Computer Systems Science & Engineering
DOI: 10.32604/csse.2023.027971
Article

An Optimized Method for Accounting Information in Logistic Systems

Ahmad Mohammed Alamri[1] and Ahmad Ali AlZubi[2,*]

[1]Administrative Sciences Department, Community College, King Saud University, Riyadh, Saudi Arabia
[2]Computer Science Department, Community College, King Saud University, P.O. Box 28095, Riyadh, 11437, Saudi Arabia
*Corresponding Author: Ahmad Ali AlZubi. Email: aalzubi@ksu.edu.sa
Received: 30 January 2022; Accepted: 06 March 2022

Abstract: In the era of rapid information development, with the popularity of computers, the advancement of science and technology, and the ongoing expansion of IT technology and business, the enterprise resource planning (ERP) system has evolved into a platform and a guarantee for the fulfilment of company management procedures after long-term operations. Because of developments in information technology, most manual accounting procedures are being replaced by computerized Accounting Information Systems (AIS), which are quicker and more accurate. The primary factors influencing the decisions of logistics firm trading parties are investigated in order to enhance the design of decision-supporting modules and to improve the performance of logistics enterprises through AIS. This paper proposed a novel approach to calculate the weights of each information element in order to establish their important degree. The main purpose of this research is to present a quantitative analytic approach for determining the important information of logistics business collaboration response. Furthermore, the idea of total orders and the significant degrees stated above are used to identify the optimal order of all information elements. Using the three ways of marginal revenue, marginal cost, and business matching degree, the information with cumulative weights is which is deployed to form the data from the intersection of the best order. It has the ability to drastically reduce the time and effort required to create a logistics business control/decision-making system.

Keywords: Accounting information systems; decisions systems; corporate accounting; logistic system

1 Introduction

Logistics business is the object of logistics operation, including transportation, warehousing, packaging, etc. Among them, transportation is the core business. Carrying out logistics business operations through logistics information platforms and big data has become one of the main trends in future logistics operations [1–3]. In recent years, my country has successively established more than 200 different types of logistics information platforms or APPs, with different styles and different specifications and categories of business information provided. The logistics information platform realizes the aggregation and sharing of logistics business information, and improves the efficiency of logistics business discovery

[4,5]. However, before the actual business operation starts, it generally involves three links: discovery, response, and transaction. As shown in Fig. 1, they affect each other and the result is uncertainty [6].

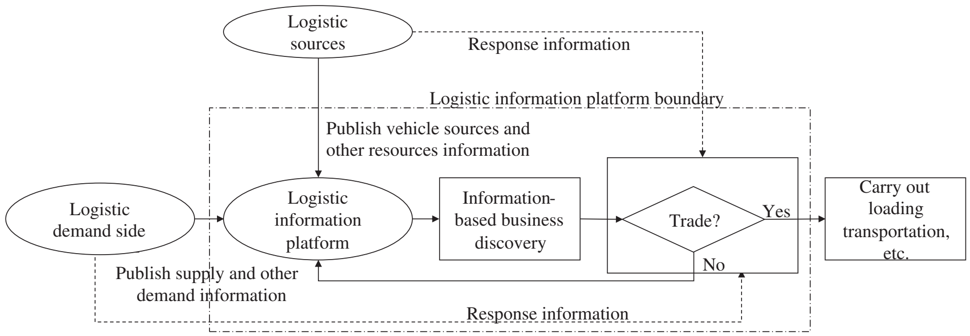

Figure 1: Transaction process based on logistics accounting information system

Due to the requirements of the logistics time effect, the timeliness of the response to the discovery of the logistics business determines whether the logistics business can be successfully executed, which in turn affects the operational efficiency and resource utilization of the corresponding business [7,8]. For example, for an empty vehicle that is going to return at a specific time, if the relevant source of goods that has learned the information does not respond before the departure time of the vehicle's return journey, it means that the vehicle cannot find the source of goods and must return with a low load or even no load [9–12]. Therefore, not controlling the response of the logistics business will greatly weaken the improvement efficiency of the logistics information platform on the operation of the logistics business [13–15]. The development of logistics information platform, especially after the active sharing economy, has attracted many scholars to carry out related research, but its research still focuses on the construction technology of logistics information platform [16], system structure [17,18] and application mode [19,20]. Although research on its operation has gradually emerged in recent years, such as the emergence of pricing [21] and auction mechanisms [22], especially business matching based on logistics information platforms, and discovery algorithms (such as matching) [23–25], but few people are involved in the research on response after logistics business discovery.

Since the logistics business involves both the supply and demand sides, the logistics business discovery method actually establishes the coupling relationship between multiple transaction parties of the logistics business through the logistics information platform organization. This means that the response to the logistics business actually requires a coordinated response in order to ensure that a specific business transaction is completed on schedule. Theoretically, the response process involves the following: the coupled transaction parties are related to the logistics information platform The interface checks the specific information of the discovered business (from recommendation or search), and then compares its own needs and analysis, and even conducts price games, income calculations, and decides whether to respond and trade. It can be seen that the response process to the logistics business is essentially a decision analysis process. The types and forms of specific information about a specific logistics business provided by the logistics information platform (interface) affect the coupling transaction. Through comparison and analysis of square processing, and then observe affects whether it can seize the opportunity to make decisions (i.e., decision-making speed [26]). For example, car owners usually consider revenue or transportation price when choosing to transport goods. If the logistics information platform directly provides the predicted revenue of the corresponding business, the car owner does not need to collect information, and can directly compare and eliminate concerns, reducing information collection in response to decision-making, machining action and time. Therefore, it is of great significance to optimize the corresponding design of the logistics information platform and provide reasonable decision support information about a specific business in a specific way. But there is a lot of information that affects everyone's decision-making, including the level of knowledge of traders, the benefits of business, and dozens of other types. If all are provided through the interface, it will greatly increase the design workload and difficulty of the decision support module corresponding to the logistics information platform. At the same time, if too much support information is provided, it will cause the prisoner's dilemma that the information is more abundant and the information is more insufficient [27]. Especially at present, many logistics information platform users obtain business information through mobile phones, that is, too much business support information will increase the decision-making analysis process of the transaction party and restrict the timeliness of the response. Therefore, it is necessary to determine the key information that affects the collaborative response of logistics business to drive the design of the corresponding information module, to ensure that the transaction decision makers of the logistics business response are provided with the most needed support information for their decision-making, and at the same time to avoid excessive information. At the same time, the existing research on decision support system rarely involves the information content and expression (including interface) of decision support.

In view of this, combined transportation is the core business of logistics business. Based on it, this paper determines the key information content of collaborative response control of logistics business by quantitatively calculating the weight of impact information to guide the logistics information platform (coordinated response control module). Optimize the design and provide key support information to the transaction parties, promote their rapid decision-making, and shorten the decision-making time. For the convenience of expression, the module dedicated to the coordinated response control of logistics business in the logistics information platform is called "coordinated response decision support system".

2 Methods of Determining Key Impact Information

Based on the fact that the logistics business collaborative response process is the essence of the decision-making process, the decision-making system of the logistics business collaborative response is firstly constructed, and the factors affecting the decision-making in the system are determined as potential information. Then, for these information, the method of quantitative comparison and calculation of weights is adopted to reflect the importance of each information and sort it. Due to the lack of basic data on these factors, it is impossible to evaluate their importance through mathematical models and other methods. For this reason, the subjective weight evaluation method is selected. However, in order to avoid the subjective influence of each method and the randomness of the determined key information results and affect the design of the entire support system, the analytic hierarchy process (AHP), the decision-making trial and evaluation laboratory (DEMATEL) and the AHP-DEMATEL method were comprehensively selected. To calculate each information factor, reliability test is carried out by applying the summation theory of serial numbers to determine the optimal result. Then, the principal component idea is determined based on the principal component analysis method, and the information with a cumulative weight contribution rate greater than or equal to 85% is determined as the key impact information of the logistics business collaborative response. The intersection of key information is the consensus information, and the quantitative weight in the optimal method is used as its final weight. Its process is shown in Fig. 2.

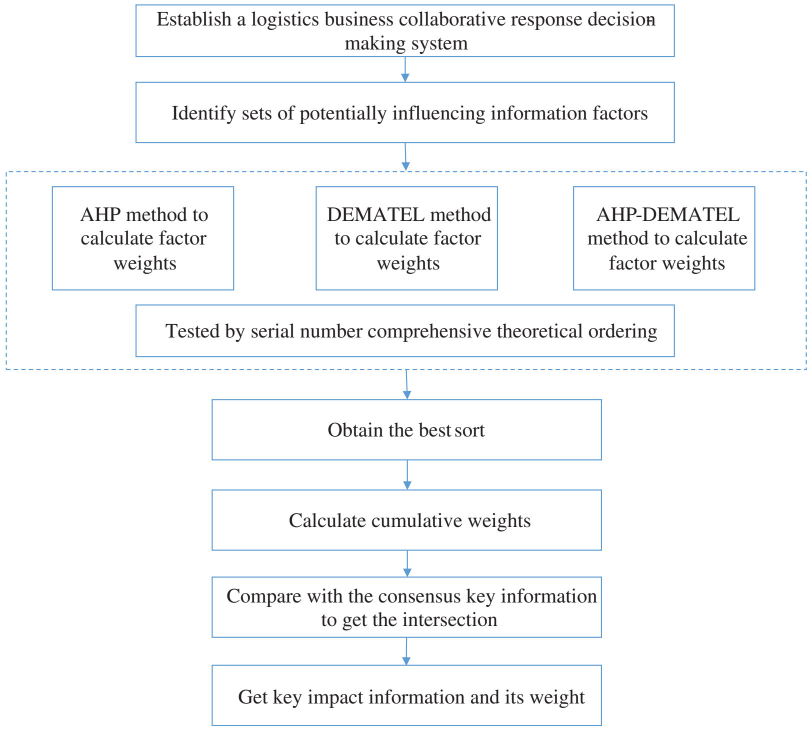

Figure 2: Flow for determining the coordinated responses to control critical information

Let the weight of the i-th information be w_i, and the calculation methods in the three methods are as follows.

(1) AHP selects the root value method to normalize the judgment matrix to obtain the weight.

$$w_i = \frac{\sqrt[n]{\prod_{j=1}^{n} a_{ij}}}{\sum_{i=1}^{n} \sqrt[n]{\prod_{j=1}^{n} a_{ij}}},\ i = 1, 2, \ldots, n \tag{1}$$

In the formula, a_{ij} represents the constructed judgment matrix element; n is the total number of information.

(2) The formula for DEMATEL to calculate the weight is [28] expressed as follows:

$$\begin{cases} P_{g_i} = \dfrac{g_i}{\sum_{i=1}^{n} |g_i|}; \\ w_i = \dfrac{h_i\left(1 - P_{g_i}\right)}{\sum_{i=1}^{n}\left[h_i\left(1 - P_{g_i}\right)\right]}; \\ 1 \le i \le n \end{cases} \tag{2}$$

In the formula, $g_i = f_i - e_i$; $h_i = f_i + e_i (1 \le i, j \le n)$; f_i and e_i are the influence degree and the influenced degree of each information, respectively.

(3) AHP-DEMATEL calculate the weight as follows:

$$w_i = w_i^1 w_i^2 \tag{3}$$

In the formula, w_i^1, w_i^2 respectively represent the weight value of the information obtained by Eq. (1) and the weight value obtained based on DEMATEL correction. The correction value is calculated as

$$w_i^2 = \frac{e_i f_i}{\sum_{i=1}^{n} e_i f_i} \tag{4}$$

3 Potential Impact Information Identification

In the logistics business transaction environment based on the logistics information platform, the collaborative response process to the logistics business itself is a multi-party coupled decision-making process, but each transaction party makes an independent decision after obtaining business information from the logistics information platform, and the transaction decision makers make decisions. The information obtained in the process about the decision-making task affects the timeliness and results of completing the decision. Therefore, by incorporating the decision-related elements into the decision-making system, that is, the logistics business decision-making system, the initial impact information of the coordinated response of the logistics business can be obtained from the perspective of the influencing factors of the components of the logistics business decision-making system. Based on this, taking the transportation business as an example, the logical structure of the logistics business decision-making system is constructed, as shown in Fig. 3. From the three aspects of decision-maker, decision-making task and environment, 17 potential factors affecting the decision-making speed of logistics business were identified, as shown in Tab. 1.

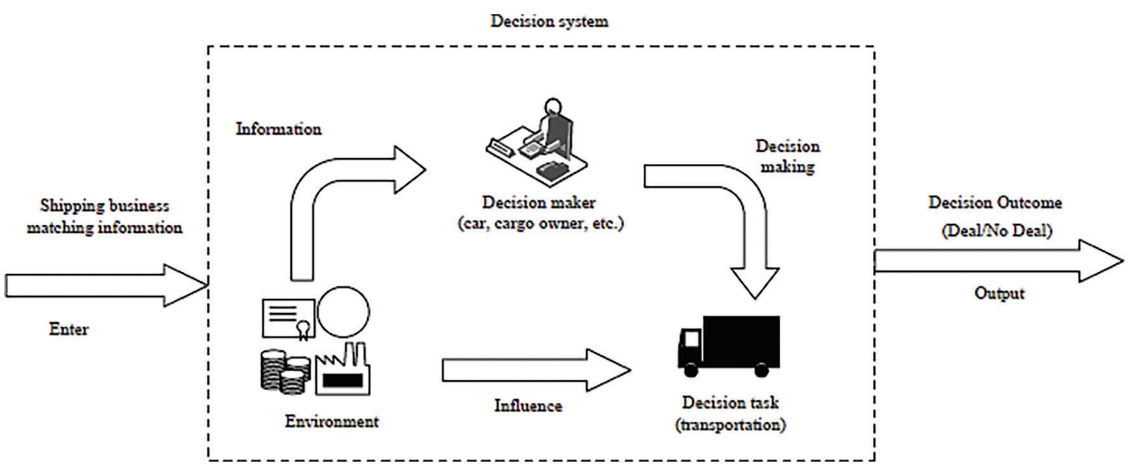

Figure 3: AIS decision system

4 Determination of Key Information Content

4.1 Information Importance Calculation for Unit Methods

4.1.1 The Importance of AHP Calculation

Based on the principle of AHP, according to the relationship between the elements in Tab. 1, a hierarchical structure of factors influencing logistics business decision-making is constructed. Affects the information layer (information in Tab. 1). Based on the two-factor comparison method, consult customers and experts of logistics company and other units to construct a judgment matrix, set n = 17 in Eq. (1), use MATLAB software to calculate, after passing the consistency test, solve the weight of each influence information (due to space limitations, the obtained judgment matrix and solution process are not listed).

$\boldsymbol{W}^1 = \left(w_1^1, w_2^1, \ldots, w_i^1, \ldots, w_{17}^1\right) = (0.014, 0.015, 0.062, 0.023, 0.043, 0.051, 0.0190, 0.022, 0.020, 0.064, 0.098, 0.118, 0.183, 0.024, 0.013, 0.013, 0.047)$. Thus, the importance of each influencing factor is ranked as $F_7 > F_{13} > F_{12} > F_{11} > F_{10} > F_3 > F_6 > F_{17} > F_5 > F_{14} > F_4 > F_8 > F_9 > F_2 > F_1 > F_{15} > F_{16}$.

Table 1: Decision making analysis

Related ingredients	Information	Key meaning of information	Variable
Decision maker	Knowledge level	How much knowledge and ability are acquired through learning	F_1
	Experience level	Judgment acquired through practice	F_2
	Strategic vision	Ability to foresee the future	F_3
	Responsibilities and Powers	Responsibilities and rights of decision makers, e.g., transportation on defined routes, profit targets	F_4
	Decision-making capacity	Skills and competencies to compare plans based on knowledge, experience, etc. through acquired participation in decision-making activities	F_5
	Decision preference	Attitude towards benefits and risks	F_6
Decision task	Business match	The degree to which the found logistics business matches its own needs	F_7
	Qualification and reputation of the counterparty	Qualifications, capabilities, corresponding quality grade standards and credit degrees for engaging in the corresponding business	F_8
	Transportation route	Transportation business decision makers are influenced by the road conditions, traffic congestion and familiarity of transportation routes when making decisions.	F_9
	Business time	Time required to complete the business	F_{10}
	Business price	The price of the business	F_{11}
	Business repeat rate	After a similar logistics business appears at a certain moment, the probability of appearing again next time affects the game of decision makers	F_{12}
	Marginal benefit/cost	bear the expected benefits or costs of the business	F_{13}
Environment	Environmental friendliness	Completing the logistics business must comply with the national environment and its own safety requirements, such as whether the transportation and other tools used meet the environmental requirements, which affects the decision makers to receive the resources	F_{14}
	Road condition	Road conditions affect the safety, speed, etc.	F_{15}
	Weather	Local natural weather conditions, such as rainy days, often affect business safety and completion timeliness, such as whether the transportation arrives on time, etc., thus affecting whether decision makers decide to conduct business	F_{16}
	Market competitiveness	The number of individuals competing to obtain the logistics business affects the decision-making speed of decision-makers. If there are many competitors, they may grab orders	F_{17}

4.1.2 The Degree of Importance Calculated by the DEMATEL Method

After consulting the experts of Guangxi AI Logistics Company and other enterprises, after the statistics of the relationship between the influencing factors given by the experts, the score of the statistical result S is calculated according to Tab. 2, and the direct influence matrix $\boldsymbol{X}$ is constructed with the score, which is denoted as:

$$\boldsymbol{X} = \left[x_{ij}\right]_{n\times n} = \begin{bmatrix} 0 & x_{12} & \cdots & x_{1n} \\ x_{21} & 0 & \cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & 0 \end{bmatrix} \tag{5}$$

Table 2: Impact level standard values

Whether or not it affects	Influence level	Proportion of expert evaluation results	Value
None	None	–	0
	None	$S \leq 1\%$	0
	Weak	$1\% < S \leq 25\%$	1
Has affect	Generally	$25\% < S \leq 50\%$	2
	Powerful	$50\% < S \leq 75\%$	3
	Very strong	$S > 75\%$	4

From Tab. 3, the importance ranking of each influencing information factor of logistics business collaborative response based on DEMATEL method is $F_{13} > F_{12} > F_7 > F_{11} > F_{10} > F_{17} > F_9 > F_{15} > F_{14} > F_8 > F_6 > F_{16} > F_3 > F_5 > F_2 > F_4 > F_1$.

Table 3: Evaluation of information

F_i	e_i	f_i	w_i^2	m_i	n_i
F_1	0.076	0.036	0.005	0.113	−0.04
F_2	0.240	0.049	0.012	0.290	−0.191
F_3	0.089	0.277	0.016	0.366	0.188
F_4	0.127	0	0.005	0.127	−0.127
F_5	0.125	0.236	0.016	0.361	0.111
F_6	0.459	0.433	0.039	0.891	−0.026
F_7	1.312	1.198	0.108	2.510	−0.114
F_8	0.622	0.358	0.041	0.980	−0.264
F_9	1.612	0.533	0.078	2.145	−1.079
F_{10}	1.197	1.111	0.100	2.308	−0.087
F_{11}	0.940	2.011	0.107	2.952	1.071
F_{12}	1.127	1.662	0.112	2.788	0.535
F_{13}	1.309	2.081	0.130	3.390	0.772

(Continued)

Table 3 (continued)

F_i	e_i	f_i	w_i^2	m_i	n_i
F_{14}	0.425	0.687	0.047	1.112	0.263
F_{15}	0.795	0.409	0.050	1.204	−0.387
F_{16}	0.795	0.076	0.034	0.871	−0.720
F_{17}	1.103	1.198	0.100	2.301	0.095

4.1.3 The Importance of AHP-DEMATEL Method Calculation

It is calculated according to Eq. (4) from Tab. 3, and then comprehensive weight according to Eq. (3), and then through normalization, a new comprehensive weight vector is obtained as (0.001, 0.002, 0.011, 0.001, 0.008, 0.023, 0.234, 0.010, 0.018, 0.073, 0.119, 0.150, 0.271, 0.013, 0.007, 0.005, 0.054). Then the importance order under this weight is $F_{13} > F_7 > F_{12} > F_{11} > F_{10} > F_{17} > F_6 > F_9 > F_{14} > F_3 > F_8 > F_5 > F_{15} > F_{16} > F_2 > F_4 > F_1$.

4.2 Optimal Information Sequence

The key information determines the design of the collaborative response decision support system, and the method used is subject to a certain degree of subjectivity. The test is carried out by applying the summation theory of serial numbers. The summation of serial number theory considers the differences in the ranking of a research object by various methods, and adds the ranking numbers of different methods to obtain the sum of the serial numbers. The objective ranking is used as an ideal reference standard for testing the ranking results of each method. The consistency can be checked by calculating the Spearman rank correlation coefficient between the ranking of various methods and the reference ranking. The calculation formula is as follows:

$$R_k = 1 - \frac{6\sum_{i=1}^{n} D_{ik}^2}{n(n^2 - 1)} \tag{6}$$

In the formula, k is the number of methods; D_{ik} is the difference between the i-th factor in the k-th method and the total sequence number. $R_k \in [-1, 1]$, the larger R_k is, the closer it is to the ideal state. When $R_k = 1$, it indicates that the method is the most ideal ordering. Based on the sorting of the above three methods, it is converted into serial numbers, and the sum of the serial numbers is calculated and sorted. The results are shown in Tab. 4.

Table 4: Comparison of algorithms results

Information variable	AHP sort number	DEMATEL sort number	AHP-DEMATEL sort number	Total sorts	Sort by reference
F_1	15	17	17	49	17
F_2	14	15	15	44	16
F_3	6	13	10	29	10
F_4	11	16	16	43	14
F_5	9	14	12	35	12
F_6	7	11	7	25	7

Table 4 (continued)

Information variable	AHP sort number	DEMATEL sort number	AHP-DEMATEL sort number	Total sorts	Sort by reference
F_7	1	3	2	6	2
F_8	12	10	11	33	11
F_9	13	7	8	28	8
F_{10}	5	5	5	15	5
F_{11}	4	4	4	12	4
F_{12}	3	2	3	8	3
F_{13}	2	1	1	4	1
F_{14}	10	9	9	28	9
F_{15}	16	8	13	37	13
F_{16}	17	12	14	43	15
F_{17}	8	6	6	20	6

The Spearman rank coefficients of such methods relative to the sum of ordinal numbers were calculated to be 0.892, 0.912, 0.993, respectively. It can be seen that among the three methods, the difference between AHP and the total serial number ranking is the largest, because it is highly subjective and does not consider the influence of factors. The proposed method has the largest Spearman coefficient and is the best method. The result is the independent application method. The best ranking is close to the total serial number ranking, and only shows a small difference in F_2, F_4, and F_{16} factors, which has been relatively objective. Therefore, the proposed method can reduce the influence of subjective factors, which is consistent with other studies [29]. For simplicity, the proposed method can be directly applied to obtain the ranking and key factors [30].

4.3 Determination of Key Information Content

In theory, all 17 informational contents in Tab. 1 should be presented in the collaborative response control and support the trader in a suitable form. For example, according to the "decision preference F6" to provide the preferred matching business results, this will undoubtedly cause a huge workload of system design, and will also increase the complexity of the interface and the workload of user browsing, but it is known from the previous calculation that its impact on decision makers vary, and all offer value is not great. To this end, it is refined by accumulating weights [31−35].

Since the ranking of the proposed method is the optimal ranking and the results are preferentially selected to calculate the cumulative weight, as shown in Tab. 5. Taking the cumulative weight of 0.85 as the boundary, the determined key information is "marginal benefit/cost (F_{13}), business matching degree (F_7), business reproduction probability (F_{12}), business price (F_{11}), business consumption time (F_{10}), market competitiveness (F_{17})", denoted as $K_1 = \{F_{13}, F_7, F_{12}, F_{11}, F_{10}, F_{17}\}$.

Comparing the number of key information determined by the three methods, it can be seen that the number of key information obtained by the proposed method is the least, and it has more key connotations, which also shows that this method has an obvious role in highlighting key effects. The weights of each factor under the three methods reflect this effect, as shown in Fig. 4. The maximum weight under AHP is 0.19, and the maximum and minimum weight ratio is 14.6. While DEMATEL is only 0.13, the maximum and minimum weight ratio is 26. However, under AHP-DEMATEL, the maximum weight reaches 0.27, which is almost 2 times that of DEMATEL, and the maximum and minimum weight ratio reaches 271, which widens the gap of importance, so that the cumulative weight value of the first 6 pieces of information has exceeded 0.9. This reflects that the proposed method has more convergent effect on the importance of factors [36,37].

Table 5: AHP-DEMATEL information cumulative weight

Information variable	Weights	Cumulative weight
F_{13}	0.271	0.271
F_7	0.234	0.505
F_{12}	0.150	0.655
F_{11}	0.119	0.774
F_{10}	0.073	0.847
F_{17}	0.054	0.901

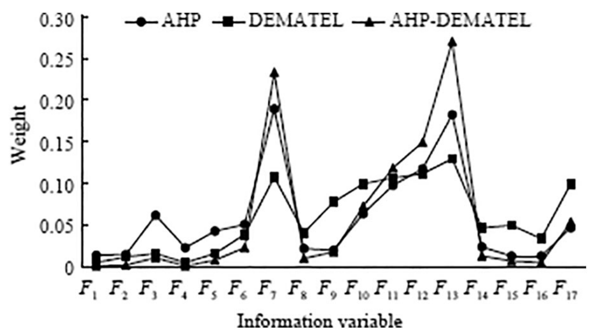

Figure 4: Comparison of information weight of different algorithms

It can be seen that there are certain differences in the importance ranking of logistics business response support information based on those methods, but the overall results are roughly similar. The key information of the comprehensive logistics business collaborative response control is marginal benefit/cost, business matching degree, business reproduction probability, business price, business consumption time and market competitiveness. Tab. 5 shows the importance weight.

Then calculate the cumulative weights of the AHP and DEMATEL methods respectively, as shown in Tabs. 6 and 7. Taking the cumulative weight of 0.85 as the boundary, there are 9 key information under AHP, including business matching degree (F_7), etc., which are denoted as $K_2 = \{F_7, F_{13}, F_{12}, F_{11}, F_{10}, F_3, F_6, F_{17}, F_5\}$. There are 10 key pieces of information in the DEMATEL method, denoted as $K_3 = \{F_{13}, F_{12}, F_7, F_{11}, F_{10}, F_{17}, F_9, F_{14}, F_{15}, F_8\}$.

Thus, the intersection of the key factors under the three methods is $K_J = \{F_{13}, F_7, F_{12}, F_{11}, F_{10}, F_{17}\} = K_1$. This also shows that the key informative factors can be obtained by directly applying the proposed method.

Table 6: AHP information cumulative weight

Information variable	Weights	Cumulative weight
F_7	0.190	0.190
F_{13}	0.183	0.373
F_{12}	0.118	0.491
F_{11}	0.098	0.589
F_{10}	0.064	0.653
F_3	0.062	0.715
F_6	0.051	0.766
F_{17}	0.047	0.813
F_5	0.043	0.856

Table 7: DEMATEL information cumulative weight

Information variable	Weights	Cumulative weight
F_{13}	0.130	0.130
F_{12}	0.112	0.242
F_7	0.108	0.350
F_{11}	0.107	0.457
F_{10}	0.100	0.557
F_{17}	0.100	0.657
F_9	0.078	0.735
F_{14}	0.050	0.785
F_{15}	0.047	0.832
F_8	0.041	0.873

5 Applications Based on Critical Information

The collaborative response decision support system takes the matching result of the logistics information platform as input, presents the result and its relationship to the transaction parties of the business, and provides the interface of response control and the algorithm of coupling control. The determination of key information provides the basis for the design of the decision support system, which greatly simplifies the design and development workload of the decision support system, especially the design of the source method of information data and the design of information expression method (including interface) are reduced by about 2/3. Because this main information generally needs to be obtained by integrating a variety of information, such as the matching degree of the business, in the matching of vehicles and goods, various information such as the vehicle, the origin of the goods, time, flow direction, weight, etc. should be comprehensively considered, and the matching degree There are different calculation methods.

Based on the above information, their calculation methods and their expressions (including interfaces) are established to reduce the time for transaction parties to obtain information and make decisions. For example, Eq. (7) establishes the calculation method of business consumption time.

$$t_{ij} = \frac{Q_k}{\eta_k} + \frac{S_3 + S_{ij}^1}{v} \quad (7)$$

In the formula, t_{ij} represents the predicted time required for the i-th vehicle to transport the j-th cargo, and the first part of the right equation represents the loading time. The second part indicates shipping time.

Fig. 5 is an example of the designed business consumption time expression. The whole expression framework is divided into two parts. On the left is the navigation bar of the key information determined earlier. We can switch to browse several kinds of information. The initial order is based on the weights in Tab. 5. The information with larger weights is located at the top, which can be adjusted according to the frequency of use to provide personalization. Interface. On the right is the specific expression content and method of each type of information. The relevant transaction parties can directly and quickly obtain the vehicle source with the least business time consumption matched by the current logistics information platform from this information, without the need for excessive information processing and improving the response efficiency.

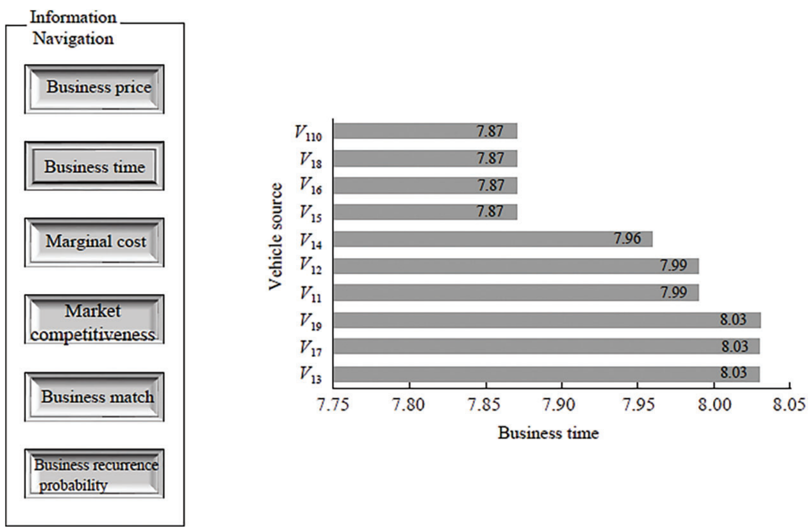

Figure 5: AIS-logistics control model and evaluation

6 Conclusion

The collaborative response process of logistics business is essentially a coupled decision-making process. The timeliness of response and decision-making determines the benefit of decision-making, which in turn affects the development of logistics business and the optimal utilization of resources. Obtaining the key information that affects the response and decision-making of the transaction party plays an important role in realizing the decision-making benefit and optimizing the design of the corresponding support system of the logistics information platform. This paper proposes a quantitative analysis method to determine the key information of logistics business collaborative response.

From the perspective of decision-making, it can be seen that there are 17 types of information that affects the transaction party's timely response and decision-making, or the information that the transaction party wants to obtain, business price, business time consumption, market competitiveness, and the weights are "0.271, 0.234, 0.150, 0.119, 0.073, 0.054" respectively. They are the basis for the design of the logistics business collaborative response control decision-making system, which greatly offload the logistics decision-making system. Providing these types of information by design not only provides the necessary support information for decision-making in the logistics business response, but also avoids excessive information, provides assurance for accelerated decision-making, and greatly reduces the design workload of the corresponding support system. This research can provide references for other decision support system designs, especially the impact of decision speed on benefits to research on impact.

In the future, we will address other important aspects of this study in the context of blockchain and ERP.

Acknowledgement: The authors extend their appreciation to King Saud University for funding this work.

Funding Statement: This work was supported by the Researchers Supporting Project (No. RSP-2021/395), King Saud University, Riyadh, Saudi Arabia.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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