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Antecedents of Radio Frequency Identification Adoption in Supply Chain Competitiveness

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Abstract

Radio frequency identification is an ubiquitous technology for real-time decision making with data processing capabilities and it works as a detector and real-time data transformer for supply-chain businesses. The year 2004 distinctly showed a substantial shift towards adopting this technology which could be used in large retail malls, private warehouses and government organization. However, the adoption rate in medium- and small-scale industries is not strong enough and the purpose is to find out if cost, data management, business process implication, and mimetic factors play a key role in supply-chain competitiveness. The competitiveness theory was applied and Structural Equation Modeling-Partial Least Squares was used to test the interrelationship between the antecedents and to reinforce the statistical results.

Keywords: Radio frequency identification, cost, data management, business process implications, mimetic factors, supply chain competitiveness

1.0 INTRODUCTION

Radio frequency identification (RFID) technology was first used during World War II to identify the difference between friends and enemy aircraft. The second phase of application was for toll paying on expressways to reduce human intervention. In 2004, it was introduced by Wal-Mart in their supply-chain business, followed by other retails chains,like Target.Wal-Mart's results ($6.7B in reduced labour cost, $600M out-of-stock supply-chain cost reduction, $575M theft reduction, $180M reduced inventory holding) show that RFID application has huge potential for supply-chain industries. Still, many companies may face barriers to adopting the technology, due to lack of information or awareness. An ineffective and non-aggressive supply-chain management highly impacts every aspect of the organization. The willingness to adopt new technology for development of industry or increase competitiveness is needed. Technology and process upgrades are more widely accepted for overall business strategies that lead companies to bemore competitive and profitable.

1.1 Supply chain

Nowadays, a supply chain is the most competitive tool to maintain quality in supply of a product. Competitive positions in the market effectively depend on companies' supply-chain management. Quality in a supply chain ensures customer satisfaction and operating revenue (inventory, margin, labour cost, etc.) and determines a company's performance. Supply chains are currently affected by the following trends:

- Agree upon and execute demand planning from all stakeholders' dedicated technology and resources for demand planning and forecasting.
- Optimize the supply-chain network to manage rapid globalization.
- Provide value-added cost-saving service to customers, like VMI, RFID, etc.
- Outsource strategy with appropriate implementation.
- Shorten product life cycle and customer demand.
- Collaborate between supplier and end user to increase visibility throughout the value chain.

1.2 RFID

Radio frequency identification (RFID) is a technology that uses a transmitter that exclusively responds to signals. RFID has two major units: a transponder (tag or label with memory chip) and transceiver with decoder. There are two types of tags (active and passive) that are encoded with unique information. A built-in antenna on tags and a receiver become lines of communication via emitting radio signals. The transceiver acts as the decoder for data received from the tag and transfers them to the data-management system.

Tag price plays an important role for implementation of RFID. Active tags are expensive because of their longer-range availability. Tag selection depends on operating frequency, data size, range, microchip availability, and memory.

RFID is much more advanced than barcode technology, which doesnot require a direct "line of sight''. When a tag is under the range of the electromagnetic zone created by the transceiver antenna, the reader decodes the data and transfers them to the database. RFID covers more data than barcodes, is more durable, and has a broader field of readability with the receiver antenna. RFID is reprogrammable and can be reused to track and trace the product.

1.3 Adoption of RFID in supply-chain competitiveness

The supply-chain industry is presently going through tremendous competition that starts from inventory management and goes through customer demand. To achieve success and reach their long-term goals, companies need effective and improved supply-chain technology, which drives the cost benefit approach and advances services and customer satisfaction. An inefficient supply chain can make an impact on an organization's long-term growth. Track and trace, inventory management, cost reduction, and demand prediction are key elements in supply-chain management.

The RFID value proposition is quite promising and effective because of minimal human intervention for tracking an item, which in turn reduces the labour cost. End-to-end visibility of a product helps to reduce inventory cost. Real-time data collection from RFID technology helps with forecasting future demand at a different level. Improved customer service due to timely delivery of a product is possible through real-time tracking of the location of products moving through the supply process. Hence, adoption of RFID for a supply chain plays an essential role.

1.4 *Sources of the research gap*

Several studies have been conducted to find and evaluate adoption factors for RFID, conversely, not many studies have attempted to understand adoption of RFID in supply-chain competitiveness or factors that predominately influence adoption of RFID. From the literature review, the below variables were identified for further study.

Cost: Liukkonen (2015), Bhattacharya(2012), and Sarac, Absi,& Dauzere-Peres (2015).

Business process implication: Whitaker, Mithas, & Krishnan (2007) and Felix & Valverde (2014).

Data management: Khan & Valverde (2014) and Jamal, Omer,& Qureshi (2013).

Mimetic actors: Liu, Suhaiza, & Fernando (2009).

The above-mentioned four areas need further study for understanding of the impact of RFID adoption in supply-chain competitiveness.

1.5 Theory of competitiveness

Competitiveness is the mantra for success for many firms, industries, or countries. This competitiveness is affected if there is less clarity about the factors of competition and weak integration of the competitive process. It rebounds with an integrated effort across different units and close linkages to the strategy process. Competitiveness is the process that helps in recognizing the importance of current activity in core processes, such as strategic management process, human resources process, and operation management process. Sources of competitiveness can be tangibles or intangibles. Figure 1 shows the relationship between several management processes and the competitiveness process.

Assets (tangibles or intangibles) and processes within an organization become a source of competitiveness that delivers a competitive advantage.

In today's business environment, dynamic capabilities, elasticity, alertness, speed, and adaptability are becoming more important sources of competitiveness (Barney, 2001; Sushil, 2000).

Asset-Process-Performance (APP) is a structure that incorporates resources to show processes that professionals understand well, andit may provide the best robust tool to link competitiveness to strategy.

1.6 Research objective and research questions

To identity the factors influencing adoption of RFID for competitiveness of supply chains:

- How does RFID cost-benefit analysis improve cost savings in supply chains?
- Does predictive analysis and anti-counterfeiting provide advancement in logistic performance?
- What are the most influencing factors for adoption of RFID in supply chains?
- How do the research findings fit the competitiveness theory?

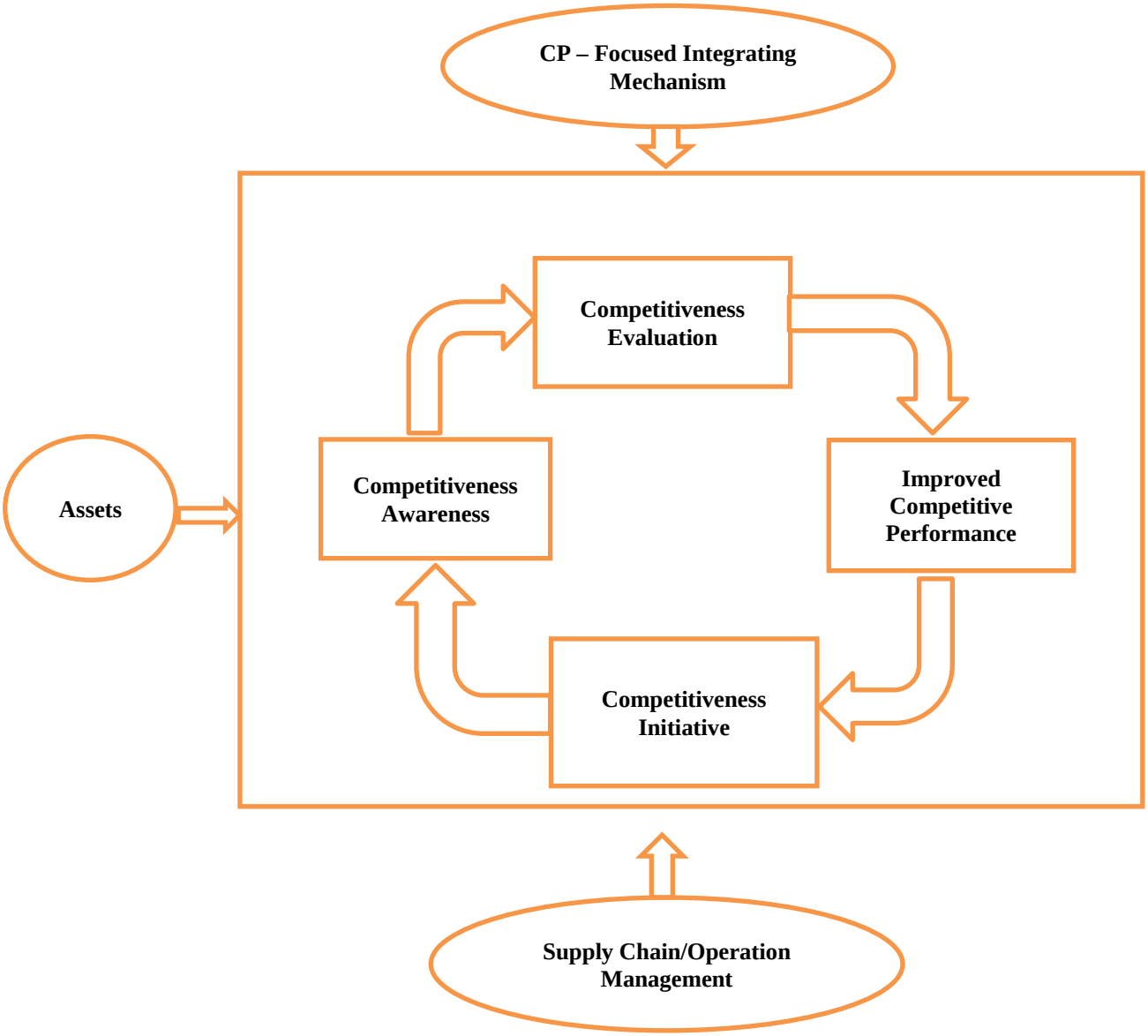

Figure 1 shows linkages between different management processes and the competitiveness process(CP)

2.0 REVIEW OF LITERATURE

2.1 Cost

RFID technology can be implemented from raw material collection to the delivery of goods to the consumer. To apply the technology at different stages of a supply chain, the initial cost plays an important role (Bhattacharya, 2012), i.e., for the cost involved for tags, readers, data management, and maintenance. Adoption of RFID in small and midsized companiesdepends on capital investment and return on investment risk. This technology needs hardware and software infrastructure, which is expensive at the initial stage but benefits operation costs, like labour and inventory cost (Jamal, Omer, & Qureshi, 2013). Hardware cost can be reduced by using different types of tags (active and passive) for which the cost has come down over a period of time, whereas software cost can be reduced by using cloud computing or a third-party software implementation.

Overall implementation of cost needs to be compared to the gained profit (Liukkonen, 2015). Over the period, RFID cost decreases as a total number of users increases, which leads to cheaper consumer products. RFID improves speed and accuracy, which in turn reduces the labour requirements, giving an effective solution for supply-chain stakeholders, which eliminates the final cost and performs as an effective asset for management. RFID tracking helps to minimize the lost products and cost related to loss and can lead to substantial savings.

2.1.1 Labour cost

In a supply chain, identification and tracking of individual products involves intensive labour, which incurs labour cost, accuracy, and time. RFID is an identification tool for an individual product. Tracking of an individual item effectively improves as compared to manual tracking, in terms of accuracy, location of product, loss of item, quality control, customer service, etc. (Kumar, Kadow, & Lamkin, 2011). Labour is one of the major costs in a supply chain. Implementation of RFID tracks individual products and transfers details to databases for further analysis, which requires minimum human intervention. From raw material to consumers, every tracking stageautomated by RFID will reduce labour demand and result in a fast process.

2.1.2 Target cost

Target cost method is an approach to reduce the total cost of a product. It fixes the upper limit for the cost during the planning stage and the targeted profit margin. Target cost method has a competitive advantage for achieving success in the supply-chain industry (Ghafeer, Rahman, & Mazahrih, 2014). Considering target cost method for RFID helps with keeping its implementation cost lower than the target and generates profit.

2.1.3 Bullwhip effect

RFID technology improves inventory management, asset management, operation process, and tracking shipment. With proper implementation and evaluation, it increases long-run forecasting, which leads to flattening the bullwhip effect (Baysan& Ustundag, 2013). Inaccurate information from one end of supply chain to the other can lead to ineffectiveness: wrong production schedule, lost revenues, misleading capacity plan, high inventory investment, and poor customer service. End-to-end traceability and computation leads to flattening uncertain spikes in a supply chain. RFID database can monitor demand forecasting, order batching, and share inventory capacity.

2.1.4 Investment at a higher echelon level

In RFID tagging, cost is the major expensive parameter, which must be tagged for every product. In a supply chain, involved parties can divide the cost among themselves based on profit margin. In a supply chain, the manufacturer is always on a high echelon, and its NPV (net present value) is high compared to that of retailers (Ustundag, 2010). Retailers' expected benefits are more compared to those of the manufacturer and distributor, which leads to a drop in its NPV.

H1: Cost through labour cost, target cost, bullwhip effect, and investment has a positive effect on adoption of RFID for supply chain competitiveness.
H2: Cost through target cost is positively related to business process implication.
H3: Competitiveness in a firm is positively related to cost.

2.2 Business process implication

In today's competitive world, companies need to do it all faster and better, preferably with lower cost and higher ROI. To gain a competitive advantage and to face global completion, "companies must continuously implement the best practice management principles, strategies, and technologies" (Carpinetti et al., 2003). One of the best solutions is business process implication (BPI). BPI is an approach to improve and optimize business processes, aiming to contribute to companies' value and performance. BPI improves the quality of products, is a continuous process improvement, improves business agility, and reduces process cycle time and cost.

2.2.1. Privacy issue

RFID, in combination with technologies, has great potential to track consumer data. It is not limited to identification of data, but it also finds the location, which results in privacy concerns (Oertel, Dibbern, & Nochta, 2010). In today's technology era, companies are discovering new ways to do business in order to satisfy consumer needs. To address consumer concerns, companies are introducing technologies to track consumer steps and make customized solutions for better service. Consumer privacy can be improved by introducing a company's privacy policies and securing the online environment for data.

2.2.2 Consumer behaviour

Especially in the retail sector, companies want to know why consumers buy what they do and act the way they do. In consumer-purchase evaluation, marketing teams want to know consumer emotions in purchasing decisions, single purchases, group purchases, post-purchase attitude, and repetition rate. Customers are not identified by RFID but through extensive data collection and analysis of data from RFID-equipped goods. Customer loyalty cards may be used to understand customer behaviour (Oertel, Dibbern, & Nochta, 2010).

2.2.3 Process innovation

Process innovation is defined as the development of production processes and technologies required to manufacture a product. Introduction of RFID in a supply chain improves the reliability of the production process and technologies. It helps with achieving speed and efficiency in the production process and leads to keeping ahead of competitors (Prajogo, 2016).

2.2.4 Product innovation

Product innovation is defined as development or introduction of new technologies, components, characteristics, and features to manufacture new products (Prajogo, 2016). RFID can be introduced with software solutions like data management, task-technology fit models, and cloud-computing structures. Data received from RFID, like data filtering, can be implemented on a cloud as part of supply-chain management. Passive RFID and cloud-computing solutions give cost-benefit solutions to supply-chain management (Jamal, Omer, & Qureshi,2013).

H5: Business process implication through process innovation is positively related to data management.

H6: Business process implication through privacy issues, consumer behaviour, process innovations, and product innovations has a positive effect on adoption of RFID for supply chain competitiveness

2.3 Data management

Data management is an important task in terms of RFID implementation. Most of the small-scale companies are reluctant for adoption of RFID, due to complication of data management and its maintenance cost. RFID data can be classified like simple data: large in flood, inaccurate, spatial, and temporal data. It can broadly be categorized into data-capture layers, business-process layers, and even processing.

2.3.1 Procedure tree (PT)

Most of the supply chain entities used Enterprise Resource Planning (ERP) and the Enterprise Information System (EIS) to manage business resources. Nowadays, for many enterprises, looking for RFID is a preferable solution because of high efficiency, accuracy, and fast reading speed. Traditional RFID has a few weaknesses in obtaining real-time information, such as analysis of workflow and predication of future demand. This is because RFID data focus on simultaneous multiple reading capabilities; thus, they cannot handle massive raw data to accommodate real-time process management. This creates demand for additional processes, like cleansing, filtering, and grouping of data, to obtain more valuable information; this advance process management is called 'Procedure Tree' (PT) for RFID data mining (Kwon, Kang, Yoon, Sohn, & Chung, 2014).

2.3.2 Anti-counterfeiting

Product counterfeiting is an illegal practice of copying any product and creating a fake version. It poses huge threats to manufacturing industries. The international Anti-Counterfeiting Coalition (IACC) estimates that $600 billion are lost, due to counterfeiting (counterfeiting coalition IACC-www.iacc.org) There are four different techniques to stop counterfeiting: (1) overt or visible feature, (2) covert or hidden market, (3) forensic techniques, and (4) track-and-trace systems. Out of the four, the track and-trace approach using RFID has the ability to protect the whole supply chain against theft and fraud, as RFID-tagged items flow along the supply chain, which generates a large amount of data. Using e-pedigree (data formatting, data processing), data generated through the RFID sensor can be used for anti-counterfeiting (Choi, Yang, Cheung, & Yang, 2005).

2.3.3 Active sensing with active and passive RFID

RFID tags have the Reversed Signal Strength (RSS) feature, which is used as back-scattered signal strength. RSS is used to conduct accurate localization, but it has limitations. RSS depends on distance and environmental interference, which create problems with signal strength and data. Therefore, tag-free RFID-based active sensing is inspired from RSS limitation. Passive tag array, together with some active RFID tags, gives opportunities for low-cost and low-power technologies for active sensing (Xie, Yin, Vasilakos, & Lu, 2014).

2.3.4 Predictive analysis

Data are extensively considered for future decision making and improved profitability. Data-driven decision-making companies on average are 5% more productive and 6% more profitable than their competitors. Predictive analysis derives from integration of qualitative and quantitative analysis, evaluation under different circumstances, data mining, and applying probability. Logistic predictive analysis is used to estimate the past and future behaviour of the flow and storage of inventory, which is also related to cost and demand. Supply-chain management uses predictive analysis to improve supply-chain design and competitiveness by estimating business processes among companies (Waller & Fawcett, 2013).

H4: Data management through procedure tree, anti-counterfeiting, active-sensing, and predictive analysis has a positive effect on adoption of RFID for supply chain competitiveness

2.4 Mimetic factors

Mimetic pressures result from a firm's response to uncertainty. In uncertain conditions, with no clear course of action available, a company's leader tends to copy the action of perceived successful organizations. Mimetic pressure is driven by bandwagon effect (following a successful competitor) or driven by status (following prominent organizations). With RFID adoption, technology uncertainty may exist, due to differences in firms that are strongly influenced to mimic firms that are considered industry leaders or competitors who have already adopted RFID (Sharma, Thomas, & Konsynski, 2008).

2.4.1 Competitive pressure

Competitive pressure is one of the main reasons for adoption of RFID. There is great competition between the companies for supply chains and their techniques rather than for products. Large and small organizations need

a competitive advantage to succeed in industry. Competitive pressures are not limited to products and the domestic market but are also from imports. This arises from the firms' interaction with their competitors in the market. More and more countries and companies are adopting RFID to enable maintaining their own competitive positions (Hossain & Quaddus, 2010).

2.4.2 Bandwagon effect

Mimetic pressure is driven by the bandwagon effect (following a successful competitor) or driven by status (following prominent organizations). It is used to create atmosphere about a product that is going to be introduced into the market. It is like: 'If everyone has one, I want one too'. Companies follow this because of the popularity of an item, or they copy successful competitors' techniques for success in industry (Sharma, Thomas, & Konsynski, 2008).

2.4.3 Market pressure

Market pressure plays a significant role in today's competitive supply chains. Domestic and international markets have a significant impact on it, which builds pressure. It can be caused by a global economy, nature of workforce, customer demand, and intense competition. Integration of economic, social, and cultural pressure increases competition. Consumers are more knowledgeable, and companies need to study customers to predict their needs. Policymakers and regulations of individual countries change the direction of business forces to introduce new technologies (Hossain & Quaddus, 2010).

H7: Mimetic factors through competitive pressure, bandwagon effect, and market pressure have a positive effect on adoption of RFID for competitiveness of supply chains.

H8: Competitiveness in countries is positively related to cost of mimetic factors.

H9: Collaboration and competitiveness in industry, country, and firm have a positive effect on adoption of RFID for competitiveness of supply chains.

Table 1: Research framework table.

No.	Sub-Variables	Literature Reference	Variables
CO1	Labour cost	Baysan & Ustundag, 2013	**COST**
CO2	Target cost	Ghafeer, Rahman, & Mazahrih, 2014	
CO3	Bullwhip effect	Baysan& Ustundag, 2013	
CO4	Investment at higher echelon level	Ustundag, 2010	
BP1	Privacy issue	Al-Kassab, Thiesse, & Buckel, 2013;Turri, Smith, & Kopp, 2017	**BPI (Business Process Implication)**
BP2	Consumer behaviour	Al-Kassab, Thiesse, & Buckel, 2013	
BP3	Process innovation	Prajogo, 2016	
BP4	Product innovation	Prajogo, 2016	
DM1	Procedure tree (PT)	Kwon, Kang, Yoon, Sohn, & Chung, 2014	**Data Management**
DM2	Anti-counterfeiting	Choi, Yang, Cheung, & Yang, 2005	
DM3	Active sensing with active and passive RFID	Xie, Yin, Vasilakos, & Lu, 2014 et.al	
DM4	Predictive analysis	Waller & Fawcett, 2013	
MF1	Competitive pressure	Hossain& Quaddus, 2010	**Mimetic Factors**
MF2	Bandwagon effect	Sharma, Thomas, & Konsynski, 2008 et.al	
MF3	Market pressure	Hossain, & Quaddus, 2010	
CT1	Collaboration with industry	Ajitabh& Momaya, 2003	**Competitiveness Theory**
CT2	Competitiveness in country	Ajitabh& Momaya, 2003	
CT3	Competitiveness in industry	Ajitabh& Momaya, 2003	
CT4	Competitiveness in firm	Ajitabh& Momaya, 2003	
AR1	Improved logistic performance	Baysan & Ustundag, 2013	**Adoption of RFID in Supply Chain Competitiveness**
AR2	Satisfaction of stakeholders of supply chains	Ustundag, 2010	
AR3	Cost savings	Baysan & Ustundag, 2013	
AR4	Clear prediction of future competitiveness	Bhattacharya,Petrick, Mullen, & Kvasny, 2011; Waller& Fawcett, 2013	

3.0 RESEARCH METHODOLOGY

The research is based on primary and secondary data. Primary data were collected through personal interviews with industry experts and a survey, and secondary data were collected from academic journals.
Figure 2 shows the relationship between dependent and independent variables.

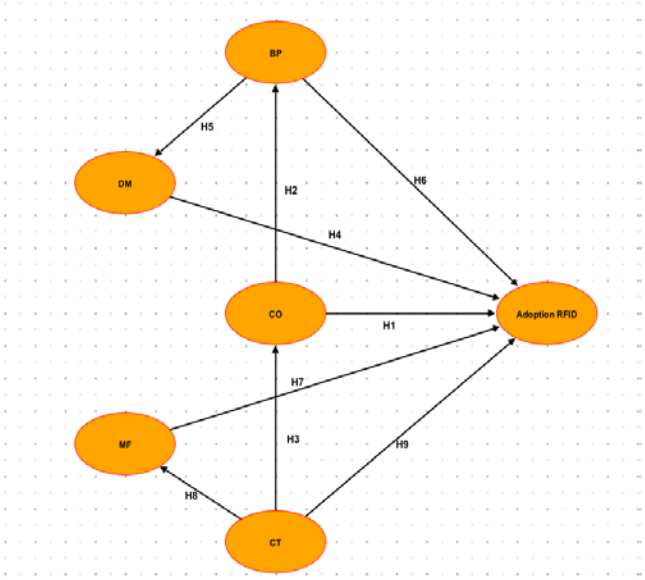

Figure 2. Adoption of RFID for Supply Chain Competitiveness

3.1 Data collection

The first 30 participants wereinterviewed for the survey questionnaire. A total of 25 questionnaires were included in the survey. Cost (CO), Business Process Implication (BPI), Data Management (DM), Mimetic Factors (MF), Competitiveness Theory (CT), and independent variables had multiple survey questions. Adoption of RFID in supply-chain industries (AR) had a dependent variable of four survey questions.

3.2 Profile of the respondents

The survey participants were mostly from supply-chain industries. A total of 231 participants responded. The table below shows details aboutthe survey respondents.

Table 2. Respondents from supply-chain organizations

Description	Measures	Frequency	Percentage
Years of Experience	5-10 Yrs.	55	27.9
	10-20 Yrs.	52	45.7
	More than 20 Yrs.	125	26.4
Current Position	Operation Manager	95	41.5
	Middle-Level Manager	136	58.5

4.0 DATA ANALYSIS

The primary data collected were from a total of 231 respondents from supply-chain industries. ADANCO 2.0.1 software was implemented to analyse all data received. Multiple path analysis was carried out to compare strengths of individual variables with other independent variables.

4.1 Reliability

The reliability determined by Cronbach's alpha value has to be above 0.6.

Table 3. Reliability of variables in the RFID adoption structure

Construct	R^2	Jöreskog's Rho (ρ_c)	Cronbach's Alpha (α)
Adoption of RFID	0.978	0.8697	0.800
Cost		0.7917	0.6756
Business Process Implication		0.8554	0.7705
Data Management		0.9007	0.7799
Mimetic Factors		0.9154	0.8613
Competitiveness Theory		0.9757	0.7464

4.2 Validity

4.2.1 Convergent validity

Convergent validityshows the theoretical relationship between variables. Convergent validity is accepted when the reading is above 0.50. The convergent validity is represented by their AVE results.

Table 4. The AVE results for each variable in the RFID adoption framework

Variables	Average Variance Extracted (AVE)
Adoption of RFID	0.6255
Cost	0.5348
Business Process Implication	0.6000
Data Management	0.8194
Mimetic Factors	0.7830
Competitiveness Theory	0.5698

4.2.2 Discriminant validity

Discriminant validity is represented by discriminants between dissimilar concepts. It tests the relationship of different variables with other variables.

Table 5. The overall discriminant validity for each construct in the RFID adoption framework

Construct	Adoption of RFID	Cost	Business Process Implication	Data Management	Mimetic Factors	Competitiveness Theory
Adoption of RFID	0.6255					
Cost	0.1158	0.5348				
Business Process Implication	0.2541	0.5030	0.6000			
Data Management	0.4619	0.0949	0.2491	0.8194		
Mimetic Factors	0.4626	0.1503	0.3890	0.4075	0.7830	
Competitiveness Theory	0.4118	0.1444	0.2420	0.2511	0.2734	0.5698

4.3 Path analysis

The path analysis procedure is used to identify the direct and indirect effects between variables. Because R^2 = 0.541, our research model is satisfactory and supports the structural equation model.

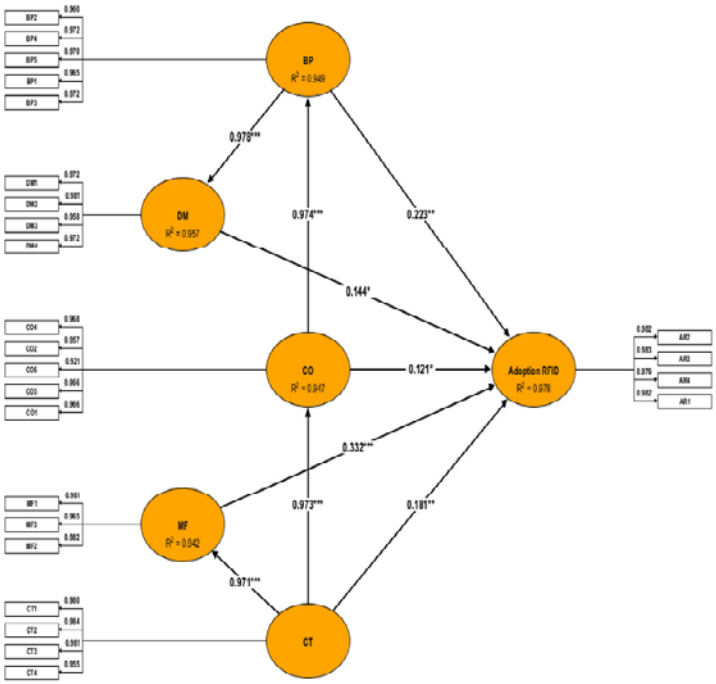

Figure 3. SEM for RFID adoption with path coefficients

4.4 Hypothesis testing

The hypothesis testing used in these research levels was measured using the t-values and the p-values. If the t-value was sufficiently low, below 1.65, this means that the null hypothesis was rejected.

Table 6. Hypothesis testing

	Significance	t-value
Limit of significance	p<0.1	1.65
	p<0.05	1.96
	p<0.01	2.59

Table 7. Hypothesis outcome for RFID adoption

Hypothesis	Effect	Coefficient	Standard bootstrap results					Percentile bootstrap quantiles				
			Mean value	Standard error	t-value	p-value (2-sided)	p-value (1-sided)	0.50%	2.50%	97.50%	99.50%	Support
H1	CO-AR	0.4747	0.4766	0.0847	5.60	0.0	0.0	0.2582	0.3118	0.6465	0.6885	YES
H2	CO-BP	0.9744	0.9742	0.0052	2.67	0.0	0	0.9580	0.9632	0.9830	0.9848	YES
H3	CT-CO	0.9732	0.9731	0.0066	5.91	0.0	0.0	0.9526	0.9585	0.1808	0.2421	YES
H4	DM-AR	0.1435	0.1444	0.0690	2.29	0.037	0.018	-0.036	0.0109	0.2813	0.3132	YES
H5	BM-DM	0.9782	0.9779	0.0043	2.67	0.0	0.0	0.9623	0.9687	0.9850	0.9865	YES
H6	BP-AR	0.3631	0.3627	0.0782	1.64	0.0	0.0	0.1619	0.2101	0.5265	0.5827	YES
H7	MF-AR	0.3318	0.3353	0.0620	4.41	0.0	0.0	0.1919	0.2170	0.4670	0.4981	YES
H8	CT-MF	0.9705	0.9700	0.0058	5.33	0.0	0.0	0.0948	0.9576	0.9796	0.9821	YES
H9	CT-AR	0.9654	0.9650	0.0071	5.10	0.0	0.0	0.9444	0.9496	0.9796	0.9798	YES

5.0 RESEARCH FINDINGS

A total of nine hypotheses were tested and their results support the proposed model and accepted RFID.

The first hypothesis (H1) examines the effect of the cost on adoption of RFID by supply-chain industries. H1 is significantly related to adoption of RFID by supply-chain industries (t-value = 5.6069, CI>99%);thus, hypothesis H1 is accepted. Earlier studies (Bhattacharya, 2012) are in line with this relationship.Through our survey, we have determined that strong influencing factors like labour cost, target cost,bullwhip effect, and investment were strongly correlated with adoption of RFID for competitiveness of supply chains.

In the structural equation model above, the path coefficient used for the labour cost was 0.966; the path coefficient used for the target cost was 0.957; the path coefficient used for the bullwhip effect was 0.956;and the path coefficient used for the investment at higher echelon was 0.968. This implies that the labour cost had the strongest impact on the cost, while target cost, bullwhip effect, and investment at a higher echelon hada moderate impact(Baysan & Ustundag, 2013).

The second hypothesis (H2) highlights the influence of cost on the business process implication(t-value = 2.67, Ci>99%); thus, H2 is accepted. This indicates that cost significantly impacts the business process implication through influencing parameters, such as labour cost, target cost, bullwhip effect, and investment at a higher echelon. This is in accordance with literature review (Ghafeer et al. 2014), and the significance of the t-value emphasizes the importance of cost in adoption of RFID by supply-chain industries

The Third hypothesis (H3) highlights the influence of competitiveness in firmson cost (t-value = 5.91, CI>99%); thus, H3 is accepted. This indicates that competitiveness significantly impacts the cost through influencing parameters, such as competitiveness at country, industry, and firm levels. This is in accordance with literature review(Ajitabh& Momaya, 2003).

The fourth hypothesis (H4) examines the effect of data management on adoption of RFID by supply-chain industries. H4 is significantly related to adoption of RFID by supply-chain industries (t-value = 2.29, CI>99%); thus, hypothesis H4 is accepted. Earlier studies (Liukkonen, 2015)are in line with this relationship. Through our survey, we have determined that strong influencing factors like procedure tree (PT),anti-counterfeiting, active sensing with active and passive RFID, and predictive analysis were strongly correlated to adoption of RFID for competitiveness of supply chains.

In the structural equation model above, the path coefficient used for the procedure tree was 0.972; the path coefficient used foranti-counterfeiting was 0.981; the path coefficient used for active sensing was 0.958;and the path coefficient used for the predictive analysis was 0.972. This implies that anti-counterfeiting had a stronger impact on data management than procedure tree (PT),active sensing with active and passive RFID, and predictive analysis had a moderate impact(Choi et al.,2005).

The fifth hypothesis (H5) highlights the influence of BPI on data management(t-value =2.67, Ci>99%); thus, H5 is accepted. This indicates that BPI significantly impacts data management through influencing parameters, such as privacy issue, consumer behaviour, process innovation, and product innovation. The significance of the t-value emphasizes the importance of BPI in adoption of RFID by supply-chain industries.
The eighth hypothesis (H8) highlights the influence of competitiveness in firms on mimetic factors (t-value = 5.33, CI>99%); thus, H8 is accepted. This indicates that competitiveness significantly impacts the mimetic factors through influencing parameters such as competitiveness at country, industry, and firm levels. This is in accordance with literature review(Ajitabh& Momaya, 2003).
The sixth hypothesis (H6)examines the effect of the business process implication on adoption of RFID by supply-chain industries. H6 was significantly related to adoption of RFID by supply-chain industries (t-value = 1.64, Cl>99%); thus, hypothesis H6 accepted. Through our survey, we have determined that strong influencing factors like privacy issue, consumer behaviour, process innovation, and product innovation were strongly correlated to adoption of RFID for competitiveness of supply chains.
In the structural equation model above, the path coefficient used for the privacy issue was 0.965; the path coefficient used for consumer behaviour was 0.972; the path coefficient used for process innovation was 0.970;and the path coefficient used for product innovation was 0.975. This implies that the product innovation had a stronger impact on BPI than privacy issue, and consumer behaviour and process innovation had a moderate impact(Baysan & Ustundag, 2013).
The seventh hypothesis (H7)examines the effect of the mimetic factors on adoption of RFID by supply-chain industries. H7 is significantly related to adoption of RFID by supply-chain industries (t-value = 4.41, Cl>99%);thus, hypothesis H7 is accepted. Earlier studies (Liu et al.,2009) are in line with this relationship. Through our survey, we have determined that strong influencing factors like competitive pressure, bandwagon effect, and market pressure were strongly correlated to adoption of RFID for competitiveness of supply chains.
The ninth hypothesis (H9)examines the effect of competitiveness on adoption of RFID by supply-chain industries. H9 is significantly related to adoption of RFID by supply-chain industries (t-value = 5.10, Cl>99%);thus, hypothesis H9 is accepted. Earlier studies (Ajitabh & Momaya, 2003) are in line with this relationship. Through our survey, we have determined that strong influencing factors like competitiveness at country, industry, and firm level were strongly correlated to adoption of RFID for competitiveness of supply chains.
In the structural equation model above, the path coefficient used for collaboration with industry was 0.980; the path coefficient used for competitiveness in country was 0.984; the path coefficient used for competitiveness in industry was 0.981,and the path coefficient used for competitiveness in firm was 0.995. This implies that the competitiveness in firms hada stronger impact than country and industry levels.

6.0 CONTRIBUTIONS

The results for influencing factors for adoption of RFIDby supply-chain industries show a positive influence on adoption of RFID.

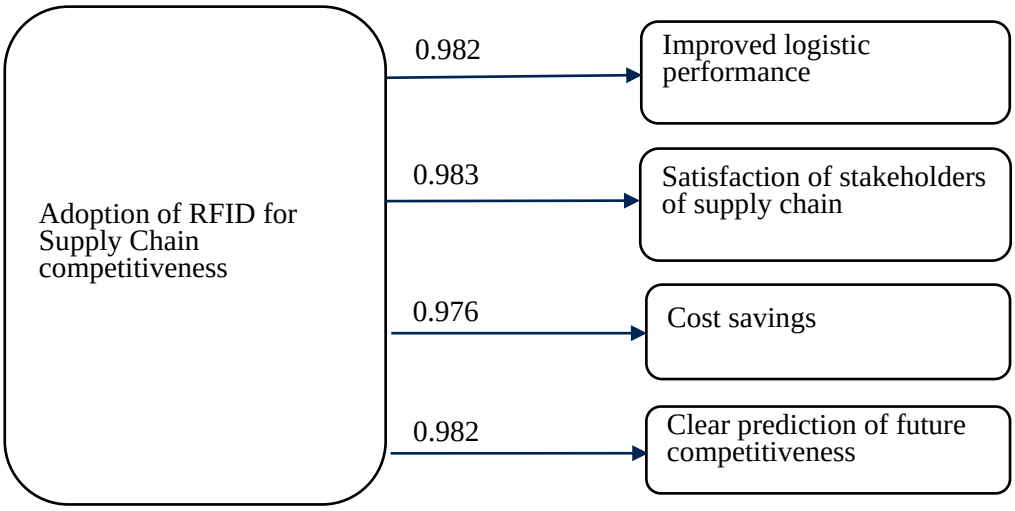

Figure 4. Adoption of RFID in supply chains with their associated path coefficients

In the above structural equation model, almost all variables had the strongest impact on the adoption decision.
Based on the research project, the answers to the four research questions are:
First, the research outcomes clearly show that a benefit analysis of RFID shows cost savings and boosts adoption of RFID in the supply-chain process. Factors such as labour cost, target cost method, bullwhip method, and investment at higher echelon showed a highly significant impact on the adoption decision.

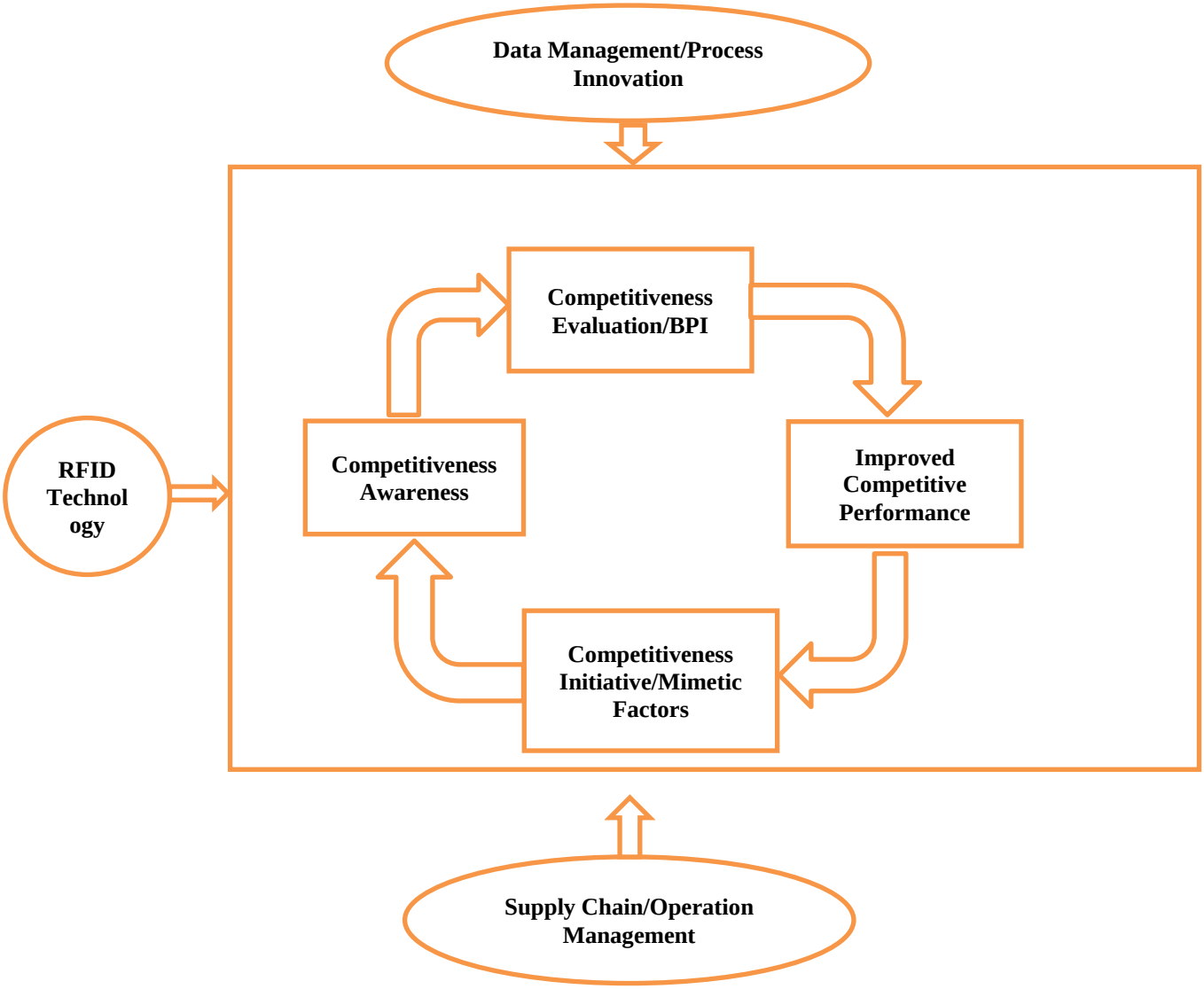

Fig 5: Integration of competitiveness process in RFID application.

Second, improvement in logistic performance, track, trace, and anti-counterfeiting features from RFID enhance logistic performance. RFID tracks goods from one endof the supply chain to other end, which helps to reduce time, cost, and labour. Factors such as bullwhip effect, process innovation, and anti-counterfeiting showed improvement in logistic performance and lead to adopting RFID.

Third, predictive analysis and competitive pressure can moderate adoption of RFID by supply-chain industries. Predictive analyses are extensively considered for future decision making and improved profitability. Predictive analyses derive from integration of qualitative and quantitative analysis, evaluating under different circumstances, data mining, and applying probability. Logistic predictive analysis is used to estimate the past and future behaviour of the flow and storage of inventory also related to cost and demand, which leads to stakeholder satisfaction. Large and small organizations need a competitive advantage to succeed in industry. Competitive pressures are not limited to products and the domestic market but are also include imports. This arises from the interaction of firms with their competitors in the market.

Finally, current research has some interesting relation to competitive theory and to the actual outcomes for adoption of RFID by supply-chain industries.

Earlier research suggests that a source of comptitiveness is categorized under asset, process, and performance on the specturm of strategic and operational levels (Ajitabh& Momaya, 2003).APP structure incorporates resources to show processes that are well understood by professionals and may provide the best robust tool to link competitiveness to strategy. Firm level has received the supreme attention among the three levels (country, industry, and firm). Competitive success achieved through firm strategy, structures, competencies, and capabilities to innovate perceived risk is an important ingredient in the consumers' decision-making process. In today's business environment, dynamic capabilities, elasticity, alertness, speed, and adaptability are becoming more important sources of competitiveness (Barney, 2001; Sushil, 2000).

Mimetic factors and business process implications play a vital role in the user choosing to accept RFID. From the reseach outcomes, it is very clear that all supply-chain stakholders are under competitive pressure and process implication. Setting up RFID in medium- and small-scale industries is expensive and needs different functional managment. Competitive APP framework can fit adoption of RFID. APP framework integrates the resources for performance through processes that are well understood by professionals and may provide the best tool to link competitivness to strategy. Through our research, we found that RFID technology is an asset for APP framwork. Process innovation, IT application, and product innovation are processes of APP framework. Performance in APP framwork is defined by improvement of logistic performance, stakholder satisfaction, and cost reduction. So we proposed thecompetitive model with 'mimetic factors' and 'business process implication' be added direct determinants of intent for adoption of RFID Techology.
The compatible competitive model is shown in figure 5.

7.0 Limitations And Scope For Future Research

The study can be expanded to other parts of the world to have different views from different people.Research should be conducted through focus groups. Research can be done within groups of people from different organizations and responsibilities. Future research can be conducted more for validating technology advancement such as solar, effective wireless, cloud data, etc. This research was conducted to understand the causal associations between adoption of RFIDby the supply-chain industry and the factors influencing their adoption decisions, such as cost, data management, business process implication, and mimetic factors. To understand the overall impact of variables, a focus group interview is needed. This research could further the study by focusing more on RFID users in supply chains.

8.0 Conclusion

The research concludes that RFID is indeed transformative. It gives a competitive advantage in business and generates tremendous growth in logistics management. A vast majority of organizations still struggle to understand the implications of RFID on their businesses and industries. Presesntly, the focus is more on implementation cost than on benefits.Data management and business process implication need to be applied.Firm competitiveness promotes RFID adoption rate. As a result of this research, competitiveness is the driving force for adoption of RFID in any company,whereas data management and business process implication play a vital role in medium- and small-scale industries.

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