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An entrepreneurial marketing process perspective of the role of intermediaries in producing innovation outcomes

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ABSTRACT

The activities of innovation system actors, particularly the importance of networks, entrepreneurs, and the role of intermediaries have not yet been integrated into a framework that explains innovation system performance at the project level. This study contributes by exploring the role of the innovation system's actors with respect to its performance. Innovation system performance is studied using multiple cases of projects using statistical inference, network analysis, and fuzzy-set qualitative comparative analysis. The number of actors effectively involved in projects is positively associated with innovation system performance. The network of relationships in the case study innovation system was relatively open, such that the contribution of some actors only became available to the system through the conduit of other actors. Both researchers and intermediaries are highly involved and effective, and the intermediaries' effectiveness contributes to innovation system performance. However, the perceived involvement or effectiveness of these and other actors did not, alone, ensure that the conditions required for innovation system performance were met. The research method and results apply to any innovation project, particularly those in highly regulated, technological fields. The present study's findings demonstrate the application of innovation system theory at the project level. The study has important implications for integrating entrepreneurial marketing into innovation system policy and practice.

> "The role of intermediary in innovation and technological development can be traced back to 'middlemen' in the agricultural, wool and textile industries of 16th, 17th, and 18th century Britain… (who) not only plied their trade, but were important informal disseminators of knowledge…" (Howells, 2006: 715–716).

1. Introduction

As Howells (2006) notes, intermediaries have long served a critical boundary spanning role in the commercialization of innovation. Likewise, Hills (1984a, 1984b), Hills and LaForge (1992) and Darroch and Miles (2011) found marketing intermediaries to be critically important in the successful commercialization of innovations. Hekkert, Suurs, Negro, Kuhlmann, and Smits (2007) describe the functions that are required for innovation system (IS) outcomes and suggest that an IS can be conceptualized as a set of three "motors" that drive innovation. Innovation can be either demand- or supply-side driven (Darroch & Miles, 2010). Demand-side processes combine Hekkert et al. (2007) *"market"* and *"entrepreneurial…motors of innovation"* to pro-actively employ entrepreneurial marketing processes (EMP) (Miles & Darroch, 2006), while supply-side sources link *system-building* and *science and technology push motors* to develop innovations that require a post-hoc application of EMPs to commercialize. EMPs guide IS actors to proactively pursue attractive opportunities by aggressively exploiting risk, leveraging resources, and maintaining customer intensity (Morris, Schindehutte, & LaForge, 2002).

Our EMP perspective of Hekkert et al. (2007) offers an explanation for how innovations are developed by IS actors through entrepreneurial actions, such as identifying and exploiting opportunities, combined with marketing strategy and processes, such as creating primary and selective demand, managing the customer adoption process, and creating superior value propositions for customers as critical for successful innovation commercialization, and a successful IS.

While intermediaries and their networks have received attention with respect to system-level policy implications in the innovation literature (Allen, James, & Gamlen, 2007; Howells, 2006; Klerkx & Leeuwis, 2008; Linton, 2000), these actors have yet to be integrated into a useful conceptual framework that explains IS performance (ISP)

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at the project level. Jenson, Leith, Doyle, West, and Miles (2016b) found that IS theories can be applied as a useful managerial tool to understand and explain the poor performance of IS at the project level. However, the role and functions of intermediaries have not been investigated with respect to project-level performance through analysis of multiple case studies.

In this study, we examine the contributions of intermediaries and other network actors, specifically focusing on how intermediaries that adopt EMP facilitate the commercialization of innovations. We define the network of actors at both the system and project level, and explore actors' roles in ISP.

Performance of an IS at the project level can be measured by the occurrence of innovation, which may include changes to the product, process, supply chains and business models (Schumpeter, 1934). The IS chosen for study was that for food safety in the Australian red meat industry, which is at the intersection of sectoral and technological IS. All the projects were managed by Meat & Livestock Australia (MLA), which is a government/industry-funded innovation intermediary with a mandate to deliver research and development services in this sector (Core & Australian Department of Agriculture Fisheries and Forestry, 2009). Multiple cases of projects with a potential innovation outcome within this IS are examined. The actors involved in the IS include: (1) researchers, often based in universities and research institutes; (2) firms in the industry; (3) industry associations; (4) intermediaries; (5) the government as a regulator; (6) suppliers; (7) customers; and (8) entrepreneurs, who exploit the innovations in the pursuit of opportunities (see Kilelu, Klerkx, Leeuwis, & Hall, 2011; Klerkx & Leeuwis, 2008).

We have structured this paper as follows: (1) review of the literature on IS and intermediaries, defining the knowledge gap that this study helps to fill, (2) our exploration of the similarities between the functions of intermediaries and entrepreneurial marketing, (3) the methods used in this study, (4) the role of system actors in IS functions (5) discussion of the implications of this study for theory, policy and practice.

2. Literature review

2.1. Innovation systems

Four major approaches have been taken to the study of ISs. They are: (1) national; (2) regional; (3) sectoral; and (4) technological; the optimal approach is an artefact of the the question being asked (Carlsson, Jacobsson, Holmén, & Rickne, 2002). The sectoral IS approach, focusing on the innovation of a single industry sector, and the technological IS approach, focusing on technology, are the most immediately relevant at the level of a project. They deal with the environment in which a project is situated (Pitt & Nelle, 2008) and the factors that positively or negatively affect the diffusion and adoption of technology (Negro, Hekkert, & Smits, 2007).

The sectoral (Breschi & Malerba, 1997) and technological (Carlsson & Stankiewicz, 1991) approaches are useful in understanding both the processes and potential failures of IS, and frameworks for diagnosing the causes of IS failure have been developed (Bergek, Jacobsson, Carlsson, Lindmark, & Rickne, 2008; Klein Woolthuis, Lankhuizen, & Gilsing, 2005). The sectoral and technological approaches acknowledge the importance of specific actors in the IS. The elements of both the sectoral (Klein Woolthuis, 2010; Klein Woolthuis et al., 2005) and technological (Bergek et al., 2008; Hekkert et al., 2007) system failure approaches have been constructed and tested as theories and are able to explain ISP (Jenson, Leith, Doyle, West, & Miles, 2016a); and are used in policy and practice (Manjón & Merino, 2012; Rosales-Carreón & García-Díaz, 2015).

While the importance of networks is acknowledged (Allen et al., 2007; Johnston & Linton, 2000; Powell & Grodal, 2005) and the kinds of actors required to be present and effectively interact in an IS have been defined (Allen, Tushman, & Lee, 1979), there are few examples in the literature that are specific to IS (Sapsed, Grantham, & DeFillippi, 2007). The exception is work by Musiolik and Markard (2011) and Musiolik, Markard, and Hekkert (2012), who used social network analysis to understand formal and informal network development in emerging technologies, and how the development of the network brought sufficient resources to the IS.

2.2. Intermediaries

The identification of actors has typically taken an organizational approach (Jacobsson & Johnson, 2000) that may include suppliers and users of a product or service, as well as boundary-spanning bridging institutions such as research, financial, and governmental organizations (Malerba, 2004). While the role of intermediaries, or bridging organizations, was identified in the early IS literature (Carlsson & Stankiewicz, 1991), the critical bridging role of intermediary actors has largely been neglected in later research on IS, with the exception of work by scholars such as Howells (2006), Klerkx and Leeuwis (2008), Kilelu et al. (2011), Klerkx, Aarts, and Leeuwis (2010) and Edler and Yeow (2016); none of whom investigated the contribution of intermediaries in a quantitative way.

Intermediaries link sources of technology with those who can develop it, commercialize, or apply it and appropriate value from its commercialization or application, compensating for the structural weaknesses of the system (Carlsson & Stankiewicz, 1991). IS intermediaries (Howells, 2006) have also been conceptualized as integrators (Hobday, Davies, & Prencipe, 2005), brokers (Batterink, Wubben, Klerkx, & Omta, 2010), and orchestrators (Dhanaraj & Parkhe, 2006); all fulfilling the same function in the IS—linking people and technologies to create tangible outputs or innovation (Edler & Yeow, 2016). Kilelu et al. (2011) note that IS intermediaries have six basic functions. They are: (1) the understanding, articulation, and stimulation of demand for the innovation; (2) network brokering; (3) serving as knowledge brokers; (4) managing the innovation process within and between the system actors; (5) capacity building; and (6) creating the institutional framework that facilitates commercialization of the innovation.

Intermediaries may be individuals, organizations, or institutions such as technology marketers, university extension services, government technology transfer programs, and research organizations. These actors are a critical component of all IS and especially so in sectoral IS (Pitt, 2007). Individuals, organizations and institutions that produce technology tend to function within various technology platforms, regional, or sector-based ecosystems and frequently have a 'lead organization' that sets the rules and coordinates the networked ecosystem (Dhanaraj & Parkhe, 2006; Ritala, Armila, & Blomqvist, 2009) providing enabling leadership for the creation of value.

Industry associations often have political or representative functions and act as intermediaries in national IS where they can articulate industry support for innovation policies and provide a source of funds (Watkins, Papaioannou, Mugwagwa, & Kale, 2015). Likewise, government and non-government institutions (semi-autonomous, owned companies, foundations) may function as both technology providers and intermediaries in technological transitions, such as in sustainable energy (Kivimaa, 2014). Likewise, researchers may also operate as intermediaries within sectoral IS (Chunhavuthiyanon & Intarakumnerd, 2014).

2.3. Entrepreneurial marketing and the motors of innovation

Commercial outcomes of IS are critically dependent upon the functions of intermediaries (Howells, 2006; Huyghe, Knockaert, Wright, & Piva, 2014). For example, Litan and Song (2008: 2) note that while "technological advances have been the most important driver of economic growth… (technological advances) by themselves do not contribute to growth unless they are somehow *commercialized* in the

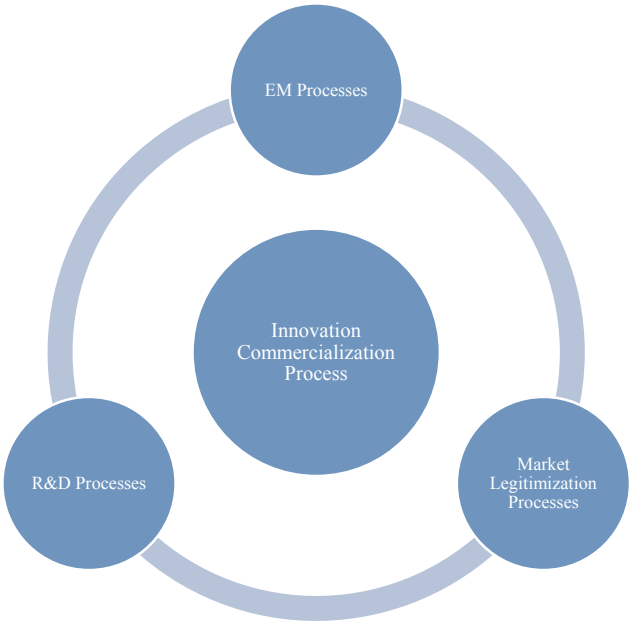

Fig. 1. An entrepreneurial marketing perspective of Hekkert et al. (2007) Motors of innovation.

form of new products or services or integrated as part of the production or service delivery process." This requires that marketing, entrepreneurial, and innovation processes must be integrated (Ahmadi, O'Cass, & Miles, 2014; Covin, Eggers, Kraus, Cheng, & Chang, 2016; Darroch & Miles, 2011; Eggers, Kraus, & Covin, 2014).

Walrave and Raven (2016) describe Hekkert et al. (2007) innovation motors as sets of actors and processes that make up: (1) science and technology push motor—based on basic science and R&D; (2) entrepreneurial motor—in which legitimacy is established by business creation and growth; (3) system-building motor—the policy, institutions and infrastructure of the IS; and (4) market motor—commercialization. IS researchers typically classify R&D, entrepreneurship and marketing activities (motors of innovation) as separate sets of unlinked processes in stark contrast to EMP scholars (Hills, 1987; Morris & Paul, 1987; Darroch & Miles, 2011).

The motors of innovation as identified by Hekkert et al. (2007) can be re-conceptualized as actions of EMP actors (see Fig. 1).

R&D: EMP actors that shape R&D, technology development, and new product development by an understanding of market needs and entrepreneurial opportunities.

EM: EMP actors that facilitate the commercialization of the innovation by lobbying the regulatory institutions to create a favorable regulatory and legitimate environment for the newly commercialized technology's products. Lobbying and the legitimization process are done to provide the requisite infrastructure, regulatory framework, and institutional environment needed for adoption by the market.

Market Legitimization: EMP actors that proactively create new markets for innovations. Market creation requires the legitimization of the innovation with regulators and users, developing both primary and selective demand for the technology's products, building the products' supply chains, and developing and implementing a pricing strategy to create superior value propositions for all targeted market segments.

3. Methods

The internal records of MLA were used as a basis to define innovation projects conducted. MLA is an industry-owned intermediary that has adopted an EMP approach to achieving innovation outcomes. MLA's (2017) strategic plan states that it:

> "…strives to be the recognized leader in delivering world-class research, development, and marketing outcomes that benefit Australian cattle, sheep and goat producers (by) invest(ing) in research & development… Funding comes from transaction levies paid on livestock sales, the Australian government and voluntary contributions from industry partners… "

Forty-one of MLA's R&D projects were assessed through a survey of those associated with a specific project (Jenson, 2016; Jenson et al., 2016a, 2016b). The cases were defined as projects in which innovation was expected at the start of the project and in which the research phase was successfully completed more than two years before the date of data collection. The survey was conducted online (supplementary material). Questions pertained to: (1) the projects' innovations; (2) the operation of IS elements; and (3) the presence, engagement, and interactions of actors

ISP and the strength of IS conditions were measured as previously described (Jenson, 2016; Jenson et al., 2016c, Jenson et al., 2016a). Respondents were also asked, for each potential actor, whether that actor had been involved in the project (scored as no = 0, yes = 1). Regardless of involvement, respondents were asked whether the (lack of) involvement had a negative, neutral or positive effect on achieving the objectives of the project (scored as negative = −1, neutral = 0, positive = 1).

When data were summarised, a significant difference in means was determined using a two-sided *t*-test assuming unequal variances, applied using Microsoft Excel.

Network analysis was performed by combining data on the involvement of each actor with their perceived effectiveness. Thus, the nodes represent an actor's involvement, while the edges represent their effectiveness as perceived by each of the other actors.

Fuzzy set Qualitative Comparative Analysis (fsQCA) methods were applied (Rihoux & Ragin, 2009; Schneider & Wagemann, 2012) to the cases using fsQCA software version 2.5 (Ragin & Davey, 2014). Two approaches to fuzzy-set calibration in fsQCA are suggested in the literature and both are used in this study. One approach (Schneider & Wagemann, 2012) promotes calibration based on theoretical knowledge and empirical evidence about the condition or outcome, and the other (Woodside, 2010, 2013, 2014) promotes the use of the 10th, 50th, and 90th percentiles as selected values for three-point calibration. Calibration of innovation (Jenson et al., 2016b) utilized 4.8 on a 7 point Likert scale as the point of indifference, which was close to the point at which an average respondent "somewhat agrees" that at least one example of innovation resulted from the project. Thirteen cases had < 0.5 membership of the set of projects with innovation outcomes (no innovation, ~INNOV), and the remainder had > 0.5 membership of the set with an innovation outcome (innovation, INNOV). For the involvement and effectiveness of actors an arbitrary calibration was chosen, to result in about half the cases being totally within the set, and about 10% of cases being completely outside their respective sets, with the remainder variable within the set.

4. Results

Two hundred and thirty-nine responses to the survey instrument were received from 100 recruited respondents, with some respondents recruited to respond to more than one project. A total of 76% of surveys sent to recruited respondents were returned. Additionally, the program manager at MLA responded to the survey instrument for all projects. Less than half (43%) of the responses came from those identifying as researchers, and the program manager responses represented 15.7% of all responses, which does not unduly privilege researcher or program manager (Table 1).

Table 1
Actors' involvement and effectiveness in the innovation system.

Actor	number of substantially complete responses from this actor	number of responses scoring this actor's involvement	average involvement score*	average effectiveness score**
Researcher	83	247	1.00	0.99
Industry firm	23	216	0.83	0.72
Industry association	8	189	0.62	0.49
Intermediary	33	242	0.94	0.87
Government	23	193	0.51	0.40
Supplier	5	180	0.38	0.31
Customer	0	181	0.17	0.10
Entrepreneur	0	173	0.40	0.38
Program manager	41	Na	Na	Na

Na – not applicable – not included in the survey.
* 0 = no, 1 = yes.
** 1 = negative, 0 = neutral, 1 = positive.

4.1. Actors' involvement and effectiveness in the innovation system

The number of actors involved in each project recognized by more than half of the respondents was calculated. The average number of these actors involved in a project that had no innovation outcome was 3.15, whereas an average of 4.75 actors were involved in projects that had an innovation outcome ($p < 0.001$).

Five actors were recognized by more than half the respondents as being involved in the projects they assessed (researchers, industry firms, industry associations, the intermediary, and government). Respondents also indicated whether (by presence or absence) the actor was effective in the conduct of the project (Table 2). Three of these five (researchers, industry firms, and intermediary) were assessed by more than half the respondents as being effective.

The involvement (Table 2) of industry associations, government, and intermediary were significantly higher ($p < 0.05$) for projects with an innovation outcome than those without innovation. The effectiveness (Table 2) of industry firms, industry associations, intermediary, and government were significantly higher ($p < 0.05$) for projects with an innovation outcome than for those without innovation. The involvement and effectiveness of researchers were consistently very high in all cases, which results in insignificant differences between projects with or without innovation outcomes.

No actors' involvement or effectiveness was found to be necessary (Table 3), to achieve innovation.

Given the significance of the involvement and effectiveness of the five major actors in this IS, we tried to identify a combination of actors whose involvement or effectiveness may be sufficient for innovation to occur. The involvement of researchers and the intermediary with either the industry (firms or association) or government is sufficient for an innovation outcome (Table 4). Researchers' effectiveness is always required for innovation, and the intermediary's effectiveness is frequently required. Industry firms' effectiveness often contributes to the outcome, but industry association and government effectiveness contribute less often to an innovation outcome (Table 5). The industry firms and association appear to substitute for each other in many cases. Government effectiveness is often not required.

Table 2
Involvement and effectiveness scores for projects with high and low membership of the innovation outcome set.

Actor	Involvement			Effectiveness		
	~INNOV*	INNOV	P	~INNOV	INNOV	p
Researcher	1.00	0.99	0.32	0.98	0.99	0.51
Industry firm	0.75	0.86	0.10	0.56	0.77	0.01
Industry association	0.37	0.70	< 0.001	0.20	0.57	< 0.001
Intermediary	0.86	0.97	0.03	0.76	0.90	0.02
Government	0.28	0.59	< 0.001	0.15	0.48	< 0.001
Supplier	0.23	0.44	0.009	0.15	0.36	0.006
Customer	0.04	0.21	< 0.001	0.04	0.12	0.19
Entrepreneur	0.35	0.43	0.36	0.28	0.41	0.15

INNOV means > 0.5 membership of the innovation outcome set.
* ~ INNOV means < 0.5 membership of the innovation outcome set.

4.2. A network of actors in the innovation system

The perception of each actor's involvement and effectiveness can be considered from the point of view of each of the other actors. The actors' perceptions of the other actors can be presented as a network of involvement and effectiveness within this IS (Fig. 2). The circles represent the actors, and the size represents their involvement, while the lines represent the effectiveness as perceived by each of the other actors. The researchers, industry firms, industry association, and intermediaries have a central position in the IS—both in terms of involvement and their effectiveness. The researchers and intermediary are both frequently involved and highly effective in this IS. Industry firms and industry association(s) were perceived as effective by other actors less often than researchers and intermediary. Industry firms recognized its association(s) as well as researchers and the intermediary as effective in the IS. The government actor was less often perceived as being involved, and not perceived as being effective. The other actors were peripheral in this IS, both in terms of involvement and effectiveness. In network terms, there are several holes in which the effectiveness of an actor is not perceived by some of the other actors but is perceived by others. The researchers and intermediary are the central actors influencing ISP, according to the actors in the network judged by their involvement and effectiveness.

4.3. Actor-related conditions leading to an innovation outcome

Previous analysis (Jenson et al., 2016b) demonstrated that in this IS certain conditions were recurrently weak, resulting in poor ISP and some projects failing to result in innovation. These IS elements, specified by sectoral and technological IS failure theories (Klein Woolthuis, Lankhuisen, and Gilsing, 2005; Hekkert et al., 2007; Klein Woolthuis, 2010), are required for ISP (Jenson et al., 2016a). We investigated whether the involvement or effectiveness of particular actors was necessary for strong IS elements. A number of actors' involvement and/or effectiveness appeared to be necessary to ensure interactions between IS actors, signaling lack of market failure, and providing direction of the search. There was no significant association between the actors and the element of knowledge development (see Table 6).

We investigated whether the behavior of major actors was sufficient to explain strong IS elements. The involvement of the researcher and intermediary was moderately successful in explaining strong interaction in the IS (Table 7), but a larger and more varied group of actors'

Table 3
The necessity of involvement and effectiveness of actors for membership in the innovation outcome set.

Actor	Involvement		Effectiveness		Both involvement and effectiveness	
	Consistency	Relevance	Consistency	Relevance	Consistency	Relevance
Researcher	1.00	0.03	1.00	0.05	1.00	0.09
Industry firm	0.89	0.51	0.73	0.84	0.72	0.85
Industry association	0.71	0.87	0.40	0.97	0.40	0.97
Intermediary	0.97	0.17	0.90	0.52	0.90	0.54
Government	0.60	0.89	0.30	0.96	0.30	0.96

Table 4
Involvement of actors in projects leading to membership of the innovation outcome set, fsQCA derived solution for the sufficiency of the condition, involvement of the major actors, to explain the outcome, Innovation, and the negation of involvement of the major actors, to explain a negation of Innovation.

Condition (actors)	Configurations for INNOV			Configurations for ~ INNOV	
Researchers	+	+	+	+	+
Industry firms	0	0	+	~	0
Industry associations	+	0	~	0	~
Intermediary	+	+	0	+	+
Government	0	+	~	~	+
Raw coverage	0.71	0.59	0.29	0.34	0.35
Solution coverage	0.91			0.60	
Solution consistency	0.82			0.70	

INNOV means > 0.5 membership of the innovation outcome set, ~ INNOV means < 0.5 membership of the innovation outcome set. + means inclusion, ~ means the inclusion of the negation, 0 indifference to inclusion, of the condition in the outcome.

Table 5
Effectiveness of actors in projects leading to membership of the innovation outcome set, fsQCA derived solution for the sufficiency of the condition, effectiveness of the major actors, to explain the outcome, Innovation, and the negation of effectiveness of the major actors, to explain a negation of Innovation.

Condition (actors)	Configurations for INNOV			Configurations for ~ INNOV	
Researchers	+	+	+	+	~
Industry firms	0	+	+	~	~
Industry associations	0	0	~	~	~
Intermediary	+	+	0	~	+
Government	~	0	~	~	~
Raw coverage	0.62	0.68	0.35	0.36	0.05
Solution coverage	0.92			0.40	
Solution consistency	0.79			0.76	

INNOV membership of the innovation outcome set, ~ INNOV means < 0.5 membership of the innovation outcome set. + means inclusion, ~ means the inclusion of the negation, 0 indifference to inclusion, of the condition in the outcome.

effectiveness is required to more completely explain strong interactions. Inclusion of industry associations is helpful, though sometimes exclusion of the industry associations may still result in strong interaction. Exclusion of the government from a project may also still result in strong interaction. No configurations of actors, or lack of actors, were sufficient to result in a lack of interaction.

The involvement of a large number of actors favored strong fulfillment of the market element, but only researchers and intermediaries were frequently involved in contributing to a solution highly consistent

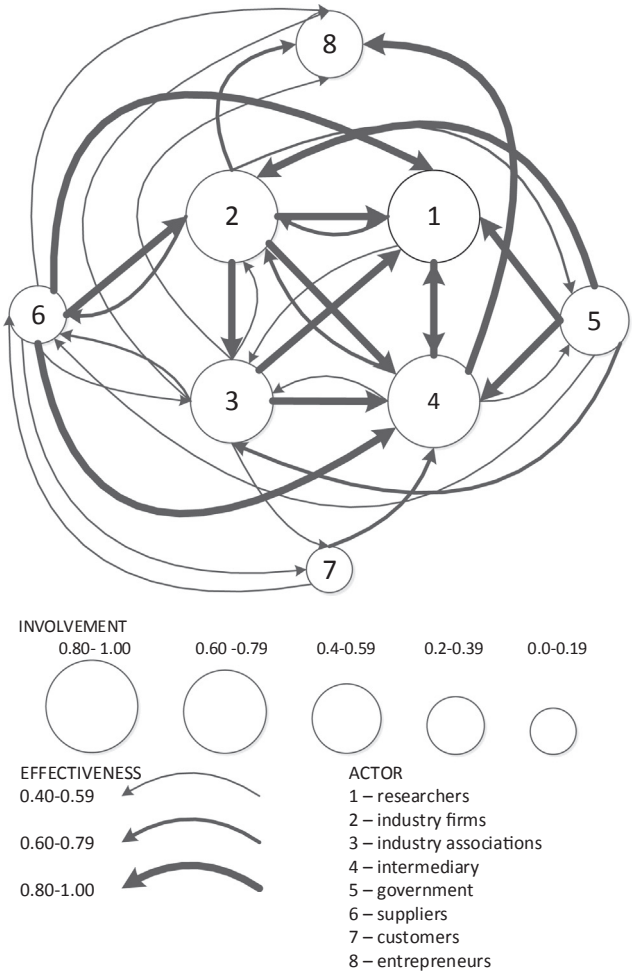

Fig. 2. Actor interactions in an IS, The size of the circles represents the involvement of the actors and the thickness of the lines represents the effectiveness of the actors (head of arrow) as perceived by the others (tail of arrow).

with the data (Table 8). The five configurations of actors' effectiveness for achieving membership of the market condition varied widely, although the solution is consistent with the data. No configurations of actors provided consistent association with lack of a strong market.

A high number of actors' involvement in projects is associated with the strong direction of the search (Table 9). Industry firms, their associations, or government involvement may substitute for one another, while intermediary involvement is always part of the group of actors providing direction. The effectiveness of actors follows much the same configurations as for involvement with intermediary always effective and industry associations and government sometimes being weakly effective to produce a consistent result. Weak actor involvement and effectiveness did not produce results which effectively covered the weakness of direction (results not shown).

Table 6
Goodness of fit parameters for the necessity of major actor involvement or effectiveness for a project to have > 0.5 membership of a condition required for innovation system performance.

Condition for innovation system performance	Network condition	Goodness of fit parameter	Actor				
			Researchers	Industry firms	Industry associations	Intermediary	Government
Interaction	Involvement	Consistency*	1.00	0.84	0.66	0.97	0.58
		Relevance	0.03	0.45	0.80	0.17	0.87
		Coverage**	0.69	0.71	0.80	0.70	0.83
	Effectiveness	Consistency	0.99	0.65	0.36	0.86	0.31
		Relevance	0.05	0.75	0.93	0.47	0.95
		Coverage	0.69	0.76	0.82	0.72	0.85
Market	Involvement	Consistency	1.00	0.87	0.64	0.97	0.55
		Relevance	0.04	0.58	0.86	0.22	0.90
		Coverage	0.77	0.82	0.87	0.79	0.88
	Effectiveness	Consistency	0.99	0.67	0.36	0.87	0.29
		Relevance	0.07	0.85	0.97	0.59	0.97
		Coverage	0.77	0.88	0.93	0.83	0.89
Knowledge development	Involvement	Consistency	0.03	0.03	0.03	0.03	0.01
		Relevance	0.03	0.42	0.76	0.15	0.80
		Coverage	0.64	0.67	0.76	0.65	0.72
	Effectiveness	Consistency	0.03	0.03	0.01	0.03	0.01
		Relevance	0.04	0.72	0.92	0.44	0.93
		Coverage	0.64	0.72	0.79	0.68	0.78
Direction	Involvement	Consistency	1.00	0.87	0.69	0.98	0.58
		Relevance	0.04	0.52	0.87	0.20	0.90
		Coverage	0.73	0.78	0.89	0.75	0.89
	Effectiveness	Consistency	0.99	0.67	0.39	0.90	0.30
		Relevance	0.06	0.81	0.98	0.56	0.96
		Coverage	0.73	0.83	0.94	0.81	0.89

* Consistency of necessity and coverage of sufficiency have the same value.
** Coverage of necessity and consistency of sufficiency have the same value.

Table 7
Involvement and effectiveness of actors in projects leading to membership of the Interaction condition set, fsQCA derived solution for the sufficiency of involvement and effectiveness of the major actors, to explain membership of the Interaction condition set.

Condition (actors)	Configurations of involvement	Configurations of effectiveness		
Researchers	+	+	+	+
Industry firms	0	+	0	0
Industry associations	0	0	0	~
Intermediary	+	+	+	+
Government	0	0	~	0
Raw coverage	0.97	0.62	0.62	0.55
Solution coverage	0.97	0.96		
Solution consistency	0.70	0.72		

\+ means inclusion, ~ means the inclusion of the negation, 0 indifference to inclusion, of the condition in the outcome.

Table 8
Involvement and effectiveness of actors in projects leading to membership of the Market condition set, fsQCA derived solution for the sufficiency of involvement and effectiveness of the major actors, to explain membership of the Interaction condition set.

Condition (actors)	Configurations of involvement			Configurations of effectiveness				
Researchers	+	+	+	+	+	+	+	0
Industry firms	0	0	+	0	0	0	0	+
Industry associations	+	0	~	0	~	0	~	~
Intermediary	+	+	0	+	0	+	+	+
Government	0	+	~	0	~	~	0	~
Raw coverage	0.64	0.54	0.31	0.63	0.61	0.62	0.55	0.26
Solution coverage	0.86			0.99				
Solution consistency	0.85			0.79				

\+ means inclusion, ~ means the inclusion of the negation, 0 indifference to inclusion, of the condition in the outcome.

5. Discussion

The work described here is a multiple case study of a single IS (food safety in the Australian red meat industry), at the intersection of sectoral and technological systems. While the results apply only to this particular IS, many of the features explored may apply to other IS, especially those with similar features. Some relevant features of this IS are the highly regulated industry with socialized funding for industry innovation and an intermediary organization created by joint agreement of government and industry with industry innovation as a key purpose.

Through this study, conducted at the level of projects, the operation of the actor-oriented elements of IS a framework is examined. Statistical analysis of the association between the number of actors, their involvement, and effectiveness and ISP is supported by fsQCA that makes claims to the analysis of causality expressed as a causal pathway (Berg-Schlosser, De Meur, Rihoux, & Ragin, 2009) or recipe (Ordanini, Parasuraman, & Rubera, 2014). fsQCA is used to examine the configurations of actors that may lead to ISP as well as the configurations of actors that may lead to the strength or weakness of IS elements whose strength is known to vary in this IS. Network analysis is used to delineate the relationships between actors. This work contributes to an understanding of EMP in IS theory and has implications for theory, policy, and practice.

Analysis of this IS at the project level demonstrates that the involvement of a sufficient number of suitable actors, and the effectiveness of those actors, leads to the ISP required for innovation. On average, projects with innovation outcomes have more actors involved than those without an innovation outcome. In this system, the recognized involvement of industry associations, government, and the

Table 9
Involvement and effectiveness of actors in projects leading to membership of the Direction condition set, fsQCA derived solution for the sufficiency of involvement and effectiveness of the major actors, to explain membership of the Interaction condition set.

Condition (actors)	Configurations of involvement			Configurations of effectiveness		
Researchers	+	+	+	+	+	+
Industry firms	+	0	0	0	0	+
Industry associations	0	+	0	0	~	0
Intermediary	+	+	+	+	+	+
Government	0	0	+	~	0	0
Raw coverage	0.86	0.69	0.58	0.64	0.56	0.64
Solution coverage	0.92			0.89		
Solution consistency	0.79			0.82		

+ means inclusion, ~ means the inclusion of the negation, 0 indifference to inclusion, of the condition in the outcome.

intermediary was significantly greater in projects with innovation outcomes, and in addition to these actors, the perceived effectiveness of industry firms and suppliers was significantly greater in projects with an innovation outcome.

The need to have more actors effectively involved in projects to ensure ISP may be explained by the network of those actors. The network analysis shows that actors whose involvement and effectiveness contribute most often to ISP do not uniformly recognize each other's contributions. An actor's contribution may be acknowledged only by a few other actors. The open network structure points to the significance of the actors that ensure the resources of the less embedded actors become available to the remainder of the network and the project. The researcher and intermediary were central in this network and may serve this role as a science and technology push motor of innovation (Walrave & Raven, 2016). Likewise, this study provides support for an EM perspective of Hekkert et al. (2007) motors of innovation framework.

Turning to the conditions required for ISP, no actor's involvement or effectiveness was necessary for the achievement of high membership in one of the IS condition sets: interaction, markets, or direction. Multiple configurations of actors may be sufficient for innovation outcome set membership. Involvement of at least three of the five major actors and variable involvement of the other two are found in cases that account for the majority of the innovation outcome set membership. It is possible that different projects will need different actors and different actions by those actors to ensure ISP. Cases without an innovation outcome may frequently be explained by the absence of industry firms and government, or by the absence of industry associations, though causes other than actor involvement are implicated through IS failure frameworks.

Intermediaries may be a significant actor in ensuring ISP by linking the IS actors with each other and critically to the market. The intermediary was seen to be highly involved and effective in a high proportion of cases and significantly more involved and effective in cases with an innovation outcome. The intermediary's effectiveness was necessary with moderate relevance to the IS conditions of interaction, market, and direction. Researchers were also seen as involved and effective reflecting the highly knowledge-intensive nature of food safety (Desmarchelier & Szabo, 2008) but the significance of their involvement and effectiveness was at least less than those of the intermediary.

We suggest that effectiveness of actors in the IS is determined by their contribution to the strength of IS conditions, either through their own effort in effectively applying resources to the IS or acting as a conduit for the contribution of others, thus ensuring ISP. In this system, the focus is on the intermediary, but this role may not be distinct or may be shared in other IS. Theory could be further developed by understanding the relationship between the effective involvement of various IS actors and the strength of IS elements. The intermediation role needs to be understood in the context of IS elements applied at the project level.

Prior to the "dismantling of the extension service and regional applied research stations" in nationally important IS such as agriculture, many of the functions of IS were supported by the public (Klerkx & Leeuwis, 2008: 264). In addition, IS approaches have had a significant impact on the development of innovation policy, but little attention has been given to how these approaches can be applied at the level of projects. Innovation policy needs to be focused not only on systems-level outcomes but on the project level outcomes that are critical to economic competitiveness. Policy needs to explicitly take into account the important role of researchers and intermediaries in innovation success. For example, what are the policy implications and institutional support required to build capacity and performance in the IS? Likewise, what barriers can be removed to enhance efficient and effective network and knowledge brokering operations?

This work adds weight to that already undertaken (Jenson et al., 2016a, 2016b) that sectoral and technological IS frameworks can and should be applied at the level of projects, where innovation outcomes are desired. Within a single IS, the effective involvement of actors varies and is associated with poor ISP. A focus of project managers should be to understand the role of intermediaries in IS and try to ensure the adequate involvement of actors and their effect on the operation of IS to maximize ISP. For example, in the case study's IS, the elements of interaction and direction of the search were frequently found to be weak, and intermediaries have an obvious role and interest in ensuring that these elements are strengthened.

Weak interactions, identified as an element in the structural theory of IS failure (Klein Woolthuis, Lankhuisen & Gilsing et al., 2005), are shown by this work to be complex and thus requiring significant attention. The system studied has an intermediary with the capacity to employ sufficient resources to cause the IS to perform effectively most of the time. An important function of intermediaries is the formation and management of interactions (Dhanaraj & Parkhe, 2006), so these need to be managed at the project level, not least for ensuring that the interactions in the IS are effective.

When analyzing this IS through the lens of the functional theory of IS failure (Bergek et al., 2008) direction of the search was found to be recurrently implicated in failures of projects to lead to innovation (Jenson et al., 2016b). The function of 'direction of the search' relates to the motivation and incentives of actors to take a particular direction, perhaps through the articulation of demand by potential users and response by providers (Hekkert et al., 2007). Demand articulation is identified as an important role for intermediaries in IS (Klerkx & Leeuwis, 2008).

6. Conclusion

This study explores the role of the marketing and entrepreneurship intermediaries that become the driver of the three motors of innovation by using EMPs at the project level in IS. Previous research has conceptualized market creation and entrepreneurship as unique functions. This study provides a more parsimonious and managerially useful conceptualization of the motors of innovation at the marketing and entrepreneurship interface.

At a policy level, there must be encouragement to involve and allow the contribution of all the relevant actors, driven by the boundary-spanning EMP capabilities of the intermediaries and entrepreneurs. This is particularly relevant in IS that are highly regulated and dependent upon research. Likewise, at the project level, managers need to understand and leverage the entrepreneurial and marketing motors of innovation intermediation to facilitate innovation outcomes.

A focus of IS project managers should be to understand the role and functions of entrepreneurs and intermediaries in IS to facilitate early involvement and thus maximize ISP. The significance of actors' involvement in ISP at the project level was explored. Projects with stronger ISP had more actors effectively involved than projects with

weaker performance. The interrelationship and network linkages between intermediaries, researchers, and firms in the industry are essential for projects that result in innovation. This finding supports the work of Howells (2006), Klerkx and Leeuwis (2008) and Edler and Yeow (2016) with intermediaries serving as boundary spanners that match the needs of industry for innovation with the ability of researchers to supply it.

The work described here is based on a multiple case study of a single IS (food safety in the Australian red meat industry), at the intersection of sectoral and technological systems. While the results apply only to this particular IS, many of the features explored may generally apply to other IS, especially those with similar features. Some relevant features of this IS are the highly regulated industry with socialized funding for industry innovation and an intermediary organization created by joint agreement of government and industry with industry innovation as a key purpose.

This study provides a glimpse into the value of intermediaries to both technological and sectoral ISP at the project level. The authors hope that this study encourages additional research into the application of IS at the project level. Likewise, the authors hope that the study stimulates work that helps better articulate and understand the value of intermediaries and entrepreneurs in IS from both a technological and sectoral perspective.

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