The Role of Innovation in the Healthcare Supply Chain of Thailand

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***Abstract*-This research aims at analyzing the influence of innovation on the performance of organizations with reference to healthcare industry. The influence on organizational performance by SC efficiency, supplier cooperation, innovation, and quality management practices (QM) has been shown by the research model. The structural equation modeling was used to test the hypothesis and proposed research model. The data was collected from about 243 hospitals. It has been supported by the results that there is positive association between SC innovation constructs and organizational performance. A significant influence is created by the innovative design of supply chain on QM practices, suppliers' relation, and improvement of QM practices. The information was collected from a large sample of about 100 beds in the hospitals of Thailand. The sample size of hospitals may limit the result generalization. A useful information planning is provided by the study for healthcare sector. The research found that continuous improvements in innovation with the cooperation of supplier could result in the implementation of SC management successfully. This ultimately improves the performance of organization.**

Keywords: *Healthcare, supply chain, Thailand*

1. Background

There have been increase concerns about the safety of patients, medical errors and costs of medical over recent years in the health care [1]. For this reason, healthcare has become a critical issue. A crucial role is played by supply chain management in improving the performance of an organization in this intensively competitive world markets. Therefore, effective supply chain management plays a key role is achieving and sustaining competitive advantage [2, 3]. Organizations are required to offer high quality products and services in this competitive environment along with quick response service. There is need for organizations to develop capabilities as per the need of dynamics in business environment [4]. Efficiency operations are strived by organization including reduction in cost of delivery, value added improvement in process, improved product and service quality and close association with the suppliers.

The importance of effective SCM has been emphasized by several researchers in the healthcare sector [3, 4]. The diseases are prevented and treated such as cleaning, laundry, medical consumption; exercise equipment, information systems, general and home care products, etc. are included in the healthcare services [5].

In the healthcare industry, the biggest challenge in managing SC is the management of cost along with fulfilling the demands of customer. There is need for healthcare industry to invest about 55% of the total expenses of hospital in the SCM implementation by the year 2011 (Healthcare Financial Management Association, 2008). Innovation is the pre-requisite for organizations in the business processes for effective management of supply chain. Organizations can gain competitive advantage to improve the performance through innovation [6]. The innovation in supply chain refers to the complexity of process, in which environmental uncertainty evolves, to fulfill the needs of customers through technological improvements in the organizational processes [6, 7]. Organizations can achieve efficiency in supply chain through innovation resulting in greater value for the customers. Customer value is created through reduction in medical errors, better patient care, and efficient management of data. This results in positive influence on the performance of an organization. Customer value is created through innovations in information technology. This leads to efficiency and better delivery care services as well as improve care quality. A research model has been proposed in this study to show the way in which organizational performance is improved by innovation in SC through better suppliers' cooperation, practices of quality management and efficiency in SC. The data is collected from the management personnel in the hospitals. The following research questions are addressed by this research study:

- What is the influence of SC innovation on process improvement of SC?
- What is the influence of SC process on the performance of an organization?

2. Literature Review

2.1 SCM in the healthcare Sector

For providing quality care to the customers in healthcare, supply chain is an important part [31]. A set of organizations, which are associated with the upward and downward product, information and finance flow to the customer from a key source is referred as SC [8].

Significant attention has been drawn by SCM in the healthcare sector with the influence of SCM on performance of hospitals (i.e. reduction in waste, quality improvement, operational efficiency and reduced medical errors)[2, 9]. The internal chain including unit of patient care, storage, patient, hospital, and external chain including manufacturers, vendors, and distributors are included in the SCM of hospitals [2, 10]. Products and services are received by a hospital from the suppliers and then these are distributed and stored to carry on the operational processes of the hospital. The business activities such as suppliers' management, purchasing, and distribution are included in the business activities along with the operations, which integration a smooth flow of products and services for delivering healthcare [10].The simplest form of healthcare supply chain is shown in the figure 1.

Figure 1. Healthcare supply chain

There are three flows included in the SCM process in the healthcare sector [11]. These flows include the flow of information, the flow of physical product and the flow of finances. The customized products and services are customized in the flow of physical products for the patient treatment. The decisions related to SC designs are included in the flow of information and finances for effective flow of product to improve the performance of an organization [9, 11].

2.2 SC innovation

For organizations to sustain, it is important to innovate and acquire knowledge to compete in the service industry. There is need for service industries to focus on innovation [12]. According to Leathwick, Sauermann [13], the service industry needs to focus on innovation in supply chain for better delivery services. In healthcare sector, three types of innovations are crucial including integrator, technology based and customer focused [7]. The focus of customer focus innovation is on reduction of waiting time for patients, medical cost, and other expenses. The delivery system is improved in the technology-based innovation, which depends on supply chain. The focus is on the process improvement for offering high quality care to the customers such as preventing diseases; reduce time of service delivery and quality of products along with information technology. The efficiency is improved in the integrator innovation such as group purchasing, healthcare services, integration network, supply chain, and information technology. All the three innovation types are supported by the IT applications.

In order to improve the organizational performance, innovation in supply chain is a key success element with reference to the healthcare sector [2, 7, 11]. The tools, which can be used to improve the processes of organization, are involved in SC innovation to provide effective interaction among the manufacturers, customers, distributors, and suppliers. Therefore, cost and lead-time is reduced through innovation in supply chain by developing new strategies of operations, quality consistency, and flexibility in complying with business changing environment [14]. Quality healthcare services are supported with effective innovation in SC through continuous improvement and reduction in the medical errors [11]. Efficient product/service supply is ensured through innovation in SC to the hospitals in this dynamic business environment.

2.3 Supplier cooperation

An important strategy for long-term organizational growth is to increase coordination with suppliers. The government and management of hospitals are working to reduce the costs of mediation through effective purchasing. The functions of purchasing may include incorrect shipment or orders from the suppliers. The importance of developing cooperation with suppliers has been emphasized by Luthra, Govindan [15] in the healthcare sector. The organizations have to analyze the dimensions of supplier cooperation for selecting the best suppliers. The supplier cooperation dimensions are based on four qualities including delivery, price, service, and product quality [15].

In the study of Luthra, Govindan [15], the perception of respondents suggested that priority of healthcare sector is the product/service quality as compared to the reduction of cost. However, most of the governments have stressed on the need to lower cost as well. The responses of 299 respondents were examined by Luthra, Govindan [15] during a survey of almost 1,005 hospitals. The researcher found that out of 79 attributes of supplier coordination, the top 20 are grouped in the five main categories. These categories include the delivered products of supplier, actions of supplier, professional services in healthcare,

competence of sales representation and criteria related to service. It was shown by the results that suppliers receive large orders, which means the suppliers are chosen based on the cooperation criteria by the hospital [15]. Hospitals can achieve the SCM objectives by developing effective cooperation with the suppliers. The measurement items have been selected from Luthra, Govindan [15] for analyzing supplier cooperation.

2.4 SC efficiency

There is need to maintain a competitive position and advantage by the suppliers and organizations in this dynamic business environment for improving performance through operational efficiency in supply chain [16]. The reliability, flexibility, elimination of waste and profitability is included in SC efficiency. It can be different for every organization according the operational processes and criteria for improving response and delivery services through use of information systems [16]. It has been proposed by Searcy [17] that cost can be reduced and quality can be improved through effective selection of suppliers. It was suggested by Khan, Habib [18] that quality of service is improved and cost is reduced through efficient management of supply chain. The flow of information and cost has been stressed to achieve greater efficiency in SC in the process of acquisition. Value is created and added to the products' services through supply chain for the customers and components of costs such as products, transportation, internal handing of material, etc play the operational process role. An incorrect order and delivery cycle can incur cost along with complexity of transportation process, and product storage. A positive relation can be developed through information networks between suppliers and customers [16]. SC efficiency can result in numerous benefits such as increase in response, elimination of waste and network information within the customers and suppliers [16-18]. The delivery lead-time increased with the speed in response, customer consumption is captured, and operational response is reduced. The reduced steps are included in the process of waste elimination that leads to reduced cost of transportation and align the processes for reduction of waste [16]. The processes can be improved with the development of efficient information network processes result in ordering notices shipping and continuous replenishment.

2.5 QM practice

The use of latest ICT (information and communication technologies) has been necessitated by the growing pressure on organizations to innovation. The ICTs support the SCM and QM in the business processes, managing effective customer relationships and enterprise resource planning (ERP) to become competitive [19]. Innovation is required by the organizations to achieve competitive edge through efficiency in supply chain, quality care, satisfaction of customers based on core competencies. For providing high quality product/service, a key factor in the process of value addition is QM (quality management). The variance process, damage of shipping and time cycle of delivery is reduced through QM practice. The delivery time, customer relationships, reduction of waste, supplier coordination, and operational efficiency is improved by quality management through reduction of process variance. Nine measurements were developed for QM practice. These measurements include training, QM supplier, and quality of reporting data, leadership, and design of product/service, standard learning, employee, and customer relations. The QM practice is assessed through these measurements in the criteria of Malcolm Baldrige Award. The measurement items of quality management practices have been modified by this study based on Winter [20] that has governed the National Quality Award of Malcolm Baldrige.

2.6 Hypothesis development

2.6.1Supplier Cooperation and SC Innovation

Seamless collaboration and cooperation is required to be established by an organization with its suppliers to recognize strategic innovation [21]. The data collection is done at a shared center of distribution for retailers call warehouse [22]. The competent distributor partner can deliver the innovative products/service developed by an organization to the market with greater speed. Alternatively, that the supply chain innovation can be generated through supplier alliances. Government or WHO approval is required by the medicinal products such as medical devices and medications developed by manufacturers for using in hospitals. A close coordination relation is required between suppliers and hospitals for successful supply chain management. New ideas are provided by customers regarding the current products/services to the suppliers, which provided value added products through communication with vendors. Therefore, innovation is supported across the supply chain [22]. At initial stage of innovation, suppliers can be included in the process of packaging, transportation, storage, and product development [19]. Therefore, organizational processes can be improved through innovation in supply chain through suppliers' cooperation and new ideas. Similarly, a positive relation is possessed by SC innovation with supplier cooperation. Considering this, the following research hypothesis has been developed:

H1. Supply chain innovation place significant effect on the supply chain cooperation.

2.6.2 SC efficiency and SC innovation

Organizations are being forced to become effective and lean because of competition in the global business environment. Firms are working on innovation to improve

the operational efficiency in all the functions to become competitive [3, 17, 19]. The process for suppliers is streamlined through SC efficiency [22]. At the initial stage of innovation, the suppliers are involved in the process of storage, packaging, and transportation for efficiency in supply chain [19]. A high-speed process through use of IT is allowed through SC efficiency such as EDI and RFID. This supports communication and waste elimination [2, 22, 23]. A crucial role is played by SC efficiency in improving performance and speed, reduction of waste, improving information network and fostering innovation within SC. The lead-time is reduced, quality becomes consistent, and operational strategies are improved through innovation in SC [14]. In this way, the following research hypothesis is formulated:

H2: Supply chain innovation place significant effect on the supply chain efficiency

QM practices are included in SC innovation to improve the product quality, which results in high satisfaction of the customers. Better and innovation processes are developed by organizations in collaboration with their partners for improving organizational performance and customer satisfaction. Consistency of product quality is supported by innovation in SC. QM practice are influenced to reduce the variance of process and eliminate errors to rework [11, 14]. Therefore, the following research hypothesis has been formulated:

H3. Supply chain innovation place significant effect on the quality management practices

2.6.3 Influence on the Performance of an Organization

Customer expectations can be fulfilled by quality products developed by the suppliers. It is important to develop good supplier relation for improving performance and sustaining competitive advantage [15]. It has been suggested by Searcy [17] that the best suppliers can be selected through responsive market process and efficient physical processes to improve the performance of an organization. The suppliers can be selected based on quality and cost, when the company focuses on the efficiency physical processes. When the process of market responsiveness is kept priority, the suppliers are selected based on quality, speed, and flexibility. The competitiveness and performance of an organization is increased through development of long-term relations with customers and suppliers in SCM. Therefore, customer base can be expanded through establishing good relationship with the partners in SCM. The speed of process flow improves, and waste is reduced through operational efficiency. In this way, performance is enhanced and competitive advantage is achieved [16-18]. It has been proposed by Fowler, Peterson [24] that organizational performance can be achieved through effectiveness and efficiency in SC. The quality of products/service and organizational performance improves through role of QM practices.

It has been suggested that collaborative efforts be integrated with suppliers, which create a positive influence of the performance of an organization. The organizational performance is positive related with the efficiency of SC, cooperation with suppliers and QM practice. Meanwhile, it is being argued that the quality management, supply chain efficiency and supply chain cooperation mediates the relationship between supply chain innovation and the organizational performance the following research hypotheses have been formulated:

H4. Quality management practices has significant impact on the organizational performance.

H5. Supply chain efficiency has significant impact on the organizational performance.

H6. Supply chain cooperation has significant impact on the organizational performance.

H7. Quality management mediates the relationship between supply chain innovation and organizational performance.

H8. Supply chain efficiency mediates the relationship between supply chain innovation and organizational performance.

H9. Supply chain cooperation mediates the relationship between supply chain innovation and organizational performance.

3. Methodology

The survey-based method is used to achieve the objectives of the study. The information was collected from the sample of logistic managers in 243 hospitals of Thailand. The collected data has been used for testing the hypothesized relations. Use information has been added by this research to the managers and leaders of organizations in the healthcare sector. The partial least square method is used to analyses the data The partial least square structural equation modeling carries out in two steps, in its first step it undertakes the inner model estimation also known as measurement model, whereas in the second step, it estimates outer or the structural model. The measurement model for this research can be determined by assessing the different criterions, i.e. internal consistency or reliability, average variance extracted, and model validity. The measurements of variables are adapted from the prior studies

4. Statistical Analysis

In order to affirm the effectiveness of measurement model and if all the variables of the model are well observed, we used the confirmatory factor analysis (CFA). Therefore, all the elements of measurement model are separately analyzed through structural, formative, and reflective modeling. A factor loading of above 0.70 is obtained for all the items of the model.

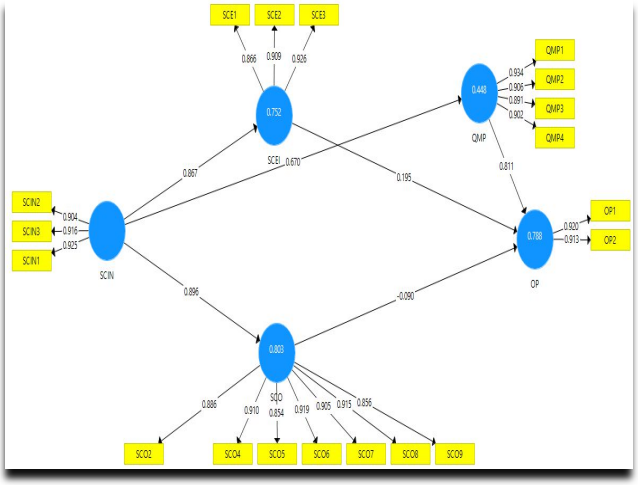

Figure 2. Measurement Model

A composite reliability test is carried out to assess reliability and internal consistency of latent variables involved in measurement model [25]. The composite reliability (CR) values turned out to be above 0.70 for all the variables of the model, which is consistent with the threshold level. In addition, internal consistency of latent variables is also analyzed by carrying out Cronbach alpha test, whose value must be above 0.70 to be acceptable [25]. The result of Cronbach alpha test for each construct exhibit $\alpha > 0.70$. In view of Hair, Sarstedt [26] and Bouwman, Daetwyler [25] researchers generally use average variance extracted (AVE) as a powerful measure for determining convergent validity. Therefore, convergent validity for this model is achieved as AVE>0.50, i.e. ranging from 0.511-0.725. Statistical findings of the measure indicate consistent outcomes in terms of internal consistency, reliability and convergent validity. However, we excluded those items from the model which have lower item loadings.

Table 1. Outer loadings

	OP	QMP	SCEI	SCIN	SCO
OP1	0.920				
OP2	0.913				
QMP1		0.934			
QMP2		0.906			
QMP3		0.891			
QMP4		0.902			
SCE1			0.866		
SCE2			0.909		
SCE3			0.926		
SCIN2				0.904	
SCIN3				0.916	
SCO2					0.886
SCO4					0.910
SCO5					0.854
SCO6					0.919
SCO7					0.905
SCO8					0.915
SCO9					0.856
SCIN1				0.925	

Table 2. Reliability

	Cronbach's Alpha	rho_A	CR	AVE
OP	0.810	0.811	0.913	0.840
QMP	0.929	0.930	0.950	0.825
SCEI	0.883	0.886	0.928	0.811
SCIN	0.902	0.903	0.939	0.837
SCO	0.957	0.958	0.965	0.796

Assessing a model's discriminant validity explains its uniqueness from other latent variables [26, 27]. A Tzempelikos and Gounaris [28] criterion is considered to observe the discriminant validity of measured constructs, however, it must exhibit value which is greater in comparison to correlations among other latent constructs. Table … presents the AVE square root values.

Table 3. Validity matrix

	OP	QMP	SCEI	SCIN	SCO
OP	0.917				
QMP	0.882	0.908			
SCEI	0.764	0.780	0.900		
SCIN	0.780	0.770	0.867	0.915	
SCO	0.734	0.775	0.809	0.896	0.892

R^2 can take any value between 0-1. An R^2 equal to 1 indicates that set of independent variables can completely predict the variation in dependent variables, whereas an R^2 of 0 indicates that variation in exogenous variable is not predictable by independent variables. For current study, R2=0.640 is obtained thereby indicating that 64% variation in dependent variable is predictable.

Table 4. R-Square

	R Square
OP	0.788
QMP	0.448
SCEI	0.752
SCO	0.803

Using first order construct, we estimated the hypothesized model. However, this model is estimated to determine the nature of association among the latent constructs. In addition, path coefficients are also observed to make decisions about the proposed set of hypotheses. Afterwards, the measurement model is altered to structural model with a purpose of observing any linkage among exogenous and endogenous constructs. The table shows the acceptance of all direct hypotheses, since they have shown significant outcomes. Meanwhile, by performing a bootstrapping procedure, significance of path-coefficients is observed, with 5000 bootstrap observations and 322 cases.

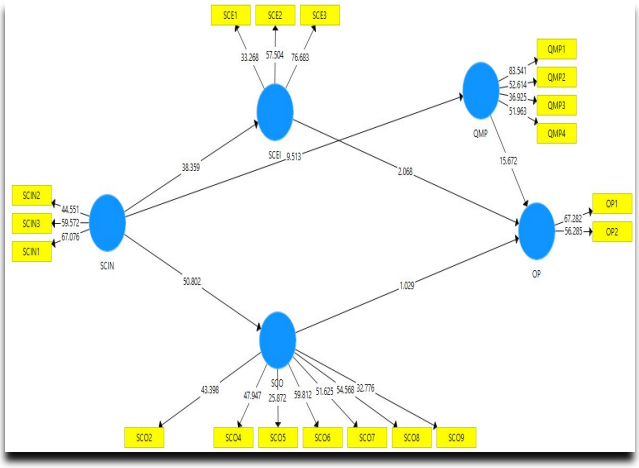

Figure 3: Structural model

Table 5. Direct relationships

	O	M	STDEV	T Statistics	P Values
QMP -> OP	0.811	0.804	0.052	15.672	**0.000**
SCEI -> OP	0.195	0.196	0.094	2.068	**0.019**
SCIN -> OP	0.631	0.630	0.066	9.536	**0.000**
SCIN -> QMP	0.670	0.669	0.070	9.513	**0.000**
SCIN -> SCEI	0.867	0.866	0.023	38.359	**0.000**
SCIN -> SCO	0.896	0.896	0.018	50.802	**0.000**
SCO -> OP	-0.090	-0.085	0.088	1.029	**0.152**

Table 6: Mediation

	O	M	STDEV	T Statistics	P Values
SCIN -> QMP -> OP	0.543	0.536	0.051	10.715	**0.000**
SCIN -> SCEI -> OP	0.169	0.170	0.082	2.070	**0.019**
SCIN -> SCO -> OP	-0.081	-0.076	0.079	1.026	**0.153**

Finally, after estimating the magnitude of R^2 as predictive accuracy measure, we then calculate the Stone-Geisser's Q^2 as a predictive relevance criterion. According to Henseler, Hubona [27] the inner model is expected to provide evidence regarding the predictive relevance of latent constructs. Although, in PLS path-modeling, generally a blindfolding procedure is performed by researchers to gain a cross-validated measure for the latent constructs. It is usually used for measuring the goodness of fit [29].

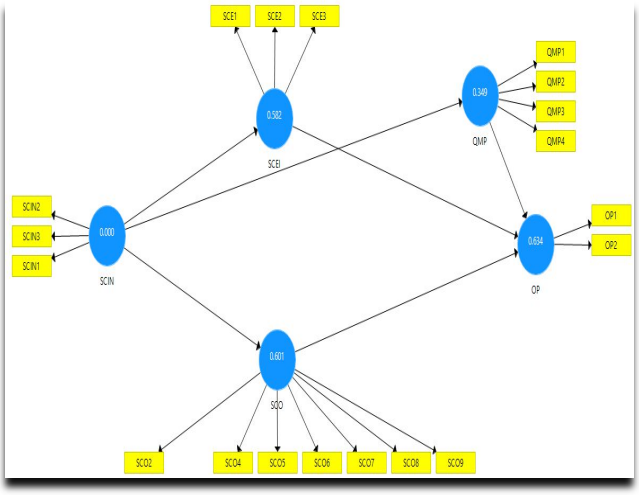

Figure 4: Blindfolding

Hair, Sarstedt [26] suggested that researchers should use certain measures while observing the models' predictive relevance [26].

Table 7: Q-square

	SSO	SSE	Q^2 (=1-SSE/SSO)
OP	434.000	158.768	0.634
QMP	868.000	564.796	0.349
SCEI	651.000	271.943	0.582
SCIN	651.000	651.000	
SCO	1,519.000	606.668	0.601

5. Conclusion and Limitations

Several important insights have been provided by this research related to the influence of supplier cooperation, QM practice, and SC efficiency on the performance of an organization. A significant influence is created through innovative SC design on the selection of suppliers, improving efficiency of SC and QM practices. This ultimately improves the performance of an organization. It has been implied by the results that there is need for the leaders to implement innovative ideas before the implementation of supply chain management. This will streamline the process of operations including the suppliers. The focus of healthcare system should be on the development of business strategy with innovation. For instance, the organizations should analyze the implementation of new resources and technologies in managing supply chain for achieving competitive advantage.

The organizational performance and cost reduction can be derived by QM in SCM when a positive relation is established by the suppliers and organization. Moreover, collaborative approaches are developed to ensure quality for customers. Both the organization can achieve competitive advantage through collaborative strategy. In order to improve the quality care in the supply chain of hospitals, there is need for organizations to develop strategies, which can be adopted by both organizations. Moreover, the SC activities should be recognized by hospitals to standardize the required material for lean supply chain. This can offer the best quality care at the reduced cost. Medical staff should participate in the standardization efforts of material. It should be analyzed that the hospitals pay the prices as per the contracts for equipment, materials, and care items. This is because of overpayment done by the hospitals to the suppliers (i.e. 2-7%) (Anderson, 2001).

The best industry practices are included in SCM for aligning the processes such as from ordering to the process of delivery. Efficient distribution and management is involved in these processes for the effective flow of

products and on time medical care delivery. The study has proposed a research model, which identifies the variables improving the performance of organization. The research model involves the relation between supplier cooperation, efficiency of SC, practices of QM and SC innovation. The information was collected from the sample of logistic managers in 243 hospitals of Thailand. The collected data has been used for testing the hypothesized relations.

Use information has been added by this research to the managers and leaders of organizations in the healthcare sector. It has been suggested by the results that continuous innovation in SC and supplier coordination results in the successful SCM implementation. This ultimately improves the performance of an organization. Excellent work environment is required by the leaders of an organization to achieve innovation in supply chain. This involves the provision of right resources for efficient processes, reduced errors, and high-quality care at reduced cost [2, 11]. Alternatively, the society can be benefited through these goals greatly through better quality of life and improved medical care. The significance of efficiency in SC and quality improvement can benefit the healthcare organizations. Therefore, SC efficiency and quality should be involved in the strategies of SCM. For ordering suppliers, the healthcare providers, using limited technology at their workstations, would depend on the manual standardized systems. These providers use limited technology in nursing, laboratory, administration, surgery, etc. Errors may arise in data entry leading to inaccurate ordering information by manual process. This can result in poor performance and inefficiency of SCM.

The speed of healthcare sector is slow in innovation and adapting to the changing needs of business environment in contrast to other sectors particularly in ICT. In 2003, 3.9% revenue was accounted by the healthcare sector out of the total IT investment in the work processes including SCM [30]. The potential benefits of IT implementation in SCM should be analyzed by the healthcare organizations including RFID, ERP, and barcode technology. These technologies can enhance the efficiency of supply chain by reduction in operational cost and supply replenishment.

The study has some limitations as well. The first limitation is related to the sample attributes. The study was conducted from the large hospitals having more than 100 beds. It was considered that the SCM is crucial for hospitals having less than 100 beds along with outpatient clinics. This involves maintaining relations with the key suppliers. The results of the study cannot be generalized as these have been analyzed on a limited sample size with distinct characteristics.

Moreover, the study is focused on healthcare sector of Thailand. The country is known a leader in ICT. In several hospitals, SMC has been implemented. Considering the level of cooperation between the downstream and upstream SCM of healthcare sector, the collection of information from Korea can be a limitation. The study has some future implications as well. The above stated limitations can be recognized in future studies along with longitudinal and cross-cultural researches on performance of organizations.

The research analysis can be used for some classifications including the information systems in SCM, hospital types, and total number of beds. Operations have been outsourced by some hospitals recently. Such hospitals can be different from others, which do not outsource in terms of management and strategies including the factors i.e. efficiency of SC, innovation of SC, cooperation with suppliers and practices of QM. The similarities and differences can be explored for the two groups of hospitals in future studies.

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