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## **A qualitative study into the innovation and technology transfer experience of a micro-manufacturer within a University-Industry collaboration context in regional Australia**

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# **A qualitative study into the innovation and technology transfer experience of a micro-manufacturer within a University-Industry collaboration context in regional Australia**

## **Abstract**

Small-Medium-Enterprises (SMEs) play a critical part and are an important contribution to the economy in Australia. This research explored a number of questions surrounding SMEs, their innovation practices and the policy that influence them. This research reviewed and identified, through a case study approach with a series of in-depth qualitative data collection, analyses and discussions, barriers to innovation in micro-regional SME in Australia, and outlines recommendations for how these can be overcome. In essence, the research aims to provide a deeper insight into what actually happens and why it happens; factors affecting innovation and technology transfer (I&TT) in regional micro-manufacturers, and describes an intervening investigation into the I&TT process in the SME sector within a University-Industry collaboration context. The research initially focused on the manufacturing factors such as increasing productivity through work study and work-flow analysis, and introducing semi-automation and flexible manufacturing methodology. As the project progressed, however, several non-manufacturing factors were identified as major influences in the I&TT process within the targeted micro-manufacturer. The ability for firms to progress in improving the manufacturing factors is often dependent on these factors, which are categorized as very personal and business related (rather than technical related). Regional Knowledge Diffusion (RKD) model was developed as a conceptual framework for developing future policies for encouraging innovation and technology transfer within a university-industry context within the regional Small-Medium-Enterprise sector.

## **Introduction**

Through innovation, Australia as a nation can and has in some way made a contribution to addressing these challenges. In a global and domestic economy where services and knowledge-based production is becoming increasingly important, the use, development and application of knowledge is now as important to economic growth as efficiencies in production. Since there are absolute limits to lifting productivity growth through increased labour-force participation and work intensification, Australia must find new ways to sustain high levels of economic growth. Whilst efficiencies in production became the primary determinate of economic prosperity in the 20th century, innovation in turn is becoming the main catalyst for economic growth in the 21st century. Indeed, with improvements to productivity, from the last two decades of microeconomic reform, beginning to fade, innovation will be critical to keeping productivity growth on par with accelerating inflation in the future.

This trend is being further amplified by the changing nature of global competition. Increasing competition, particularly from low-cost emerging economies, and the steadily increasing rate of technological change means that competing through efficiencies delivered by structural reform is no longer enough for developed economies such as Australia. In short, the changing nature of our economic circumstances is pushing to the fore the importance of innovation for future economic prosperity in Australia. That is why governments, together with the private sector, have

made innovation a national economic priority<sup>1</sup>. Even though a stream of government policies have been released and implemented to realize the innovation potential of Australia, there little evidence that it is of any benefits to the Small-to-Medium Enterprise (SME) sector, and of particular interest in this study, micro-manufacturers in regional settings.

The statistics captured on innovation often provide a mixed view on the greater benefits in the form of increased productivity and higher value for the goods and services we produce. Though the value of statistical information and analysis is beneficial, it does not provide an in-depth view of the effects and benefits on small businesses, their owner(s) and the resultant innovation outcomes. Specifically, most research undertaken in evaluating the outcomes of innovation policy often do no more than broad and in some cases, industry specific statistical analyses, surveys and short interviews. The question may be posed, “what actually happens and how does it (innovation) actually work in reality?” Each agent in the innovation process brings its own capabilities and strengths to this process. Broadly speaking, business brings the commercial and technological know-how, capital and access to distribution and markets, educational institutions the intellectual capital and linkages (a key driver for this research), while the key inputs from government are policy leadership, strategic focus, and overarching vision that enable these other agents and their capabilities to be ‘joined together’ into a coherent whole. In principle, these resultant interactions between these variables (business, education institutions, government) mentioned above must have delivered some contribution towards effective innovative solutions and practices in SMEs.

This research is an exploration and reflection of the innovation experience of a regional micro-manufacturer through embedment of the researcher in a specific micro-manufacturing firm as a case-officer from a regional university. The case study involved learning and discovering the obstacles and barriers for innovation, seeking and proposing ways to reduce them, and improving the overall innovation process within micro-manufacturers in regional areas. The firm was founded and owned by an individual based at the regional township located within a 50km radius from Toowoomba in Queensland, Australia. The operation started off as a commercial flower growing business focusing on organic and medicinal herbs. However it revolved, now it specializes in and manufactures a range of high-quality organic/pure “chemical-free” soap, shampoo and skin care products. The business has been in operation for about 15 years. Along with a good domestic distribution, it also exports to New Zealand, the United Kingdom and Asia.

The research initially focused on the manufacturing factors such as increasing productivity through work study and work-flow analysis, and introducing semi-automation and flexible manufacturing methodology. As the project progressed, however, several non-manufacturing factors were identified as major influences in the innovation process within the targeted micro-manufacturer. The ability for firms to progress in improving the manufacturing factors is often dependent on these factors, which are categorized as personal and business related. The underlying project on which the work described is based on involved: (1) a SWOT (strengths-weaknesses-opportunities-threats) analysis on the business, (2) learning and discovering the obstacles and barriers for innovation, (3) seeking and proposing ways to reduce it, (4) and modelling the overall innovation and technology transfer (I&TT) process within micro-manufacturers in regional areas.

## Literature

MacPherson<sup>2</sup> as a quantitative study explores the role of academic linkages in the product development effort of SMEs within the scientific instruments sector. Data from 204 firms suggests that university research units can play a helpful role in small firm innovation. Knowledge spillovers from the academic sector are shown to be geographically localized. A key finding is that the intensity of academic SME interaction varies inversely with the time-distance that separates firms from major campuses. A related finding is that innovation rates are higher among SMEs that enjoy close proximity to academic resources within the context of micro-geographical factors in regional knowledge diffusion. MacPherson<sup>2</sup> addressed the role of time-distance in the propensity of firms to interact with the academic sector. But probably more relevant to this study, MacPherson<sup>2</sup> suggested that 'why might geographical factors play a role in the academic-industry relationship and why is a focus upon SMEs justified?' is left to be answered in further research opportunities.

MacPherson<sup>2</sup> suggests policy implications that may be of interest to economic development agencies in the USA and elsewhere. MacPherson<sup>2</sup> suggests that prime locations reside within 2hr driving time from major campuses. This would imply a need for industrial zoning policies that reflect the location of a region's main transportation hubs and highways. MacPherson<sup>2</sup> proposes a second policy issue which concerns the fate of 'peripheral' firms that find themselves 'out of the loop'. Across the three proximity bands examined in his study, there were no significant differences were found in terms of R&D intensity, and the same held true for external spending on non-university technical support. Firms located close to major campuses enjoy an innovation advantage. In policy terms, MacPherson<sup>2</sup> suggests that it might make sense for universities to keep private firms informed regarding the types of outreach initiatives and/or research activities that are currently underway. He suggests that the starting point for any of this initiatives would appear to be information dissemination; a function that universities ought to endorse as a matter of policy. MacPherson<sup>2</sup> noted with caution that with any initiative to increase academic--industry interaction would surely run into difficulty if academics and technical support staff were to suddenly experience a demand surge from non-university sources. As noted earlier, part of the academic--industry interaction problem described by Quintas et al.<sup>3</sup> reflects a mismatch between the needs of firms and the needs of academics. MacPherson<sup>2</sup> put bluntly, how would university staff be paid, promoted, and be recognized for their contribution to the local economy? These are difficult policy issues.

His evidence reveals that the incidence of university linkages varies inversely with the time-distance that separates academics from firms. The evidence also suggests a relationship between SME innovation and the presence of university linkages. Taken together, these findings aligns to the technological spillover ideas tested by Acs et al.<sup>4</sup>, Anselin et al.<sup>5</sup>, Eicher<sup>6</sup>, Feldman and Florida<sup>7</sup>, and Jaffe<sup>8</sup>. Academics and SME interaction is sensitive to time-distance, in that useful interactions typically require face-to-face meetings at or near the relevant academic department. Interestingly despite all the advances in communication technologies, it would appear that electronic modes of communication cannot act as substitutes for these meetings in MacPherson's study<sup>2</sup>.

Nevertheless, a variety of important questions remain unresolved in MacPherson's study<sup>2</sup>. He suggested that in order for the role of geographic proximity can be fully understood; at least three relatively straightforward extensions to the present enquiry might be worth considering. Firstly, a multi-sectoral and multi-state survey would be helpful. Secondly, it might be useful to conduct case studies of successful versus less successful academic-industry interactions

across regions of different types. Thirdly, it would be interesting to probe for international variations in the academic-industry relationship, perhaps with a view towards finding optimal combinations of 'positive factors' that could be either replicated or adapted for different places.

Freel<sup>9</sup> as a quantitative study looks at relationships and interaction required for small firms to collaborate, as a means to supplementing and complementing limited internal resources. The study noted that the issues in the UK have dominated much of the academic and policy debate on regional development and small firm innovation. However, it asserts that there is relatively little empirical work that has sought to look further than simple frequency enumeration; noting that the most innovative and better performing firms are generally more likely to have links with external organizations. Based upon a sample of 228 small West Midlands' manufacturers, this study considers the source, function, geography and strength of innovation-related co-operation. While the Freel's<sup>9</sup> findings point to innovators making greater use of external linkages, of certain types and in particular directions (notably, vertical value chain linkages), the results are less emphatic than might have been anticipated. His study leads to consideration of the factors contributing to and impeding joint innovation and the firms' perceptions of the impact of innovation. Freel<sup>9</sup> points out that much of the observed difference between innovators and non-innovators lies in less objective measures. His findings suggest the importance of inter-personal dynamics, attitude and expectations in facilitating successful collaboration.

There is now a large body of quantitative evidence that connects industrial innovation with knowledge spillovers from academic research<sup>4,8,10,12,13,14,15</sup>. These spillovers can be defined as formal or informal movements of new science-based concepts, ideas, technical procedures or information from the academic sector to private industry. A recurring theme in the literature is that firms located close to major universities exhibit higher innovation rates than their counterparts that reside elsewhere<sup>4</sup>. Part of the logic behind this pattern is that new technical knowledge from the university sector can be more readily accessed by firms that forge face-to-face linkages with academics<sup>16</sup>. Despite the advances in modern telecommunications and improved transportation systems, the empirical evidence suggests that the intensity of university-industry interaction varies inversely with the distance that separates academics from firms<sup>5</sup>. Significantly, evidence is growing to suggest that SMEs are becoming more adept at tapping knowledge spillovers than larger companies<sup>17,18,19,20</sup>. This may explain somewhat why literature has identified a growing innovative role for SMEs<sup>21</sup>, notably within industries that exhibit low levels of market concentration<sup>10</sup>. From other perspectives, evidence<sup>7,22,23</sup> reveals a rising innovation share for SMEs across a variety of industries. Freeman<sup>24</sup> suggests that part of this trend can be traced to the growing ability of SMEs to exploit external resources, including universities.

## **Methodology and Methods**

This research was based on a description case study within an action-based participatory research framework grounded in explanative principle. In this study, the author is involved as an active observer and participant, namely, a technology and business advisor from the local university visiting on site about two days a week during a 12 month period from 2006 to 2007 in supporting and enhancing the innovation process with the participants and their manufacturing business.

The case study approach is not a data-gathering technique per say. Rather, it is a methodological approach that incorporates a number of data-gathering measures<sup>25</sup>. Here, the

descriptions of change in values and behaviours at one small and regional manufacturer are based on observations and interviews applied to the participants. The case study method is useful in describing change processes because it provides for investigation of value and behavioural change within its real-life context<sup>26</sup>. This diverges from modernist reductionism (deductive) and represents a shift from objectivism towards critical subjectivity, and from relativism to relationalism<sup>27</sup>. Its purpose is pragmatic because it shares practice: Case studies may provide ideas, suggestions, or imagery that might sensitise outsiders to issues they may have not considered, particularly with regards to the process of behavioural change<sup>27</sup>.

The conceptual framework for this research is based on relational<sup>28</sup> and constructivist<sup>29</sup> pedagogy in that if participants are immersed in a rich and authentic professional environment with real-time input from industry practitioners, they are more engaged with the experience as designed.

This study uses ‘impromptu’ interview methods; open, unstructured and informal. This study uses Bernard’s<sup>30</sup> model to match the collected data (observation, interviews, photographs and videos) to variables (Internal states, External states, Behaviour, Artifacts, Environment) in answering the research questions.

## Research Findings

Four research questions were developed and these are presented in the form of propositions:

- Proposition 1: Failure and Novelty is mutually inclusive and is the governing principle behind innovation policy (ie. systematically grasping opportunities in the midst of change while minimising failures)?
- Proposition 2: SMEs are not effective and efficient beneficiaries of innovation policies and their outputs (such as research, education and business support)?
- Proposition 3: To what extent do influencing macro-environmental factors affect the decisions of firm’s manager to innovate?
- Proposition 4: Regional universities can play an instrumental part in delivering support mechanisms for innovation within a networked cluster?

**Proposition 1 findings:** This research in examining the artifacts of the available innovation related programs has indicated a growing weight of evidence to suggest that failure and novelty is mutually inclusive and is the governing principle behind innovation policy, in that it presumed by the policy makers that it is a process that systematically grasps opportunities in the midst of change while minimizing failures. The research observed that SMEs have the natural tendency to innovate, and a willingness to approach innovation in a “trial-and-error” in comparison to large businesses where significant large R&D budgets are involved (and reduced risks of failure). The notion of failure is fundamentally embedded within the culture of SMEs in a positive sense that you have to “give-it-a-go” to innovate, however often than not, failure could mean the end of the business venture. Some would suggest that the SME’s owners wear these “failures” as a “badge of honour”. Though the principles behind the policies are aligned with visible SME requirements, there is a fundamental difference in the approach taken; ie. process vs people centricity. Many of the programs and literature resources (engineering and business) that were developed to cater for SMEs have this belief that SMEs do have core fundamental expertise and resources, strategic and operational systems, and in general, good business principles and application. However, this research

suggests that many SMEs and specifically in our case study, micro-manufacturers in regional settings do lack many of the standardized and theoretical models of a SME, in that the business is the owner, and that every owner is different in their profile, traits, personality, and skill sets. That is, the business can only grow and prosper with the owner in isolation of the policy-based support that are seemingly accessible at face value but often rendered useless. Process-centric policies will not suit people-centric needs. Process-centric policies would not have much traction dealing with essentially people-oriented problems and issues.

**Proposition 2 findings:** Our study has shown that SMEs especially micro-manufacturing in regional setting are not effective and efficient beneficiaries of innovation policies and their outputs, such as research, education and business support. In addition to the process-centric programs that are not conducive to business owners as day-to-day decision makers, there is a limitation of the availability of time and money to gain support and then innovate accordingly in a planned and systematic fashion. Often than not, innovation came through as an adhoc and experimental approach lacking in assurance of success but lacerated with zeal and passion for the new products and improved processes one envisioned in one's sleep. Often than not, the source of finance for the experimentation and innovation is the "credit card", in the hope that the new product line will sell. Time constraint is a significant barrier to SMEs innovating. Literature suggests that the most innovative firms do not rely on just the owners to innovate but one that creates a culture of innovation across the organization. Very difficult to achieve when the organization is only three people as in our study, and the ownership of innovation derived from the owner. Time to do research and consult on the potential grants and innovation programs that are available were not prioritized. This is perhaps not just a time or prioritization issue, but one that is buried within the entrepreneurial spirit "I-did-it-my-way" and "See, I-made-it-worked". The self-reliant belief is very visible especially in our regional setting, where isolation has been part and parcel of the Australia outback way of life. Investing in support for SMEs mean investing in the owners. This could be in the form of business coaching, educational support and skill development.

**Proposition 3 findings:** The study examines the question on what extent do macro-environmental factors influence the decisions of business owners to innovate. It has concluded that macro-environmental influence will affect business strategy, performance and competitiveness one way or another, at different level of impact, of which owners must consider and address in their management of SMEs. In many cases, managers can only absorb the impact by repositioning or restructuring their businesses. This variable is very much a determinant of how well business owners deal with time constraints. Often than not, owners are approaching multiple fronts; strategic, operational, and frontline activities. You have the customers, the banks, the taxman, the suppliers, the forwarding services, even a simple utility bill can cause "hernias" in any given day. The old saying in SMEs, "work on the business not in the business" still hold true, but the difficulty still reside on values and behavioural barriers to remove oneself from the frontline. Monitoring the operational progress and "working on the business" defeats the purpose of why owners started the business in the first instances. The core value of a "need" or "passion" in SMEs is in itself providing the basis for starting the venture but holding back the owners in the toil of day-to-day activities. However, in saying this, the most successful SMEs are the ones that are able to change this paradigm in their thinking, and invest in themselves and allow others to "work in the business". The proliferation of business coaching for SMEs is an exemplary illustration of such a change in discourse.

**Proposition 4 findings:** From the basis of this participatory study, one could suggest that regional universities can play an instrumental part in delivering support mechanisms for innovation within a networked cluster. Though the active participatory researcher (and author) made preparations and skilling in the engineering, business, and management expertise, it was unprepared for the interpersonal and counselling nature of the interactions. One would spend an afternoon listening to the owner sharing the “struggles” and “battles” of the week, and this is somewhat missing in all innovation program and policies; the psychological difficulties and barriers associated with regional SMEs who generally operate in isolation and remoteness. Though enriching an experience, it was difficult to apply the technical expertise into business and technological solutions without dealing with the psychological barriers to innovation. As a result, many of the envisaged solutions were not tested or implemented. However, the impact of the “first-priority” innovation implemented saw immediate increase in production efficiencies, and hence, a reinforcement for the owner of the need to change the SME discourse into “working on the business”. Even that the location was still within a 2hr driving distance, it was still evidenced that the lack of focal point, in terms of a networked “cluster”, diffuses any incentive to engage or interact with the university in its region. It is also quite evidenced that there is a lack of understanding by the SME community of the role of tertiary institutions in their research and teaching for economic and community development. Governments in this instant have an important role to play as the creator and facilitator of collaborative environments. Universities cannot do it alone nor will it as the incentives are not compelling in relation to the third prong of its existence: “Service”. There is also a major disconnect in the other two prongs in that Australian universities in recent times have the tendency to focus only in teaching and research but in a mutually exclusive way. Perhaps, one can suggest that all three prongs should be advancing in harmony, teaching, research, and service, and be funded appropriately to do so. This study suggests a model where a team of case managers would facilitate collaborative research between networked clusters consisting of manufacturers in the region, teaching of entrepreneurial skills and educational development for the managers and owners, and providing a service to the community in a coordinated effort between industry and institution to encourage innovation and economic prosperity in the region.

### **Research Applicability**

Research was conducted as a descriptive case study that explored and reflected on the innovation and technology transfer (I&TT) experience of a regional micro-manufacturer of soaps, through embedment of the researcher in the business as a university-placed consultant or case manager. The case study involved learning and discovering the discourse, values, obstacles and barriers for I&TT, seeking and proposing ways to reduce it, and improving the overall I&TT process within micro-manufacturers in regional areas, using a regional knowledge diffusion approach. This study found that there were both strengths and weaknesses in the firm. Particular strengths included its willingness to innovate and its intellectual property. Perceived weaknesses were related to the owner’s close embedment in the business operations, thus reducing the ability to think strategically, time and lack of funding. At the same time, there were found to be a number of opportunities, particularly in process transformation. Most threats were related to macro-environmental reasons. The research also indicates that the small size of the firms studied is likely to enhance their ability to develop, test and implement innovations. The desire to meet changes in the business environment with a high level of rapidity also indicates that SMEs may be prepared to take risks in the expectation of receiving gain in the long term, in spite of the financial issues involved.

This study into micro-manufacturer indicated that there were roles for government agencies, universities and other education providers in assisting the SME sector. Thus, for government agencies and relevant policy development, implications included the following:

- The desirability of developing a “One-Stop-Shop” for SME support.
- Improvement of accessibility of field officers to regional areas.
- Provision of financial support for advisory/coaching services.
- Provision of financial support for education and training.
- Facilitation of establishment of vertical supply chain clusters.
- Provision of financial incentives for larger enterprises to host innovation activities with SMEs in the form of innovation clusters.

Universities and education providers could:

- Exploit opportunities in the “business coaching” market.
- Develop targeted educational/training products for SME in the form of short customized courses.
- Established technical advisory, process auditing and mentoring consultancies in collaboration with government agencies.
- Facilitate and host SMEs’ innovation activities supported by relevant government funding to form clustered applied research and SME “nurturing” centres.

This study indicates that there are some common elements, with respect to the innovation process, in the SMEs studied in prior literature. While such firms can be quite innovative in their own right, and in fact their small size can in fact be an advantage with respect to being able to quickly adopt innovations, it is clear that little use is being directly made of the knowledge and skills of universities and researchers to assist the innovation. A suggested model of this process for smaller regional firms has therefore been developed to demonstrate the dependency of the business to the owner, and the need to rely on systematic planning and organization. Such a process will require changes in the owner’s behaviour and sufficient education and training, along with relevant advisory and financial support needed to improve the probability of a successful innovation experience. The model proposed here is termed “Regional Knowledge Diffusion” (RKD) model, and is illustrated in Figure 1.

SMEs are an important sector of the Australian economy. While not all have good success rates in innovation, especially within regional areas, they are generally receptive to opportunities to innovate and adopt new technologies to lift business growth. The innovation discourse and processes in SMEs are not easily understood and not well researched within the literature. Existing support for these processes is also not particularly suited to SMEs. The lack of time, capital and new technology knowledge may be seen as hurdle in innovation, particularly for regional SMEs. In addition, the strategy and organization that is the result of working owners being highly focused on their businesses also need to be addressed.

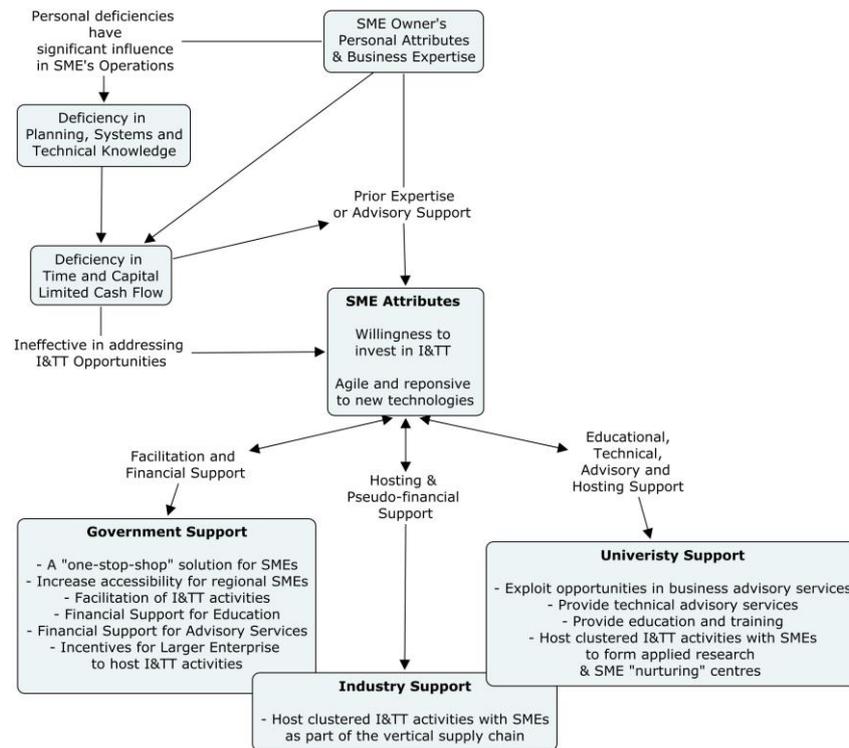


Figure 1: Regional Knowledge Diffusion (RKD) - Suggested Model for Innovation Experience in Small Regional firms

Innovation is driven by new products, improved productivity and efficiency within the firm, as is meeting perceived client and customer requirements. Personal goals and values (e.g., those of the firm's management, often the firm's owners) were also important drivers of the innovations reported. The innovations developed and pursued ultimately benefited the firm and, in particular, resulted in a positive perception of the firm by customers, clients and competing firms. At the same time, there was an ill-defined benefit with respect to profitability, although the firms generally indicated that they would continue to use their key innovations. One of the important aspects in the innovation process is the transfer of research knowledge within the industry. It would appear that research knowledge is largely being received indirectly by firms through indirect sources such as industry associations and design professionals. As is considered beneficial for the results of research to be more directly accessible to the firms, and for the firms to receive direct input from universities and other research organizations, it is recommended that researchers develop closer links with the industry representatives who undertake the intermediary's role, and that universities should take a stronger role in collaborating with the firms. To this end, the "Regional Knowledge Diffusion" model has been developed as a result of this research.

## Conclusion

Small-Medium-Enterprises (SMEs) play a critical part and are an important contribution to the economy in Australia, and the imperative to innovate has been greater than ever in a globalized economic setting. This research explored a number of questions surrounding SMEs, their innovation practices and the policy that influence them. This research builds on prior studies and addressed a significant gap within the literature in a descriptive and explanatory way.

This research reviewed and identified, through a case study approach with a series of in-depth qualitative data collection, analyses and discussions, barriers to innovation in micro-regional SME in Australia, and outlines recommendations for how these can be overcome. In essence, the research aims to provide a deeper insight into what actually happens and why it happens; factors affecting innovation and technology transfer (I&TT) in regional micro-manufacturers, and describes an intervening investigation into the I&TT process in the SME sector within a University-Industry collaboration context.

The underlying project on which the work described is based involved a SWOT analysis on the business, learning and discovering the obstacles and barriers for I&TT, seeking and proposing ways to reduce it, and modeling the overall I&TT process within micro-manufacturers in regional areas, and termed Regional Knowledge Diffusion (RKD) model. This model developed through this research can be used as a conceptual framework for developing future policies for encouraging innovation and technology transfer within a university-industry context within the Small-Medium-Enterprise sector.

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