How schedule issues affect drug logistics operations: an empirical study in hospitals in China

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Abstract

Purpose – The drug logistics play a crucial role in the hospital service performance. It has been proved that modern logistics concept is a valid access to competitiveness. In order to enhance the comprehensive capability and core competence of hospitals, including the internal support system, there is a great need to have an in-depth and systematic study on the drug logistics system in hospitals. The purpose of this paper is to explore the current situation of the drug logistics and the drug centres operations in public hospitals in China; specifically how the organizational partnerships with the supply chain partners can affect the operational performance.

Design/methodology/approach – In this study, the possibility of correlations between schedule instability, partnerships with supply chain partners, and internal drug logistics operation is investigated by modelling, with reference to the previous work of Law *et al.* (2009), in which collective efficacy of the performance is incorporated into the model.

Findings – The findings of this study show that the drug logistics working teams in public hospitals in China have a high level of efficacy and self-confidence, while they perceive they provide good operations even at a low level of schedule nervousness. The study also reinforces the significant correlation between internal operation and partnership with customers. This is definitely useful for the development of an appropriate framework for drug logistics operation improvement in the long run.

Originality/value – The study thus offers a good reference for the administrators and practitioners who are keen on improving the service operations in the healthcare sector in the region.

Keywords China, Collective efficacy, Drug logistics, Public hospitals, Supply chain partners

Paper type Research paper

Introduction

Organizations are constantly confronting challenges in regard to changes in production or service logistics. With fierce competition in the healthcare market, quality service, operational efficiency and cost control have become hot topics and strategic goals for hospitals. The benefits of the integration of supply chain operations are widely acknowledged today, as the involvement of supply chain partners has been shown to contribute to the overall performance of the supply chain operation. Good co-ordination and relations with suppliers and customers are important in acquiring external resources in a timely fashion and in reducing uncertainties in the business operation. As a result, extensive research has been done on understanding how the various factors in the supply chain contribute to operational performance. Optimal logistics management contributes not only to lower operational cost, but also improves performance efficiency, medical service and as well patients' satisfaction.

The drug logistics industry in Mainland China has been developing rapidly in recent years (Zhang, 2015; He *et al.*, 2012; Wang, 2013; Sun, 2014). It has been shown to be of very important societal concern according to some studies by local researchers (Zhang, 2015; Liang and Jiang, 2010; Zhi, 2008; Wu, 2006; Wang *et al.*, 2006). In order to enhance the comprehensive capability and core competence of hospitals, including the internal

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support system, there is a great need to have an in-depth and systematic study on about the drug logistics system in hospitals.

This study thus aims to explore the current situation of the drug logistics operations in public hospitals in China; specifically how the relationships with the suppliers and customers can affect the operational performance. The possibility of correlations between schedule instability, relationships with supply chain partners, and internal drug logistics operation is investigated by modelling, in which the collective efficacy of the performance is incorporated.

Literature review

Factors affecting logistics operations

Previous research has empirically examined the relationship among the various factors affecting logistics operation, e.g. the impact of supplier and customer involvement on new product development processes and operations (Frishammar and Horte, 2005; Brown and Eisenhardt, 1995; Wong *et al.*, 2011). In line with the concept of supply chain or logistics management, supplier and customer involvement activities include the business processes that integrate the supplier and customer with the manufacturer or the internal operation of the manufacturer (Rosenzweig *et al.*, 2003; Sarkis *et al.*, 2007; Vickery *et al.*, 2003; Law, 2009; Law and Pujawan, 2009; Law *et al.*, 2009). There are many studies in the literature relating to the impact of instability or nervousness of scheduling on the performance, but not specifically in the medical services sector. In the literature, a number of terms have been associated with frequent changes to scheduling. Several authors called it schedule nervousness or schedule instability (Zhao *et al.*, 2001; Sridharan and Laforge, 1990; Kadipasaoglu and Sridharan, 1997; Law *et al.*, 2009). Frequent changes in logistics schedules can be very disruptive. Changes in schedule are due to various reasons which include uncertainty in demand and supply which frequently occur in operations. These often occur in both production and service operations (Law *et al.*, 2009; Phusavat *et al.*, 2010; Law, 2011). Continuous changes in the schedule can undermine management's confidence in the system and result in disruptions in the delivery systems (Blackburn *et al.*, 1985, Kafetzidakis and Mihiotis, 2012; Pan and Pokharel, 2007; Law and Pujawan, 2009). These disruptions will lead to changes in personnel scheduling, fluctuation in capacity utilization, rescheduling costs, confusion in delivery schedules, increased inventory, increased freight cost, extra material handling, more complex record keeping and managerial intervention (Inman and Gonsalvez, 1997).

The drug logistics operations in healthcare sector

Logistics operations is also a vital part in "service" industries (Law, 2011). Considering the healthcare sector, particularly in hospital management, drug management is one of the most important aspects, because of the demanding requirements and wide range of categories of drugs. The fundamental goal is often described as meeting the "five R's" or five rights: to administer the right drug at the right dose through the right route and at the right frequency to the right patient (Benjamin *et al.*, 2003). In this case, drug logistics operations play a crucial role in the hospital service operation performance (Kafetzidakis and Mihiotis, 2012; Pan and Pokharel, 2007).

The logistics of handling drugs along the supply chain (between suppliers, drug stores and end users) in hospitals differ significantly from the classical material flow in other industries, which involve the suppliers, manufacturers and customers.

Continuous changes in the schedule can undermine the confidence in the system and result in disruptions in delivery systems (Pan and Pokharel, 2007).

Optimizing drug logistics management not only leads to the lower operating cost, and more efficient logistics, but also greatly improves the efficiency of hospital/clinics services operations and the quality of service.

Kim and Schniederjans (1993) stressed the importance of material management systems in the healthcare system. Effective material management, say from a resources-based view, can bring down healthcare costs (Heinbuch, 1995; Verona, 1999; Pan and Pokharel, 2007; Kafetzidakis and Mihiotis, 2012). Aptel and Pourjalali (2001) compared logistics parameters in hospitals in France and the USA. It was observed that, although hospitals provide critical services and require unexpected levels of inventory, JIT deliveries can be used to minimize the inventory cost in hospitals.

Some hospitals have normalized the operation of logistics system or adopted various kinds of scheduling approaches to logistics activities (Lapierre and Ruiz, 2007; Pan and Pokharel, 2007; Kafetzidakis and Mihiotis, 2012). On that basis, invalid operation can be eliminated and the inventory will be controlled reasonably and maintained at balanced inventory levels, and it also ensures an unobstructed inbound channel (Moschuris and Kondylis, 2006).

Drug logistics in hospitals in China

With the reformation to the healthcare sector in the recent decade, more detailed descriptions of the healthcare system in China have been documented. One of the key problems in the healthcare system in China is the high cost of drugs and poor logistics management, while the other key problems are mainly related to strategic and governmental issues. Therefore, at the operational level, it becomes a critical issue to determine a clearer picture about the drug logistics operations. China's domestic drug logistics system has undergone four stages (Table I).

Period	Economy background	Characteristics of drug logistics
1949-1978	Central planned economy	The government controlled drug logistics completely and enforced strict regulations on drug quality and prices Flow of drugs was limited and hospitals at different levels purchased drugs only from different wholesalers Lack of study on drug logistics
1978-1992	In the transition from planned to market economy	Decentralized drug circulation system while monopoly still existed Drug manufacturers realized the importance of logistics research Drug logistics emphasized on cost reduction through strengthening internal management, especially warehousing
1992-2000	Socialist market economy is initially built	Private capital entered the drug logistics field and the monopoly of state-owned enterprises was broken Logistics function was expanded to distribution, delivery
2000-	Market economy system is perfect progressively	Primary application of modern logistics, the third party logistics and information technology Drug logistics industry is opened to foreign and domestic investment Weak functional and logistics standardization infrastructure Lack of expertise logistics management personnel

Table I.
Drug logistics in the recent six decades in China Hospitals

Though the drug logistics industry in Mainland China is still not as competitive as most of the developed countries in the West, it is anticipated that there is space for improvement, in both operation efficiency and service quality.

The industry. Recent national policies (Ministry of Commerce, 2011; The Central People's Government, 2009, 2015) proposed previously, have highlighted the importance of reforming the drug logistics industry. Theoretical and application research in this field is encouraged, with the aim of providing valuable references for policy design. One of the critical challenges in the medical reform is the drug logistics systems in hospitals (Ji *et al.*, 2013; Jiang, 2011). Specifically, the instability of operations and the low efficacy level of personnel working in these systems have been noted (Chu *et al.*, 2013; Li, 2013).

Necessity of further research. With recently launched polices, drug logistics operations in public hospitals in China are in the spotlight. Hospitals are eager to advance their drug logistics operations for higher efficiency and improved medication safety (Yang, 2013; He, 2011; Gu *et al.*, 2007). In this case, business partners in the industry, possibly the suppliers, would have more opportunities to collaborate with the hospitals to work out better logistics systems. This increasing demand calls for further research on a better understanding of how the supply chain partners in the industry are working together and how they affect logistics operations.

This study aims to explore the current situation of drug logistics operations in public hospitals in China. Some important questions are posed, such as:

RQ1. Is there strong relationship between drug delivery suppliers and customers?

RQ2. What are the impacts of the supply chain partner relationships (customers and suppliers) on the drug delivery operation performance?

Theoretical model and hypothesis development

Theoretical model

In this study, the possibility of correlation between schedule instability, partnerships with supply chain partners, and internal drug logistics operation is proposed, with reference to the previous work of Law *et al.* (2009). Collective efficacy on performance is incorporated into the model. Collective efficacy here refers to the confidence of the team in performing scheduling-related tasks. These include the collective efficacies in having efficient scheduling, achieving goals, maintaining good partnerships with both drug suppliers and customers (medical practitioners and patients) and as well maintaining high levels of excellence in operation. The research model is presented in Figure 1.

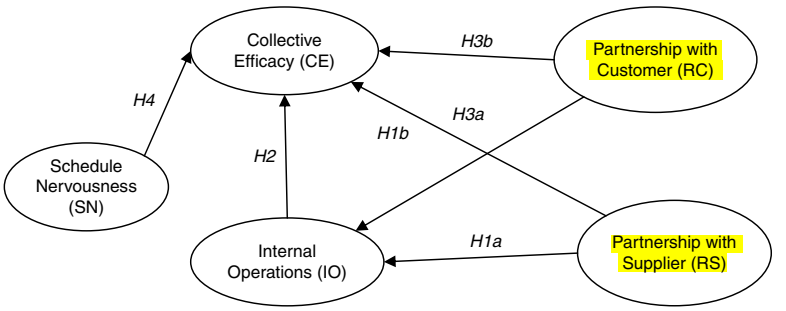


Figure 1.
The hypothesized research model linking collective efficacy and various actors

Hypotheses development

Dealing with the increasingly shorter service operation cycles, drug centres in hospitals require accurate and timely information to enable planning of operations and relevant medication deliveries. Following the principle of operation management, reduction of inventories is also an objective (Metters, 1993; Meixell, 2005; Krajewski *et al.*, 2005; Gunasekaran and Ngai, 2005; Sridharan and Laforge, 1990). In order to maintain low levels of schedule nervousness, good partnerships with business partners such as suppliers and customers, are crucial, and the internal operation performance should also be taken into account (Figure 1).

Internal operation includes various factors within a hospital, such as drug store inventory system, procurement, material flows, human factors, and the schedule system. The benefits of the linkages with drug suppliers and customers (end users) on internal operation have been confirmed by previous research (Watts and Hahn, 1993; Ellram, 1991; Choi *et al.*, 2001; Law *et al.*, 2009). Studies confirmed the understanding between the benefits in terms of enhanced internal operational processes and the linkages with suppliers and with customers. The information exchange among supply chain partners lead to improved supply chain operations in terms of quality and efficiency (Armistead and Mapes, 1993; Towill *et al.*, 2002). Studies have shown the internal operational performance can be improved by well managed partnerships with both supply chain partners (Narasimhan and Jayaram, 1998; Groves and Valsamakis, 1998; Salvador *et al.*, 2001). With better supply chain partners, hospitals can expect better drug logistics operational performance. To summarize, the impact of supply chain linkages on a hospital's internal drug logistics operation has received due visibility and recognition (Rungtusanatham *et al.*, 2003). Therefore, we hypothesize the positive relationships between internal drug logistics operation and the partnerships with supply chain partners. It is further elaborated to:

H1. A strong organizational partnership between supply chain members (supplier and customers) has a positive influence on the internal operations of drug logistics.

H1a. A strong organizational partnership with suppliers has a positive influence on the internal operations of drug logistics.

H1b. A strong organizational partnership with customers has a positive influence on the internal operations of drug logistics.

Individuals working within well-designed logistics systems also account for effective logistics operation management (Law *et al.*, 2009). People performing well are likely to have high self-efficacy (Locke and Latham, 1990). Efficacy refers to what a person believes he or she can do in a particular task (Wofford *et al.*, 1992). If better internal operations are achieved, working teams in the operations have a higher level of collective efficacy (Hackman and Oldham, 1980; Durham *et al.*, 1997). Whilst changes in the schedule might lead to negative impacts, such as less effective operations (Blackburn *et al.*, 1987), higher operational and inventory costs (Xie *et al.*, 2003, 2004), they also lead to a general loss in planning/scheduling confidence (De Kok and Inderfurth, 1997; Heisig, 2001). Therefore, we hypothesize that less effective internal operations regarding drug logistics affect the efficacy at the collective level:

H2. Efficient internal operations of drug logistics has a positive influence on the efficacy of the involved individuals at the collective level.

Partnerships between both the buyer and supplier can improve the performance of logistics operations (Carr and Pearson, 1999; Kelle and Miller, 1998; Sarkis *et al.*, 2007; Ellram, 1991), and this is also applicable to drug logistics operations within hospitals. We suspect that the ability to manage drug suppliers is also a potential determinant of schedule instability. In the highly competitive market in the region, it is common that the companies have multiple suppliers for better quality and price of medical used drugs. Logistics performance can be enhanced if the drug centres have better relationships with suppliers. A drug centre that has a good knowledge of its suppliers may be able to plan better for schedule changes and hence the collective efficacy of performance is higher. Information sharing between drug logistics operation units and their customers (medical practitioners and patients) is highly valued, while studies on supply chain management have advocated the importance of frictionless information sharing with customers. The literature on supply chain management has also emphasized the importance of frictionless information sharing (Chan, 2005). Dealing with the increasingly stringent service cycles, accurate and timely information are required to enable quality planning of services and deliveries. Therefore, partnership with customers in terms of efficient information can affect the accuracy in demand forecast, and thus the collective efficacy (Blackburn *et al.*, 1985, 1986, 1987):

H3. A strong organizational partnership with supply chain partners has a positive influence on the collective efficacy.

H3a. A strong organizational partnership with suppliers has a positive influence on the collective efficacy.

H3b. A strong organizational partnership with customers has a positive influence on the collective efficacy.

In the healthcare sector, the quality of internal drug logistics operations definitely affect the level of schedule nervousness experienced. A number of sub-factors are considered, namely, the reliability of the logistics system, component commonality, skills of the corresponding staff in managing planning and scheduling activities, the existence of an effective time-fencing system, and the flexibility of the scheduling system (Zhao *et al.*, 2001; Inman and Gonsalvez, 1997; Pujawan and Kingsman, 2000; Pujawan, 2004; Kadipasaoglu and Sridharan, 1995; Zhao and Lee, 1993; Pfeiffer *et al.*, 2007; Bayraktar *et al.*, 2008; Wong *et al.*, 2011). Studies have proven the significant impact of various internal factors, such as lot-sizing rules and time-fencing mechanisms on schedule instability (Zhao *et al.*, 2001; Kadipasaoglu and Sridharan, 1995). Therefore, we also expect that better drug logistics operation leads to lower levels of schedule nervousness, and such lower levels of schedule nervousness will lead to higher levels of collective efficacy.

To answer another research question posed:

RQ3. What are the impacts of schedule instability or nervousness on the drug logistics operation in hospitals in China?

It is hypothesized as the correlation between schedule nervousness and its impact on collective efficacy on performance:

H4. Schedule nervousness negatively influences the collective efficacy.

Research methodology

Measures of the constructs were obtained via a questionnaire administered to the practitioners in the drug logistics operating units in public hospitals in China.

Questionnaire

The questionnaire was designed according to the model illustrated in Figure 1, on the linkage between schedule nervousness and collective efficacy for organizations in the service sectors (Law *et al.*, 2009). The first section gathered respondents' demographic details, and the second section solicited internal operational issues. The third series of questions addressed the partnership with suppliers and customers, while the fourth section addressed the schedule nervousness issues. The last section of the questionnaire measured the perceived efficacies in performance at the collective level.

Pilot studies and questionnaire refinement

In order to improve the comprehensibility of the drafted questionnaire, two pilot studies were conducted. In the first pilot study, five practitioners working in hospitals in China were interviewed to discuss the content and presentation of the questionnaire. It was then followed by conducting a second pre-test of the improved questionnaire. Simple statistical analyses were used to test the reliability of the scales and the questionnaire was improved further (Flynn *et al.*, 1990; Dillman, 1983).

The questionnaire was modified for official data collection. The modified questionnaire consists of two parts. The first part concerns the post of the respondent. The second part consists of statements regarding the key constructs as presented in Table II. The respondents were asked to rate each statement by using a five-point Likert scale, where 1 represents "strongly disagree" and 5 represents "strongly agree" (Table II).

The original questionnaire was designed in English. For the study to be carried out in China, the questionnaire was first, translated into a preliminary Chinese version from the original English version by the author. Then a professional translator helped to translate the Chinese version back to English. Comparison between the two English versions was conducted to identify if there was any discrepancy. Modifications were made to the questionnaire and it was then translated to the second Chinese version by the author. The final version is in both English and Chinese.

Data collection

The scope of the present research was limited to the public hospitals in China. Data collection was carried out from July 2011 to February 2012.

In consideration of the geographical distribution of the hospital locations, target hospitals were randomly selected from different areas in China, generally divided into the eastern region (Shandong, Jiangsu, Shanghai, Zhejiang), western region (Xinjiang, Gansu, Ningxia, Shaanxi, Tibet, Qinghai, Sichuan, Chongqing, Yunnan, Guizhou), northern region (Heilongjiang, Jilin, Liaoning, Inner Mongolia, Beijing, Tianjin, Hebei, Shanxi), southern region (Guangxi, Guangdong, Fujian, Hainan) and central region (Henan, Hubei, Anhui, Hunan, Jiangxi). Three hospitals were selected from each area while two to three drug logistics practitioners at the management or executive levels, closely related to drug logistics operations in hospitals, were targeted in each hospital.

The expected sample size was around 2,000 responses from 50 hospitals, with about ten hospitals in each area (Table III). Demographic details of the respondents are shown in Table IV.

In total, 1,686 out of 1,738 responses were qualified in the first round data collection. The second round study was carried out again in seven hospitals. Finally, 1,850 out of 1,908 responses received were found valid.

Internal operations (IO)	
I1	Reliable service delivery system
I2	Materials (drugs) commonality
I3	Flexible planning system
I4	Skillful and able planning staff
I5	Good operations management
Partnership with suppliers (RS)	
R1	Flexible suppliers in delivery
R2	Reliable suppliers with on-time delivery
R3	Suppliers are willing to share information
R4	Effective information and communication infrastructures of suppliers
Partnership with customers (RC)	
R5	Availability of information by customers (medical practitioners/patients) well in advance
R6	Customer's commitment to the agreed order
R7	Customers are collaborative and willingness to share
R8	Customers with effective information and communication infrastructure
Schedule nervousness (SN)	
G1	Impacts on operation performance
G2	Significant time and resources devotion
G3	Significant costs due to schedule instability
G4	Impacts inventory handling management
G5	Impacts on management's confidence in our company's scheduling system
Collective efficacy in performance (CE)	
E1	Scheduling efficiency
E2	High level of excellence
E3	Goals achievement
E4	Good relationships with suppliers
E5	Good relationships with customers with better services
Individual efficacy (PE)	
P1	Sense of meaningfulness
P2	Strong sense of accountability
P3	Strong sense of mastery of personal job tasks

Table II. The items in the questionnaire

Location	Area	Target hospitals
Shandong, Jiangsu, Shanghai, Zhejiang	Eastern region	10
Xinjiang, Gansu, Ningxia, Shaanxi, Tibet, Qinghai, Sichuan, Chongqing, Yunnan, Guizhou	Western region	10
Heilongjiang, Jilin, Liaoning, Inner Mongolia, Beijing, Tianjin, Hebei, Shanxi	Northern region	10
Guangxi, Guangdong, Fujian, Hainan	Southern region	10
Henan, Hubei, Anhui, Hunan, Jiangxi	Central region	10
Sum		50

Table III. Data collection design

Results of the study

The accuracy of the survey study was verified by validity and reliability tests. To warrant the reliability of a particular measure (scale), the set of items measuring the construct should be highly correlated. The reliabilities of the survey questions have been

	Number (n) of responses
Region	
Central	376
East	370
South	375
West	374
North	355
Size	
Small hospital (staff 1,000-2,999)	1,026
Large hospital (staff > 3,000)	824
Position	
Top management	73
Administrative, operation managers, executives	859
Medical professionals	773
Others	145
Job specification	
Directly involved in drug logistics (i.e. procurement, inventory, dispensary and management)	1,705
Not related	145

Table IV. Demographic details of respondents

tested using the SPSS® – reliability analysis technique. The validity of the constructs of the questionnaire was verified through principal component analysis of the factors.

Non-response bias. To detect any non-response bias, the average values of the survey instruments in both the 30 per cent of early respondents and 30 per cent of late respondents were compared by *t*-test. It was conducted to see if there were differences between early respondents and late respondents in terms of variables relevant to the research hypothesis (Dillman, 1983). The results of the *t*-test showed no statistical significance between the means for the items across the two groups, indicating that non-bias response is not a problem in this study.

Reliability and validity. Scale purification was done by reliability testing and exploratory factor analysis. The reliability was tested based on the average inter-item correlation (i.e. Cronbach α). Cronbach's α was used to assess the scale reliability of each construct in our model. The α of every factor was more than 0.70, which is a very good statistical result (Johnson and Wichern, 1998). The high value of α suggests a high level of internal consistency of the data. Discriminant validity was checked using a multi-trait matrix as presented in Table V. The diagonal figures of the matrix are the reliability coefficients for each latent variable identified. The remainder of the table is a correlation matrix between the pairs of latent constructs. The correlation coefficients within each column are less than the Cronbach's α's (Table AI). This indicates that the internal reliability is much higher than the inter-item reliability (Churchill, 1979), which, in turn, shows strong empirical support for discriminant validity.

In this case, the reliability analysis values are found to be relatively high (> 0.95), and to ensure the internal consistency of the items, validity tests were also done to ensure the items are contributing to the measurement. Reviewing the items of each construct was also performed to ensure the items were not redundant.

The choice of the scales for the study was modified from previous research studies relating to logistics operation and schedule nervousness (Law and Pujawan, 2009;

Table V.
Inter-correlations of variables

	Internal operation	Partnership with supplier	Partnership with customer	Schedule nervousness	Collective efficacy
Internal operation	/				
Partnership with supplier	0.01	/			
Partnership with customer	0.02	−0.03	/		
Schedule nervousness	−0.1	−0.15	0.01	/	
Collective efficacy	0.40**	0.20**	0.17**	−0.03	/

Note: *,**p-value significant at < 0.05, 0.01, respectively

Law *et al.*, 2009; Law, 2009, 2011). With reference to previous studies, it has been proven that the questionnaire design was reliable.

The instruments of the constructs were then validated by exploratory factor analysis (i.e. principal components analysis, with varimax orthogonal rotation). The results confirmed the structure of the constructs. Construct validation includes content, and convergent and discriminant validities. Content validity is a non-statistical assessment of validity which is ensured by expert judgment, or through an extended literature search and then confirmed by the pilot studies discussed above. A confirmatory factor analysis was also conducted to check the convergent validity and the discriminant validity of the prior factor structures. The results are reported in Table AI.

Summary of findings

Table V shows the inter-correlations of the variables and Table VI presents a summary of the mean scores obtained from the study and of the key measures respectively. It is shown that schedule nervousness and internal operation are the highest values. This can be interpreted as practitioners perceiving they are experiencing high level of nervousness regarding scheduling operations, while their catering operations are managed well. It is also noted that the "partnership with suppliers" scored the lowest.

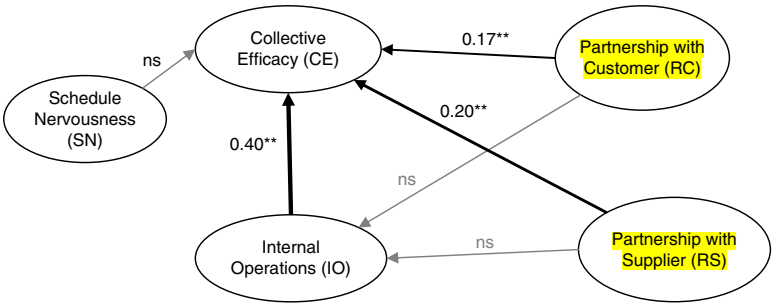
Hypotheses testing

To justify and test the developed model, structural equation modelling is the appropriate technique to use (Kline, 1998). AMOS (by SPSS) is used for the statistical analysis in this study. The most widely used fitting function maximum likelihood method was employed (Bollen, 1989). Construct validity was evaluated using the fit measures: the $\chi^2/\mathrm{df} = 0.91$ (χ^2 to degrees of freedom ratio), the Comparative Fit Index (CFI) is 0.994 and RMSEA = 0.005. The χ^2/df is less than 3 (Kline, 1998), and the CFI is close to 1 (Bentler, 1990). The research hypotheses were validated with the significance of t-test in each path with parameter estimates ($p < 0.1$) in the structural equation modelling.

Figure 2 presents the structure equation model of the hypothesized research model. Simply put, the two-way arrows represents the correlation coefficients between two connected variables and the one-way arrow represents the regression coefficients. The standardized path coefficients of significance are displayed to represent the

Measures ($n=$)		All 1,850	C 376	E 370	N 355	S 375	W 374
Internal operation ($\alpha=0.98$)	IO	3.13	3.07	3.17	3.13	3.13	3.13
Reliable service delivery system	I1	3.11	3.07	3.27	3.06	3.10	3.07
Materials (drugs) commonality	I2	3.85	3.76	3.81	3.88	3.95	3.87
Flexible planning system	I3	3.19	3.19	3.16	3.26	3.15	3.16
Skillful and able planning staff	I4	2.71	2.65	2.78	2.66	2.71	2.74
Good operations management	I5	2.77	2.69	2.82	2.77	2.75	2.82
Partnership with supplier ($\alpha=0.97$)	RS	3.15	3.06	3.18	3.20	3.17	3.17
Flexible suppliers in delivery	R1	4.03	3.91	4.00	4.09	4.08	4.06
Reliable suppliers with on-time delivery	R2	3.70	3.61	3.67	3.74	3.77	3.73
Suppliers are willing to share information	R3	2.81	2.75	2.85	2.86	2.78	2.80
Effective information and communication infrastructures of suppliers	R4	2.08	1.97	2.19	2.10	2.07	2.09
Partnership with customer ($\alpha=0.97$)	RC	2.96	2.97	3.01	2.96	2.93	2.95
Availability of information by customers (medical practitioners/patients) well in advance	R5	1.26	1.25	1.28	1.24	1.25	1.26
Customer's commitment to the agreed order	R6	4.66	4.65	4.70	4.67	4.61	4.65
Customers are collaborative and willingness to share	R7	4.23	4.26	4.28	4.24	4.17	4.21
Customers with effective information and communication infrastructure	R8	1.71	1.70	1.76	1.70	1.69	1.68
Schedule nervousness ($\alpha=0.975$)	SN	2.82	2.78	2.81	2.83	2.83	2.84
Impacts on business performance	G1	3.21	3.20	3.15	3.29	3.21	3.20
Significant time and resources devotion	G2	2.58	2.52	2.55	2.57	2.62	2.62
Significant costs due to schedule instability	G3	2.21	2.14	2.18	2.18	2.26	2.30
Impacts inventory handling management	G4	4.02	3.96	4.09	4.07	3.97	4.00
Impacts on management's confidence in our company's scheduling system	G5	2.08	2.08	2.06	2.06	2.12	2.08
Efficacy ($\alpha=0.98$)	CE	3.30	3.22	3.36	3.27	3.33	3.31
Scheduling efficiency	E1	2.87	2.85	2.94	2.79	2.90	2.89
High level of excellence	E2	3.02	2.91	3.08	2.97	3.09	3.04
Goals achievement	E3	3.07	2.98	3.23	3.02	3.02	3.08
Good relationships with suppliers	E4	4.00	3.90	3.97	4.09	4.05	4.01
Good relationships with customers with better services	E5	3.52	3.45	3.56	3.49	3.58	3.53

Table VI.
Summary of mean scores of the key measures



Notes: CFI = 0.994; RMESA = 0.005; χ^2/df = 0.914. Standardized regression weights were used from interpretation. Error terms in the model are omitted to clarify the figure. Correlation coefficients are represented by a two-way arrow, whereas the regression coefficients are represented by one-way arrows. p-value in regression analysis $^{**}p<0.01$

Figure 2.
Structural equation model

significance of the correlation or regression coefficients respectively (Worren *et al.*, 2002). The results support the conceptual ideas and constructs of this study.

Tables VII and VIII summarize the results of the study based on the hypotheses proposed. Our results indicate schedule nervousness is significantly correlated with internal operations related to drug logistics in hospitals. The operational performance is significantly affected by the "partnership with customers" (*H1b*), and this further affects the working team's efficacy (*H2*, *H3b*). These findings are consistent with the theories in Wofford *et al.* (1992), Locke and Latham (1990) and Prussia and Kinicki (1996), and confirm the relationship between team efficacy and work performance.

Discussion

Internal operation

"Internal operation" is found to have a significant correlation with "efficacy" (Table V). The results primarily support *H2*. Better internal operation may lead to higher level of collective efficacy. The results from the hypothesis testing support the contention that "internal operation" significantly affects "collective efficacy" (*H2*).

The very mild and negative linkages between "schedule nervousness" and "partnership with supplier" and "internal operation" are of some concern. It may be interpreted that the

Hypothesis testing	*r*	*p*-value	Results
Partnership with customer → internal operation	ns	ns	Rejected
Partnership with supplier → internal operation	ns	ns	Rejected
Internal operation → collective efficacy	0.40	**	Accepted
Partnership with supplier → collective efficacy	0.20	**	Accepted
Partnership with customer → collective efficacy	0.17	**	Accepted
Schedule nervousness → collective efficacy	ns	ns	Rejected

Table VII. Hypothesis testing and results

Notes: ns, the hypothesis is insignificant and deleted in the model re-specification in structural equation modelling. $^{**}p < 0.05, 0.01$

Hypotheses	
H1. A strong organizational partnership between supply chain members (suppliers and customers) has a positive influence on the internal operations of drug logistics	*H1* is rejected
H1a. A strong organizational partnership with suppliers has a positive influence on the internal operations of drug logistics	
H1b. A strong organizational partnership with customers has a positive influence on the internal operations of drug logistics	
H2. Efficient internal operations of drug logistics have a positive influence on the efficacy of the involved individuals at the collective level	*H2* justified in the structural equation model
H3. A strong organizational partnership with supply chain partners has a positive influence on the collective efficacy	*H3* is justified in the structural equation model
H3a. A strong organizational partnership with suppliers has a positive influence on the collective efficacy	
H3b. A strong organizational partnership with customers has a positive influence on the collective efficacy	
H4. Schedule nervousness negatively influences the collective efficacy	*H4* is rejected

Table VIII. Summary of hypothesis testing

mild negative impacts due to worsening internal operation and the partnership with supply chain partners may induce an incline on schedule nervousness level. However, we cannot confirm this cause-and-effect relationship, and further investigation is thus worthy.

From the results of hypothesis testing (Tables VII and VIII), internal operation significantly and strongly affects "collective efficacy". Only *H2* is justified, but does not show significant linkages with partnership with supply chain partners (suppliers and customers). This is different from logistics operations in service industries such as catering and hospitality, where the benefits of linkages with suppliers and customers on internal operation are expected (Watts and Hahn, 1993; Ellram, 1991; Choi *et al.*, 2001). This may imply the "internal operations" in drug logistics is kind of "distinctive feature" in the public healthcare sector, when compared to other service industry sectors.

Collective efficacy

In this study, it was attempted to verify the impacts from schedule nervousness, internal operation and partnership with supply chain partners (supplier and customer) on collective efficacy ($\mu = 3.30$). It is seen that most of the mentioned determinants have significant and positive impacts on collective efficacy, except schedule nervousness (Table V). Meanwhile, staff in the drug centres in public hospitals in China perceive the "partnership with customers" is in a relatively worse situation ($\mu = 2.96$) if compared to "partnership with suppliers" ($\mu = 3.15$). It is also interesting that the perceived "schedule nervousness" has a relatively low value ($\mu = 2.82$), which indicates that staff do perceive the drug logistics operation is not much affected. It is much different from the results obtained from the previous work of the author in other industries (Law *et al.*, 2009; Phusavat *et al.*, 2010).

The low value of "schedule nervousness" and "partnership with customer" and significant correlation of "collective efficacy" and "internal operation" and "partnership with supplier" likely address the scenario that "internal operation" is not much affected by the supply chain partners, like schedule nervousness, while it does affect the "collective efficacy" significantly. This may imply the special business setting of drug logistics in the healthcare sector. The operations and schedules are not much affected by issues from the customer side which is very different from the other service industries.

There was a tendency for subjects to choose some of the factors as having a higher level of agreement, such as internal operation, schedule nervousness and collective efficacy (Table VI). This may imply that the working teams in the drug centres in public hospitals in China have a high level of efficacy and self-confidence, and they perceive they have good operations even at the high level of schedule nervousness. The study also fortifies the significant correlation between internal operation and "partnership with customers".

Limitations and future work

In this paper, an attempt has been made to review the challenges of the drug logistics operations faced by hospitals in Mainland China, in particular the impact of the partnership with supply chain partners and scheduling nervousness on performance. The subject is very important considering the rapid by developing healthcare sector and drug logistics industry in China, and hospitals aim to be more agile when considering the nature of the demand for drugs.

Our findings raise interesting issues which point to future research directions. First, why do drug centres perceive worse partnerships with customers than with suppliers? Second, we have learnt that the various factors (partnerships with supply chain partners and internal operation) affect the work efficacy at the collective level, but how?

The relationship between the major determinants (partnerships with business partners, internal operations) was investigated and the impact of schedule nervousness on the concerned personnel in dealing with scheduling issues in the logistics operations within hospitals was studied.

A research framework highlighting the relationship between schedule instability and contributors (suppliers/customers and internal operation) and individuals (perceived efficacy) is developed. This framework has been validated with the help of empirical data collected in a number of public hospitals in China. The sample size in this study may affect the generalization of the findings and the study was bounded in public hospitals. It is anticipated that there may be different findings if further study is carried out among privately owned hospitals regarding differences in organizational culture and business strategies.

The proposed research framework can be extended to other drug logistics systems, not just confined within the scope of the healthcare sector in China. Since there may be cultural differences (nationally and/or organizationally), further investigation is therefore of significant value.

Conclusions

In this paper, an attempt has been made to review the challenges faced by the drug logistics teams in hospitals, in particular the impact of logistics issues on the collective efficacy. Drug logistics teams aim to be more agile, considering the nature of the demand for services. A research framework highlighting the partnerships with supply chain partners, internal operation and individuals (perceived efficacy) has been developed. This framework has been validated with the help of empirical data collected from public hospitals in China.

Furthermore, the study offers an opportunity for exploring the current situation of drug logistics in public hospitals in China.

The findings of this study show that the drug logistics working teams in public hospitals in China have a high level of efficacy and self-confidence, while they perceive they provide good operations even at a low level of schedule nervousness. The study also reinforces the significant correlation between internal operation and "partnership" with customers. This is definitely useful for the development of an appropriate framework for drug logistics operation improvement in the long run. Administrators can realize the priorities required for assisting the drug logistics operations and their business value chains.

The cross-sectional data used in this study may not be fully useful for identifying fundamental relationships among the variables. To improve future research, multiple cross-sectional analyses at different points in time should be used to generalize the research model. To further explore this issue, the author will further extend the study in the private sector and even in other countries.

References

Aptel, O. and Pourjalali, H. (2001), "Improving activities and decreasing costs of logistics in hospitals: a comparison of US and French hospitals", *The International Journal of Accounting*, Vol. 36 No. 1, pp. 65-90.

Armistead, C.G. and Mapes, J. (1993), "The impact of supply chain integration on operating performance", *Logistics Information Management*, Vol. 6 No. 4, pp. 9-14.

Bayraktar, E., Koh, S.C.L., Gunnsekaran, A., Sari, K. and Tatoglu, E. (2008), "The role of forecasting on bullwhip effect for E-SCM applications", *International Journal of Production Economics*, Vol. 113 No. 1, pp. 193-204.

Benjamin, G.C., Rothschild, J.M., Genest, R. and Bates, D.W. (2003), "What do we know about medication errors in inpatient psychiatry?", *Journal on Quality and Patient Safety*, Vol. 29 No. 8, pp. 391-400.

Bentler, P.M. (1990), "Comparative fit indexes in structural models", *Psychological Bulletin*, Vol. 107 No. 2, pp. 238-246.

Blackburn, J.D., Kropp, D.H. and Millen, R.A. (1985), "MRP system nervousness: causes and cures", *Engineering Costs and Production Economics*, Vol. 9 Nos 1-3, pp. 141-146.

Blackburn, J.D., Kropp, D.H. and Millen, R.A. (1986), "A comparison of strategies to dampen nervousness in MRP systems", *Management Science*, Vol. 32 No. 4, pp. 413-429.

Blackburn, J.D., Kropp, D.H. and Millen, R.A. (1987), "A comparison of strategies to dampen nervousness in MRP systems", *International Journal of Production Research*, Vol. 25 No. 12, pp. 1739-1749.

Bollen, K.A. (1989), *Structural Equations with Latent Variables*, John Wiley, New York, NY.

Brown, S.L. and Eisenhardt, K.M. (1995), "Product development: past research, present findings, and future directions", *Academy of Management Review*, Vol. 20 No. 2, pp. 343-378.

Carr, A.S. and Pearson, J.N. (1999), "Strategically managed buyer-supplier relationships and performance outcomes", *Journals of Operations Management*, Vol. 17 No. 5, pp. 497-519.

Chan, J.W.K. (2005), "Competitive strategies and manufacturing logistics. An empirical study of Hong Kong manufacturers", *International Journal of Physical Distribution & Logistics Management*, Vol. 35 No. 1, pp. 20-43.

Choi, T.Y., Dooley, K.J. and Rungtusanatham, M. (2001), "Supply networks and complex adaptive systems: control versus emergence", *Journal of Operations Management*, Vol. 19 No. 3, pp. 351-366.

Churchill, G.A. (1979), "A paradigm for developing better measures of marketing constructs", *Journal of Marketing Research*, Vol. 16 No. 1, pp. 64-72.

De Kok, T. and Inderfurth, K. (1997), "Nervousness in inventory management: comparison of basic control rules", *European Journal of Operational Research*, Vol. 103 No. 1, pp. 55-82.

Dillman, D.A. (1983), "Mail and other self-administered questionnaires", in Rossi, P.H., Wright, J.D. and Anderson, A.B. (Eds), *Handbook of Survey Research*, Academic Press, San Diego, CA, pp. 161-174.

Durham, C.C., Knight, D. and Locke, E.A. (1997), "Effects of leader role, team-set goal difficulty, efficacy, and tactics on team effectiveness", *Organizational Behaviour and Human Decision Processes*, Vol. 72 No. 2, pp. 203-231.

Ellram, L.M. (1991), "A managerial guideline for the development and implementation of purchasing partnerships", *International Journal of Purchasing and Materials Management*, Vol. 27 No. 2, pp. 2-8.

Flynn, B.B., Sakakibara, S., Schroeder, R.G., Bates, K.A. and Flynn, E.J. (1990), "Empirical research methods in operations management", *Journal of Operations Management*, Vol. 9 No. 2, pp. 250-285.

Frishammar, J. and Horte, S.A. (2005), "Managing external information in manufacturing firms: the impact on innovation performance", *The Journal of Product Innovation Management*, Vol. 22, pp. 251-266.

Groves, G. and Valsamakis, V. (1998), "Supplier-customer relationships and company performance", *International Journal of Logistics Management*, Vol. 9 No. 2, pp. 51-64.

Gunasekaran, A. and Ngai, E.W.T. (2005), "Build-to-order supply chain management: a literature review and framework for development", *Journal of Operations Management*, Vol. 23 No. 5, pp. 423-451.

Hackman, J.R. and Oldham, G.R. (1980), *Work Redesign*, Addison-Wesley, Reading, MA.

Heinbuch, S.E. (1995), "A case of successful technology transfer to health care: total quality materials management and just-in-time", *Journal of Management in Medicine*, Vol. 9 No. 2, pp. 48-56.

Heisig, G. (2001), "Comparison of (s, S) and (s, nQ) inventory control rules with respect to planning stability", *International Journal of Production Economics*, Vol. 73 No. 1, pp. 59-82.

Inman, R.R. and Gonsalvez, D.J. (1997), "The causes of schedule instability in an automotive supply chain", *Production and Inventory Management Journal*, Vol. 38 No. 2, pp. 26-32.

Johnson, R.A. and Wichern, D.W. (1998), *Applied Multivariate Statistical Analysis*, Prentice-Hall International, Englewood Cliffs, NJ.

Kadipasaoglu, S. and Sridharan, V. (1995), "Alternative approaches for reducing schedule instability in multistage manufacturing under demand uncertainty", *Journal of Operations Management*, Vol. 13 No. 3, pp. 193-211.

Kadipasaoglu, S.N. and Sridharan, S.V. (1997), "Measurement of instability in multi-level MRP systems", *International Journal of Production Research*, Vol. 35 No. 3, pp. 713-737.

Kafetzidakis, I. and Mihiotis, A. (2012), "Logistics in the health care system: the case of Greek Hospitals", *International Journal of Business Administration*, Vol. 3 No. 5, pp. 23-32.

Kelle, P. and Miller, P.A. (1998), "Transition to just-in-time purchasing", *International Journal of Operations and Production Management*, Vol. 18 No. 1, pp. 53-65.

Kim, G.C. and Schniederjans, M.J. (1993), "Empirical comparison of just-in-time and stockless materiel management systems in the health care industry", *Hospital Materiel Management Quarterly*, Vol. 14 No. 4, pp. 65-74.

Kline, R.B. (1998), *Principles and Practices of Structural Equation Modeling*, Guilford Press, New York, NY.

Krajewski, L., Wei, J.C. and Tang, L. (2005), "Responding to schedule changes in build-to-order supply chains", *Journal of Operations Management*, Vol. 23 No. 5, pp. 452-469.

Lapierre, S.D. and Ruiz, A.B. (2007), "Scheduling logistic activities to improve hospital supply systems", *Computers and Operations Research*, Vol. 34 No. 3, pp. 624-641.

Law, K.M.Y. (2009), "Relationship with supply chain partners affecting internal operation of high-tech manufacturers in Taiwan", *Journal of High Technology Management Research*, Vol. 20 No. 1, pp. 31-39.

Law, K.M.Y. (2011), "Airline catering service operation, schedule nervousness and collective efficacy on performance: Hong Kong evidence", *The Service Industries Journal.*, Vol. 31 No. 6, pp. 959-974.

Law, K.M.Y. and Pujawan, I.N. (2009), "Collective efficacy and manufacturing schedule instability – a study in Hong Kong and the Pearl River Delta Region", *International Journal of Industrial & Systems Engineering*, Vol. 4 No. 1, pp. 1-18.

Law, K.M.Y., Helo, P., Kanchana, R. and Phusavat, P. (2009), "Managing supply chains: lessons learned and future challenges", *Industrial Management and Data Systems*, Vol. 109 No. 8, pp. 1137-1152.

Locke, E.A. and Latham, G.P. (1990), *A Theory of Goal Setting and Task Performance*, Prentice Hall, Englewood Cliffs, NJ.

Meixell, M. (2005), "The impact of setup cost, commonality, and capacity on schedule instability: an exploratory study", *International Journal of Production Economics*, Vol. 95 No. 1, pp. 95-107.

Metters, R.D. (1993), "A method for achieving better customer service, lower costs, and less instability in master production schedules", *Production and Inventory Management Journal*, Vol. 34 No. 4, pp. 61-66.

Moschuris, S.J. and Kondylis, M.N. (2006), "Outsourcing in public hospitals: a Greek perspective", *Journal of Health Organization and Management*, Vol. 20 No. 1, pp. 4-14.

Narasimhan, R. and Jayaram, J. (1998), "Causal linkages in supply chain management: an exploratory study of North American manufacturing firms", *Decision Sciences*, Vol. 29 No. 3, pp. 579-605.

Pan, Z.X. and Pokharel, S. (2007), "Logistics in hospitals: a case study of some Singapore hospitals", *Leadership in Health Services*, Vol. 20 No. 3, pp. 195-207.

Pfeiffer, A., Kadar, B. and Monostori, L. (2007), "Stability-oriented evaluation of rescheduling strategies, by using simulation", *Computers in Industry*, Vol. 58 No. 7, pp. 630-643.

Phusavat, K., Kess, P., Law, K.M.Y. and Kanchana, R. (2010), "Sustaining effective business value chain: future challenges", *Industrial Management and Data Systems*, Vol. 110 No. 8, pp. 1176-1191.

Prussia, G.E. and Kinicki, A.J. (1996), "A motivational investigation of group effectiveness using social-cognitive theory", *Journal of Applied Psychology*, Vol. 81 No. 2, pp. 187-198.

Pujawan, I.N. (2004), "Schedule nervousness in a manufacturing system: a case study", *Production Planning and Control*, Vol. 15 No. 5, pp. 515-524.

Pujawan, I.N. and Kingsman, B.G. (2000), "System nervousness and inventory locations", *Proceedings of the 31st Decision Science Institute National Meeting, Orlando, FL*, pp. 1174-1176.

Rosenzweig, E.D., Roth, A.V. and Dean, J.W. Jr (2003), "The influence of an integration strategy on competitive capabilities and business performance: an exploratory study of consumer products manufacturers", *Journal of Operations Management*, Vol. 21 No. 4, pp. 437-456.

Rungtusanatham, M., Salvador, F., Forza, C. and Choi, T.Y. (2003), "Supply-chain linkages and operational performance, a resource-based-view perspective", *International Journal of Operations and Production Management*, Vol. 23 No. 9, pp. 1084-1099.

Salvador, F., Forza, C., Rungtusanatham, M. and Choi, T.Y. (2001), "Supply chain interactions and time-related performances: an operations management perspective", *International Journal of Operations and Production Management*, Vol. 21 No. 4, pp. 461-475.

Sarkis, J., Talluri, S. and Gunasekaran, A. (2007), "A strategic model for agile virtual enterprises partner selection", *International Journal of Operations and Production Management*, Vol. 27 No. 11, pp. 1213-1234.

Sridharan, V. and Laforge, R.L. (1990), "On using buffer stock to combat schedule instability", *International Journal of Operations and Production Management*, Vol. 10 No. 7, pp. 37-46.

Towill, D.R., Childerhouse, P. and Disney, S.M. (2002), "Integrating the automotive supply chain: where are we now", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 2, pp. 79-95.

Verona, G. (1999), "A resource-based view of product development", *Academy of Management Review*, Vol. 24 No. 1, pp. 132-142.

Vickery, S.K., Jayaram, J., Droge, C. and Calantone, R. (2003), "The effects of an integrative supply chain strategy on customer service and financial performance: an analysis of direct versus indirect relationships", *Journal of Operations Managementt*, Vol. 21, pp. 523-539.

Watts, C.A. and Hahn, C.K. (1993), "Supplier development programs: an empirical analysis", *International Journal of Purchasing and Materials Management*, Vol. 29 No. 2, pp. 11-17.

Wofford, J.C., Goodwin, V.L. and Premack, S. (1992), "Meta-analysis of the antecedents of personal goal level", *Journal of Management*, Vol. 18 No. 3, pp. 595-615.

Wong, T.C., Law, K.M.Y., Yau, H.K. and Ngan, S.-C. (2011), "Analyzing supply chain operation models with the PC-algorithm and the neural network", *Expert Systems with Application: An International Journal*, Vol. 38 No. 6, pp. 7526-7534.

Worren, N., Moore, K. and Cardona, P. (2002), "Modularity, strategic flexibility, and firm performance: a study of the home appliance industry", *Strategic Management Journal*, Vol. 23 No. 12, pp. 1123-1140.

Xie, J., Lee, T.S. and Zhao, X. (2004), "Impact of forecasting error on the performance of capacitated multi-item production systems", *Computers and Industrial Engineering*, Vol. 46 No. 2, pp. 205-219.

Xie, J., Zhao, X. and Lee, T.S. (2003), "Freezing the master production schedule under single resource constraint and demand uncertainty", *International Journal of Production Economics*, Vol. 83 No. 1, pp. 65-84.

Zhao, X. and Lee, T.S. (1993), "Freezing the master production schedule for material requirements planning systems under demand uncertainty", *Journal of Operations Management*, Vol. 11 No. 2, pp. 185-205.

Zhao, X., Lai, F. and Lee, T.S. (2001), "Evaluation of safety stock methods in multilevel materials requirements planning (MRP) system", *Production Planning and Control*, Vol. 12 No. 8, pp. 798-803.

References (in Chinese)

Chu, F., Chen, S., Yang, Q., Zhou, Y. and Huang, Z. (2013), 褚福明, 程慎令, 杨琼, 周永勤, &黄振. (2013). 医药分开管理模式的探索与实践. 中国药业, Vol. 22 No. 10, pp. 1-2.

Gu, S., Zhen, W. and Chen, Y. (2007), 顾苏俊, 单文治, & 陈宜鸿. 现代物流技术在医院药品管理中的应用分析. 首都医药, Vol. 14 No. 8, pp. 55-56.

He, S. 贺书武 (2011), 医院药品物流一体化管理的探讨. 今日药学, Vol. 21 No. 12, pp. 766-767.

He, X., Zheng, P., Guo, H. and Li, L. (2012), 何雪君, 郑平, 郭洪伟, & 李垒. 中国医药物流发展趋势分析. 价值工程, Vol. 31 No. 4, pp. 20-21.

Ji, M., Xi, Y. and Wu, T. (2013), 季敏, 奚玉鸣, &吴涛. (2013). 新医改背景下的医院药品物流管理模式初探.上海医药, Vol. 19, pp. 25-27.

Jiang, C. 江灿 (2011), 新医改下药品物流企业服务模式研究.北京交通大学.

Li, X. 李雪红 (2013), 医药分家现状及存在的问题研究. 求医问药 : 学术版, Vol. 11, No. 2.

Liang, Z. and Jiang, L. (2010), 梁忠明, &姜丽萍. 医院物流现状与发展趋势. 中国当代医药, Vol. 17 No. 19, pp. 202-203.

Ministry of Commerce of the People's Republic of China (2011), 商务部. 全国药品流通行业发展规划纲要 (2011-2015), available at: www.mofcom.gov.cn/aarticle/ae/ai/201105/20110507534948.html

Sun, L. 孙琍 (2014), 一种基于第三方物流和电子商务的医药供应链新模式. 物流科技, Vol. 37 No. 7, pp. 95-97.

The Central People's Government of the People's Republic of China, 国务院 (2015), 中国政府工作报告, available at: www.gov.cn/guowuyuan/2015-03/16/content_2835101.htm

The Central People's Government of the People's Republic of China (2009), 国务院. 物流业调整和振兴规划, available at: www.gov.cn/zwgk/2009-03/13/content_1259194.htm

Wang, Y. 王宏. (2013), 从新版GSP看我国医药物流企业的发展趋势. 2013年中国药学会药事管理专业委员会年会暨"医药安全与科学发展"学术论坛论文集(下册).

Wang, Y. Zhou, Y. and Zhang, D. (2006), 王云, 周宇, &张东. 医院物流管理的现状与改革思路. 江苏省药学会第七届药师周大会、第十一届华东地区药剂学术会议.

Wu, Z. (2006), 吴志利. 试述我国医药物流的现状及发展趋势. 医院院长论坛-首都医科大学学报 : 社会科学版, Vol. 3 No. 4, 46-48.

Yang, X. 杨小丽. (2013), 关于构建和完善医院物流管理系统的探讨. 经济师, Vol. 5, pp. 127-128.

Zhang, S.L. (2015), 张少兰. 我国药品第三方物流的现状及发展策略探讨. 中国药业, Vol. 6.

Zhi, J. (2008), 郅军. 关于医院物流管理的综述. 护理研究, Vol. 22 No. 9, pp. 2452-2454.

Appendix

Items		Standardized factor loadings[a]
Please indicate how you agree on the following: (strongly disagree = 1, strongly agree = 5), we have:		
Internal operations (IO) $\alpha = 0.98$		
I1	Reliable service delivery system	0.71
I2	Materials (drugs) commonality	0.51
I3	Flexible planning system	0.69
I4	Skillful and able planning staff	0.80
I5	Good operations management	0.78
Partnership with suppliers (RS) $\alpha = 0.97$		
R1	Flexible suppliers in delivery	0.88
R2	Reliable suppliers with on-time delivery	0.83
R3	Suppliers are willing to share information	0.63
R4	Effective information and communication infrastructures of suppliers	0.50
Partnership with customers (RC) $\alpha = 0.97$		
R5	Availability of information by customers well in advance	0.83
R6	Customer's commitment to the agreed order	0.87
R7	Customers are collaborative and willingness to share	0.89
R8	Customers with effective information and communication infrastructure	0.89
We always observe that:		
Schedule nervousness (SN) $\alpha = 0.97$		
G1	Schedule nervousness has significant affect our business performance	0.73
G2	Significant time and resources devotion to deal with schedule nervousness	0.54
G3	Significant costs are incurred due to schedule instability	0.88
G4	Schedule nervousness has significant impacts on inventory handling management	0.88
G5	Schedule nervousness significantly undermines management's confidence in our company's scheduling system	0.88
We are confident that:		
Collective efficacy in performance (CE) $\alpha = 0.98$		
E1	We deal with the scheduling-related issues efficiently	0.76
E2	We at dealing the logistics-related operations at high level of excellence	0.73
E3	We can achieve expected goals, such as targeted deliveries, inventory level and time	0.71
E4	We can maintain good relationships with suppliers	0.88
E5	We can maintain good relationships with customers with good services	0.78

Note: [a]All standardized regression weights are significant at p-value < 0.01

Table AI. Factors loadings from the confirmatory factor analysis

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