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IMPACT OF EXTERNAL ENVIRONMENTAL FACTORS ON RFID ADOPTION IN AUSTRALIAN LIVESTOCK INDUSTRY: AN EXPLORATORY STUDY

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Abstract

A significant numbers of 'mad cow' disease outbreaks around the globe as well as the recent food safety concerns in Japan, Europe, and Korea increase the necessity of a lifetime traceable information system of animals. Ideally, this system would generate a lifetime history of the potentially affected animals and simultaneously allow unaffected livestock owners to continue to trade. Therefore, as a result of the market demand and pressure, and to save local industry, a number of countries around the globe have adopted Radio Frequency Identification (RFID) technology, as RFID has enormous capabilities in identifying and tracking animals. At farm level, the farmers have adopted RFID due to the external pressure emanating from various stakeholders and the contextual environment. The contextual external environment, therefore, contributes towards most for RFID's adoption. This paper first examines the influence of the external environmental factors on RFID adoption in various worldwide applications and then determines how important those factors are in Australian livestock industry, using seven livestock farms as cases. The study finds that legislative pressure is the main driving factor in RFID adoption while competitive pressure and external support are also important. The paper then proposes a framework that contributes to the adoption theories and can be used to identify the impacts of the components of the external environment in practice.

Keywords: RFID; adoption; external environment, government, market, pressure.

1 INTRODUCTION

Australian meat and livestock industry is regarded as one of the largest in the world. Australia is the second-largest exporter of beef, mutton, and lamb in the world, exporting to more than 100 countries, and world's largest exporter of beef (ABARE 2007). During 2006-07, the gross value of livestock production was \$18.185b, contributing nearly half of the gross value of agricultural product. A significant portion of these produces was exported, contributing 53% of the agribusiness's export in 2006-07 (ABARE 2007). Considering this huge dependence on livestock industry, in 1999, Australia introduced National Livestock Identification System (NLIS) and made it mandatory in July 2005, for cattle. During an outbreak this system generates a lifetime report of the affected animals and the animals that have contacted with, which need to be rapidly identified, and isolated. The efficiency (speed and accuracy) of this system affects the potential financial impact of such an incident (Elbakidze 2007). For example, without having NLIS Australia would lose over \$9 billion during an epidemic (Productivity-Commission 2002). RFID based animal tracking system, in turn, reduces the extent of loss by allowing unaffected livestock owners to continue to trade.

The significant numbers of animal disease outbreaks reported around the globe over the past decade have greatly intensified worldwide consumer interest and demand to develop an animal identification and tracking system. Among numerous animal identification technologies, RFID tags are highly recommended because it is the most appropriate for the current industry needs, and is capable to meet customers' ever changing requirements. RFID is one of the most effective technologies which identifies an object automatically and uniquely, and can store enormous amount of data for many years which can later be retrieved as information (Hossain 2009). In fact, livestock identification and management is one of the first and largest (by the number of tags) applications of RFID technology and is regarded as a "revolutionary" innovation for the food and livestock industry.

Primarily and most significantly, the revolution of RFID technology started with the compulsion from Wal-Mart and Department of Defense (DoD) to their suppliers. In livestock industry, the pressure was first introduced by European Union (EU) in the late 1990s which was followed by Japan, South Korea, and United States. Simultaneously, a considerable amount of consumer awareness and demand has developed in favor of a *complete* animal tracking system. As a cumulative pressure from market, customer/ consumer, and competition some countries including Canada, Europe, Australia, and Uruguay passed legislations on mandatory use of RFID-based livestock identification, while some other countries such as United States and Japan are doing on a volunteer basis. However, the pressure from various agencies leaves fewer options to the farmers; either to adopt RFID or "*stay out of the business*".

Though a number of studies have been found which dealt with the effect of technological, organizational, and environmental (TOE) characteristics on RFID adoption, surprisingly no study was found on the effect of mandatory-pressure on RFID adoption, though it is considered to be the most important driver for RFID adoption. Generally, only a handful of research are available on the overall uptake of RFID in the livestock sector (Hossain and Quaddus 2010, for example). Even fewer have addressed particularly the effect of environmental factors in livestock application, though there is a significant body of research in logistics area. This paper thus addresses and attempts to close this research gap by exploring the external environmental factors on RFID adoption in the context of Australian livestock industry. Equipped with a background study this paper performs an exploratory filed study on seven livestock farms in Australia and develops a framework to examine and identify the external environmental factors affecting the adoption of RFID.

2 BACKGROUND

Environment is defined as the *totality of physical and social factors that are taken directly into consideration in the decision-making behavior* of individuals in an organizations or a decision unit

(Duncan 1972). These factors can be differentiated into 'internal' or 'external' to the organization where external factors include the 'global' factors which are beyond organization's control but is important in functioning and decision-making behavior (Quaddus and Hofmeyer 2007). In general, external environment has been recognized to play a very significant role in adoption diffusion research and so as for RFID adoption (Sharma and Citurs 2005; Wen, Zailani et al. 2009). Government support, external pressure, external information source, and environmental uncertainty are viewed as important environmental influences on a firm's RFID adoption decision. In this study, to have a concise understanding, external environmental factors are grouped into external pressure, external support, and environmental uncertainty.

2.1 External Pressure

External pressure has been considered as a significant factor in adoption research; not surprisingly is also treated similarly for RFID adoption (Matta and Moberg 2007; Schmitt and Michahelles 2009). External pressure is defined as formal or informal pressures from outside of the organization and may come in different forms including government and regulatory pressure (Kuan and Chau 2001), market pressure, vendor pressure, coercive pressure, mimetic pressure, normative pressure, and competitive pressure (Teo, Wei et al. 2003). This study considers only government pressure, market pressure, and competitive pressure as these are more prominent in RFID adoption literature.

Government pressure: Government regulation can either encourage or discourage the adoption of innovation (Scupola 2003). Shih et al. (2008) considered government policy/legislation as one of the leading challenges for RFID adoption. More specifically, Luo et al. (2007) argued that government mandate can speed up the rate of RFID adoption.

Market pressure: An ultimate reason to adopt RFID is the increasing market pressure and mandate imposed by (resource dominant) organizations (Li and Visich 2006; Chang, Hung et al. 2008; Schmitt and Michahelles 2009). Livestock selling agents are pressured to provide livestock details which they impose finally to livestock producers; *whole lot of market pressure*. Therefore imposition from trading partners makes the livestock producers to adopt RFID because they are susceptible to such imposition. Such impositions are prevalent in case of RFID because of its network nature, like EDI. However, Lee and Shim (2007) did not find the influence of market pressure on RFID adoption in healthcare industry.

Competitive pressure: One of the main sources of external pressure to adopt RFID is the pressure due to fierce competition (Iacovou, Benbasat et al. 1995; Chang, Hung et al. 2008). Larger retailers and also small farms are keenly aware of what competitors are doing, that may provide competitive advantage. As more and more countries and competitors are becoming RFID-enabled, livestock farms in Australia are more inclined to adopt RFID in order to maintain their own competitive position, though Brown and Russell (2007) did not find so.

2.2 External Support

Government is treated as an important environmental actor for technology adoption (Lin and Ho 2009) and can play an important role through information provision, facilitating research and development, providing incentives (Luo, Tan et al. 2007), tax-breaks, building and enhancing the infrastructure (Scupola 2003), conducting pilot projects, collective training, and providing counseling services. Supports may also come from **technology providers** (Huyskens and Loebbecke 2007). Many livestock producers may not have the internal expertise to trial and implement RFID projects, and would rely on external providers (Lee and Shim 2007). The providers can supply information, develop the setup, supply resources, and provide support on troubleshooting. This type of external support is quiet obvious for individual level RFID adoption. Finally, the speed and level of adoption of an innovation depends on the communication behavior of the adopters to its networks (Rogers 1995). It is found that, many times, the social, organizational and business network supports the adopters with idea, information, and persuasion to adopt an innovation. In an agricultural environment

the farmers have formal associations through which they share and seek knowledge, bargain with externals, and market their product. Therefore this study assumes a significant affect of farmers' **association's support** to RFID adoption.

2.3 Environmental Uncertainty

Zhu et al. (2003) argued that demand uncertainty tends to increase firm's incentive to adopt new technologies. Lee & Shim (2007) found that market uncertainty drives RFID adoption. Environmental complexity and uncertainty would influence the organizational innovation. Organizations would pay more attention on innovation when they faced an environment with higher instability and chaos (Gatignon and Robertson 1989; Patterson, Grimm et al. 2003).

3 RESEARCH METHOD AND RESULTS

RFID is the world's oldest new technology. Not many studies came up with RFID adoption analysis, because its adoption in the commercial sector is at its early stage. This study, therefore, used field-study based qualitative research approach as it is well suited to *new research areas or research areas in which existing theory seems insufficient* (Yin 2008) and *when the purpose of the research is descriptive, and theory building* (Benbasat, Goldstein et al. 1987).

This study approached seven livestock farms for face-to-face, one-to-one, in-field, and in-person investigation. Literature shows that appropriate range of field study cases falls between four and eight (Eisenhardt 1989). The case organizations consisted of two corporate and five family-owned farms in Western Australia, ranging from 44 hectares to 10,000 hectares in area. In analyzing data, a *modus operandi* approach has been adopted (Yin 2008) which was achieved by analyzing the same factor from multiple instances using NVivo 8.

3.1 External Pressure

Government pressure: RFID-based cattle identification is a legal requirement in Australia, regardless of the purpose of keeping the cattle. The government here has a strong stand against any resistance to it. Furthermore, farmers *do not have any political clout and are paralyzed to protest any government decision but follow*. It is evident that the regulative pressure from the government made farmers to adopt RFID, as four out of seven farms are directly influenced by government legislation. They all are unanimous to say *"I just had to do it...would not go for this system if it were not mandatory"*. However, one of the rest three farms felt the initiative as a *genuine push and a heavily saturated awareness program* but not a *pressure* by the government. Likewise, the rest two farms were not influenced by government pressure but considered it as a *voluntary activity and commercial advantage*, but agree that the legislation worked as a catalyst. However, the presence of government pressure was not underestimated though:

[...] Though it was not mandatory at the time we implemented, two factors have driven us to do so. First, we knew that it is coming as mandatory. Second, we also wanted to try and investigate how the system may affect or add another beneficial dimension to our business.

This finding is well supported by literature. In practice, because of the slow adoption rate of voluntary NAIS in USA, livestock industry organizations and even consumer advocacy groups urged to the Congress to make NAIS mandatory as the *only way to get all segments of the food chain coordinated* (Schnepf 2009).

Market pressure: RFID-enabled animal identification is a must on major livestock markets such as EU, Japan, and South Korea. During 2007-08, these three nations received 22% of total meat from the exporting world (Schnepf 2009). In 2007-08, out of 55% of Australia's exported beef 39.3% was taken by Japan and 15.7% by South Korea. Therefore, Australia cannot ignore its important markets' traceability requirements but follow the NLIS. However, at farm level, most of the interviewees do not feel much pressure from the market. *No market pressure whatsoever.* This phenomenon is likely

to happen with the local-market concentric farms because the local market is not much concerned about the NLIS. Similarly, farms that supply products to an agent (most farms do business with the agents; and agents are responsible for the export) would not feel the market pressure either. On the contrary, the farms who do business directly with international buyers feel the market pressure for RFID. As evidence, one interviewee, who does direct exports, finds the RFID system as a prerequisite to do business with the EU and Japanese market, and looks after this system as those markets are *absolutely rigid about the identification and other requirements*. Interestingly, another farm does not experience any market pressure for RFID but finds customers demand for RFID.

Competitive pressure: Like other businesses livestock industry today faces a more complex and competitive environment than ever before. As many of the meat exporting countries have implemented RFID-based animal identification system Australian producers face fierce competitive pressure. In this study, five farms have, at least initially, found *competitive pressure* as an important factor in adopting RFID. However, the term competitive pressure, pressure from competitors, and competitive advantage were used interchangeably.

[...] We found (NLIS) as a competitive advantage. We implemented it with the hope that (the) complete traceability of NLIS eventually will help in the bigger picture in the export market. It might not come back to our property here (farm level advantage), but in the bigger picture you hope that Western Australia or Australia is gonna better off because everybody has got it. So the market will be bigger with more options, in turn, more demand for beef in general which will lift up the price of beef; that was the hope in doing that. [...] You have the competing organizations pushing their products with better than the other one. Therefore if you have got this sort of traceability in place, it would give your product a push in the competitive market for a better position.

Thus, the decision for RFID adoption was inspired by the competitive pressure or perceived competitive advantage in the international market. However, most of the interviewees are not convinced and think that *“the expectation of getting an international marketing advantage or competitive advantage because of this system, which would open new markets, unfortunately did not happen”*. It is supported by Australian Beef Association (ABA) which finds that *“increase export volumes at higher prices have not eventuated”* (Evans and Paterson 2009). Farmers worry that this type of disappointment would influence RFID adoption negatively for sheep or other animal identification and management practice.

3.2 External Support

[...] (At the beginning of RFID introduction) there was fairly a strong awareness program going on. The awareness was made by the agriculture department, government staffs, industry staffs. Because over here, you know, we have WA Farmers’ Association and Pastoralists and Graziers Association, they were trying to encourage people. There was whole lot of political stuffs going on.

Therefore, in this study, *external support* is decomposed into government support, technology provider support, and the support from livestock related associations.

Government support: Government in Australia is supporting the livestock industry by taking the expenses of building, maintaining, and developing infrastructure for livestock business including identifying the farms uniquely, managing the NLIS database, and providing ICT infrastructure. From the interviews it is found that infrastructure did not have any influence in RFID adoption rather the RFID adoption has a positive influence in upgrading the infrastructure because government needed to provide internet facility, for example, to force farmers to upload livestock data into the database. Farmers are very satisfied with the counselling or troubleshooting supports from the government department. Except one farm, all farms asked for incentives, unanimously. Some farmers want to invest on RFID integration but as they do not find a ‘guaranteed’ return from RFID investment they ask for incentive or subsidy in RFID systems. *“Without the subsidy, it’s a bit of struggle”*. However,

one farm does not support if the total tag cost is reimbursed to the farmers because it would send the farmers wrong message. It was the lesson to blow for a management change; that's really came down to.

Provider support: Three of the interviewees received support from the providers at the initial stage and then the service discontinued, while three others are still receiving. It is apparent from the interviews that the providers were much proactive and supportive at the initial stage of RFID introduction. However, it is suggested that the providers could arrange “display centres” where farmers would learn *practically* about the benefits and innovative uses of RFID.

Union support: Six participants do have a regular participation in their associations. However, one interviewee feels that the association is more concentric on farming issues rather than on RFID practices and recommends that the associations need to be more serious about business issues such as marketing and enhancing the brand image in international market.

3.3 Environmental Uncertainty

In contrast to the literature, this study did not find any relationship between market uncertainty and RFID adoption. The uncertain Japanese and South Korean market does not convince them yet to adopt an extended RFID system rather they concentrate on finding new markets with less RFID requirements such as in the Middle East, Lebanon, Dubai, Philippines, and Russia (Rees 2008).

Based on the above analysis the final framework (model) is presented in Figure 1. This model depicts the effects of only environmental factors on RFID adoption, and does not include technological or organizational factors, as proposed in a TOE framework. This model proposes that, external pressure (consists of government pressure, Market pressure and competitive pressure), and external support (consists of government support, Provider support and Association/Union support) positively influence RFID adoption in Australian livestock industry.

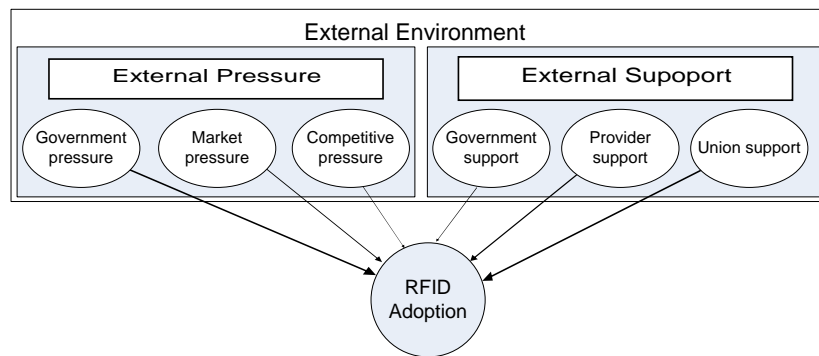


Figure 1: Proposed framework for environmental effects on RFID adoption

4 CONCLUSION

In this paper the qualitative analysis from seven farms found that *external pressure* and *external support* are important for RFID adoption. Typically, livestock farmers adopt RFID because of the *government pressure* and *perceived competitive advantage*. In this process, they expect and receive support from various sources including government agencies, technology providers, and related industry associations and social networks. However, the disappointment of not receiving increased market share or competitive advantage, as they experienced so far, would affect the adoption process adversely for further diffusion. It is interesting to find that *infrastructure* does not have an effect on *RFID adoption*; rather the adoption has a positive effect on *infrastructure upgrade*. It is surprising not to find any relationship between *market pressure* and *RFID adoption*. May be, it is because of the

sample-bias who either do business in the local market or export to those markets who already are concerned about Australia's NLIS. However, Japan and South Korea are going for extended traceability requirements. Intuitively, this change would make it clearer that there might be a market pressure which is not visible now because the mandatory Australian system (NLIS) satisfies most markets' business requirements.

The findings from this study are of considerable significance for RFID adoption theory and literature. This study tries and explores the external environmental factors for RFID adoption, the area which is relatively quiet unexplored. In practice, the findings would be helpful particularly for those countries which have a strategy or are under pressure in developing such a system, like USA, and has a plan to make the system mandatory. Factors like legislation and/or providing incentives or subsidies can be practiced to achieve a quick adoption rate. The contribution from this study can also be practiced with RFID adoption in other applications, generally from a national point of view.

In future the proposed model in this study could be integrated with technological and organizational factors and be tested. It would be worth testing this model with the non-adopters of RFID and with innovative RFID adopters who adopted it without having a mandatory pressure. For a fine tuning, individual effect of factors like competitive pressure, pressure from competitors, and competitive advantage can also be investigated.

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