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Applying a Sectoral System of Innovation (SSI) Approach to the Australian Red Meat Industry with Implications for Improving Innovation and Entrepreneurship in the Australian Agrifood Industry

Christine Pitt [a]Ⓘ and Susan Nelle [b]

[a] *General Manager, Innovation Services, Meat Livestock Australia (MLA), 165 Walker Street, North Sydney NSW, 2060, Australia.*
[b] *Senior Research Fellow, Australian Innovation Research Centre (AIRC) of the University of Tasmania, Level 5, Salamanca Galleria, Hobart, Tas, 7000, Australia.*

Abstract

This paper describes an action research study conducted over four years (2002-2006) in the Australian red meat industry. The study aimed to extend the body of knowledge on innovation and entrepreneurship. It also sought to explore options for improving practice through interventions that would accelerate the development of innovation culture and capabilities. A conceptual framework was developed leading to a new Systems Innovation Intervention Framework. The framework was subsequently implemented via 30 individual pilots. The outcomes of the research study were tested for relevance more broadly within the Australian food industry and high levels of acceptance were reported.

Keywords: innovation, sectoral innovation systems, innovation system failures, intervention strategies

Ⓘ Corresponding author: Tel: + 61-2-9463-9117
Email: cpitt@mla.com.au
Other contact information: S. Nelle: susan.nelle@utas.edu.au

Introduction

The dynamic and often hostile competitive landscape of the twenty-first century has created significant threats to existing patterns of competition. A review of the extant literature and research about innovation and entrepreneurship identifies their importance to ensuring corporate vitality and wealth generation in today's global economy. For over one hundred and fifty years the foundation of Australia's prosperity has been from resource-based industries such as agriculture and mining. Changes in the world economy clearly require a much broader range of globally competitive industries to sustain Australia's strong economic position. It is proposed that the older more traditional industries such as the agrifood sector must also undergo rapid transformation if they are to maintain their competitive advantage.

This paper is based on Dr Pitt's doctoral thesis entitled 'Leading Innovation and Entrepreneurship: An Action Research Study in the Australian Red Meat Industry (Pitt 2007). In addition, the two authors have worked together to develop an integrated innovation systems framework and champion its application more broadly in the Australian food industry. Further research studies are currently underway to continue the development of analytical tools under the (SSI) framework.

Application of a 'Systems of Innovation' Framework to the Agrifood Industry

The agrifood industry is a major contributor to the Australian economy operating in global markets under increasing competitive pressures. Climate change and the development of bio-fuels have created additional uncertainty for the industry. In the face of these challenges, food industry leaders in Australia believe that innovation – in products/services, processes and business models – must be the driver of future prosperity.[2]

Although it is classified as a low-to-medium technology sector because the classifications are based on the level of internal R&D expenditure, the agrifood industry has been highly dependent on science and technology advances. For the most part, these have been developed through sector-specific R&D programs that have created accessible distributed knowledge networks. In addition, the industry has a wide range of future innovation opportunities that include new science-based products and processes including adoption of new technologies developed in other sectors (eg ICT in supply chain management, 'smart materials' in packaging, biotechnology in product development, and robotics in food processing).

[2] The Innovators' Forum – Future Vision for Australia's Food Industry, National Food Industry Strategy, June 2007 (report available on www.nfis.com.au)

Industry leaders and government policy makers understand that the continued competitiveness of the food industry will depend on the extent and rate of innovation within the sector. Innovation studies (Bryant 1998; Dodgson & Bessant 1996; Freeman 1994) have provided substantial empirical evidence of a high correlation between innovation performance and economic growth including:

- Technical change is the most important contributory factor in economic growth;
- Innovative activity as measured by R&D expenditure and by patenting is closely associated with the level of output and income at country level; and
- R&D and innovation are strongly associated with firm productivity growth

From innovation studies results conducted over twenty years primarily in Europe and the United States (Smith & West 2005), we can conclude that:

- Innovation involves continuous interaction and feedback between perceptions of market opportunities, technological capabilities and learning processes within firms;
- R&D is often not a *cause* of innovation, but an *effect* of innovation decisions made by firms;
- Innovation requires sustained investment under conditions of *risk and uncertainty;*
- Innovation capabilities are cumulative, building over time and dependent on sustained investment; and
- Innovation depends in large part on collaboration and interactive learning.

Thus, an accepted definition of innovation is 'the development of new products, services, processes and business models under conditions of risk and uncertainty'. Although enterprises make these decisions, they do not make them in isolation, but within persistent structures of business firms, economic institutions, science and technology infrastructures, policy frameworks and knowledge and resource bases and under varying degrees of risk (Smith & West 2005).

Over the past ten years, the focus of innovation studies has tended to shift from demonstrating the impact of innovation on growth and competitiveness, to analysing 'how' innovation occurs. There has been a convergence in the literature of innovation theory and systems theory giving rise to the concepts of national and regional systems of innovation which are based on geographic location, and sectoral systems of innovation (SSI) which are industry based.

Within a systems approach, innovation performance is seen as a coordination problem, with components of the system needing to work in a coherent way. A systems approach can therefore provide the framework for understanding how the

interactions within a system work together to facilitate (or hinder) innovative behaviour.

Thus, a sectoral system of innovation (SSI) framework provides a means for industry and public policy makers to assess how effectively elements of a system operate and interact under current conditions. It can also be used to assess a system's fit for future purpose when drivers of innovation affecting that sector change.

Building the Conceptual Framework

Prior to commencing the study, a conceptual framework was developed from a review of the literature with further testing of the components for relevance and application based on industry input. To access industry knowledge, a series of 28 in-depth interviews were undertaken from a cross-sectional sample of the key stakeholder groups (based on a stakeholder analysis methodology developed by Elias, Cavana and Jackson 2002) and utilising a snowball method (Glaser & Strauss 1967) to identify individuals. A convergent interviewing technique (Dick 1998) was applied in which open-ended questions were initially posed and modified to include probe questions in subsequent interviews for confirmation and disconfirmation.

An iterative triangulation methodology (Lewis 1998) was used to interpret data that involved multiple iterations between systematic engagement with the literature, analysis of emerging data from the interviews with industry stakeholders, and critical reflection by the MLA research team. The result was the development of a conceptual framework of the sectoral innovation and entrepreneurship system (Figure 1) and a supporting model of firm innovation and entrepreneurship capabilities (Figure 2).

The basic premise of the framework, at both industry sector and firm level, is that innovation and entrepreneurship are context sensitive and should be conceptualised within a systems perspective.

At the level of the industry sector, the proposition is that the over-riding sector culture (mediated by environmental impacts such as economic, social and political/legal conditions) will determine the degree to which firms in the industry exhibit an entrepreneurial orientation. The sector culture, and the resulting entrepreneurial orientation, will impact on how problems and opportunities arising from changes in the external environment are perceived by the players in the sector. This, in turn, will determine how proactively the sector responds.

It is proposed that conditions external to firms (markets, institutional arrangements and resource infrastructure) also impact directly on a firm's

innovation and entrepreneurship capability. In turn, this determines the level and success of corporate entrepreneurship strategies and ultimately the firm's ability to capture competitive advantage through innovation. The framework proposes that the impact of the external elements is mediated by a two-way relationship between the firm and its environment. The degree to which a firm is able to capture new knowledge and capabilities from interacting with other actors in the system is particularly important.

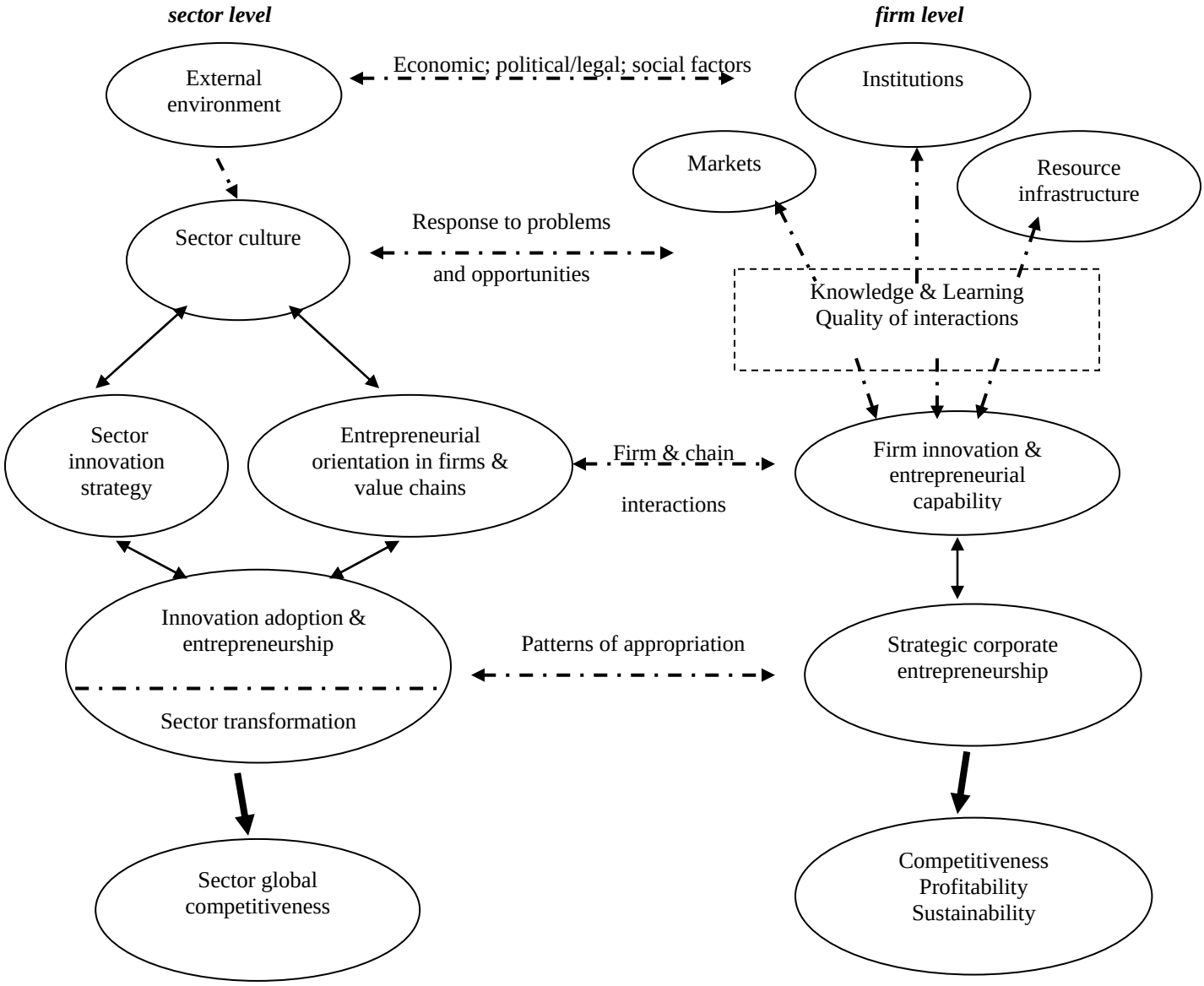

Figure 1: Sectoral Innovation and Entrepreneurship System

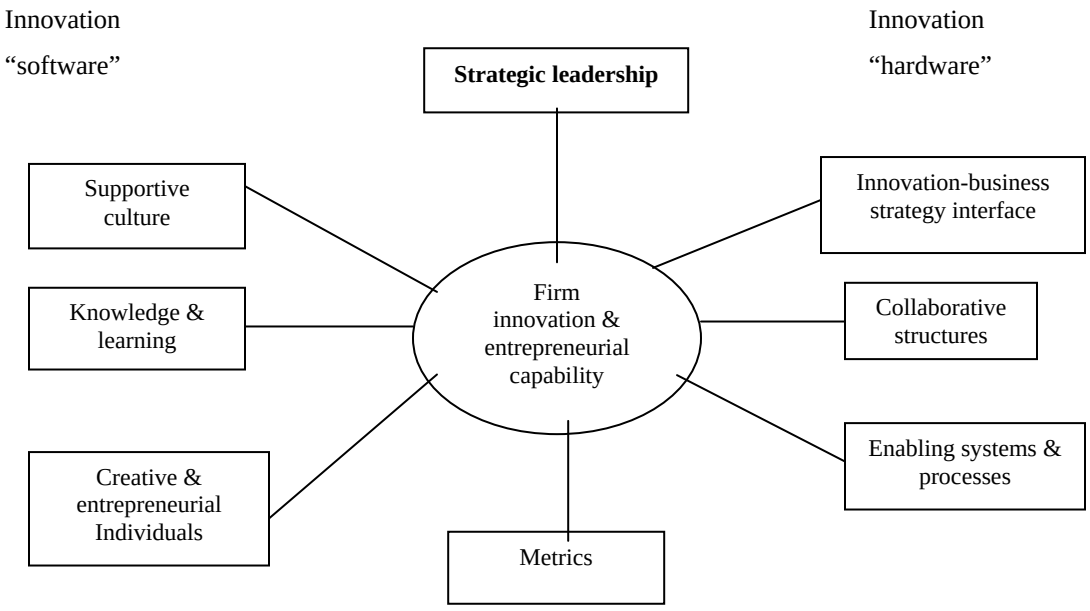

Figure 2: Model of Firm Innovation and Entrepreneurial Capabilities

Clearly the concepts at firm and sector level are interconnected. Ultimately the level of innovation adoption and entrepreneurship occurring within the sector will determine the degree to which the sector transforms itself and achieves a desired level of global competitiveness. However, this success is dependent on a variety of factors and interactions including: the level of entrepreneurial orientation within firms; the innovation options developed as a result of the sector's innovation strategy; the level of interaction between firms and value chains; and the patterns of appropriation associated with individual firm entrepreneurship.

The next stage of the literature review considered the concept of 'innovation system mapping' which has emerged in recent years as an approach to analysing empirical data (Stevens 1997) and comparing innovation systems (Bikar, Capron & Cincera 2006; Georghiou 2002; Nelson 1993). System maps represent an analysis of the various elements of a system that are seen to have an impact on innovation performance. However, there is, as yet, very little theoretical or practical information on how to analyse a system's health or failures in order to inform either policy development or the design of strategies and programs to strengthen a system (Bryant 1998; Edquist et al 2004; Scott-Kemmis et al 2005; Smith 1998).

Based on an approach developed by Woolthuis, Lankhuizen and Gilsing (2005), a system failure analytical framework was adapted for this study in which the effectiveness of system elements is evaluated from the perspective of the key actors within the system. In their model, Woolthuis and colleagues identify the following three groups of actors:

- *Firms/value chains*: large firms; SME's; innovative start-ups; value chain partners such as supermarkets; whole value chains
- *Knowledge providers*: universities; public R&D institutes; technology commercialisers; knowledge brokers and consultants; training and education providers.
- *Third parties*: regulators; finance sector such as banks and VC's; trade unions; industry associations

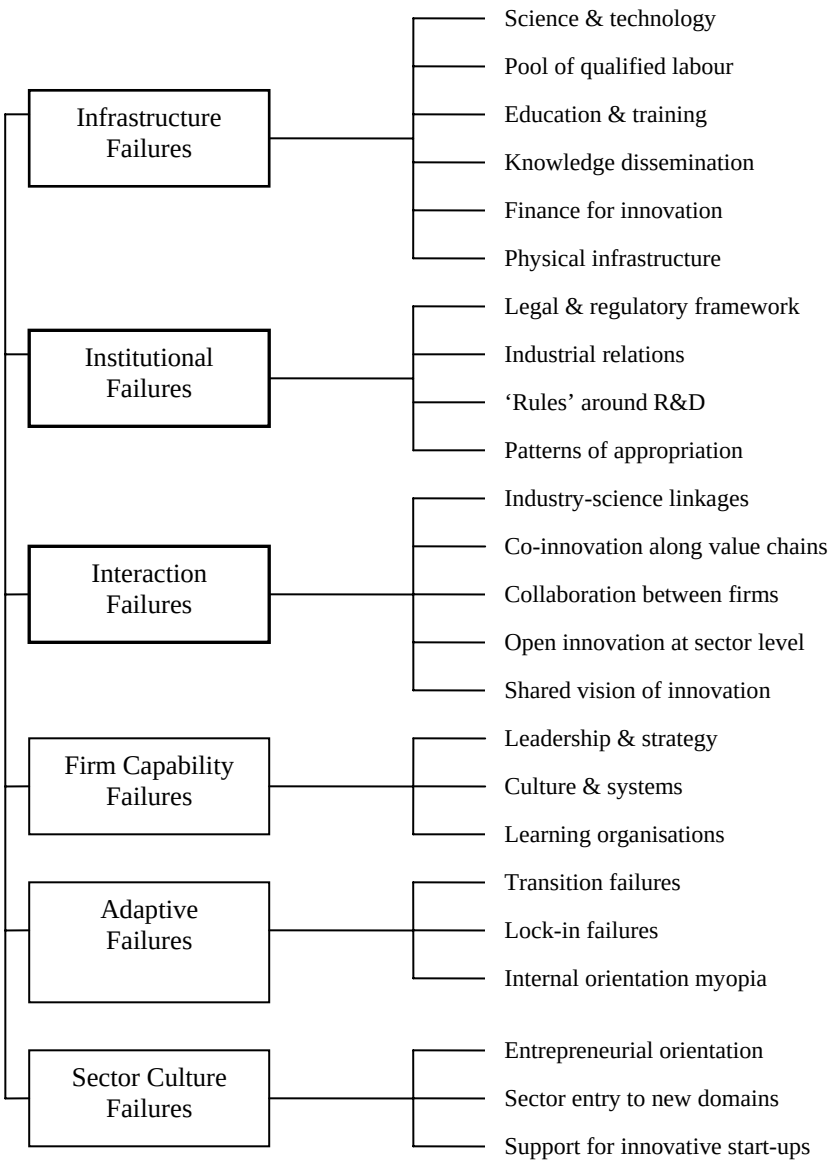

Figure 3: System Failure Analytical Framework

Table 1: List of Possible Evidence of System Failures

Category	System Health	System Failure
Infrastructure	• S&T capability geared to sector • Adequate physical R&D infrastructure • Critical mass of scientific expertise in key areas • Skilled technology commercialisers • Availability of skilled and educated staff • Supportive training and educational structures meeting technical labour supply needs • Competitive intelligence capability developed and used by firms • Access to multiple types of finance for innovation and entrepreneurship • Evidence of investment in R&D in emerging areas such as biotechnology; automation; ICT • Network of knowledge brokers • ICT infrastructure supporting information exchange needs	• Sector lagging competitors in adoption of new S&T • Inability of firms to attract/ retain qualified technical staff • Poor perception of sector by finance industry • Low representation by sector in government R&D programs • Low levels of investment in R&D • Inadequate numbers of S&T providers • Low awareness by firms of emerging issues in key markets • Lack of exposure to formal education and training • Lack of alignment between R&D providers and industry • Low utilisation by firms of external knowledge providers • Inadequate ICT infrastructure and low utilisation of modern ICT
Institutional	• Acceptance from regulators • Balance between consumer protection and operational flexibility • Regulations are science based • Regulators aware of commercial realities • Regulators support innovation and entrepreneurial behaviour • Good collaboration and respect between regulators and firms • High levels of trust between management and employees • Employees involved in innovation and change management • Incentives and rewards in place for innovative firms • Benefits of innovation shared equitably along the value chain • R&D investments support innovative firms	• Industry lagging competitors in relationship with regulators • Regulators perceive role as defending customers at expense of sector • High cost of compliance compared with competitors • Regulators perceived as creating barriers to innovation • Regulators too slow to change • Too many regulations creating confusion and inefficiencies • Regulators lack resources and expertise to address sector issues • High levels of industrial disputes • R&D system discourages private investment in innovation • Benefits from R&D do not flow equally to participants • Outcomes from R&D 'locked up' for long periods
Interactions	• Firms have access to and are aware of multiple sources of knowledge and learning • High levels of trust and interaction between firms and R&D providers • Effective user-producer interfaces in development of new technology • High levels of interaction by firms with sophisticated customers • Effective innovation along the value chain • Effective commercialisation of R&D outputs from R&D providers • Evidence of multiple collaborative R&D projects • Participation by firms in multiple knowledge sharing and innovation networks • Adoption of innovation from outside the sector • Widely supported sector innovation strategy • Use of trusted intermediaries to facilitate inter-firm collaboration	• Limited evidence of public-private partnerships • Minimal exchange of staff between commercial firms and R&D providers • Adversarial relations between segments within the value chain (firms and representative bodies) • Fragmented structures with little value chain integration • Absence of industry networks • Low levels of trust and communication between firms • Incompatible information systems between segments within the value chain • Low participation rates in syndicated R&D projects • Low levels of engagement between technology commercialisers and R&D providers • Low levels of international collaboration • Lack of coherence in sector R&D and marketing strategies

Firm capability	• Successful launch of new products • Successful entry to new markets • Successful adoption of new technologies and business processes • Evidence of entrepreneurial behaviour and implementation of growth strategies • Evidence of excellence in environmental and social sustainability • High scores on innovation capability benchmarks • Ability to foster creativity, innovation and risk taking • Cost competitiveness • Ability to attract new people with new skills • Application of concepts of open innovation	• Falling behind competitors in relation to key performance benchmarks • Low investment in R&D and innovation • Focus on short term payback periods for R&D investment • Absence of skilled R&D and innovation personnel • Absence of clearly articulated innovation strategies • Lack of documented innovation systems • Poor record in implementing change strategies • Poor record in commercialising R&D outcomes • Low scores on innovation capability benchmarks • Low participation rates in industry innovation projects • Lack of investment in training in creativity and innovation • Low tolerance for risk taking • 'Stick to the knitting' mentality • Dominance of commodity focus and production oriented mindset
Adaptiveness	• Cost competitiveness as a result of adoption of new technologies • Adoption of new product development platforms • Sector supported technology innovation strategy • High levels of adoption of new technology • Successful commercialisation of new technology	• Slow to respond to changing market requirements which require implementation of new technologies • Loss of market share due to high costs associated with outdated technologies • Evidence of redundancy in skills and capabilities • Lack of support for R&D providers to build capability in new technology areas • Lagging competitors in relation to new technology • Tight control of investment in technological innovation creating barriers • High capital investment in current technology a barrier to innovation • Poor technology foresighting capability • Mistrust of technology providers
Sector culture	• Support for innovative & entrepreneurial firms • Evidence of innovative & entrepreneurial individuals • Acceptance of legitimacy of entrepreneurship • Participation in new venture creation • Investment by venture capitalists and business angels in start-ups	• Low skill levels in entrepreneurship • Negative attitudes towards risk • High failure rate for new ventures • Suspicion and mistrust of innovators and entrepreneurs • Resistance to engaging in new business opportunities • Low participation rates in entrepreneurship support schemes

The resulting framework (Figure 3) identified six categories with 24 individual dimensions of potential system failures. The underlying assumptions of the approach are that:

- A key activity of the innovation system is "to enhance the entry and survival of new firms and the growth of successful SME firms by facilitating and supporting entrepreneurship" (Chaminade & Edquist 2005, p.25);
- System failures act as barriers or inefficiencies to the creation, distribution and application of knowledge that produce value-creating innovations; and
- System failures are caused by key system actors or activities being missing or ineffective.

A 'system failure' approach provides an alternative to the 'market failure' approach to underpin innovation policy and program decisions. The market failure approach 'rests on the idea that existing markets fail to coordinate behaviour effectively, but assume that such problems can be resolved by the creation of new markets, or by substituting government action for a market… However, overcoming problems related to knowledge creation and distribution or technology 'lock-in' requires institution building, not market rectification' (Smith & West 2007).

Finally, a preliminary methodology for determining evidence of system failure was developed which considered both positive and negative indicators as evidence of system 'health' or system 'failure'. It was identified that both quantitative and qualitative data would be relevant, with qualitative data likely to be most useful when designing intervention strategies and quantitative data required to undertake comparisons over time and between systems. While the design of a comprehensive qualitative and quantitative system diagnostic instrument was outside the scope of this study, Table 1 represents the preliminary list of possible evidence of 'system health and failure' applied in this study.

Research Objectives

The challenge within this study was to determine how best to integrate the various views of innovation systems thinking and to test how useful the SSI framework would be in assessing the effectiveness of the current innovation system in supporting the innovation endeavours of firms and value chains within the Australian Red Meat Industry, and in providing guidance for future innovation policies and investments in system improvements by MLA (the industry-owned innovation services provider).

The overall aim of the research was to develop an integrated intervention strategy that would build innovation capabilities within firms and facilitate the emergence of a much stronger culture of innovation and entrepreneurship across the red meat industry. The specific objectives were to:

- Apply the integrated model of sectoral innovation and entrepreneurship to the red meat industry to develop a better understanding of the environment in which the industry was operating and of how the innovation system could be supported to deliver greater impact;
- Apply the methodology for mapping the effectiveness of the innovation system based on the emerging concept of 'system failures' to assist MLA to more effectively deliver innovation services; and
- Apply the SSI framework to developing and testing acceptance of a range of intervention strategies that could shape future MLA policy directions and programs aimed at improving industry competitiveness and sustainability.

The central research question addressed by the study was:

How should MLA (the industry innovation service provider) design and deliver interventions that will significantly enhance the innovation capabilities of the Australian red meat industry in order to sustain competitive advantage in a rapidly changing environment?

Methodology

The methodology used in this study was action research which has been found to be particularly useful when a study is seeking innovation, change, growth and transformation of firms and their leaders/managers (Wilson-Evered & Hartel (2001). It has been suggested that in-depth inductive studies should be conducted in the innovation field to safeguard against the premature adoption of a rigid framework that may limit the scope of inquiry (Dyer & Page 1988; Van de Ven, Angle & Poole 1989). Specifically, the collaborative and participatory approach embodied in action research methodologies was deemed to be most appropriate to MLA's proposed intervention framework as it would require a high degree of stakeholder engagement.

The research design (summarised in Figure 4) consisted of multiple iterative cycles conducted over four years (2002-2006) in the Australian red meat industry. The following four principal steps were undertaken during the study to address the key research question:

1. Based on the conceptual framework, the red meat industry's innovation system was analysed to identify stresses and failures;
2. Based on the priorities identified as a result of the analysis, specific intervention instruments and projects to address system failures were designed;
3. Preliminary acceptance-testing of the proposed interventions to determine potential for impact was undertaken; and
4. Finally, consolidate the outcomes of the research study into an integrated innovation intervention framework underpinned by innovation systems theory to be presented to MLA as a model for future innovation policies and strategies.

To ensure adherence to the collaborative and participatory nature of action research, a seven-member research team was formed within MLA to undertake the study as a key component of the collaborative and participatory approach critical to the action research methodology (Dr Pitt was the leader of this team). In addition, multiple opportunities were created for input and engagement of industry participants to facilitate acceptance of the proposed intervention strategies arising from this research.

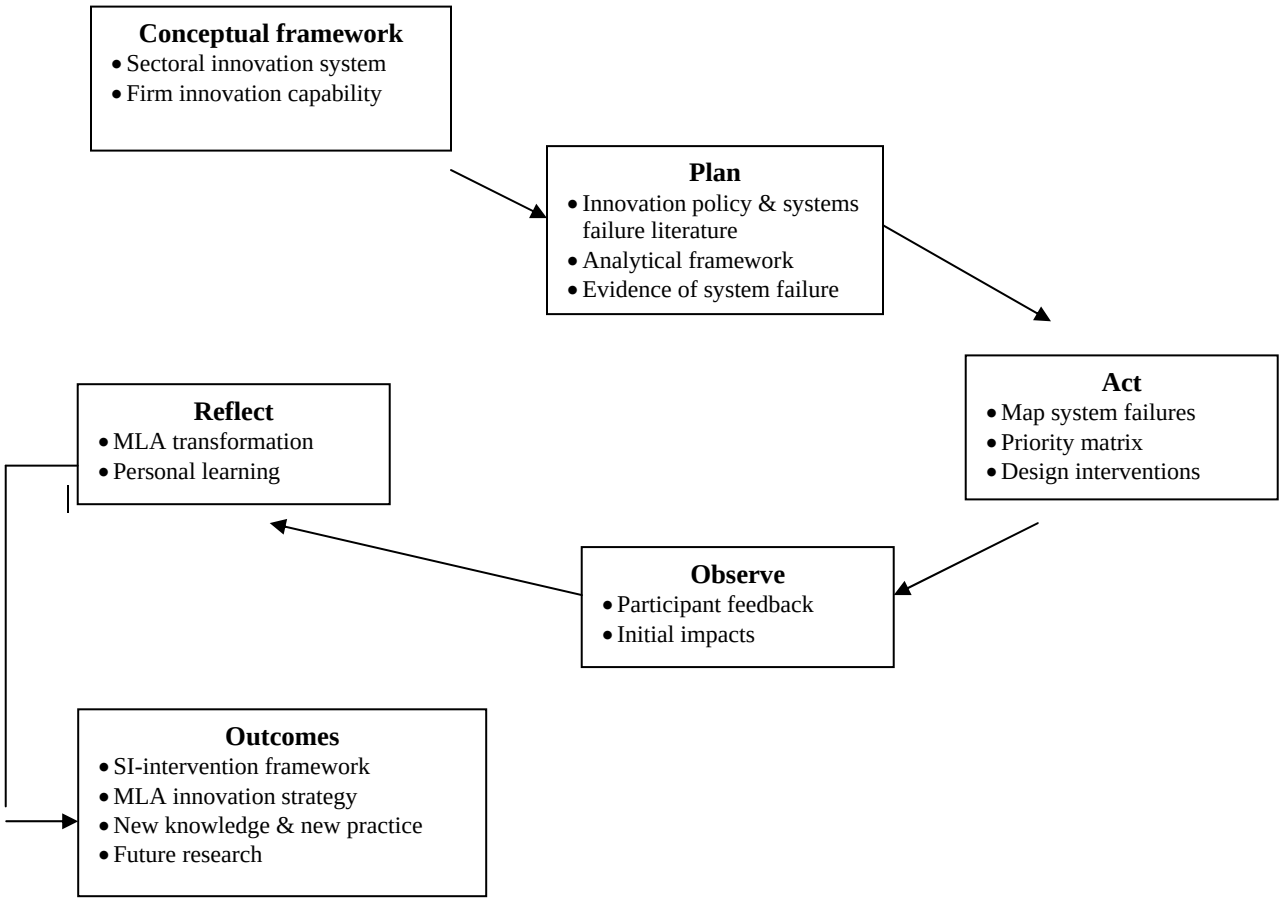

Figure 4: Overview of Research Design

Following is a brief summary of the key activities undertaken during the four principal steps in the research study.

Step One: Identifying Evidence of System Failure

This step involved searching for evidence of system failures (see preliminary list developed for this study in Table 1). The literature review revealed that previous studies seeking to analyse the functioning of an innovation system have taken a pragmatic methodological approach due to the limitations imposed by the availability of existing data and the high costs associated with the collection of specific and targeted data. It was also noted that there are, in fact, very few data sets available which support analysis at a sectoral level. It was therefore determined that for this study, evidence of system failure within the red meat sector

Table 2: Evidence of System Failure in Red Meat Industry

System Failure Category	Evidence in red meat sector (*source*)
Infrastructure	• Industry not aware of R&D outcomes (*MLA/AMPC Impact Report 2004)* • No alignment between R&D providers and industry *(interviews)* • Insufficient technology providers and poor commercialisation history *(interviews)* • Difficulty attracting and retaining skilled staff *(interviews; MLA Report – Abba 2004)* • Education and training providers do not have sufficient industry knowledge *(interviews)* • Low industry awareness of threats and opportunities in global environment *(interviews)* • Lack of benchmarking performance data *(interviews)* • Inadequate physical R&D infrastructure *(interviews; MLA Report – KPMG 2000)* • Inadequate ICT infrastructure *(interviews; MLA/QLD Gov. Report 2001)*
Institutional	• NZ competitors have better relationship with regulators *(interviews; MLA Report – TAP 2000)* • Regulators locked into historical paradigm of representing customer not supporting industry *(interviews)* • Over regulated creating confusion and inefficiencies *(interviews)* • Regulations not science-based and not aligned to commercial realities *(interviews)* • Socialised R&D removes incentives for firms to innovate *(interviews)* • Industry bodies narrow focus on crisis management, not innovation strategy *(interviews)* • Dominance of supermarkets in domestic supply chain removes incentives to innovate *(interviews)*
Interaction	• Limited evidence of public-private partnerships compared with competitors (*MLA Report – MINTRAC study tour 2006*) • Need for closer linkages between industry and researchers *(interviews)* • Fragmented industry structures with little evidence of collaboration along value chain *(interviews; MLA Report – KPMG 2001; MLA Report – Currie 2002)* • Relationships within the value chain limited by adversarial behaviours *(interviews)* • Lack of trust and low levels of collaboration between firms *(interviews)* • Very difficult to engage firms in syndicated projects *(interviews)* • Lack of collaboration has resulted in lack of coherence in industry R&D and marketing strategies *(interviews)*
Firm capability	• Industry firms are dominated by a focus on short-term cost-cutting initiatives at the expense of investment in innovation *(interviews)* • Lack of formal education and training by managers *(interviews; MRC Report – Andrewartha 1995)* • Many CEOs rely on approaches that have worked in the past and are reluctant to embrace new ideas *(interviews)* • Firms are not tolerant of failure and are resistant to change *(interviews)* • General lack of support for creative or entrepreneurial individuals *(interviews)* • Competitors such as NZ firms demonstrate superior innovation capability *(interviews)* • Industry is losing market share to competitors in both domestic and export markets *(MLA Market Intelligence Reports 1999-2006)* • Firms rely on innovations filtering through from overseas and do not take a proactive approach to innovation *(interviews)*
Adaptive	• Firms do not take a proactive approach to technology innovation *(interviews)* • Lack of in-house professional skill base makes it difficult for firms to adopt new technology *(interviews)* • Industry not prepared to support capability building in R&D providers *(interviews)* • Evidence of possible misuse of power on industry committees to block investment in new technology *(interviews)* • Reinforcement of status quo via shared industry perceptions such as "we sell all the meat we can produce – we are pretty right" *(interviews)*
Entrepreneurship culture	• Negative attitudes towards risks associated with innovation due to past R&D failures *(interviews; MLA Report – PIP Review 2005)* • Need to attract more creative and entrepreneurial people to the industry *(interviews)* • Industry culture is dominated by suspicion and mistrust of innovators *(interviews)* • Industry reluctant to enter new domains *(MLA Report – Bioactives 2005)*

would be identified based on: re-analysing the qualitative data collected during the 28 in-depth interviews conducted during the earlier phase of the research; and an analysis of secondary data contained in a wide variety of MLA reports which would provide an opportunity to triangulate the interview data. Table 2 illustrates specific examples of the types and source (interview data and/or MLA reports) of evidence of system failure identified in the red meat sector.

In this phase of the research, the MLA research team also rated the degree of impact on system effectiveness of each of the six system failure categories by each category of actor (firm, knowledge provider, and third party). Based on their own experiences working within the sector, the research team applied a 5-point rating scale to assess the relative importance of each system failure dimension for each of the groups of actors with a rating of '1' indicating 'not relevant' through to '5' indicating 'critical'.

The following summary map (Figure 5) broadly indicates the perceived level of impact of failures in system activities (by actor groupings) within each of the six categories within the analytical model as assessed by the MLA research team. When qualified by the potential for interventions by MLA to have an impact, this mapping framework provided a mechanism for determining where MLA intervention efforts aimed at improving the sector's innovation capability should be concentrated in the future.

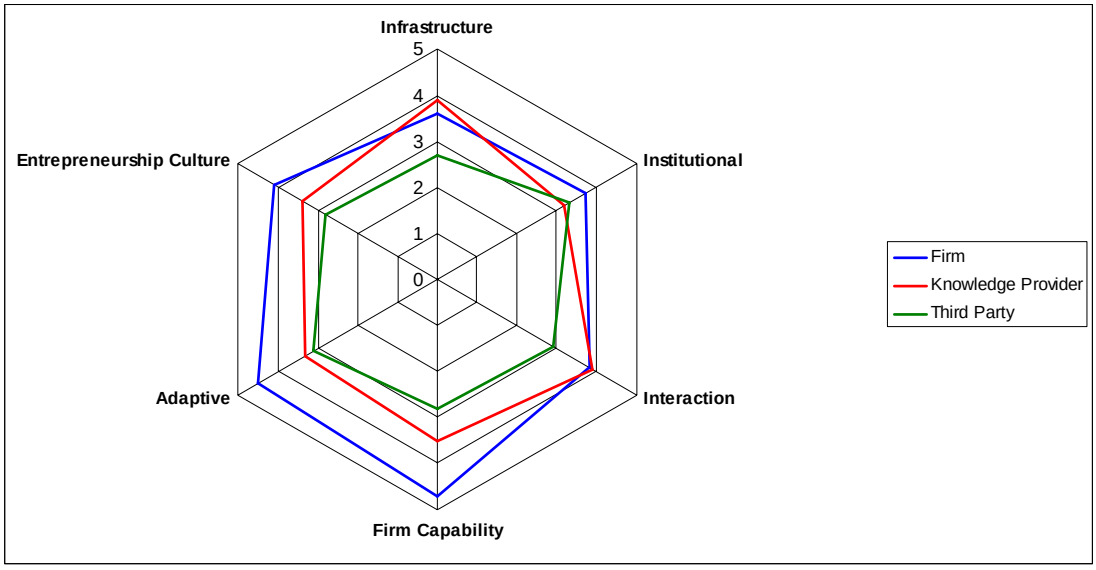

Figure 5: Mapping System Failures in the Red Meat Industry

Step 2: Developing Interventions

As noted in the literature (Edquist et al 2004), system intervention strategies must be comprehensive, efficient and cost-effective; and they must be focused on the

broad range of areas where problems are having the greatest impact and where interventions are most likely to succeed. In the next stage of this research, a suite of intervention instruments and projects were designed to address high priority system failures where the potential for MLA to have an impact was identified. The key inputs into determining potential intervention options were:

- Suggestions made by interviewees during the earlier stage of the research;
- Recommendations by participants in a National Food Industry Strategy food industry stakeholder workshop undertaken in June 2004;
- Review of existing MLA initiatives that the MLA research team believed could be further developed;
- Lessons learned from the lead researcher's past practice; and
- Consideration of the priority areas based on the mapping exercise.

A number of interventions were identified for further investigation by evaluating options against the following criteria:

- Intervention fits broadly within MLA's mandate;[3]
- Intervention fits within the priority areas identified in the mapping of system failures;
- Intervention does not duplicate a service already provided by other industry or government bodies;
- MLA has (or could acquire) the necessary skills to implement the intervention;
- Intervention appears to offer a cost-effective solution and is within MLA's broad budgetary constraints; and
- Intervention would not seriously confront industry political considerations.

Details of the actual design of each of the interventions are too lengthy for inclusion in this paper but may be found in Dr Pitt's doctoral thesis (Pitt 2007).

Step 3: Acceptance Testing of Intervention Initiatives

Figure 6 presents a summary of the interventions that were tested during this research study for acceptance and potential impact via a series of 30 pilots that included multiple engagements with industry participants.

[3] It was noted that the new approach represented a significant expansion of MLA's role. Specifically the approach explicitly challenged the existing paradigm that intervention should only occur in the case of 'market failure'. For this reason a relatively broad interpretation of MLA's mandate was required.

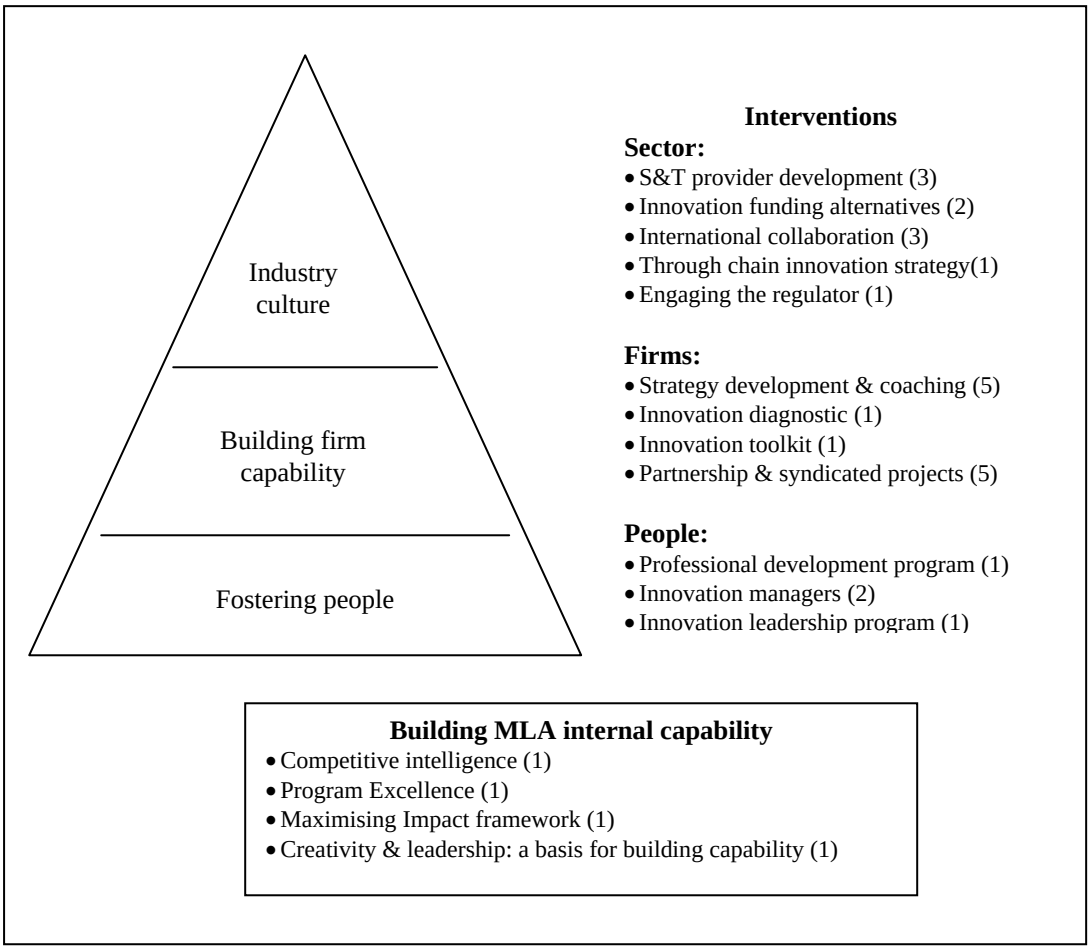

Figure 6: Pilot of Intervention Initiatives

While the numbers of industry participants directly involved in the research varied between each of the 30 initiatives (included both individuals and organisations), following is an overall summary:

- 48 undergraduates and new graduates; 43 universities; and 17 firms participated in testing the Professional Development Program;
- Six industry firms/supply chains participated in testing the new innovation capability building change management program over a period of three years;
- Three major technology providers, an international R&D organisation and four industry firms participated in testing a new technology strategy initiative;
- Two venture capital firms participated in testing new innovation funding models;
- Australia's major food safety regulator participated in testing new approaches to introducing innovation; and

- An MLA business unit involving 26 professional and support staff participated throughout the study in testing application of the new approaches to designing and implementing innovation interventions

A wide range of both qualitative and quantitative data were collected and analysed throughout this phase of the research including: interviews; range of secondary data sources including internal MLA documents, minutes of meetings, independent R&D reports and company innovation plans; and critical reflection by the principal researcher.

Step 4: Consolidation of Outcomes Presented to MLA

As stated, the purpose of the research study was to design an integrated innovation system intervention strategy that would assist the Australian red meat sector to improve its overall global competitiveness.

From the insights derived from the research study, the following 10 key principles for the design of an integrated intervention framework were developed:

1. Principle 1: The overall purpose of the innovation system should be defined (Edquist et al 2004; Lundvall & Borras 1998; OECD 2000).
2. Principle 2: The intervention framework must be based on a comprehensive understanding of the sector's innovation and entrepreneurship system.
3. Principle 3: The intervention strategy must address areas where significant problems have been identified within the system.
4. Principle 4: The intervention strategy should be based on a comprehensive approach to change which provides multiple options at the systems level rather than a piecemeal approach comprised of ad hoc, narrowly-based initiatives (Woolthuis, Lankhuizen and Gilsing 2005).
5. Principle 5: Industry engagement and participation in identifying intervention options is an important design criterion
6. Principle 6: There must be a reasonable expectation that the proposed interventions are likely to have an impact.
7. Principle 7: Clear objectives and measures for the intervention strategies should be articulated in order to facilitate ongoing review and reframing of the strategy.
8. Principle 8: A holistic socio-technical perspective that encompasses people, technology and the organisation should be incorporated into the overall design of any intervention.
9. Principle 9: A multi-level approach should be adopted which includes interventions focused on: developing people; building firm capability; and intervening at the overall sector level.

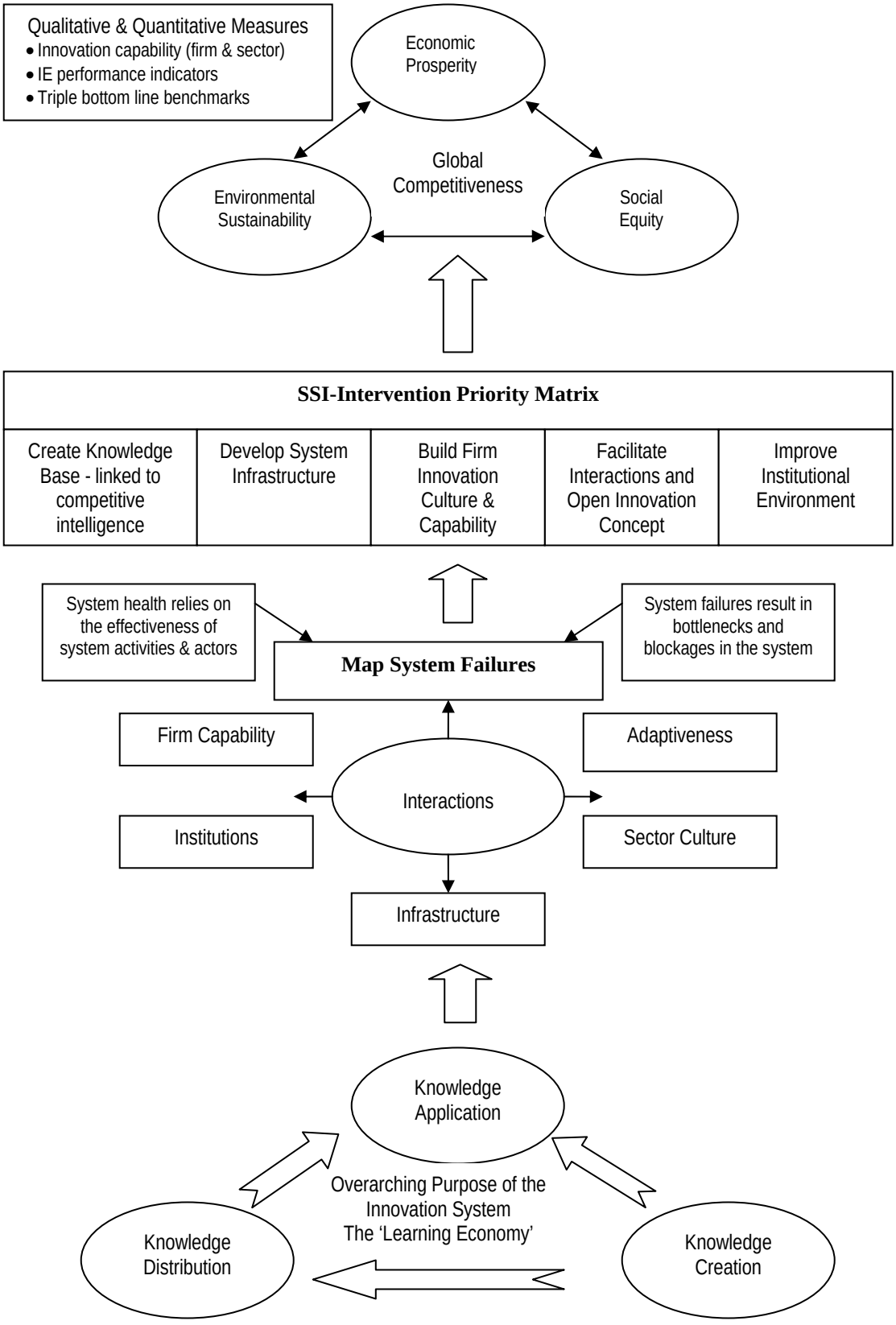

Figure 7: Integrated SSI Intervention Framework

10. Principle 10: Capabilities of the intervention agency must be aligned to the complexities of the innovation system in order to meet changing industry requirements (Hofer & Polt 1998; Scott-Kemmis et al 2005; Smith, K. 1998).

Based on these principles, a new integrated *SSI Intervention Framework* (supported by innovation systems theory) was developed to underpin the design of innovation interventions for the wider industry (see Figure 7). It is proposed that this framework demonstrates how interventions based on identified system failures can enhance the effectiveness of the relationship between the purpose of the innovation system and the achievement of global competitiveness.

Following completion of the study, the new *SSI Intervention Framework* was submitted for consideration by the MLA Board and has subsequently been incorporated within the company's new 5 year *Through Chain Innovation Strategy* which commenced implementation in July 2007 and will be subjected to extensive independent evaluation in 2010.

Results: Industry impact

While the timeframe for this study did not permit an extensive evaluation of the impact of the interventions, the following data are presented as early indicators that point to industry acceptance and improved practice based on application of the models and tools developed in this study:

- The level of investment in MLA's Innovation Partnership Program by the meat processing sector doubled in the two year period (2004-2006) from $16 million to $32 million (following a relatively slow growth over the previous five years). The MLA research team credit this accelerated growth to a number of factors including: higher quality projects resulting in faster approval times; wider awareness of the benefits of innovation encouraging more firms to invest; increased level of in-house skills and confidence as firms took advantage of the professional development program; better alignment and interactions between firms and R&D providers.
- Industry investment in a high risk automation technology strategy grew from zero in 2002 to more than $18 million by 2005-06.
- The automation technology program has provided significant opportunities for individual firms to participate in a range of interaction initiatives through: collaboration with a New Zealand processing company; co-funding a major syndicated R&D program; and involvement in a new technology innovation network that includes international study tours, sharing of knowledge and experience, and input into future industry direction. The willingness of firms to participate collaboratively in this initiative is a first for the Australian red meat industry.

- Venture capitalists were secured as investors in two new start-ups commercialising innovations in the red meat industry, which is another first for this type of investment. This represents a very early indicator of a potential to impact on the infrastructure failure identified in relation to finance for innovation. However, the experience has enabled MLA to develop a much greater understanding of the barriers to this type of investment and the requirements for building productive relationships with the venture capital community. Success in this area is also seen as an early indicator of the emergence of a more entrepreneurial orientation within the industry.
- The Professional Development Program attracted participation from 39 students, nine graduates, 17 companies, and 34 universities with a number of graduates offered permanent positions within the industry.
- A strategic R&D alliance was signed between MLA and a counterpart organisation in New Zealand valued at more than $1 million p.a. that provides access to substantial new intellectual property for the red meat industry. This is seen as an early example of the industry's willingness to apply concepts of open innovation at the sectoral level, a key dimension to be addressed in the area of interaction failures.
- There is early evidence (reported by participating firms) of positive cultural change within firms implementing new technology based on socio-technical approaches.
- Feedback received (at general presentations and input from industry project teams), indicates the response from industry and government representatives, and from the MLA board has been extremely positive to the proposed new intervention approach.

Based on these early results, it is proposed that this study will assist future researchers to develop a more comprehensive understanding of the elements within a sectoral system of innovation that must be evaluated. The approach will therefore be of particular relevance to practitioners attempting to intervene and change system dynamics to improve competitive performance.

Conclusions and Discussion

In summary, it is proposed that the research study discussed in this paper makes a contribution to the field of innovation and entrepreneurship studies in a number of areas including:

1. Contribution to knowledge by identifying specific opportunities for convergence in the two fields of innovation and entrepreneurship that will assist future researchers to develop a more comprehensive understanding of the elements within a sectoral system of innovation.
2. Development of novel theoretical and analytical models in the areas of: a system failure analytical framework; a methodology for determining evidence

of system failure; and a structured methodology to develop an integrated intervention strategy for making industry policy and program decisions. It is noted that these models were subsequently adopted by MLA and NFIS.
3. Improved practice within the red meat industry following implementation of the above models.
4. Evidence of the potential for the innovation systems approach to be a powerful tool in relation to developing innovation policy and investment options and in developing more effective programs to build a community of innovative firms within the red meat industry.
5. Lessons learned within the NFIS initiative independently confirmed the relevance and potential impact of innovation systems thinking on the Australian food industry's capacity to innovate (Nelle 2007).

Opportunities clearly exist to undertake further research to extend the approach within the red meat industry by conducting comparative and longitudinal studies of the effectiveness of MLA's interventions over the next five years. In addition, there are also opportunities to further develop the methodologies to determine evidence of system failure. Such methodologies would include quantitative and qualitative data related to both positive and negative indicators (i.e. system 'health' and system 'failure' indicators).

It is proposed that, based on the models and approaches developed in this study, more sophisticated SSI analytical tools could be developed. Of particular interest is the potential to identify specific areas of competitive advantage based on the 'health' of a sector's innovation system. There would also be opportunities to benchmark innovation systems with competitors' systems as a basis for designing interventions to overcome identified gaps.

This study is based on a single case and therefore does not purport to offer broad generalisations regarding the usefulness of the models and methodologies outside this single case. However it is proposed that the new approaches offered by innovation systems theory and the concept of system failure could provide innovation policy makers with a desirable alternative to the current economic policy paradigm based on the concept of 'market failure'.

Next Steps

Since 2005, the authors have worked together, first under the framework of the National Food Industry Strategy (NFIS) and more recently under the auspices of the Australian Innovation Research Centre (AIRC) at the University of Tasmania, to apply innovation system thinking more broadly across the agrifood industry within Australia. For example, a study with the national dairy industry is currently underway using an SSI framework to determine future RD&E

infrastructure requirements and to identify other priority system improvements that might increase innovation performance.

It is anticipated that this work will be extended to include a series of innovation studies that will apply the SSI framework to a range of agrifood sectors to address issues such as:

- Relative roles of market demand and technology advances as drivers of innovation;
- Roles and inter-relationships of 'actors' in the system (particularly firms and science and technology providers);
- Role and impact of collaborative networks (and network brokers, intermediaries and system integrators)'
- Knowledge creation and distribution across the system;
- Impact of national and regional institutions ('rules') on innovation performance;
- Identification and impact of system failures; and
- Identification and impact of potential intervention strategies.

Ultimately it is the authors' intent to develop a broad set of analytical tools to analyse the structure and functionality of sectoral systems of innovation in the agrifood industry; develop and test system 'health' and 'failure' indicators; and assess 'fit for future purpose' of sectoral innovation systems facing new competitive pressures. The authors also hope to identify common system failures across agrifood sectors that would create opportunities for collaborative policy and program development.

References

Bikar, V. Capron, H. & Cincera, M. (2006) *An integrated evaluation scheme of innovation systems from an institutional perspective.* Working Paper No. 06-09 Dulbea, Brussels.

Bryant, K. (1998) "Evolutionary innovation systems: Their origins and emergence as a new economic paradigm" in K. Bryant & A. Wells (eds.) *A new economic paradigm? Innovation-based evolutionary systems: Discussions of science and innovation.* Department of industry, Science and Innovation, Canberra

Buzan, T. & Buzan, B. (2000) *The Mind Map book.* BBC Worldwide Limited, London

Chaminade, C. & Edquist, C. (2005) *From theory to practice: The use of systems of innovation approach in innovation policy* CIRCLE, Lund, Sweden

Commonwealth of Australia (2003) *Mapping Australian science and innovation: Main report* McMillan Printing Group, Canberra

Dick, B. (1998) *Convergent interviewing: a technique for qualitative data collection.* Available on-line at www.scu.edu.au/schools/gcm/ar/arp/iview.html

Dodgson, M. & Bessant, J. (1996) *Effective innovation policy: a new approach.* International Thomson Business Press, London

Dyer, W. & Page, R. (1988) "The politics of innovation," *Knowledge in Society: An International Journal of Knowledge Transfer*

Edquist, C. Malerba, F. Metcalfe, J. Montobbio, F. & Steinmueller, W. (2004) "Sectoral systems: Implications for European technology policy" in F. Malerba (ed.) *Sectoral systems of innovation.* Cambridge University Press, Cambridge

Elias, A., Cavana, R. & Jackson, L. (2002) "Stakeholder analysis for R&D project management" *R&D Management* 32 (4)

Freeman, R. (1994) "The economics of technical change" *Cambridge Journal of Economics* (18)

Georghiou, L. (2002) "The United Kingdom system of research, technology and innovation" in P. Laredo & P. Muster (eds.) *Research innovation policies in the new global economy: An international comparative analysis.* Elgar, London

Glaser, B. & Strauss, A. (1967) *The discovery of grounded theory: Strategies for qualitative research.* Aldine, Chicago

Hindle, K. (2002) "Small-i or BIG-I? How entrepreneurial capacity transforms "small-i" into "Big-I" innovation: Some implications for national policy" *Telecommunications Journal of Australia* 52(3): 51-63

Hofer, R. & Polt, W. (1998) "Evolutionary innovation theory and innovation policy: An overview" in K. Bryant & A. Wells (eds.) *A new economic paradigm? Innovation-based evolutionary systems: Discussions of science and innovation.* Department of Industry, Science and Resources, Canberra

Lewis, M. (1998) "Iterative triangulation: A theory development process using existing case studies" *Journal of Operations Management* (16): 455-469

Lundvall, B. & Borras, S. (1998) *The globalizing learning economy: Implications for innovation policy.* The European Commission, Brussels

Maxwell, J. (2005) *Qualitative research design: An interactive approach.* Sage, Thousand Oaks CA

Nelle, S. (2007) 'Exploring the Innovation System' paper prepared for *The Innovators Forum, Future Vision for Australia's Food Industry*, June 2007

Nelson, R. (1993) (ed.) *National innovation systems: a comparative analysis.* Oxford University Press, Oxford

OECD (2000) *OECD Science, Technology and Industry Outlook 2000.* OECD, Paris

Pitt, C. (2007) *Leading Innovation and Entrepreneurship: An Action Research Study in the Australian Red Meat Industry* DBA Thesis, Southern Cross University

Scott-Kemmis, D. Holmen, M. Balaguer, A. Dalitz, R. Bryant, K. Jones, A. & Matthews, J. (2005) *No simple solutions: How sectoral innovation systems can be transformed.* Australian National University, Canberra

Smith, K. (1998) "Innovation as a systemic phenomenon: Rethinking the role of policy" in K. Bryant & A. Wells (eds.) *A new economic paradigm? Innovation-based evolutionary systems: Discussions of science and innovation.* Department of Industry, Science and Resources, Canberra

Smith, K. & West, J., *'Innovation Policy, Productivity, and the Reform Agenda in Australia: A Framework for Analysis',* Australian Innovation Research Centre, 2007.

Stevens, C. (1997) "Mapping innovation" *The OECD Observer* 207: 16-19

Ticehurst, G. & Veal, A. (1999) *Business research methods: A managerial approach.* Longman, Australia

Van de Ven, A. Angle, H. & Poole, M. (eds.) (1989) *Research on the management of innovation: The Minnesota studies.* Harper & Row, New York

Wilson-Evered, E. & Hartel, C. (2001) "Creating a climate for innovation: A participative approach," in S. Sankaran B. Dick R. Passfield & P. Swepson (eds.) *Effective change management using action learning and action research.* Southern Cross University Press, Lismore

Woolthuis, R. Lankhuizen, M. & Gilsing, V. (2005) "A system failure framework for innovation policy design" *Technovation* (25): 609-619

