



An integrated framework for RFID adoption and diffusion with a stage-scale-scope cubicle model: A case of Indonesia

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ABSTRACT

This study presents a comprehensive framework to identify dynamic radio frequency identification (RFID) adoption and diffusion from three different perspectives: stages of adoption, levels of analysis, and domain of issues. The main concern of this study is stages of adoption, which covers three phases in respect of the maturity of the RFID project and the sophistication of business applications and RFID technology. The level of analysis involves different units of analysis beyond the organization level, including the industry- and country-level, which is lacking in the current literature. To understand dimensions of RFID issues, a strategy, technology, organization, people and environment (STOPE) based approach was applied. An extensive review of prior literature was conducted to find various RFID success factors and the Delphi method was applied to find positions of these factors within the framework. Based on the Delphi, some factors belong to early stage of adoption, and some others persist in the later stages of adoption. At the country level, factors such as RFID national policy, R&D policy and income per capita were accepted by most experts at the preliminary and intermediate stage; strategy and environment were accepted as important domains. To find practical implications of the framework, a case study of Indonesia was conducted at each level of analysis. Analytic hierarchy process (AHP) was applied to identify most important factors and important domains of issues with respect to the factors from the Delphi results. At country level, RFID policy, vision of leadership and RFID potential market are the most important factors; strategy and environment are the most important domains.

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1. Introduction

Radio frequency identification (RFID) is currently regarded as one of the most promising auto-identification and data capture technologies, and much of the literature has discussed it as one of the sixteen key technologies in the coming decade, particularly in terms of pervasiveness, commercial availability, and market demand (Silbergliitt, Anton, Howell, & Wong, 2006). RFID is perceived as critical technology for various purposes and applications, such as improving the efficiency and effectiveness of supply chains, improving security in business operations, and providing better customer service. In today's business, all of these advantages would dramatically impact a firm's business operations through the improvement of efficiency and effectiveness in production and operation as well as providing better service to customers (Irani, Gunasekaran, & Dwivedi, 2010). Pervasive RFID adoption and diffusion in the future by the extensive use of inexpensive tags will realize the notion of what many scholars foresee as "Internet of

things," which merges online worlds with objects in the real world (Slette-meås, 2009).

Along the advent of the innovative IT like Internet which makes overall impact on industry and society, the interest of IT has been increased gradually on the national level (Wolcott, Press, McHenry, Goodman, & Foster, 2001). Advanced countries implemented various policies to support IT diffusion within their industries to strengthen the competitiveness advantage. They made an effort to build sustainable environment to promote innovative technology. In case of developing countries, the government approaches IT as effective tool to enhance their backward industry (Palvia, Palvia, & Zigli, 1992). In addition, the case of highly impacted IT on multiple industries of business ecosystem like smart mobile, it is important to exceed critical mass point based on network economics (Slyke, Ilie, Lou, & Stafford, 2007). And depending on the organizational culture and political structures, success factors of the spread of technology are different between each country, especially developing country (Ngai, Law, & Wat, 2008). Despite of increasing the role of government and industry sector, most of the studies for the diffusion factors have been more concentrated on the technology adoption of company or individual user's acceptance in micro level. And the macro level factors are simply treated in environment scope. Similar problems have been occurred in RFID research.

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Currently, most studies on RFID adoption focus on organizations or companies with issues discussed including adoption, implementation, organizational determinants, and key drivers; however, all were mainly observed from an organization perspective. Few studies have discussed RFID adoption from higher levels of analysis, such as industry or country level. In terms of industry applications, the most popular examples for applications seem to be supply chains, logistics, and retail (Asif & Mandviwalla, 2005). Two main studies specifically discussed RFID adoption at the industry level including the OECD (2008), which conducted comparative analysis from various industries in European countries and Al-Kassab and Rumsch (2008) conducted cross-industry comparisons of RFID adoption, which raised issues such as standardization, physical properties of RFID systems, and data standards. Study of RFID adoption at the country level is currently becoming important as the technology progresses and RFID becomes more affordable for various organizations and industries, and it is expected that global adoption of RFID is imminent in the near future. However, there are few papers that discussed RFID adoption at the country level, and they mostly focused on specific case studies such as Brown and Russell (2007) and Luo, Yen, Tan, & Ni (2008). Among country-level papers, only Wu, Tsai, Chang, and Yu (2010) specifically addressed RFID policy issues among five Asian countries/territories.

Although there are many theories and approaches to discussing stages of information technology (IT) adoption, few conceptual and empirical research studies discuss RFID stages of adoption from early stages of adoption to maturity. Understanding stages of adoption is critical for policy and decision makers to understand behavior and dynamic changes of RFID implementation at the organization, industry, or country level. Among many theories, Diffusion of Innovation (DOI) proposed by Rogers (2003) is regarded as the foundation of much literature in IT adoption and is the most referred-to theory in IT adoption due to its well-developed concepts and large number of empirical results (Schmitt & Michahelles, 2009). In addition, alongside stages of adoption, understanding dimension or scope of issues in stages of RFID adoption is also critical for successful RFID implementation. Currently there are various theories or models that suggest approaches to classify IT adoption issues or success factors, but few studies specifically addressed RFID adoption issues. Generally, technology, organization/management, strategy, and environment are suggested as common dimensions in classifying success factors.

As from literature study, there are different levels of adoption analysis and different approaches to identify stages and issues of adoption. In this study we proposed an integrated framework for comprehensively understanding characteristics of RFID adoption and diffusion from three perspectives: level of analysis, stages of adoption, and scope of issues. Our proposed framework and its collected RFID success factors will provide a broader understanding of successful RFID implementation. The three perspectives in our framework address RFID adoption issues from early to advanced stages, namely preliminary, intermediate, and mature; at three different levels of analysis e.g. country, industry, and organization; and scope of issues classified into strategy, technology, organization, policy, and environment domain. Based on the literature study, we collected and identified success factors of RFID adoption and diffusion at each level of analysis and stage of adoption. To validate the framework, we asked experts to distribute the success factors using the Delphi method. This also allowed us to identify the most appropriate positions for each success factor within our proposed framework. From RFID success factors collected from various cases and literature, it is expected that the findings will provide some insights for policy makers and decision makers to implement RFID in various circumstances. Based on Delphi, we then conducted Analytic Hierarchy Process (AHP) analysis for the case of Indonesia

to identify the most important success factors of each specific cluster within our framework.

2. Literature review

Much of the literature on RFID adoption and diffusion is based on well-known frameworks that originated from other areas of research such as innovation or information systems. There are several well-known theories and their adaptations are generally applied, such as Diffusion of Innovation – DOI (Lin, 2009a; Sharma, Citurs, & Konsynski, 2007; Wen, Zailani, & Fernando, 2009), technology acceptance model (TAM) (Hossain & Prybutok, 2008), technology, organization, and environment (TOE) (Schmitt et al., 2007), as well as other IT adoption theories. Most existing RFID research has been dominated by organizational, behavioral, and information system perspectives (Slettemeås, 2009). Among the literature available, few conceptual and empirical research studies have been undertaken in RFID adoption. As described by Rogers and many other works, the adoption and diffusion of any information technology generally does not follow a linear path, but rather an S-shaped curve as described by several works, such as Corrocher and Ordanini (2002), Guo and Chen (2005), and Schmitt and Michahelles (2009).

Beyond the well-developed theory of DOI, much of the literature discusses adoption and diffusion for different IT cases from different perspectives from the country level to the organization level, but organization perspectives have received the most attention in the literature. Studies of IT adoption at the country level are generally characterized by diverse research goals and topics. Some studies have a strong focus on IT infrastructure and others focus on user issues, which result in different assessments and outcomes (Maugis et al., 2005). Some works have discussed stages of adoption: for example, Guo and Chen (2005) investigated patterns of Internet adoption in Chinese companies based on DOI and organizational spending from country-level IT perspectives, and the OECD (1999) conducted a case study of eCommerce adoption and identified relevant measures for eCommerce growth. Corrocher and Ordanini (2002) developed a framework for the stages of a digital economy, from stages characterized by speed of adoption to impact focusing on the social and economic activities of IT. Other theories or approaches, such as TOE and TAM received little attention from literature, among them Schmitt and Michahelles (2009) and Hossain and Prybutok (2008).

Based on our previous literature study (Adhiarna, Hwang, & Rho, 2011), adoption at the industry level received the least attention from literature. Several studies on the industry level discussed RFID adoption, but the framework was adapted from the organization perspective such as Schmitt and Michahelles (2009) as applied to the automotive industry. Other literature proposed case studies to analyze RFID adoption issues, such as the OECD (2008), as it relates to European countries. In terms of a conceptual model being used, Porter's popular five competitive forces model is used for IT industry analyses particularly to identify success factors (as in Haghghi, Divandari, & Keimasi, 2010; White, Johnson, & Wilson, 2008).

For IT adoption issues, critical success factors (CSFs) are generally suggested in many works of IT literature. In this research, we identify RFID success factors to understand RFID project implementation issues. Rockart (1979) defines CSFs as key areas of activities that necessitate favorable results for a particular company or institution to reach its goals. CSFs usually refer to areas that management or policy makers of RFID adoption should pay attention to. In addition, organizational efforts should be allocated to those issues to achieve successful RFID adoption. Currently, there is some literature on RFID success factors, particularly Ngai, Suk, and Lo (2007) and Koh, Kim, and Kim (2006), but most focus on intra-organization and managerial perspectives.

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