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Original Article

Information Sharing and Information Quality in the Drugs and Medical Consumables Supply Chain Management (SCM)

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Abstract

Information management is considered as one of the keys to the supply chain management (SCM) success. This study intends to explore the factors affecting the knowledge sharing and knowledge quality in the SCM of the drugs and medical consumables. This applied study was conducted using analytical-survey research method. The research population consisted of 78 people involved in the supply chain of the drug and medical consumables in the teaching hospitals of Isfahan University of Medical Sciences (IUMS). Data were collected by a questionnaire whose face and content validity were both confirmed by pooling the ideas of some professors of Health Information Technology and Health-care Services Management faculties of IUMS. The reliability of the questionnaire was validated by estimating Cornbrash's alpha coefficient (α=0.93). Data were analyzed using multiple regression analysis method and SPSS software version.23. Based on the results, the environmental uncertainty and intra-organizational facilitators had no impact on information sharing and information quality but inter-organizational relationships influenced the information sharing ($p = 0.01$) and information quality ($p = 0.001$). To achieve high-quality information sharing, establishing appropriate relationships with the other chain partners is of critical importance. Based on the results of the study, although there was no statistically significant relationship between the intra-organizational facilitators and environmental uncertainty and the information sharing and information quality, top management support, information technology (IT), appropriate selection of supplier and attention to the drug needs of the patients, should not be neglected.

Keywords: Drug and medical consumables supply chain management (SCM), Information sharing, Information quality.

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1. Introduction

Nowadays, competition is no longer between the organizations but the supply chains. As a result, the effective supply chain management has been known as a potentially valuable solution for securing the competitive advantage and improving the organizational performance [1]. Compared to their previous versions, the modern supply chains have become more complex, facing increasing challenges. Customer demands for innovative products, the significance of global economic condition as well as the environmental concerns have driven the companies and organizations to greater innovation [2]. The supply chain is composed of three main stages: the supply of raw materials, production and distribution covering three major cycles of materials, cost and information. Without information flows, no product can exist; hence, information flow is of particular significance [3].

In an effort to optimize the performance of supply chains, replacing the input flow and materials with the information in the supply chain has been targeted, since the information is less expensive than the inventory management; hence, higher levels of efficiency may be obtained by information management [4]. Timely access to the information and inter-organizational relationships management are considered as a potential source of business competitive advantage in the supply chains. Successful supply chain management mainly depends on the clarity of information as well as timely access to information factors, which in turn are attainable by the effective integration of the information resources [5].

Information sharing is one of the key components of SCM [6]. Information accessibility and sharing information with other supply chain partners bring a number of benefits for the enterprises including the following: increased information flow rate across the organization, enhanced efficiency and effectiveness of the supply chain, more rapid response to the changing customer demands, improved coordination between the supply chain processes, better materials flow, lower inventory management cost and increased innovation in the production of goods. Placing a positive effect on the customer satisfaction and collaboration and decision-making quality, sharing high quality information may result in increased supply chain integration [7].

Information flow management and information integration along the supply chain are one of the most hotly debated topics in the health-care research [2]. Hospitals operating budget account for approximately 30–40 % of the healthcare expenditures [8]. According to a recent report published by Ontario Buys and healthcare Supply

Network, supply chain management represents more than 20% of the total operating budget; nevertheless, the hospitals have not yet fully taken advantage from the benefits of the supply chain [9]. Although the majority of the hospitals mainly focus on the clinical and medical aspects, the costs relating to the supply chain and the provision of the equipment should not be underestimated. Nachtman and Pahl (2009) revealed that 31% of hospital's annual costs is being spent to support the supply chain—where 9% is being devoted to the inventory management, 10% to the orders management and 4% to the transportation management [10].

Due its critical effect on the human being health, the pharmaceutics industry has always been one of the pillars of the healthcare system. Based on 2010 Fortune, the global pharmaceutics industry is among the top most profitable industries throughout the world, ranking lower than Oil & Petrochemical industry but higher than some other industries such as foods, telecommunications, energy etc. [11]. One of the main problems in the drug supply chains is that the drugs are perishable products. In 2007, a supply of drugs, vaccines and other medical equipment with a worth of more than $1 million, stored in a warehouse belonging to the Ministry of Health in Chicago were found to be either been deteriorated, stolen or not included in the calculations in 2007 [2].

The main purpose of information sharing in the drug supply chain is information redundancy prevention [3]. The impact of the information sharing on the performance of the supply chain depends on "what information is shared, how, when and where it is shared and with whom". To facilitate the high quality information sharing across the drugs supply chains, it is necessary to identify the factors impacting the information sharing so that Identifying an appropriate strategy may be found to facing barriers to the information sharing and enhance the integrated information flow in the drugs supply chains [6].

The factors influencing the information sharing in the SCM have been extensively discussed in the literature. Nevertheless, a very few number of the extant researches have simultaneously examined the impact of environmental uncertainty, intra-organizational facilitators and inter-organizational relationships on the information sharing and information quality in the SCM. Particularly, information sharing in the healthcare supply chains management has not clearly been highlighted.

In Iran, there has been limited research on the healthcare supply chains (such as the supply chains of the drugs and medical consumables) mostly focused on specific aspects including the identification and evaluation of the risks in the respective supply chains, the impact of IT enablers on the SCM, provision of information systems and simulation of the supply chains, without taking into account the factors affecting the information sharing and information quality in SCM. Accordingly, the purpose of this research was to simultaneously examine the impact of the environmental uncertainty (the

customers uncertainty, supplier uncertainty and IT uncertainty), intra-organizational facilitators (top management support and IT enablers) and inter-organizational relationships (trust in supply chain partners, commitment of supply chain partners and shared vision between supply chain partners) on the information sharing and information quality in the drugs and medical consumables SCM.

2. Materials and Methods

This study is of applied nature conducted using analytical-survey research method. Research population consisted of 78 subjects involved in the drugs and medical consumables including the manager of the hospital, the technical authority of the pharmacy, the hospital internal manager, drugs storekeeper, medical consumables storekeeper, imprest account holder, the procurement authority, accounting authority, supervisor and IT expert selected from teaching hospitals of IUMS. Data were collected using a questionnaire developed based on a study (2006) entitled "Accessing Information Sharing and Information Quality in Supply Chain Management". In the designed questionnaire, the impacts of environmental uncertainty (the customer's uncertainty, supplier uncertainty and IT uncertainty), intra-organizational facilitators (top management support and IT enablers) and inter-organizational relationships (trust in supply chain partners, commitment of supply chain partners and shared vision between supply chain partners) on the information sharing and information quality in the drugs and medical consumables SCM were investigated. (Figure 1)

The face and content validity of the questionnaire was confirmed by pooling the ideas of some professors from Health Information System Health Information and Healthcare Management Services faculties of IUMS. In the same vein, the reliability of the questionnaire was validated by estimating the Cronbach alpha ($\alpha = 0.93$). Data were analyzed using multiple regression analysis method and SPSS software V.23 at significance level of 0.05.

3. Results and Discussion

From among 78 respondents, 62.8% were male. The average age and average job experience of the respondents were found to be 40.8 ± 46.34 and 15.68 ± 8.64, respectively. Furthermore, 43.6% of the respondents had BSc. degree. In this study, the information sharing and information quality were the dependent variables while the environmental uncertainty, intra-organizational facilitators and the inter-organizational relationships in the supply chain were treated as the independent variable. To analyze the data, firstly, information sharing and information quality and the factors influencing them were evaluated based on mean scores estimation. This was followed by the regression analysis in terms of each dependent variable. Prior to conducting the regression analysis, the data normality was checked by using Kolmogorov–Smirnov test. The final

significance level obtained from these two tests was found to be higher than the assumed value of 0.05; hence, the normal distribution of the dependent variables was confirmed, allowing the regression analysis usage. The results obtained from Kolmogorov–Smirnov test have been summarized in table 1.

In tables 2 - 4, the results of regression analyses in terms of each dependent variable have been presented. In addition, the mean scores obtained for the dependent and independent variables in terms of their components have been rendered in table 2.

As is evident from table 2, the mean score and standard deviation for the information sharing and information quality were calculated that were found to be 22/36 and 4/82 and 42/60 and 4/76, respectively. Furthermore, the technology uncertainty with a mean score of 13/18 and standard deviation of 1/63 had the lowest distance from the upper limit while the top management support had the highest distance from the upper limit (a mean score of 16/57 and standard deviation of 15/57). In other words, the top management support had obtained the lowest score.

As the results summarized in table 3 indicate, there was only a statistically significant association between hospital's inter-departmental relationships and information sharing in the drugs and medical consumables SCM in the teaching hospitals of IUMS (p=0.01) without revealing any significant association for the remaining variables. Given the VIF value being lower than three, this result is acceptable. Besides, the tolerance of the independent variable i.e. inter-departmental relationships in the hospital was found to be over 0.85, indicating that only 15% of the factors beyond the inter-departmental relationships may account for information sharing variations. The results of regression analysis obtained for each possible factor impacting the first dependent variable have been summarized in table 4.

As per table 4, only the inter-organizational relationships was significantly associated with the information quality (p=0.001) in the drug and medical consumables SCM in the teaching hospitals of IUMS. However, no statistically significant association was observed for the remaining variables. These results are justifiable given the VIF value that was found to be lower than three. The tolerance value obtained for the inter-organizational relationships was over 0.82. This indicates that only %18 of the factors being out of the inter-organizational relationships may account for the information quality variations.

To have an effective SCM, efficient associations should be established between different partners involved in the supply chain. The partners in the drugs and medical consumables supply chain include the hospitals, the sellers and suppliers of the drugs and medical consumables while the staff top management include the Drugs & Foods Deputy, Supporting Deputy and Healthcare Deputy. In this research, the relationship between the hospitals, which have drug interactions, the relationship between the vendors and suppliers of the drug

products and medical consumables, as well as the relationship between the hospitals and deputies of Drugs & Foods, Support and Healthcare have been taken into account. As far as the information-sharing domain is concerned, the following issues were studied: the awareness of the changing demands, the exchange of proprietary information as well as the knowledge interactions in relation to the main business activities. Finally, the information quality was examined based on the inter- and intra-hospital information exchange with the sellers and suppliers in terms of the timeliness, accuracy, relevance, completeness and reliability components of data.

The results of the research indicated that there was no statistically significant association between the environmental uncertainty and information sharing (p=0.94) and information quality (p=0.13). More clearly, the environmental uncertainty had no impact on the information sharing and information quality. As Gupta & Wilemone have argued, the environmental uncertainty is a product of the interaction among the following four factors: increased global competition, continued development of the modern technologies, shorter product life cycles and increased need to the involvement of the external organizations such as suppliers and customers [6]. According to Yu, there are three distinct sources of uncertainty influencing the supply chain that are as follows: the suppliers, customers and producers [12]. Ettlie & Reza have stated that the environmental uncertainty comes from the unanticipated changes of the customers, suppliers and information technology [6].

In this research, the environmental uncertainty was examined from three aspects of the customer uncertainty, supplier uncertainty and technology uncertainty while the customer uncertainty has been explored based on the ordering variability and changing consumer preferences. Similarly, the supplier uncertainty was explored based on the following factors: the unpredictability of the technical and applied support provided by the suppliers, unpredictability of the suppliers' product quality and supplier's lead-time. Finally, the information technology uncertainty was studied based on factors such as the effect of the IT variability and progress in creating the competitive opportunities, producing the innovative products and the creation of new production ideas.

As Li & Lin report, the environmental uncertainty in general and the supplier uncertainty in particular may place a negative effect on the information sharing and information quality [6]. Talarposhti has claimed that hospitals would gain the competitive advantage if they can rapidly respond to the increasingly variable consumer demands [13].

According to the results of one study by Mehrolhasani et al. in Kerman, appropriate selection of supplier and non-compliance with standard time of purchase and delivery of goods negatively affect the supply chain performance [14]. The results of this study on the lack of association between the information sharing and information quality

contradicted those reported in Li & Lin and Mehrolhasani et al. [6, 14]. This discrepancy seems to result from the differences in the populations studied. The drugs and medical consumables supply chain in the hospitals are of a servicing nature while the previous researches have taken into account the productive aspects of the supply chains.

The results of this study revealed that the intra-organizational facilitators were significantly associated with neither information sharing (p=0.66) nor information quality (p=0.47). To put it differently, the intra-organizational facilitators have no impact on the information sharing and information quality. In this research, the intra-organizational facilitators included the top management support and IT enablers. The factors studies in the top management support domain included the following: consideration given by the managers to the relationships between the hospitals, the relationships between the hospitals and suppliers and sellers, the supply of the required resources as well as the position of the drug and medical consumables SCM in the priority list of the top managers. At last, for the IT enabler's domain, the application rate of different information technologies was examined.

According to one study in USA by Li and Lin, there was a statistically significant association between the intra-organizational facilitators and information quality with the top management support having a positive effect on the information sharing but not on the information quality [6]. Another study by Pule on the national medical stores of Uganda reported that the service delivery is positively influenced by the SCM (including three factors of information processing, information flow and information storage) [15]. Chukwu et al. in their study found that the Nigerian pharmacists have a limited understanding of and preparation for in the drugs supply chain management. 84.1% of the respondents in this study asserted that the pharmacists in Nigeria are not still prepared for the management of the drug chains. This lack of understanding can be attributed to the insufficient infrastructures and skills in the SCM, weak financial resources, weak management and "evasion of responsibility" [16]. Hua-li et al. study in China provided some evidence that the hospital information systems (HISs) do not support the drug supply chain and drug logistics. As a result, the documentation management is performed manually, consequently creating an information gap between the drug suppliers and hospitals [17]. In the same vein, Kritchanchai and Suwandechochai in their study in Thailand concluded that there is no appropriate association between the internal supply chain in the drug inventory system, the drug store of different departments of the hospital, the central store and purchasing department of the hospital in question [18].

According to the study by Mehrolhasani et al. the weakness in the information system in use in the supply department and lack of appropriate link between this department and the other departments of the hospital have led to some errors in the SCM which would be remarkably lowered by the implementation of

office automation system and electronic facilities [14].

According to Yousefi and Alibabaei, the application of the information systems along the supply chains would not only bring in numerous benefits for the drug organizations and medical centers but also it has particularly significant social and political advantages. It is noteworthy that the implementation of such systems is not a straightforward process; hence, "the proper design of all the levels of an information system and paying enough attention to barriers of performance and probable risks and challenges are highly recommended in order to be successful in establishing a prosperous information system" [19]. The results of this study on the lack of a statistically significant association between the intra-organizational facilitators and information quality are in full compliance with those obtained in Li & Lin research [6].

Furthermore, it was found that the inter-organizational relationships are significantly associated with both information sharing ($p=0.01$) and information quality ($p=0.001$). To put it differently, the inter-organizational relationships affect both the information sharing and information quality.

In the present study, the inter-organizational relationships in the supply chain were studied in terms of the following items: the trust in the supply chain partners, the commitment of supply chain partners and shared vision between supply chain partners. The trust itself was examined based on trust-creating behavior, the information confidentiality and lack of need to the direct supervision factors; the commitment based on the recognition of the good faith between the business partners, investment on establishing stronger associations, abiding by the administrative agreements and laws by the supply chain partners. The shared vision between the supply chain partners was investigated based on the following factors: similar understanding about the objectives and aims of supply chain, the significance of the collaboration across the supply chain and the importance of the improvements that benefit the supply chain as a whole.

According to Li & Lin study, the information sharing and information quality are positively affected by the trust and shared vision between the supply chains collaborates [6]. Similarly, the study by Koçoiluai et al. revealed that the supply chain partner's integration may positively influence the information sharing and the supply chain performance leading to promoted relationships, coordination and collaboration between the supply chain partners [20]. As Rajabzadeh et al. argue, the speed of service delivery, planning and trust promotion are considered as the main factors playing a part in the drug supply chain agility [21]. The result of this study on the statistically significant association between the inter-organizational relationships and information sharing and information quality was found to comply with the obtained in studies by Li & Lin, Koçoiluai and Rajabzadeh [6, 20, 21].

According to the findings of this study, there was only a statistically significant

association between information sharing and information quality and the inter-organizational relationships in the supply chain. To put it another way, the inter-organizational relationships in the supply chain had impact on the information sharing and information quality. However, the environmental uncertainty and intra-organizational facilitators had no impact on the information quality and information sharing. In case the relationships between the drug and medical consumables supply chain partners is built based on factors such as the trust-creating behavior, information confidentiality, good faith, abiding by the agreements and administrative laws, similar understanding about the objectives and aims of the supply chain and similar understanding about the collaboration across the supply chain, the various supply chain partners would tend to trust each other and share the required information. Hence, the increased trust, commitment and shared vision between the supply chain partners would improve the information sharing in the drugs and medical consumables supply chain. As a result, it can be concluded that for having an efficient supply chain management, effective relationships between its various trading partners should be established.

The hospitals are dynamic environments; hence, they should have the required preparation for facing the unexpected changes and force majeure conditions including the epidemic, natural disasters and war so that they can meet their requirements under all the circumstances. The hospitals continuously face the budget shortage, a fact that makes them to exploit their resources as fully as possible. The customers of the drugs and medical consumables supply chain are the patients and medical staff. The physicians tend to prescribe the drugs based on the patient's need on the one hand and the hospitals are well aware of their drug requirements on the other, rarely facing unanticipated changes in the drug and medical consumables orderings. In fact, the hospitals usually have no drug ordering variability. Furthermore, the managers of the pharmacies and people involved in the procurement and storage departments completely know their hospital drug demands. Accordingly, the customers could not be regarded as a factor of uncertainty.

Thanks to their experience, the hospitals under study completely knew the suppliers of the drugs and medical equipment and their products quality. As far as supporting the suppliers is concerned, the financial support by the supplier companies is of particular significance, because the hospitals often are indebted to the supplier companies due to their financial problems. Accordingly, in case of being financially strong, the supplier companies can survive despite the delayed payment by the hospitals. It is noteworthy that to survive in the highly competitive context of the drug market, the companies are required to take into account factors such as the delivery time and the features and quality of the products. As most of the people argue, the suppliers commonly fulfill their obligations regarding the time of delivery and

the main problem is the budget shortage of the hospitals. As a result, the suppliers should not be regarded as a source of uncertainty.

Besides, the hospitals tend to use specific information systems, namely the hospital information system, pharmacy information system and Accrual Accounting system. It seems that these systems have no impact on the creation of innovative ideas and drug products manufacturing. In addition, these systems users do not show much willingness towards the creation of new drugs and only prefer to have a routine workflow. Instead, the manufacturing companies are generally interested in the production of new drugs. Taking all these into account, IT should not be considered as a source of uncertainty.

Hospitals always have the resources scarcity problem, especially the financial and human being resources. The managers perform the resources allocation in the hospital. If the managers fully understand the significance of the problems in the drug and medical consumables supply chain, place them on the top of their priority list and make appropriate decisions, a large number of the existing problems will be resolved. Most of the people know supervision a necessity under all circumstances, even if the mutual relationships were built on trust and intimacy especially in the drug domain where lack of supervision would result in the profiteering.

One main issue in the inter-organizational relationships in the supply chain is abiding by the agreements. Most of the respondents held the opinion that it is the hospitals that break their promises. In consequence, the hospitals are recommended to try their best to avoid drugs and medical consumables shortage.

Due to having similar work contexts, the hospitals with drug exchanges would exhibit greater consensus. Nonetheless, it is completely natural that the companies mainly show profiteering behaviors because of the business nature of their job. In contrast, the hospitals in general and the public hospitals in particular are required to pay more attention to the provision of safe and high quality medical services including the appropriate diagnostics and rehabilitation for the patients. Despite this, the business enterprises should regard the hospitals as the major member of the supply chain so that they can maintain their competitive position.

4. Conclusion

The results of this study indicated that to improve the information sharing in the drugs and medical consumables supply chain, the inter-organizational relationships is a necessity. Therefore, spending time and effort for establishing appropriate relationships with the supply chain partners is of high value in moving towards information quality and information sharing promotion. In the present research, the drugs and medical consumables supply chain included the hospitals, vendors and suppliers of the drugs and medical consumables and staff top management (i.e. Deputy of Food and Drug, Deputy of Support and Deputy of Treatment). This study revealed that the intra-organizational facilitators and environmental uncertainty are not significantly associated with the

information sharing and information quality. Nonetheless, it should be noted that top management support, IT (as both a source of uncertainty and an efficient tool for the progress and performance promotion), appropriate supplier selection and paying attention to the drug needs of the patients as the final customers of the drugs and medical consumables supply chain should not be ignored.

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Tables:

Table 1. Preliminary tests of information quality and information sharing.

Kolmogorov–Smirnov test	*Test value*	Level of significance (p-value)	Conversion	Final result after conversion	Examination of Residuals
Information sharing	0.08	0.20	Not necessary	-	Normal
Information quality	0.12	0.005	Necessary	Normal ($p<0.05$)	Normal

Table 2. Examination of the mean scores obtained for the dependent and independent variables.

Variable in in question	*Standard deviation ± mean score*	*Highest score*	*Lowest score*	*Components*	*Standard deviation ± mean score*	*Highest score*	*Lowest score*
Information sharing	22/26±4/82	30	6	-	-		
Information quality	42/60±4/76	50	10	-	-		
Environmental uncertainty	33/35±4/81	45	9	Customer uncertainty	7/18±1/63	10	2
				Supplier uncertainty	12/91±3/02	20	4
				IT uncertainty	13/18±1/63	15	3
Intra-organizational facilitators	80/20±18/08	105	21	Top management support	63/62±15/57		
				IT enablers	16/57±5/57		
Inter-organizational relationships	84/42±11/33	110	22	Trust in the supply chain partners	21/51±4/02	30	6
				Commitment of the supply chain partners	39/05±5/74	50	10
				Shared vision between the supply chain partners	24/03±4/21	30	6

Table 3. Examination of the impacting independent variable and its coefficients on the information sharing.

Variable in question	Effective regression coefficient	The significance level of the effective coefficient	Standard deviation of the effective coefficient	VIF factor	Tolerance
Model's constant	10/04	0/16	7/12	-	-
Environmental uncertainty	0/01	0/94	0/13	1/21	0/82
Intra-organizational facilitators	0/07	0/66	0/03	1/27	0.78
Inter-organizational uncertainty	0.12	0.01	0.05	1/10	0.85

Table 4. Examination of the effective independent variable and its coefficients on the information quality.

Variables in question	Effective regression coefficient	Significance level of effective coefficient (p-value)	Standard deviation of effective coefficient	VIF	Tolerance
Model's constant	3/14	0/00	0/16	-	-
Environmental uncertainty	0/005	0/13	0/003	1/20	0/83
Intra-organizational facilitators	-0/001	0/47	0/001	1/20	0/77
Inter-organizational relationships	0/005	0/001	0/001	1/21	0/82

Figures:

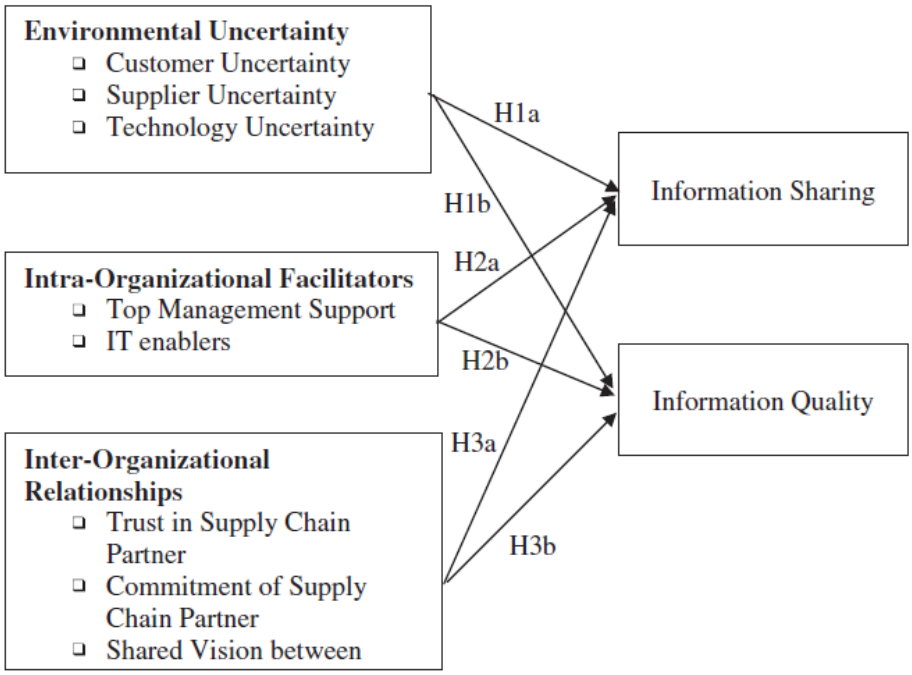

Figure 1. Preliminary research model (6).

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