International Business Management 5 (2): 76-84, 2011
ISSN: 1993-5250

The Comprehensive Framework for RFID Justification in Healthcare

[1]Iwan Vanany and [2]Awaluddin Mohamed Shaharoun
[1]Department of Industrial Engineering, Sepuluh Nopember Institute of Technology,
Campus ITS, 61111 Sukolilo, Surabaya, Indonesia
[2]Razak School of Engineering and Technology, University Teknologi Malaysia (UTM),
Jalan Semarak, 54100 Kuala Lumpur, Malaysia

Abstract: RFID technology has emerged popular information technology enabled in wide industry areas including healthcare industry. Justifying and decision making of RFID investment is crucial to rationalize and achieve successful implementation. Decision makers need a better framework to structure the complexity of RFID justification. This study proposes the comprehensive framework for RFID justification that had been tested and validated on 4 hospitals in Indonesian and Malaysian hospitals. It describes how 5 phases consisting of steps, techniques and tools of the framework can be used to justify RFID investment. A case study example is used throughout the study to explain how the framework works and how it is applied to justify RFID investment. Specifics and general validation had been used to validate the framework through multiple case studies.

Key words: Framework, justification, RFID investment, healthcare, framwork, implementation

INTRODUCTION

Information Technology (IT) justification is still considered as critical issues in managing IT. Many organizations often face several difficulties when adopting these new technologies, particularly IT (Small and Chen, 1995; Love *et al*., 2005) and fail to achieve the full potential of the IT including RFID technology due to the weaknesses in the justification of the IT themselves (Gunasekaran *et al*., 2006). Therefore, practitioners still need a better systematic way to handle the complexity of IT justification. Better technique or framework is needed to structure complexity of IT justification and can be made to sure the implementation of new IT become the success to achieve full potential benefits.

In recent years, RFID technology has been emerging popular IT to be adopted in wide industry areas such as retail, manufacturing, logistics, education (libraries) and healthcare (e.g., pharmaceuticals and hospitals) industries. The complexity of RFID justification is also still problems and critical issues such as the lack of suitable criteria and the lack of appropriate technique and tools. Better framework for RFID justification is needed to solve these problems. The failures of RFID justification and implementation are also high disruption impacts. It can be high costly, waste time and consume resources of organizations. Wang *et al*. (2006) declared that Taipei Medical University Hospital (TMUH) spent approximately US$1 million for the RFID project and proposed a 1 year plan to develop the Location-Based Medicare Service (LBMS) system.

Many techniques and frameworks of IT justification have been applied by researchers and practitioners such as economics, strategic, analytic and comprehensive approach. In the context of RFID justification, most of the previous studies used economics and analytic approach. Return on Investment (ROI) is one the economics techniques that is often applied to justify RFID investment (Roberti, 2004; Fontanella, 2004; Murphy-Hoye *et al*., 2005). Meanwhile, Analytic Hierarchy Process (AHP) as a technique in analytic approach by Lin and Lin (2007) and business justification for RFID framework as the framework in comprehensive approach by Lahiri (2005) had been used to evaluate the decision of RFID adoption. However, these techniques and frameworks still have several weaknesses. They are few addressing comprehensive frameworks that provide the suitable criteria and appropriate techniques and tools.

Based on literature reviews, fewer previous frameworks use phase, steps and combine the suitable criteria and appropriate techniques and tools to justify RFID investment. In techniques and tools issues, at least 3 importance issues are not covered in the previous

Corresponding Author: Iwan Vanany, Department of Industrial Engineering, Sepuluh Nopember Institute of Technology, Campus ITS, 61111 Sukolilo, Surabaya, Indonesia

framework. Firstly, fewer frameworks use the strategy to explore objectives. The ROSS (real option strategy scorecard) decision framework by Munoz used Balanced Scorecard (BSc) to execute the objective of the IT justification. However, only 10% of the organizations execute their strategy because 4 barriers that impede their BSc implementation such as vision, people, management, resource barriers (Niven, 2003). Secondly, a few frameworks employed the sensitivity analysis. In fact, the price of RFID components is rapidly changing and the stability of final decision is critical to be tested. Thirdly, a few frameworks provide the improvements of a business process such as time and costs reduction. In facts, the improvements of a business process by RFID impacted are critical judgment for decision makers in organizations (Reyes and Jaska, 2007).

In this study, we present the improved framework for RFID justification. The term RFID justification is used to imply the framework is used to decide the justification of RFID investment. The proposed framework is required which can provide appropriate techniques and tools that can be adopted to solve 3 importance issues. We used 5 phases and their objectives and steps. Several well-known techniques and tools are adapted such as SWOT analysis, WHAT's-HOW's matrix, AHP, flow charts and property table. We modified WHAT's-HOW's matrix for determine expected benefits from RFID stakeholder objectives, adapted AHP technique for the decision where-best potential application areas and the sensitivity analysis of each criterion and adopted the flow charts and property table for the determination the RFID impacted and their improvement in the business process.

The proposed framework for RFID justification and how it works. To provide an illustration of the framework on how the framework works, we present the application of the framework to a large public Malaysian hospital.

MATERIALS AND METHODS

RFID of justification framework: The framework for RFID justification developed uses 5 phases that present their objectives, steps and appropriate techniques and tools in each phase. This framework also covered two main factors of the framework for IT justification such as suitable criteria in phase 2 and 4 and appropriate techniques and tools for each phase to achieve their phase objectives. The flow mechanism of the framework is sequential. It means that the next phase or stage cannot be done if the previous phase or stage is not completed. The mechanism of the framework used 5 phases namely: initiation, identification the suitable criteria and application areas, determination expected benefits from rfid stakeholder objectives, decision on where-best potential application area and post-decision (Fig. 1). The followings are an illustration of each phase and how each phase of the framework works.

Initiation: Many researchers believe that decision makers should consider a wide variety of both internal and external factor of environment organizations when making decision. In RFID context, Reyes and Jaska (2007) reveal that organization readiness as internal factors, external factors and entry timing are important to be considered for RFID adoption. Therefore, it is critical in the first phase of

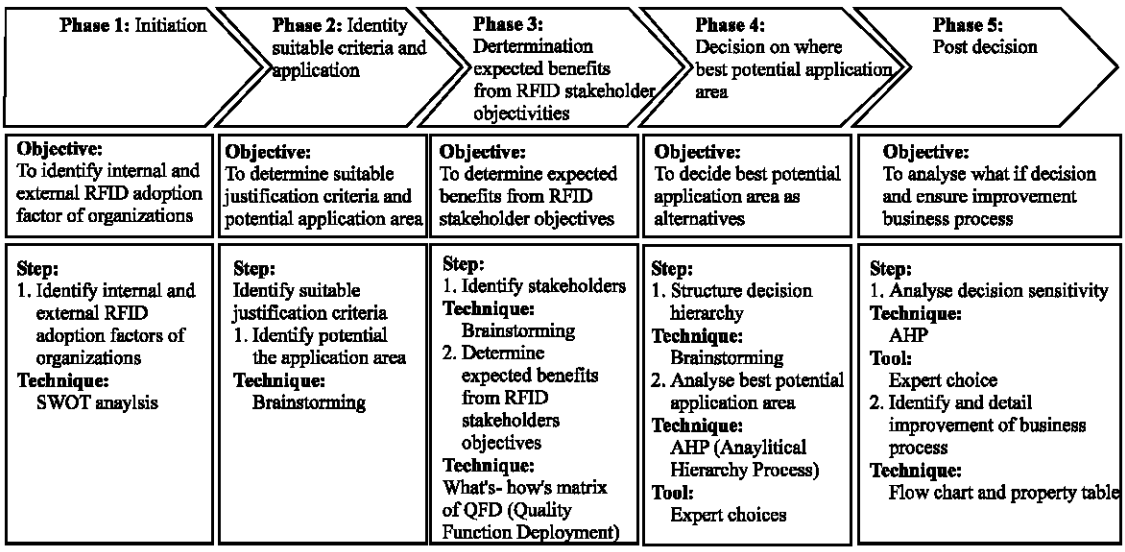

Fig. 1: The machanism flows of proposed framwork for RFID justification

the framework to identify internal and external organization factors in first phase of the framework before decide the justification of RFID investment. The framework uses SWOT analysis as an appropriate technique in order to identify internal and external organization factors that influence the adoption of RFID technology.

The SWOT analysis technique is employed to reveal certain strengths and weaknesses of organization as internal organization factors and probable opportunities and threats as external organization factors of RFID adoption. Decision makers should leverage the factors of internal strengths, alert and correct the factors of internal weaknesses, pursue factors of external opportunities and avoid and deter factors of external threats. The SWOT analysis technique is selected because the popularity of technique, effectiveness and beneficial, simple and easy to be understood. It is one of the popular techniques in strategic planning (Glaister and Falshaw, 1999) and employed in wide areas including decision making in IT application (Stewart *et al*., 2002). It is also effective and beneficial to elaborate internal and external analysis (Schmoldt *et al*., 1994). On the other hand, it is simple and easy to be understood (Balamuralikrishna and Dugger, 1995; Kurttila *et al*., 2000).

The perceived benefits and technology competence factors are internal strengths of RFID adoptions. The improved patient safety, business process and efficiency and effectiveness are benefits of RFID adoption in healthcare that are expected to be achieved (Vanany and Shaharoun, 2008).

The readiness of RFID infrastructures (Wang *et al*., 2006) and a confidence of RFID superiority than barcode technology (Wyld, 2006) can be addressed as technology competence factors of RFID adoptions. The lack of organization readiness and the lack of user readiness are factors that can be located in internal weaknesses because impede RFID adoption from internal organizations. In opportunity factors, external impetuses and increased RFID patents (Anonymous, 2003; Taghaboni-Dutta *et al*., 2009) can stimulate organizations adopt RFID technology from external organizations.

Finally, external threats include complexity, lack or partner and patients readiness factors can hamper RFID adoptions from external organizations.

Identifying suitable criteria and application area: The objectives of phase two determine the most suitable criteria and potential application areas for decision. Based on literature review and confirmation with practitioners, several criteria can be used to justify RFID investment such as benefits, costs, risks, complexity, ROI timeliness and social needs. Determining the most suitable criteria is important and must be consistent with the nature of the system (Gunasekaran *et al*., 2006).

The application areas of RFID technology in healthcare are relatively broad. There are 3 main application areas) asset management, patient and medical staff case and inventory management. Each application area has subbed application areas that are divided by virtue of functions. Table 1 showed 8 sub-application areas. Organizations should determine several potential application areas in order to ease the next phase of RFID justification.

Determination expected benefits from rfid stakeholder objectives: This phase determines expected benefits from the RFID stakeholder objectives in each application area using WHAT's-HOW's matrix. Stakeholder in healthcare is relatively unique compared with manufacturing or business for example, governments as shareholders, patients and people as customers, medical staffs as employees, healthcare insurance and supporting industries such as medical equipment, pharmaceutical industries.

RFID application in each application area has difference impacts and consequences for organizations. For example, patient tracking and newborn application can be used to improve efficiency and effectiveness for monitoring of the patient. On the other hand, blood bags tracking application cannot be employed in this case. The WHAT's-HOW's matrix of QFD will be employed to deploy the srelationships between stakeholder objectives and application area. The WHAT's-HOW's matrix of

Table 1: Application areas of RFID technology in healthcare and their specific functions

Application area	Functions	Reference
Asset management	Tracking and tracing for medical equipment	Reyes and Jaska (2007)
	Tracking and tracing other assets (e.g., computer)	
Patient and medical staff	Tracking and tracing for a patient in the operating room	Wang *et al*. (2006), Su and Chou (2008)
case (Fisher and Monahan, 2008)	Tracking and tracing for a patient in the emergency room	Reyes and Jaska (2007), Tzeng*et al*. (2008)
	Tracking and tracing for a newborn	Tzeng *et al*. (2008), Anonymous (2005)
	Tracking and tracing for a medical staff	Wang *et al*. (2006)
Inventory management	Tracking and tracing a blood bags/sample	Tzeng *et al*. (2008)
(Fisher and Monahan, 2008)	Tracking and tracing the medicine drugs	Anonymous (2003)
	Tracking and tracing for the medical record books	Bacheldor (2006)

Table 2: Template of property table

			Time				Cost	
Characteristic activity	Description	Resource	Current	Future	Rule	Input/output	Current	Future
Start								
Activity 1								
Activity 2								
Activity 3								
Activity 4								
Stop								

QFD as critical part had been used to deploy organization objectives (Clargo, 2004). In RFID justification context, the WHAT's part are stakeholder objectives and HOW's part is application areas. The original symbols of QFD used three symbols to describe the relative importance of relationships in the matrix. The researcher prefers to use Likert's scales from 1-9 (weak-very strong) that gives wider options for decision makers. The results of this phase will be used to determine preference on important weight and value for benefits and each application area in phase 4.

Decision on where-best potential application area: The objective of this phase is to decide on the best application areas as alternatives. Structure hierarchy decision that describes the suitable criteria and alternatives is the first step that should be developed before analyzing the decision. AHP is a well-known technique in decision making. The expert choice as AHP software is employed to develop the structuring hierarchy, data processing using pair-wise comparisons and entering a quantitative data and synthesis decision.

Post decision: Phase 5 explores the post decision to analyze the sensitivity or what-if? decision and details out the improvement business process. The sensitivity analysis decision is important to understand the effect of weights assigned to each criterion. AHP is one of the well-known decision making techniques that can be used to analyze the sensitivity as mentioned by Saaty (1980). This phase employed AHP technique that is supported by expert choice software to analyze the sensitivity of each criterion. A flow chart had been used to describe a business process impacted which is caused by RFID implementation by Lahiri (2005). Nevertheless, it is not clear and detailed enough in order to prove the improvement of a process. The property table is important to describe the activities in detail and to show detailed information such as description, resources, time, rule, input/output and cost of each activity (Damij *et al.*, 2008). This phase used a flow chart and the property table to ensure and to detail out the improvement of a business process. An example of the property table is shown in Table 2.

RESULTS AND DISSCUSION

The practical application of the framework: Healthcare industry is different and more complex than the one used in manufacturing and retail industry because healthcare has a unique paradigm. Firstly in the healthcare context, patients' safety is important and comes foremost ahead of profitability. Secondly, stakeholders in healthcare are relative multiple diverse. Thirdly, the consequences of error in operation poss high risks compared with manufacturing industry. Therefore, healthcare is good object research to test the framework for RFID justification.

The framework has been applied in four hospitals in Indonesia and Malaysia. The respondents of this study are IT managers who are accountable for justify the new IT. All respondents are public hospitals and administrated under the medicine department of a public university. Three hospitals have been successful implemented Hospital Information Systems (HIS) and one hospital has been successful developed HIS in part of exclusive service in their hospitals. IT manager has planted to justify RFID investment that will be used in next phase of HIS development. The characteristics of 4 cases studies are shown in Table 3.

This study presented detailed the applicability of in one case study. Case study A which is presented is a public hospital in Malaysia and is located in Kuala Lumpur. We used three rounds to test the applicability of this framework. First, we conducted a presentation to explain the purpose of research, concept and mechanism of the framework to IT managers. It is critical to make clear to the IT managers about the phase and techniques and tools used by the framework. Secondly, the IT managers had tested and applied the framework. Finally, we and IT manager discussed how to fit and finalize the application of the framework. The followings are the results of each phase for the case study A.

Initiation: In the SWOT analysis, the IT manager preferred the readiness of RFID applications that are based on internal and external condition of his hospital. The questionnaire had been validated by 2 experts. Furthermore, the IT manager believes that in his hospital,

Table 3: The characteristics of four case studies

Case studies	Description of organization	No. of employees	No. of patients
A	It is a major public hospital in Malaysia and located in Kuala Lumpur. It has developed its own HIS as called Caring Hospital Enterprise System (C-HEtS). RFID technology is one of the new IT that will be considered to be used in next phase of development there C-HEiS	±3,500 (doctors, nurses, administration staff	1,050 beds, outpatients: ±50,000 patient year^{-1}, inpatients: ±40,000 patient year^{-1}
B	It is regarded as one of the best teaching and public hospital in Kelantan and East Cost of Peninsular Malaysia. It has implemented HIS. IT manager who responsible development of IT in their hospital has planted to justify RFID investment	2,672 employees (medical and management staff)	747 beds, outpatients: ±26,000 patient year^{-1}, inpatients: ±21,000 patient year^{-1}
C	It is a public hospital in Malang, Indonesia. It has developed HIS. It has planted to develop HIS for next phase. RFID technology is one technology that considered to be used for HIS	±1.853 employees (medical and administration staff)	822 beds, outpatients: ±33,374 patient year^{-1}, inpatients: ±31,022 patient year^{-1}
D	It is a public hospital in Surabaya, Indonesia. A part of exclusive service has implemented HIS. IT manager who's responsibility to develop IT considered RFID technology is one of the information technology that will be implemented in his hospital	±5.429 employees (medical and administration staff)	1,514 bed, outpatient: ±2,700 patients day^{-1}, inpatient: ±1,500 patients day^{-1}

Table 4: Determination expected benefits from RFID stakeholder objectives

Stakeholder		Application areas (HOW's)®			
Objectives (WHAT's)	Wt. (%)	Newborn®	Tracking patient®	Tracking medical records®	Blood bags®
Shareholder (government)					
Realizing the safety patients	35	5 (1.75)	8 (2.80)	6 (2.10)	8 (2.80)
Customers (patients)					
Security alerto					
Improving service for patients	45	8 (3.60)	8 (3.60)	4 (1.80)	6 (2.70)
Employee (medical staff)					
Efficiency and effective to monitorpatients or medical record books	20	5 (1.00)	5 (1.00)	2 (0.40)	None (0.00)
Expected benefits total	100	6.35	7.40	4.30	5.50

®Weight * value

the opportunities' factor (4.60) and the strengths' factor (3.50) of RFID technology will contribute to successful RFID adoption. He believed that several items of the weaknesses' factor (3.00) (e.g., internal resources such as medical staffs and infrastructures support are not ready) must be increased. The low numbers of organizations that adopted RFID technology are seen as a threats factor (3.43).

Identify suitable criteria and application areas: The discussion was continued to identify suitable criteria and potential application areas. K's IT manager believed that benefits, costs, risks, complexity and ROI timeliness criterion is important to justify RFID investment and tracking patient, newborn, blood bags and medical records are possible areas of RFID applications in his hospital.

Determination expected benefits from rfid stakeholder objectives: This stage had two purposes to identify main stakeholder and elaborate RFID stakeholder objectives using WHAT's-HOW's matrix. The main stakeholders that must be satisfied and fulfilled using RFID application are government as the shareholder, patients as customer and medical staff as the employee. Elaborate stakeholder objectives that are based on expected benefits are discussed and established. The stakeholder objectives are employed as WHAT's attributes and the results of potential application areas in stage 2 as HOW's attributes in a matrix. The testing was continued to elicit IT manager judgement in weighting each main stakeholders and on WHAT's-HOW's cells using Likert's scales from 0-9 (extremely strongly). Finally, the multiplication between the weight each main stakeholders and each value of potential application and total of each potential application area had been calculated in Table 4. The outputs of RFID stakeholder objectives represented the determination value of expected benefits in next stage using WHAT's-HOW's matrix.

Decision on where-best potential application area: The main output of the framework for RFID justification is the best potential application that is elaborated in this stage. Structuring of decision hierarchy can be constructed as shown in Fig. 2. The level 0 of the structure is the RFID justification as a goal, the suitable criteria of RFID justification are indicated by level 1 and application areas as alternatives of decision are indicated by level 2. The

Table 5: Results of decision for RFID investment in case study A using AHP technique

	Benefits (0.371)		Complexity (0.131)		Risks (0.108)		Costs (0.181)		ROI timeliness (0.210)		Total	
Alternatives	Value	Norm	Value	Norm	Value	Norm	Value	Norm	Value	Norm	Norm	Rank
Newborn	6.35	0.259	0.557	0.184	0.557	0.192	246,250	0.261	1.000	0.299	0.250	3
Patients	7.40	0.301	0.485	0.160	0.485	0.168	602,500	0.208	0.760	0.227	0.236	4
Blood bags	5.50	0.224	0.990	0.327	0.990	0.290	182,500	0.270	0.904	0.270	0.263	1
Medical records	5.30	0.216	1.000	0.330	1.000	0.350	243,750	0.261	0.683	0.204	0.251	2

Table 6: Sensitivity analysis of decision in case study A

	Probability					
Scenario	Benefits	Complexity	Risks	Costs	ROI timeliness	Decision
Normal	0.371	0.131	0.108	0.181	0.210	Blood bags
Benefits increased	0.541*	0.095	0.079	0.132	0.153	Tracking patients
Complexity increased	0.072	0.832*	0.021	0.035	0.041	Medical records
Risks increased	0.295	0.104	0.289*	0.145	0.167	Medical records
Costs increased	0.226	0.080	0.066	0.500*	0.128	Blood bags
ROI timeliness increased	0.276	0.087	0.072	0.121	0.474*	Newborn

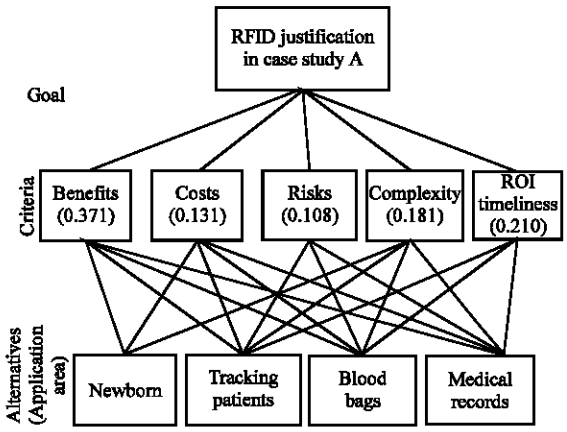

Fig. 2: Decision hierarchy structure for case study A

results indicated that benefit criterion (0.371) is more important than ROI timeliness (0.210), complexity (0.181), costs (0.131) and risks criterion (0.108) in Fig. 2. Expert choice as AHP software was used to decide the best potential application areas. The results of decision are shown in Table 5. It can be seen that tracking blood bags (0.263) is better than tracking medical records (0.251), tracking newborn (0.250) and tracking patients (0.236).

Post decision: The final decision of application area is highly dependent on the weights of criteria. Small changes in the relative weights of criteria may cause major changes in the final decision. Highly subjective judgments of decision makers affect the weights of criteria. It is important to analyze how the application area selected will change if the probability of weight of criteria changes.

Testing of the stability of decision is also critical. The expert choices software again could be used to evaluate the sensitivity analysis that is shown in Table 6. To ensure the improvement of a business process in the blood bags as the best application area, the framework uses a flow chart and the property table. A flow chart was used to describe a business process impacted which is caused by RFID application in tracking blood bags and the property table was employed to describe activities in detail such as resources, time, rule, input/output and costs of each activity. Figure 3 showed a flow chart and Table 7 shows the property table of the tracking blood bags.

The validation of the framework: The framework should be validated in order to certify the framework from practitioners. IT managers must test the applicability of the framework before they answer validation questions. The validation factors are divided into 2 namely specific and general validation factors.

Santhanam *et al.* (1989) indicate that a decision framework method should be able to provide a realistic description of the selection problem, support a comprehensive analysis of alternatives and should be easy to be used and applied. Muralidhar *et al.* (1990) pointed out that a method should also include both qualitative and quantitative factors and a procedure to measure the relative importance of factors.

Hazelrigg (2003) suggests for the structuring of the decision making problem and they must analyzealternatives. Saaty (2004) argues that a new method can express the relative importance of the factors. Munoz also suggests a method should create a roadmap for management plan and evaluation. Most IT managers confirm that framework validates in most cases. All interviewees clarify the framework is adequate capable of justify RFID investment. It can provide a realistic description of the selection problem, simple to guide decision makers easy to be understood, integrated both

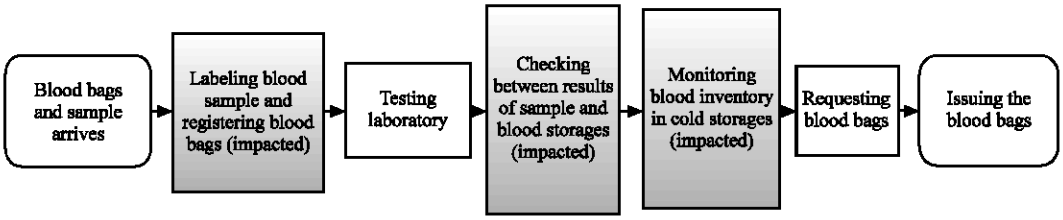

Fig. 3: The business process impacted by RFID technology for the blood bags applications in case study A

Table 7: The property table for the tracking blood bags application in case study A

			Time (min)				Cost	
Characteristic activity	Description	Resource	Current	Future	Rule	Input/output	Current	Future
Blood Bags (BB) and samples (BS) arrive	BB from National Blood Centre (NBC) BS from other departments arrive							
Labelling and registering BB and BS	Lab Staffs (LS) label and register BB and BS	Lab staff	2 per BS and BB	1/2 per BB and BS	RFID Label must be affixed in BB and BS	BS and BB/BS and B labelled and registered	Undeclared	Decreased (5%)
Testing laboratory	Lab staffs test BS and doctors monitor activities of lab staffs	Lab staff and doctors	10-15 per pack (CT)	10-15 per pack (CT)	Lab procedures and standards	BS/the contents of BS	Undeclared	Stable
Checking and matching between contents of BS and BB	Lab staffs check and match between contents of BS and BB in storages	Lab	5-10 per BB	1-2 per BB	Lab standards	The contents of BS and BB/BB needed	Undeclared	Decreased (10-15%)
Monitoring the blood inventory in the cold storages	Lab staffs and doctors must monitor BB stocks in cold storages	Lab staff and doctors	60-120	15-30	Lab management	BB stocks/ inventory status and reports of BB	Undeclared	Decreased (20-25 %)
Issuing BB	Lab staffs confirm and issue to department	Lab staff	3-10	3-10	Lab procedures	BB needed/ accomplishment for blood requested	Undeclared	Stables
Requesting BB	Lab staff issues the request BB to NBC	Lab staff	5-10	5-10	Lab procedures	Inventory status, reports/issuing the request letter to NBC	Undeclared	Stables
Request is fulfilled	The output of activities							

Table 8: Validation factors and their results from 4 case-studies

Validation factors	Case A	Case B	Case C	Case D
Specific validation				
Providing a realistic description of the selection problem	✓	✓	✓✓	✓✓
Comprehensive/complete analysis	∞	✓	✓	✓✓
Simple to guide decision makers	✓✓	✓	✓	✓
Easy to be used and applied	✓	✓	✓	✓
Easy to be understood	✓	✓	✓	✓
Integrated both quantitative and qualitative criteria	✓	✓	✓	✓
Structuring the decision making problem	✓	✓	✓	✓
Analyzing alternatives	✓	✓	✓	✓
Expressing the relative importance of the factors	✓	✓	✓	✓
Create a roadmap for management plan and evaluation	✓	✓	✓	∞
General validation				
Strengths or strong points of the framework	✓	✓	✓	✓✓
Weaknesses of the framework	∞	Φ	Φ	∞
Missing links in phases, steps and techniques and tools	Φ	Φ	Φ	Φ

✓= positively,∞ = negatively (low), Φ = none

quantitative and qualitative criteria, structure the decision making problem, analyze alternative, express the relative importance of the factors. They also believe that the framework has strong points and missing link between

phases, steps and techniques and tools is relative few. Respondent in case one suggested that the framework should provide the detailing types of RFID components used including their costs. Few respondents relative unfamiliar to use techniques and tools but they can be easy to use after are explained how to use these techniques and tools. Respondent in case 4 hesitant the framework can be used to create a roadmap for management plan and evaluation.

But decision makers should enrich the priority of decision in order to create a roadmap for management plan and evaluation. However, they believe that the framework is generally, adequate and the weaknesses can be covered by the supplement of RFID component used. The framework had been slightly revised through an addition the types of RFID component used. The validation factors and their results are shown in Table 8. We use the symbol to describe the opinions of respondents such as a tick (✓) for positively, infinity (∞) for negatively and phi (Φ) symbols for none. With each more symbol expresses highly positively or negatively of their factors.

CONCLUSION

The comprehensive framework for RFID justification has been developed and tested in 4 hospitals and its application in one case has been presented. The justifying RFID investment can be done using this framework in order to decide where-best application area and its post decision.

The testing of applicability in one case showed that the justifying RFID investment can be decided into five phases (initiation, identification suitable criteria and application areas, deployment of RFID stakeholder objectives, decision on where-best potential application area and post decisions). Each phase has provided objectives, steps and appropriate techniques and tools can cover limitation of the previous framework.

The testing of the applicability that is represented in one case study indicated that the comprehensive framework is applicable to be used by decision makers in the healthcare sector. Decision maker satisfies used and he asserted that framework adequate to be employed to justify RFID technology. The important benefits gained from the framework may be summarized as provides suitable criteria of RFID justification and provides appropriate techniques and tools in each phase of the framework.

The framework is also relatively robust after is tested in two Malaysian and 2 Indonesian hospitals that posed different characteristics despite the best decision application area in each case is different. Hence, 4th in order to validate the framework, the interviewees had also validated the framework by several specific and general factors of validation. Generally, respondents believe that the comprehensive framework is adequate to be used to justify RFID investment.

REFERENCES

Anonymous, 2003. RFID Medicine Tracking: Medical formulation packages tracked with RFID. http://www.yenra.com/rfid-medicine-tracking/.

Anonymous, 2005. RFID delivers newborn security. http://www.rfidjournal.com/article/purchase/1372.

Bacheldor, B., 2006. Fort hood to RFID-tag medical records. http://www.rfidjournal.com/article/articleprint/2536/-1/1/.

Balamuralikrishna, R. and J.C. Dugger, 1995. SWOT analysis-A management tool for initiating new programs in vocational schools. J. Vocational Tech. Educ., 12: 36-41.

Clargo, M., 2004. The designer organisation: Organisations too can benefit from the application of design and quality tools and with startling results. Int. J. Qual. Reliab. Manage., 21: 973-983.

Damij, N., T. Damij, J. Grad and F. Jelenc, 2008. A methodology for business process improvement and IS development. Inform. Software Technol., 50: 1127-1141.

Fisher, J.A. and T. Monahan, 2008. Tracking the social dimensions of RFID systems in hospitals. Int. J. Med. Inform., 77: 176-183.

Fontanella, J., 2004. Finding the ROI in RFID. Supply Chain Manage. Rev., 8: 13-14.

Glaister, K.W. and J.R. Falshaw, 1999. Strategic planning: Still going strong. Long Range Plann., 32: 107-116.

Gunasekaran, A., E.W.T. Ngai and R.E. McGaughey, 2006. Information technology and systems justification: A review for research and applications. Eur. J. Operat. Res., 173: 957-983.

Hazelrigg, G.A., 2003. Validation of engineering design alternative selection methods. Eng. Optimization, 35: 103-120.

Kurttila, M., M. Pesonen, J. Kangas and M. Kajanus, 2000. Utilizing the Analytic Hierarchy Process (AHP) in SWOT analysis: A hybrid method and its application to a forest-certification case. Forest Policy Econ., 1: 41-52.

Lahiri, S., 2005. RFID Sourcebook. Prentice-Hall, USA.

Lin, K. and C. Lin, 2007. Evaluating the decision to adopt RFID systems using analytic hierarchy process. J. Am. Acad. Bus., 11: 72-78.

Love, P.E.D., Z. Irani and D.J. Edwards, 2005. Researching the investment of information technology in construction: An examination of evaluation practices. Automation Construction, 14: 569-582.

Muralidhar, K., R. Santhanam and R.L. Wilson, 1990. Using the analytic hierarchy process for information system project selection. Inform. Manage., 18: 87-95.

Murphy-Hoye, M., H.L. Lee and J.B.J. Rice, 2005. A real-world look at RFID. Supply Chain Manage. Rev., 7: 18-26.

Niven, P.R., 2003. Balanced Scorecard: A Step-by-Step for Government and Non-profit Agencies. John Wiley and Sons, New York.

Reyes, P.M. and P. Jaska, 2007. Is RFID right for your organization or application. Manage. Res. News, 30: 570-580.

Roberti, M., 2004. A healthy ROI. http://healthyroi.net/.

Saaty, T.L., 1980. The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation. McGraw Hill, New York.

Saaty, T.L., 2004. Fundamentals of analytical network process: Dependence and feedback in decision making. J. Syst. Sci. Syst. Eng., 13: 129-157.

Santhanam, R., K. Muralidhar and M. Schniederjans, 1989. A zero-one goal programming approach for information system project selection. Omega, 17: 583-593.

Schmoldt, D.L., D. Peterson and D.G. Silsbee, 1994. Developing inventory and monitoring programmes based on multiple objectives. Environ. Manage., 28: 707-727.

Small, M.H. and I.J. Chen, 1995. Investment justification of advanced manufacturing technology: An empirical analysis. J. Eng. Technol. Manage., 12: 27-55.

Stewart, A.R., S. Mohamad and R. Daet, 2002. Strategic implementation of IT/IS projects in construction: A case study. Automation Construction, 11: 681-694.

Su, C.J. and T.C. Chou, 2008. Improving patient safety and control in operating room by leveraging RFID technology. Proceedings of the International Multi Conference of Engineers and Computer Scientists, March 19-21, Hong Kong, pp: 1-6.

Taghaboni-Dutta, F., A.J.C. Trappey, C.V. Trappey and H.Y. Wu, 2009. An exploratory RFID patent analysis. Manage. Res. News, 32: 1163-1176.

Tzeng, S.F., W.H. Chen and F.Y. Pai, 2008. Evaluating the business value of RFID: Evidence from five case studies. Int. J. Prod. Econ., 112: 601-613.

Vanany, I. and A.B.M. Shaharoun, 2008. Barriers and critical success factors towards RFID technology adoption in South-East Asian healthcare industry. Proceedings of The 9th Asia Pasific Industrial Engineering and Management Systems Conference, Dec. 3-5, Bali, Indonesia, pp: 148-155.

Wang, S.W., W.H. Chen, C.S. Ong, L. Liu and Y.W. Chuang, 2006. RFID applications in hospitals: A case study on a demonstration RFID project in a Taiwan hospital. Proceedings of the 39th Hawaii International Conference on Systems Sciences, Jan. 4-7, Los Alomos, pp: 1-10.

Wyld, D.C., 2006. RFID 101: The next big thing for management. Manage. Res. News, 29: 154-173.