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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 Hofineyer 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