood in order for knowledge to be used strategically. Our framework has used previous dominant views in strategic management as a starting point for exploring this multi-dimensional view of knowledge.

A limitation of this paper has been its concentration on the explicit component of a biotechnology firm's organisational knowledge. However, the purpose of this paper was merely to provide researchers with an awareness when investigating KM in some contexts and to demonstrate the inadequacies of the KBV. In any future work on knowledge management, it will be important to obtain a more holistic view.⁹⁶ As Tsoukas⁹⁷ defines organisational knowledge as three things at once, personal knowledge of the individuals, propositional statement tasks guiding individual action and collective knowledge consisting of shared understanding of a

community. From this definition it is clear that human and social factors are also important in KM although it has until now had little attention in academia.⁹⁸ In particular, as the relational view is being brought to the foreground because of its role in the diffusion of tacit knowledge through informal networks, the model will need to be extended further to include tacit knowledge. Future research will help refine this aspect of the KBV and develop this perspective on knowledge to incorporate multiple levels of analysis and integrate human and social factors.

At the broadest level, this paper has highlighted that knowledge-based firms, such as those in the biotechnology industry, rely heavily on their '*intellectual capital*'. The proactive management of intellectual capital by innovative firms is one of the most significant emerging business developments in the last decade and has heralded a new era for management.⁹⁹ Intellectual capital consists of intellectual property rights (patents, databases, trade secrets, trademarks); relational capital (organisational capital, goodwill and reputation); and human capital (competences, skills and embodied knowledge).¹⁰⁰ Whilst this paper has focused predominantly on the IPR aspect of intellectual capital, the importance and the role of human capital in IP practices was alluded to with discussion on the role of scientists in technology licensing. A fruitful avenue for further research would also be to explore the other dimensions of intellectual capital and their interdependencies.

In the emerging knowledge-based economy innovation has become an increasingly important element in acquiring competitive edge.¹⁰¹ Simultaneously, it has been recognised that effective KM strategies can act as potential catalysts for innovation¹⁰² and that knowledge and know-how are key assets of innovative companies.¹⁰³ Knowledge is at the heart of innovation and competitiveness.¹⁰⁴ The better the process of creating knowledge is understood, the more likely innovative behaviours can be fostered in organisations.¹⁰⁵ Keogh¹⁰⁶ has further demonstrated the vital role of the interaction of intellectual capital (organisational knowledge, knowledge of individuals and information), with innovation and competitiveness in technology-based companies. Future research by the authors will also explore the role KM plays in innovation and competitiveness with Australian biotechnology firms.

Conclusion

The dominance of the resource-based approach in strategic management research has proven to be an effective basis for knowledge management. In the Australian biotechnology industry this approach highlights that for SMEs their IP is an obvious source of competitive advantage. However, closer examination of biotechnology SMEs reveals that these firms also seek other sources of competitive advantage, through industry structure, creating barriers to entry, and relational-based, through strategic alliances and clustering. From a research perspective this has highlighted the need to explore other approaches to sources of competitive advantage. For biotechnology SMEs to 'play the game' with large biotechnology firms, a more holistic research view is required, encapsulating resource, industry and relational-based sources of competitive advantage.

The intention of this paper has been to examine and explore the assumptions upon which knowledge management research has been based. Examination of current research in the context of biotechnology SMEs indicates the need for the development of a knowledge management framework, which incorporates IP and

perceives the sources of competitive advantage as complementary rather than mutually exclusive.

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