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Full Length Research Paper

Research on the procedure joint process and synthesized performance evaluation of logistics service supply chain

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The study of the procedure joint process of logistics service supply chain (LSSC) can help evaluate the synthesized performance scientifically as well as understand the coordination process systematically from microcosmic viewpoint. This paper systematically analyzes the three aspects of the joint procedure, namely: before, during, and after. Before the procedure joint, the paper investigates four essential mechanism environment required to achieve procedure joint, including trust mechanism environment, information sharing mechanism environment, incentive and constraint mechanism environment, and evaluation mechanism environment. During the procedure joint, the joint mode between functional logistics service provider (FLSP) and logistics service integrator (LSI) is proposed from the viewpoint of operation management and the organization structure. After the procedure joint, the synthesized evaluation index system is proposed, which consists of the result level, process level and environment level, corresponding to the posterior evaluation, the intermediate evaluation and the beforehand evaluation, respectively. Then an analytical network process (ANP) model for comprehensive performance evaluation index system of LSSC is established and evaluated with superdecision software. The example results indicate that this method could overcome the correlation among those evaluating factors, and improve the accuracy of performance evaluation. Consequently, it can provide a quantitative method for the synthesized performance evaluation of procedure joint process in LSSC.

Key words: Logistics service supply chain, procedure joint, performance evaluation.

INTRODUCTION

Logistics service supply chain (LSSC) is a new type of supply chain (Lisa, 2004), it essentially centered on logistics capacity cooperation, focuses on logistics service integrator (LSI), whose basic structure is functional logistics service provider (FLSP) → logistics service integrator (LSI) → manufacturing companies and retail sales, and provides flexible logistics service to guarantee the logistics operation of the product supply chain (Liu et al., 2011). According to the customer demand, LSI purchases a certain amount of logistics capacity from FLSPs. FLSP provides corresponding logistics capacity in terms of the need of LSI's capacity in order to fulfill logistics service. For example, as one of the largest LSIs in China, Baogong Logistics Company in Guangzhou integrates more than 500 storage FLSPs, more than 1,200 highway transportation FLSPs, and over 500 manual loading and unloading FLSPs. By making use of these FLSPs, Baogong provides integrated logistics services for various companies, such as Procter & Gamble, Unilever, etc.

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Abbreviations: LSSC, logistics service supply chain; **FLSP,** functional logistics service provider; **LSI,** logistics services integrator.

During the capacity cooperation, members in the supply chain are independent enterprise unities whose operation goals, operation modes and company cultures are all different, and even certain conflicts exist, which will influence the integral operational results of the whole organization. The procedure joint is an important guarantee to promote the coordination of each member in LSSC, and realize the cooperation goals smoothly. Therefore, it's quite important to investigate the procedure joint process of LSSC and conduct suitable performance evaluation.

LITERATURE REVIEW

In recent years, with the concern to LSSC management, some achievement about LSSC and its procedure joint have been obtained. Thus, the literature review firstly summarizes the logistics service supply chain and its procedure joint method, and then discusses the research progress of synthesized performance evaluation approaches. For the research of LSSC, many scholars focus on the qualitative analysis and quantitative analysis of capacity cooperation; few studies have examined the procedure joint process of LSSC. As for the qualitative analysis of LSSC, Liu et al. (2006) proposed a coordinating strategic framework for the capacity cooperation in LSSC systematically. Yan and Li (2009) established the collaboration model based on the theory of genecology. Wu and Gao (2010) investigated the characteristics of product-based LSSC and its influence on coordination. As for the quantitative modeling of LSSC, the current studies are mostly centered on the coordination of capacity cooperation among different members in LSSC, the concerns are about LSI and FLSP and the main issues involved are as followed: supply chain order allocation (Hua and Hui, 2008; Liu et al., 2011), quantity coordination of logistics capacity(Cui et al., 2008; Liu et al., 2011), monitoring of the logistics service quality (Liu et al., 2006; Zhang et al., 2010), optimization of the logistics performance (Yan and Li, 2009; Liu, 2010) and some other aspects.

In the research of manufacturing supply chain, many studies have paid attention on the process of supply chain, but current studies are mainly concerned with the connotation analysis and practical application of the supply chain operations reference (SCOR) model (Siegl, 2008; Schwarz, 2008; Irfan et al., 2008; Persson and Araldi, 2009; Li et al., 2011). Besides, what is closely related to the procedure joint of supply chain is the study on collaboration issues. Many researchers divided the supply chain collaboration management into three levels, namely: strategic level, tactical level and technical level. Cao et al. (2011) conceptualized supply chain collaboration as seven interconnecting elements: information sharing, goal congruence, decision synchronization, incentive alignment, resource sharing, collaborative communication, and joint knowledge creation. It developed valid and reliable instruments to measure supply chain collaboration through rigorous empirical and statistical analysis including structured interviews, Q-sort, and a large-scale study. What's more, supply chain collaboration approaches include capacity sharing (Kaltenbach, 2006) and cross-joint delivery strategy (Kreng and Chen, 2008). In the aspect of industrial practice, pulp and paper industry (Lehoux et al., 2010) and semiconductor manufacturing industry (Bahinipati et al., 2009) and other industries (Akkermans et al., 2004) are studied.

For the synthesized performance evaluation of supply chain, Beamon (1999) analyzed the supply chain performance evaluation indexes from both qualitative and quantitative aspects. Lummus and Alber (1998) listed a series of main evaluation indices for supply chain performance based on four aspects, namely: supply management, process management, delivery and shipping, and demand management. Gunasekaran et al. (2001) developed a frame for supply chain performance evaluation from the strategic level, tactical level and operational level. Currently, in the aspect of the quantitative evaluation for supply chain performance, the methods include analytical hierarchy process (Guan et al., 2010), fuzzy comprehensive evaluation (Du et al., 2009; El-Baz, 2011), artificial neural networks(Li et al., 2006), supply chain balanced scorecard(Brewer and Speh, 2002), data envelopment analysis (Song, 2008), SCOR model (Ren, 2006; Ren, 2008; Jiang and Yang, 2008), grey system model (Chen et al., 2009), AHP-PGP model (Bhagwat and Sharma, 2009) and multi-attribute decision-making (Chan, 2003).

The literature review shows that current studies are still focused on the qualitative analysis or quantitative modeling about the capacity cooperation of LSSC, few studies focused on the procedure joint methods of LSSC, and it lacks in-depth discussion about the procedure joint process from micro-level systematically. In terms of the supply chain performance evaluation, the academic study on synthesized performance evaluation of LSSC is few. The rest of this paper is organized as follows: discussion of the environment of procedure joint. Procedure joint process and joint mode of LSSC is elaborated. After the procedure joint, a synthesized performance evaluation index system is proposed for LSSC. Thereafter, this paper will propose ANP evaluation method and give an example. Finally, we will put forward the main conclusions and further studies.

ENVIRONMENT ANALYSIS FOR THE PROCEDURE JOINT OF LSSC

Before the procedure joint between FLSP and LSI, some certain requirements must be satisfied. Generally speaking, two main environment conditions are included: one is trusting environment, that is, the trust mechanism environment between these two sides, while the other is

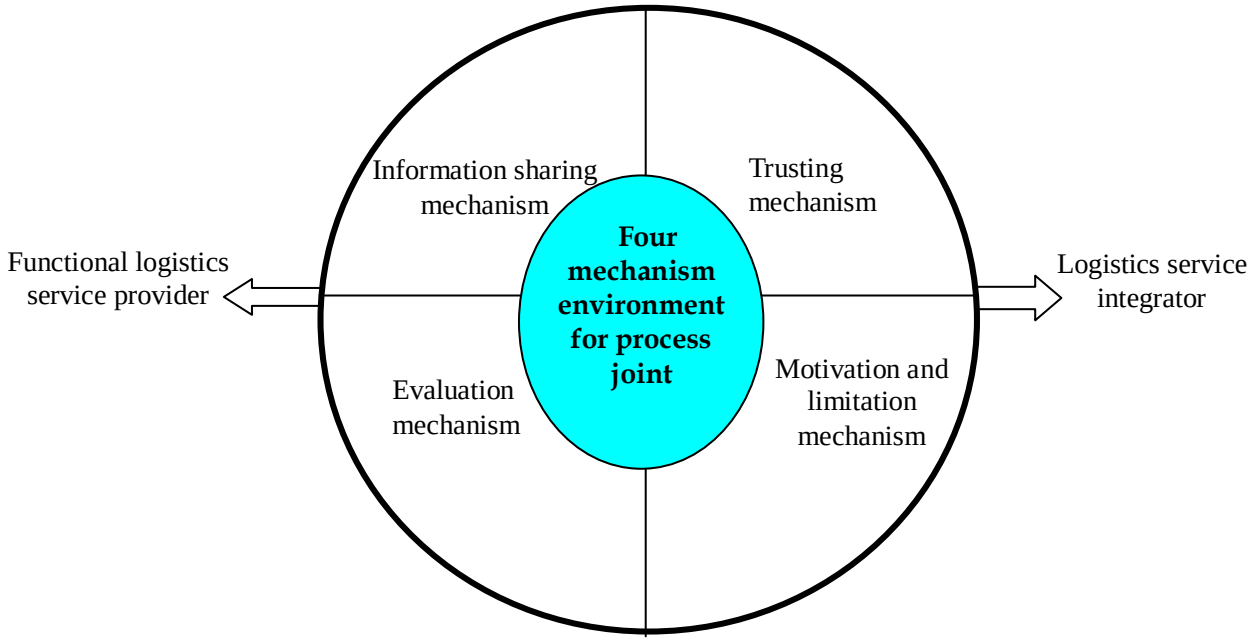

Figure 1. Four mechanism environments to achieve the process joint.

operation environment, that is, the information sharing environment, motivation and constraint mechanism environment, and the evaluation mechanism environment is shown in Figure 1.

Trusting mechanism

Trusting mechanism is referred as enough confidence about one side to another's reliability and honesty. The LSSC system is inter-organizational collaboration built on the mutual trust. For the successful LSSC management, the trust between these enterprises is an essential prerequisite. In a supply chain without trusting mechanism, the cost of guarding opportunism behavior is high, which is apparently no help to the highly efficient operation of the supply chain. Thus, the trusting mechanism plays an important role in reducing the cost and promoting the achievement of logistics service procedure joint.

The trusting mechanism environment can be composed of various factors, such as the partner's enterprise scale, enterprise history records, enterprise qualification and enterprise reputation, etc. These factors are all important to form the trusting mechanism. The better the trusting mechanism is, the easier the implementation of the procedure joint is.

Information sharing mechanism

The information sharing mechanism environment is a part of the operation environment. The procedure joint involves four flows: personnel flow, logistics flow, fund flow and information flow; while the information flow is a significant guarantee to accelerate other three flows to operate well. Good information sharing environment can assure the smooth achievement of procedure joint. For example, in order to promote the cooperation of LSSC smoothly, Baogong Logistics Company in China built an information sharing platform for his FLSPs, provided the corresponding information sharing permissions for each FLSP, and used electric data interchange (EDI) system with key FLSPs.

Motivation and constraint mechanism

The supply chain cooperation is based on the contractual relationship and trust relationship, so the contract design is the critical support of successful supply chain cooperation. In order to urge each member in supply chain to fulfill its responsibility prescribed in the contract, motivation and constraint mechanism is very necessary. The more complete the motivation and constraint is, the more smooth the supply chain cooperation is, and the easier the procedure joint work is. For instance, Baogong Logistics Company in China signed cooperation agreement with each FLSP and took measures to encourage FLSPs, and then Baogong will give ranking list after quarterly quality comparison, and increase the business volume of top 3 FLSPs while reducing the business volume of the last 3 FLSPs. In addition, Baogong will award the excellent FLSPs by delaying the cooperation time, improving the cooperation level and presenting the

plaque at the end of each year.

Evaluation mechanism

A robust evaluation mechanism could reflect the cooperation performance level and actual effects of LSSC objectively. Therefore, the more robust the evaluation mechanism of the LSSC cooperation is, the easier the cooperation process could be quantized and implemented, and the easier to achieve the expected cooperative performance goals, so it also is an important part of the procedure joint environment as well. For example, Tianjin Baoyun Logistics Company is a LSI in China, which sets different evaluation modes for different FLSPs. Key FLSP, is evaluated by over 3 months long term, important FLSP is evaluated by bimonthly and common FLSP is evaluated by monthly. In addition, the evaluation questionnaires is designed for each type of FLSP.

PROCEDURE JOINT MODE OF LSSC

During the procedure joint process, not only the joint between LSI and FLSP, but also the joint between subordinates and superiors of each side and each department are included, so the procedure joint involves many organizational structure arrangements between LSI and FLSP. It also involves the relationship coordination between subordinates and superiors within the enterprises as well as other several levels, from the strategic level, tactical level to the operational level.

Procedure joint mode analysis of LSI and FLSP — based on the operation management viewpoint

As shown in Figure 2, from the perspective of operation management, in the strategic level, LSI and FLSP mainly offer the following joint work: unification of the service task goal, revenue sharing, risk sharing, cooperation decisions and so on; In the tactical level, LSI and FLSP mainly conduct service demand forecasting, service product designing, logistics capacity coordination, logistics quality monitoring, logistics after-sales service and so on. In the technical level, the joint works are as follows: information collection and transmission, confidentiality agreement, information sharing platform, communication regulations, financial policies and so on. In the operation level, the joints are focused on the followings, such as operation states, operation requirements, operational orders, operation programs, operation performance, etc, and then implemented effectively.

Procedure joint mode analysis of LSI and FLSP — based on the organization structure viewpoint

As shown in Figure 3, from the organization structure viewpoint, the enterprise superiors mainly determine the joint contents in strategic level, such as cooperation intention, cooperation time range, and cooperation mode arrangement, etc. In the functional departments, like marketing, operation, financial and quality controlling, the main jobs are to determine the specific cooperation style and cooperation rules, and to build the cooperation joint platform. The joints in the branches or groups are to arrange the related details in the cooperation strategies established by the functional departments, and to determine the joint means in the operation level. The personnel joints are mainly focused on the joints of operation commands in the site service system, operation program, personnel allocation, logistics facilities and equipment and so on.

SYNTHESIZED PERFORMANCE EVALUATION INDEX SYSTEM OF LSSC PROCEDURE JOINT PROCESS

After procedure joint is finished, the evaluation of synthesized performance is required according to the periodic time arrangement reached by both sides of the LSSC. Generally speaking, establishing the synthesized performance evaluation index system of the LSSC procedure joint process should obey the following principles:

1. Index system should be layered: The performance index system should focus both on the results (such as customer satisfaction) and the process (the specific service operation process). Thus the overall index system can be divided into three levels, namely, result level, operation level, and environment level of the procedure joint, corresponding to the posterior evaluation, the intermediate evaluation and the beforehand evaluation, respectively.
2. Evaluation results of various bodies should be reflected: The key indices should be considered from three bodies, the customers, LSI and FLSP. Customers mainly focus on the evaluation of satisfaction degree about result level while the latter mainly concentrates on the evaluation of all the operation level, environment level and result level.
3. Index is selected in the customer-oriented way: In order to make the evaluation results to follow customers' feelings, the index system should include some indices reflecting customer satisfaction.
4. Characteristics of the procedure joint process in LSSC should be fully considered: The index system should reflect the performance coordination level during the joint process between the upstream and downstream bodies in LSSC. For example, the joint in strategic level, tactical level, technical level and operational level should be included.
5. The service characteristics of LSSC should be considered comprehensively: Different from product supply chain in manufacturing industry, the performance evaluation of LSSC should highlight the service

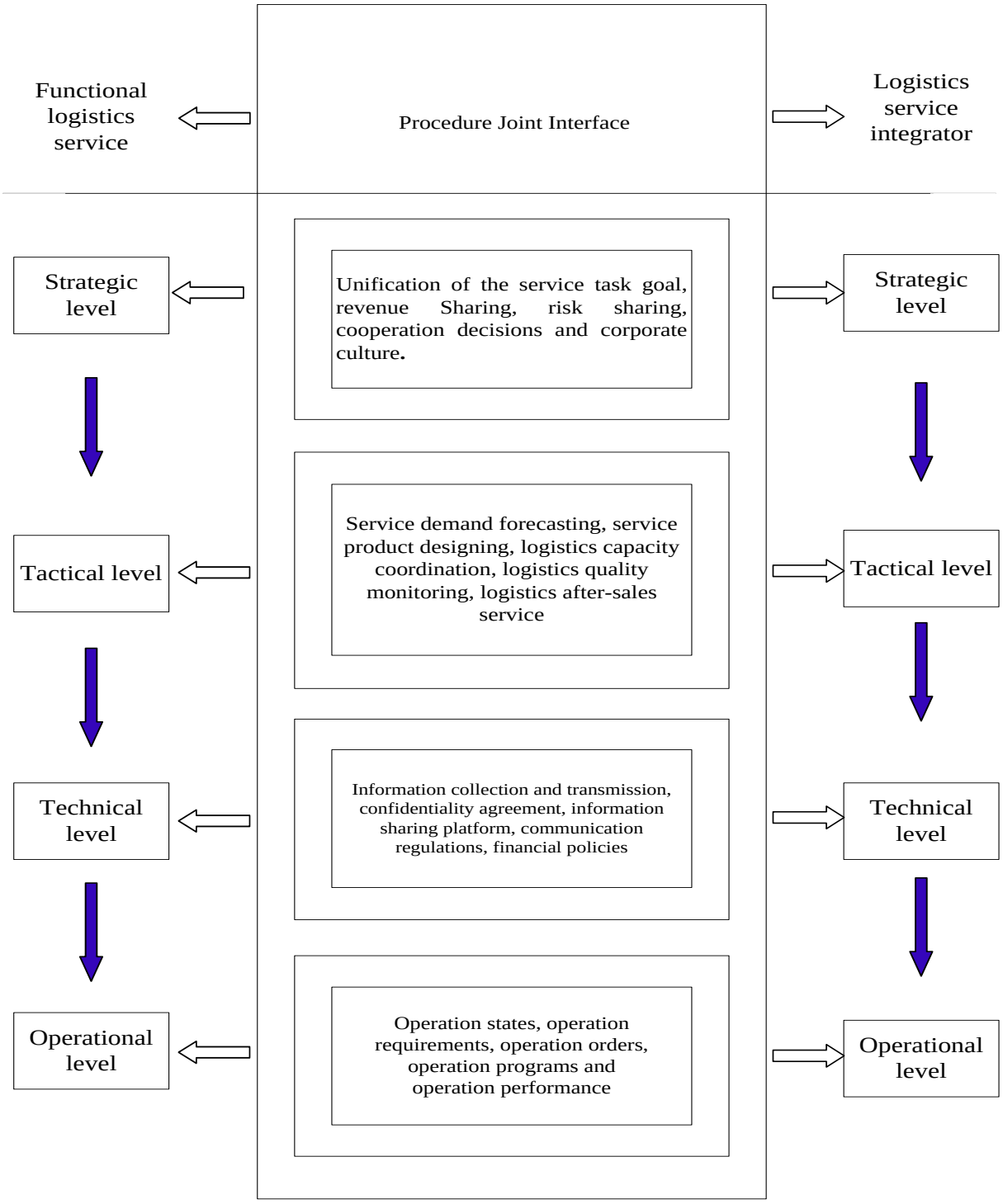

Figure 2. Procedure joint mode analysis based on the operation management viewpoint.

characteristics. Some service indices should be included, such as demand forecasting collaboration degree and service product designing collaboration degree before the service, logistics order allocation collaboration degree and logistics quality monitoring collaboration degree during the service, logistics after-sales service after the service, etc.

Based on the designing principles of the synthesized performance evaluation mentioned earlier and combined

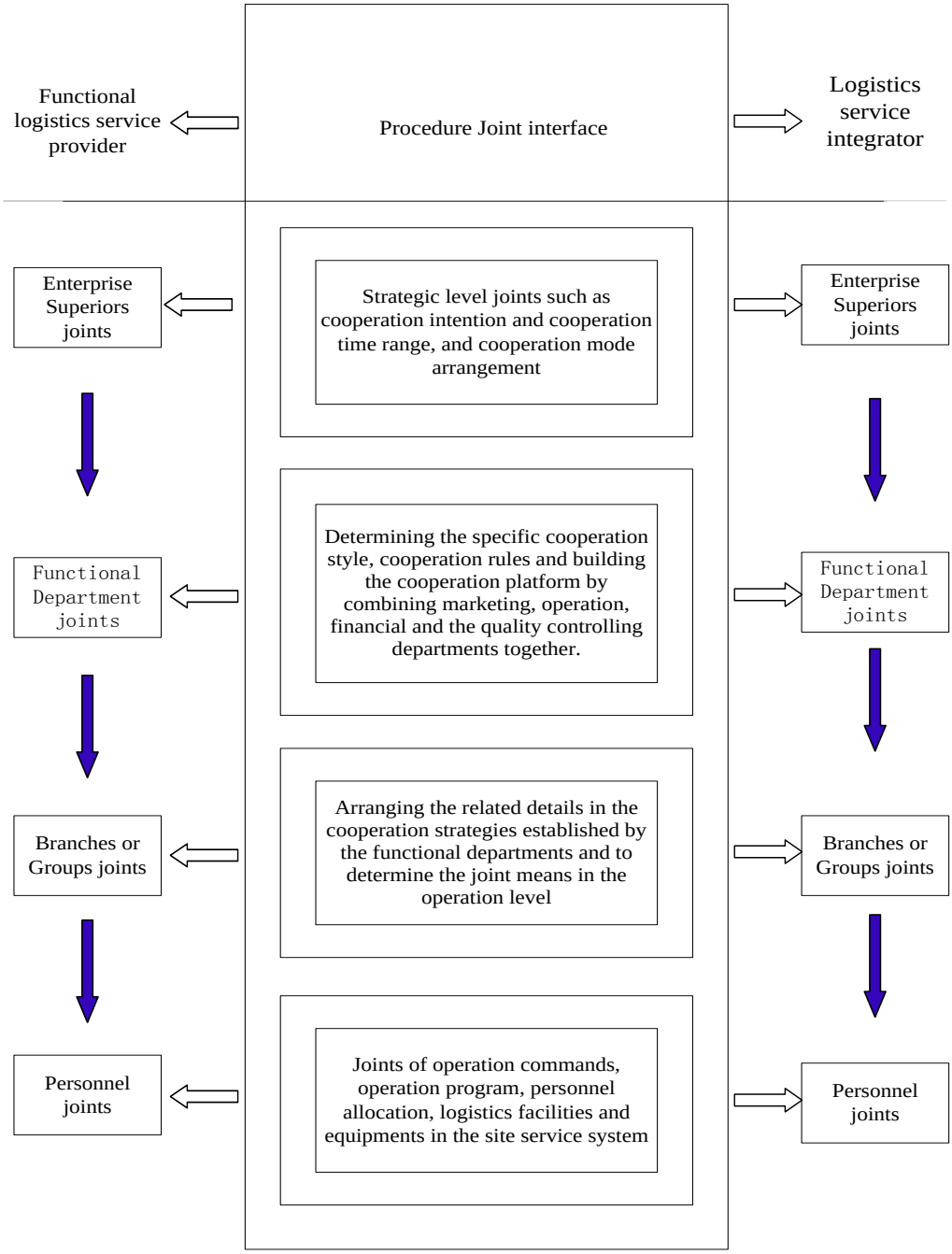

Figure 3. Procedure joint mode analysis based on the organization structure viewpoint.

with the procedure joint mode and environment mentioned before, Table 1 shows the index system for synthesized evaluation.

It should be noted that in Table 1 if one evaluation index needs to be assessed by several bodies at the same time, the overall evaluation bodies should be assessed, and the results are summarized according to the weight of each evaluation body so as to obtain the final value of this index.

ANP-BASED SYNTHESIZED PERFORMANCE EVALUATION FOR THE PROCEDURE JOINT OF LSSC

ANP introduction

Analytic network process (ANP) was proposed by Professor T. L. Saaty in 1996. ANP is a new decision-making method developed and formed from AHP (analytic hierarchy process) method, which allows several

Table 1. Index system for the synthesized performance evaluation of the procedure joint process in LSSC.

First layer index	Evaluation body	Second layer index	Third layer index	Specific explanation of the index
Environment of process joint C1	LSI, FLSP	Trusting environment C11	Trusting mechanism environment C111	The trusting degree about the partner, such as its enterprise qualification and reputation
	LSI, FLSP	Operational environment C12	Information sharing environment C121	Perfection degree of the infrastructure condition for information sharing
			Incentive and constraint mechanism environment C122	Perfection degree of the incentive and constraint
			Evaluation mechanism environment C123	Soundness of the cooperation evaluation mechanism
Procedure of joint process C2	LSI, FLSP	Joint performance of strategic level C21	Consistency of cooperation goals C211	Consistency of the understanding about cooperation goals
			Consistency of collaboration decision-making C212	Consistency of the achievement during the collaboration decision-making process
			Acceptance of revenue sharing C213	Acceptance of revenue sharing mechanism
			Acceptance of risk sharing C214	Acceptance of risk sharing mechanism
			Integration of corporate culture C215	Integration of each other's cultural value
	LSI, FLSP	Joint performance of tactical level C22	Collaboration of service demand forecasting C221	Sharing degree of demand forecasting information
			Collaboration of service product designing C222	Collaboration degree of concept designing , structural designing and process designing about logistics service products
			Collaboration of logistics capacity management C223	Quantity consistency, quality consistency and time requirement consistency about logistics capacity

Table 1. Contd.

			Collaboration of logistics quality monitor C224	Sharing degree of quality monitoring information
			Collaboration of logistics after-sales service C225	Coordination of the after-sale service operation by both sides
	LSI, FLSP	Joint performance of technical level C23	Information collection and transmission C231	Unified degree of the information collection and transmission standards
			Secrecy contracts C232	Completing degree of the secrecy contrasts
			Building of the public joint platform C233	Perfection degree of the public joint platform
			Coordination and institutionalization of mutual communication C234	Perfection degree of the coordination standards
			Finance joint mechanism C235	Soundness degree of financial joint standards
	LSI, FLSP	Joint performance of operational level C24	Joint in service operation status C241	Accuracy and punctuality degree in operation status
			Joint in service operation requirements C242	Level of detail and accuracy degree of the operational requirements
			Joint in service operation commands C243	Accuracy and punctuality degree of the operation commands
			Joint in service operational schedule C244	Level of detail and accuracy degree of the operational schedule
			Joint in service operational performance evaluation C245	Opportune feedback degree of the operational performance
Results of process joint C3	Customers	Customer satisfaction C31	Response speed to customer demand C311	Speed of response to customer demand
			Capacity to satisfy customer demand C312	The capacity index which reflects the capacity to satisfy customer demand

Table 1. Contd.

		Punctual completing rate of logistics service C313	Punctuality degree about the logistics service completing
		Rate of goods breakage C314	Rate of goods breakage
		Rate of customer complaints C315	Complaint condition about logistics service by customers
		Price superiority of logistics service C316	Price superiority of logistics service in market competition
LSI, FLSP	Profitability C32	Market share rate C321	Market share situation of logistics service
		Profit growth rate C322	Profit growth rate of logistics situation
		Return on investment C323	Return on investment situation of logistics service
		Capital turnover rate C324	Capital turnover rate Situation of logistics service

indices coexisting together, and considers the relevance or response relationships between element groups in different levels and between elements within an element group. Therefore, ANP method could reflect and describe the decision-making issues closer to the reality than AHP. The ANP method divides the system into two parts: One is the control level, including the problem goals and decision-making principles, in which each decision principle is considered to be independent, and it's a typically hierarchical structure; the other is network level, which is composed of all the elements dominated by control level. These elements interact with each other to form a network structure.

The calculation of ANP model is complicated, and it's difficult to apply the ANP model into solving actual decision-making problems without the software assistance. Rozann and William (2002) proposed the Superdecision software, which is based on the ANP theory and programmed the calculation of ANP. It is not only a powerful calculation tool of ANP, but also establishes the foundation for the extension of ANP.

Index data processing

Generally speaking, the index could be classified into quantitative type and qualitative type. For the quantitative index, it could be divided into two categories namely, benefit-based and cost-based type. In order to make these indices normalization conveniently, index value can be set within interval range according to possible conditions, that is, an upper limit and a lower limit can be provided. Then, the non-dimensionalization method of the benefit-based index is shown in Equation 1.

$$r_j = \begin{cases} 1 & , \quad y_j > y_j^{\max} \quad ; \\ \dfrac{y_j - y_j^{\min}}{y_j^{\max} - y_j^{\min}} & , \quad y_j^{\max} \geq y_j \geq y_j^{\min} \quad ; \\ 0 & , \quad y_j < y_j^{\min} \quad 。 \end{cases} \tag{1}$$

The non-dimensionalization method of the cost-based index is expressed as Equation 2:

$$r_j = \begin{cases} 0 & , \quad y_j > y_j^{\max} \quad ; \\ \dfrac{y_j^{\max} - y_j}{y_j^{\max} - y_j^{\min}} & , \quad y_j^{\max} \geq y_j \geq y_j^{\min} \quad ; \\ 1 & , \quad y_j < y_j^{\min} \quad 。 \end{cases} \tag{2}$$

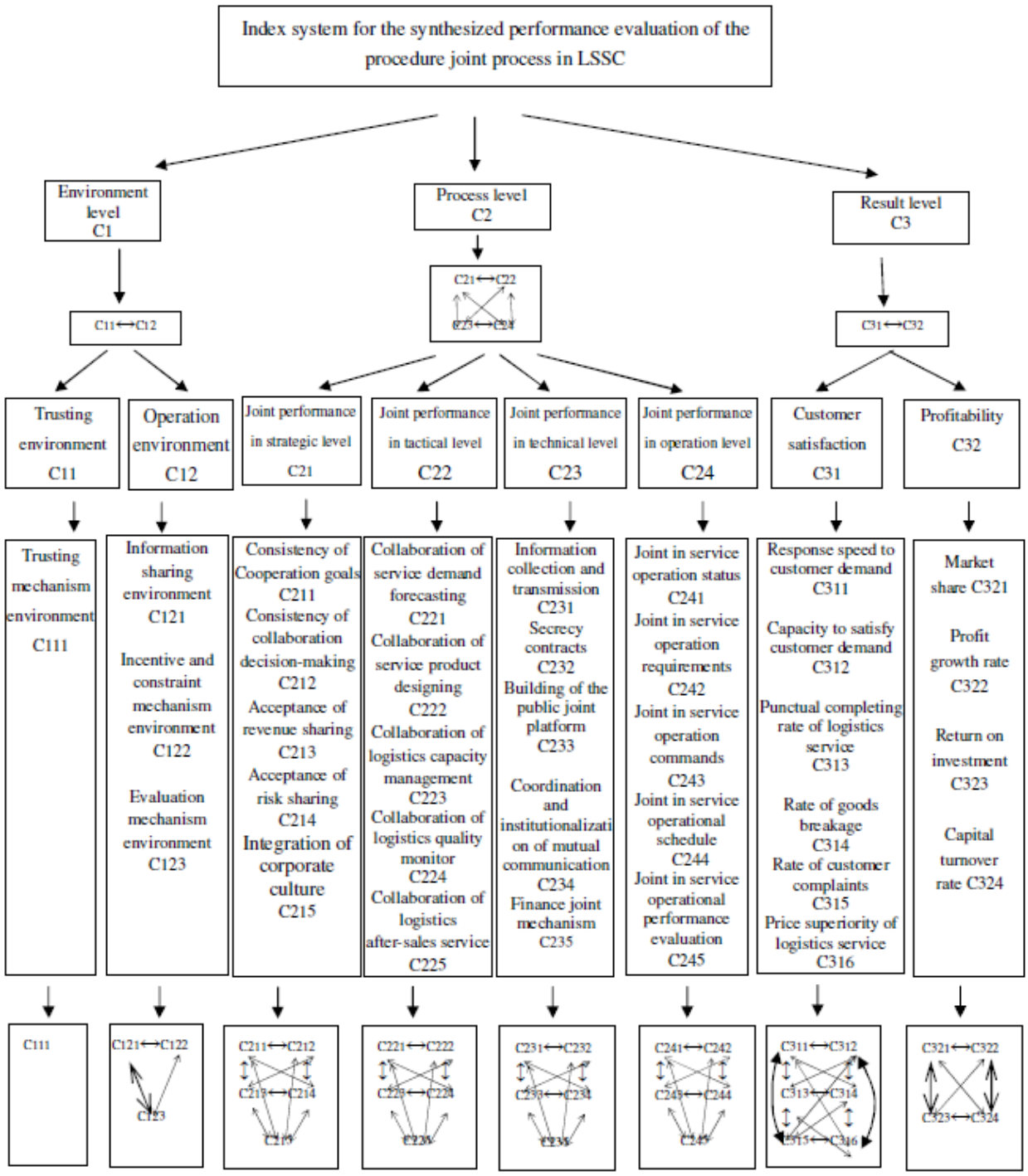

Figure 4. ANP model of the index system for the synthesized performance evaluation of the procedure joint process in LSSC.

where $y_j^{\max}, y_j^{\min}$ are the upper and lower limits provided of the j[th] index. y_j is the actual value of the j^{th} index.

For the qualitative index, the experts could give a score based on their own experience cognition. The score could be classified into seven classes, namely, excellent, very good, good, average, not good, bad, and worse. Then the qualitative index can be converted into quantitative index, and dealt with the non-dimensionalization as Equations 1

and 2.

Application

In order to illustrate the application of ANP method more clearly, here a LSSC is exemplified. The data in this paper are hypothetical data and the detailed process is as follows:

ANP model building and index non-dimensionalization

Firstly, the ANP model of the index system for the synthesized performance evaluation of the procedure joint process LSSC is established as shown in Figure 4. Each member of LSSC including FLSP, LSI and customer will evaluate the performance of procedure joint in accordance with their role in LSSC. According to the evaluation index system in Table 1, each index is evaluated by multi-member, and the evaluation result of this index is shown as the weighted average value. Then each index is assessed and is non-dimensionalized according to Equations 1 and 2, so the index is transformed into a number within the range of (0, 1). Finally Table 2 can be obtained.

Weight setting of the inner independent principles

AHP method is used to determine the weight of the inner independent index levels. Due to the independent relationship among the indices, the comparison with each other is finished as long as the relative importance of sub-rules in the lower level under the upper level. For example, as shown in Table 3, for the result level, operation level and environment level, only if the weight of the synthesized performance index for LSSC is calculated relative to the control level, this paper achieves the judgment matrix by comparing these indices according to weight measures (number 1 to 9).

Weight setting of the inner dependent index level

In order to reflect the interaction relationships among these inner dependent principles, the importance of horizontal comparison among different principles is required, besides that in the upper level. For example, there are five joint indices in the strategic level (C211, C212, C213, C214, and C215), so the importance of impact among them needs to be obtained. Under the principle of consistency of cooperation goals (C211), not only the importance of collaboration decision-making consistency (C212), and acceptance of revenue sharing (C213), but the acceptance of risk sharing (C214) and integration of corporate culture (C215) are compared as shown in Table 4. Other judgment matrixes are displayed in Tables 5, 6, 7 and 8. These five judgment matrixes illustrate how these five indices influence on each other in strategic level. In the same way, the dependent relationships among other indices could be determined.

Super-matrix, weighted super-matrix and ultimate super-matrix calculation of ANP structure

After the mutual dependent relationships among different indices are considered, the influencing weights of these relationships among all the indices can be assembled into a matrix, namely, a super-matrix. Then the super-matrix can be weighted to obtain the weighted super-matrix shown in Table 8, and the convergence status can be obtained by using the Superdecisions software. Increasing the exponent of weighted super-matrix gradually till a steady ultimate super-matrix is obtained, the calculation results are described in the corresponding rows of Table 9.

Analysis of evaluation results

The synthesized performance index of the procedure jointin LSSC is defined as $Z = \sum_{i=1}^{29} W_i R_i$ where, W_i denotes the i^{th} index's global weight relative to the overall objective, R_i denotes the i^{th} index's non-dimensionalization value, which is a number in the range of (0, 1). Then Z can be given a qualitative explanation. This paper classifies the performance, based on the Z values, into four categories, which are excellent (0.85 to 1), good (0.70 to 0.85), average (0.6 to 0.70) and bad (below 0.6).

Table 9 lists the final calculation results. Based on the data in these tables, the synthesized score of the procedure joint performance in LSSC is Z = 0.8625, which falls in the range of 0.85 and 1, so the synthesized performance is excellent.

CONCLUSIONS

Procedure joint is an important part of the collaboration process, and also is a key factor affecting the synthesized performance of LSSC. From three aspects, "before the procedure joint, during the procedure joint, after the procedure joint", this paper analyzed four essential

Table 2. Results of the index after non-dimensionalization.

Index	Data non-dimensionalized	Index	Data non-dimensionalized
Trusting mechanism environment C111	0.8	Coordination and institutionalization of mutual communication C234	0.9
Information sharing environment C121	0.78	Financial joint mechanismC235	0.90
Incentive and constraint mechanism environment C122	0.9	Joint in service operation status C241	0.91
Evaluation mechanism environment C123	0.8	Joint in service operation requirements C242	0.98
Consistency of cooperation goals C211	0.9	Joint in service operation commands C243	0.88
Consistency of collaboration decision-making C212	0.92	Joint in service operational schedule C244	0.86
Acceptance of revenue sharing C213	0.87	Joint in service operational performance evaluation C245	0.82
Acceptance of risk sharing C214	0.88	Response speed to customer demand C311	0.9
Integration of corporate culture C215	0.75	Capacity to satisfy customer demand C312	0.86
Collaboration of service demand forecasting C221	0.78	Punctual completion rate of logistics service C313	0.93
Collaboration of service product designing C222	0.86	Rate of goods breakage C314	0.90
Collaboration of logistics capacity management C223	0.9	Rate of customer complaints C315	0.90
Collaboration of logistics quality monitor C224	0.86	Price superiority of logistics service C316	0.83
Collaboration of logistics after-sales service C225	0.83	Market share rate C321	0.8
Information collection and transmission C231	0.84	Profit growth rate C322	0.85
Confidential contractsC232	0.85	Return on investment C323	0.82
Building of the public joint platform C233	0.9	Capital turnover rate C324	0.86

Table 3. Judgment matrix under the synthesized performance of procedure joint for LSSC.

C	C1	C2	C3	Weight normalized
C1	1	4/9	1/2	0.1905
C2	9/4	1	9/8	0.4286
C3	2	8/9	1	0.3810

Table 4. Judgment matrix under the consistency of cooperation goals index.

C211	C212	C213	C214	C215	Weight normalized
C212	1	3/2	2	2	0.3703
C213	2/3	1	7/4	7/4	0.2828
C214	1/2	4/7	1	4/3	0.1859
C215	1/2	4/7	3/4	1	0.1610

Table 5. Judgment matrix under the consistency of collaboration decision-making index.

C212	C211	C213	C214	C215	Weight normalized
C211	1	1/2	1	1	0.1996
C213	2	1	2	2	0.3992
C214	1	1/2	1	4/3	0.2151
C215	1	1/2	3/4	1	0.1862

Table 6. Judgment matrix under the acceptance of revenue sharing index.

C213	C211	C212	C214	C215	Weight normalized
C211	1	0.5	1	4/3	0.2028
C212	2	1	2	3	0.4180
C214	1	1/2	1	4/3	0.2028
C215	3/4	1/3	3/4	1	0.1478

Table 7. Judgment matrix under the acceptance of risk sharing index.

C214	C211	C212	C213	C215	Weight normalized
C211	1	1/2	4/7	4/3	0.1804
C212	2	1	6/5	3	0.3763
C213	7/4	5/6	1	7/3	0.3118
C215	3/4	1/3	3/7	1	0.1314

Table 8. Judgment matrix under the integration of corporate culture index.

C215	C211	C212	C213	C214	Weight normalized
C211	1	1/2	4/7	1	0.1739
C212	2	1	8/7	2	0.3478
C213	7/4	7/8	1	7/4	0.3043
C214	1	0.5	4/7	1	0.1739

mechanism environment required to achieve procedure joint and proposed a synthesized performance evaluation index system for LSSC. Seen from the index system, theindices have the impact and interference with each other.

In order to solve these problems, the ANP method was applied into the synthesized performance evaluation of the procedure joint in LSSC, and the Superdecision software was used for the assessment. The results show that the ANP method can solve the interaction problems among different index systems, and greatly improve the accuracy of performance evaluation as well, which makes the decision-making issues more scientific and reasonable.

Managerial insights

From the research perspective, understanding the procedure joint and performance evaluation of LSSC enlightens new approaches to develop theories about LSSC. For instance, can we build a service supply chain operation reference model (SSCOR) based on procedure joint? How can we better change the qualitative data into quantitative data in ANP evaluation method? In performance evaluation, is the fuzzy-ANP method better? This study provides benefit thinking for further research on the procedure joint in LSSC.

From the managerial standpoint, the results of this study show that there are many factors affect the

Table 8. Weights of the super-matrix

	C111	C121	C122	C123	C211	C212	C213	C214	C215	C221	C222	C223	C224	C225	C231	C232	C233	C234	C235	C241	C242	C243	C244	C245	C311	C312	C313	C314	C315	C316	C321	C322	C323	C324
C111	0																																	
C121		0	0.4	0.429																														
C122		0.667	0	0.571																														
C123		0.333	0.6	0																														
C211					0	0.2	0.203	0.18	0.174																									
C212					0.37	0	0.418	0.376	0.348																									
C213					0.283	0.399	0	0.312	0.304																									
C214					0.186	0.215	0.203	0	0.174																									
C215					0.161	0.186	0.148	0.131	0																									
C221										0	0.186	0.218	0.194	0.177																				
C222										0.229	0	0.272	0.246	0.23																				
C223										0.313	0.342	0	0.367	0.315																				
C224										0.277	0.286	0.293	0	0.278																				
C225										0.181	0.186	0.218	0.194	0																				
C231															0	0.225	0.259	0.25	0.234															
C232															0.207	0	0.222	0.214	0.2															
C233															0.315	0.305	0	0.321	0.292															
C234															0.271	0.262	0.296	0	0.275															
C235															0.207	0.208	0.222	0.214	0															
C241																				0	0.243	0.243	0.261	0.231										
C242																				0.238	0	0.243	0.261	0.231										
C243																				0.238	0.243	0	0.261	0.231										
C244																				0.336	0.323	0.323	0	0.308										
C245																				0.188	0.192	0.192	0.217	0										
C311																									0	0.18	0.19	0.19	0.2	0.22				
C312																									0.15	0	0.15	0.15	0.15	0.16				
C313																									0.2	0.19	0	0.21	0.2	0.21				
C314																									0.24	0.23	0.24	0	0.22	0.23				
C315																									0.18	0.17	0.18	0.19	0	0.18				
C316																									0.24	0.23	0.25	0.25	0.24	0				
C321																															0	0.25	0.24	0.23
C322																															0.38	0	0.41	0.39
C323																															0.33	0.4	0	0.38
C324																															0.29	0.35	0.36	0

Table 9. Synthesized evaluation score of the procedure joint performance in LSSC.

First level index	Weight	Second level index	Local weight	Third level index	Local weight	Global weight	Value of index non-dimensionalized	Score
C1	0.1905	C11	0.4675	C111	1	0.0891	0.8	0.0712
		C12	0.5325	C121	0.2924	0.0297	0.78	0.0231
				C122	0.3814	0.0387	0.9	0.0348
				C123	0.3262	0.0331	0.8	0.0265
C2	0.4286	C21	0.3016	C211	0.1624	0.0210	0.9	0.0189
				C212	0.2790	0.0361	0.92	0.0332
				C213	0.2533	0.0327	0.87	0.0285
				C214	0.1669	0.0216	0.88	0.0190
				C215	0.1384	0.0179	0.75	0.0134
		C22	0.2262	C221	0.1638	0.0159	0.78	0.0124
				C222	0.1982	0.0192	0.86	0.0165
				C223	0.2520	0.0244	0.9	0.0220
				C224	0.2217	0.0215	0.86	0.0185
				C225	0.1643	0.0159	0.83	0.0132
		C23	0.2262	C231	0.1959	0.0190	0.84	0.0160
				C232	0.1747	0.0169	0.85	0.0144
				C233	0.2361	0.0229	0.9	0.0206
				C234	0.2173	0.0211	0.9	0.0190
				C235	0.1759	0.0171	0.9	0.0153
		C24	0.2461	C241	0.1972	0.0208	0.91	0.0189
				C242	0.1965	0.0207	0.98	0.0203
				C243	0.1965	0.0207	0.88	0.0182
				C244	0.2443	0.0258	0.86	0.0222
				C245	0.1655	0.0175	0.82	0.0143
C3	0.3810	C31	0.7143	C311	0.1641	0.0447	0.9	0.0402
				C312	0.1309	0.0356	0.86	0.0306
				C313	0.1701	0.0463	0.93	0.0431
				C314	0.1862	0.0507	0.9	0.0456
				C315	0.1533	0.0417	0.9	0.0375
				C316	0.1953	0.0532	0.83	0.0441
		C32	0.2857	C321	0.1931	0.0210	0.8	0.0168
				C322	0.2821	0.0307	0.85	0.0261
				C323	0.2727	0.0297	0.82	0.0243
				C324	0.2521	0.0274	0.86	0.0236
Total score								0.8625

performance evaluation in LSSC. To successfully complete the cooperation of LSSC, the managers of LSI and FLSP should not only understand the each other's concerns, seek the commons while reserving the differences, but also establish the strategic partnership, reduce the information asymmetry and improve satisfaction of cooperation. In addition, it is necessary of using the suitable method to evaluation procedure joint and keeping dynamic evaluation to obtain the dynamic performance. According to the performance evaluation

results, managers of LSI and FLSP should take more effective means to improve procedure joint process.

Future study

For the future study, many aspects about the procedure joint in LSSC can be explored deeply. For example, from the empirical perspective, the influencing of procedure joint on the synthesized performance, which comes from the unbalanced information hold by LSI and FLSP, can be investigated; The procedure joint analysis tool of LSSC can be developed to improve the joint performance; The application of different performance evaluation methods in LSSC can be analyzed, and the advantages of different methods may be integrated to establish an integrated evaluation method for procedure joint in LSSC.

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