



## Green Medical Reserve Logistics Provider Selection Using DEMATEL Method

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### Abstract

Compared with general commercial reverse logistics operators, the recovery and treatment of expired drugs and medical waste is a complex and highly technically difficult project. The qualifications required by the relevant service providers are also more stringent. For medical institutions, the selection of reverse logistics operators is always a critical issue. On the perspective of sustainability, this paper aims to investigate and explore the critical factors of selecting a medical reverse logistics service provider. Through the process of the Delphi method, the experts' assessments were collected, and 24 factors affecting the selection of medical reverse logistics service provider were screened and summarized. Then, Decision-Making Trial and Evaluation Laboratory (DEMATEL) was employed to calculate the total influence values and net influence values between factors that could be used to draw the visual causal map. Referring the causal map, "Green process operation level" and "Recycling process greening degree" are significantly higher than other factors in terms of total influence value and net influence value. Therefore, they can be regarded as crucial factors. This finding implies that medical reverse logistics providers must have the ability to improve the greening of facilities, as well as equipment, integrating existing processes to make it greener and environmentally friendly.

**Keywords:** Sustainability; Medical reverse logistics provider; Selection model; DEMATEL.

## 1. Introduction

In our society today, when economic scope has persisted to expand, the people have developed for more demands on both material and spiritual levels along with rapid developments of science and technology as well as its continuous advancement. However, the progress of human civilization has also brought a series of irreversible problems to our environmental resources, such as energy shortage, serious loss of forest resources, and sharp reduction in mineral resources and others. With the contradiction between economic and environmental benefits being exposed, they have seriously threatened the survival and development of human beings. Therefore, the circular and low-carbon economy has shown up as they have taken the coordinated development of environmental resources as well as spiritual life of human material into account, while it is considered a slap on the face to sacrifice limited resources in pursuit of rapid economic development. But, it is out of the question if we only protect the environment without pursuing development. As viewed, if we could organically combine the two and improve the environment during development before we can have achieved the sustainable development of resources.

To cope with the general trend of circular economy, China has introduced a large number of protection policies towards environmental resource protection in recent years, spending a lot of manpower, material resources, and funding, for it has proposed to turn itself into an environment-friendly and resource-saving society for green mountains and clean waters as foremost of all, and these well-known slogans of environmental protection have then become so popular among all. In addition, the breakthroughs in developments of medical technology have, as well, helped bring more comprehensive health care. However, large amount of various kinds of unused medications being over-produced or not taken by patients have also increased significantly. If these medications are not properly recycled, they will bring environmental pollution as well as scenario of resource destruction, so that the development of reversal medical logistics has become such urgent task for any delay.

Firstly, this study will be conducted through understanding the status quo of green logistics and medical logistics research, and integrate with reversal logistics service model as it consolidates the factors that help select the service providers of green medical reversal logistics. Then, it will construct the hierarchical structure through expert interviews; secondly, it will propose key factors through DEMATEL analysis to select and evaluate service providers of green city reversal logistics to provide for reference basis when relevant competent authorities and operators are to carry out decision-making.

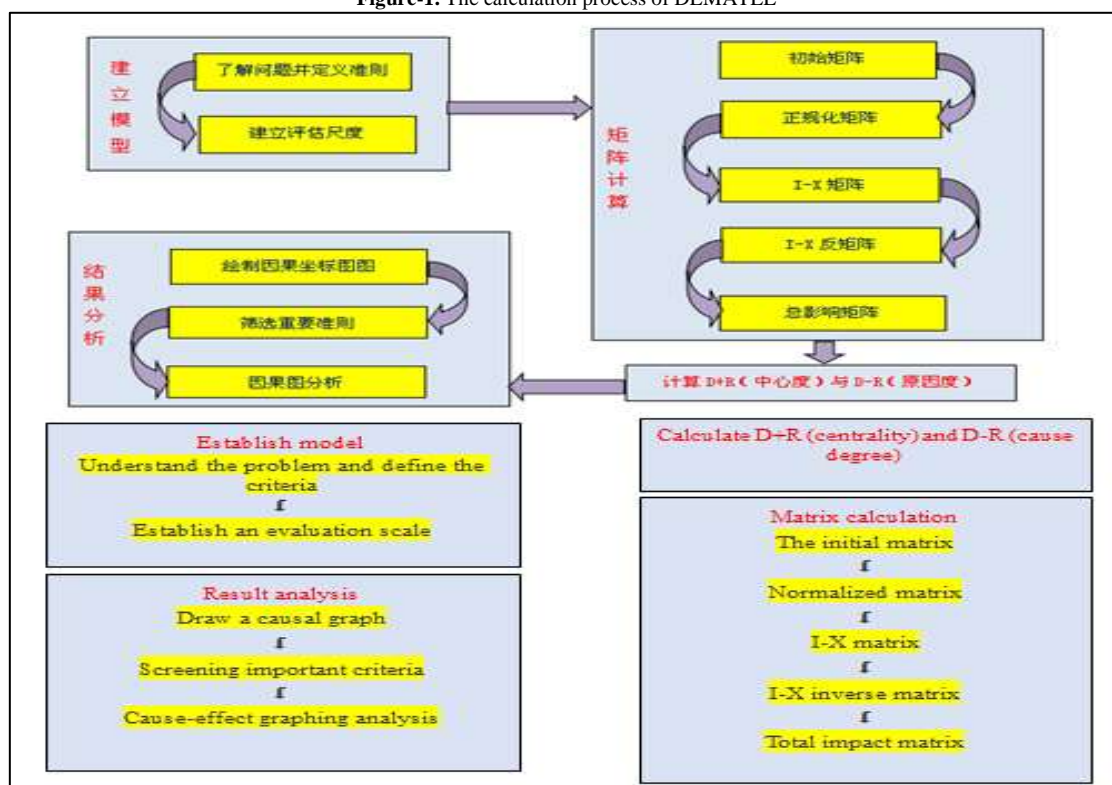
## 2. Literature Review

In general, scholar research on the selection and evaluation model of reversal logistics operators is relatively being tardy. Saaty and Alexander analyzed the influence factors of service providers through Analytic Hierarchy Process (AHP) as it constructs evaluation indicators. The advantage of this method is that it simplifies evaluation procedures and clearly indicates the relationship between each level, each criterion, and each factor. Meade et al. used Network Analysis Method (ANP) to evaluate the reversal logistics service providers of third-party manufacturers to carry out evaluation. As viewed, the construct of ANP is based on the support of AHP, combining different factors and mutual degree of impact among each of the adjacent levels. Therefore, the company can have exerted significant function as it solves difficult projects and produces counter-measures. Tugba Efendigil et al. had combined fuzzy logic and artificial neural network to evaluate reversal logistics service providers of the third-party manufacturers to carry out evaluation, thus reaching relevant conclusions.

In addition, research by Chinese scholars on reversal logistics is much later than those in other countries of the world, so that the number of studies is limited. In terms of research for selection model, the study by Yang (2005) worked on the performance dynamics of service providers and it combines with Analytic Hierarchy Process (AHP) as well as data envelopment method for research. Geng (2010), established a neural network through a modular neural network and established an evaluation model to select the third-party reversal logistics service provider. Guo (2009), constructed an evaluation index system from four dimensions as service quality, resource capacity, management level, and cooperation index to build up the evaluation index system, and used the improved fuzzy level --- that is grey relational analysis as the comprehensive evaluation to conduct evaluation and selection for reversal logistics service providers from its third-party manufacturers. Wang (2011), adopted a weighted fuzzy clustering method when evaluating the reversal logistics service providers of third-party manufacturers. Xiang (2011), established a selection index system for complete reversal logistics service providers through FCM, and thus constructed its evaluation model. Dai (2018), established a comprehensive evaluation index system for reversal logistics service providers through fuzzy comprehensive evaluation method, combined AHP to determine the weights of evaluation indicators, and conducted data analysis so as to come up with the conclusions.

## 3. Methodology

Figure-1. The calculation process of DEMATEL



Usually, the developments of an industry will be affected by many different factors. Some factors can exert significant impact, while some relatively smaller one, and even these factors would have mutual impact on each other. In order to solve such complex problems, the Bastille National Laboratory in the United States in 1971 developed a method for professional and systematic analysis on these factors by using graph knowledge and matrix tools as Decision Making Trial and Evaluation Laboratory, DEMATEL). Its calculation process is found as follows: 1. analyze the actual situation, and determine the factors of impact; 2. determine the degree of impact among the factors; 3. construct the impact matrix; 4. calculate the centrality and cause of the factors; 5. sketch out the causality coordinates; 6. select important factors according to the centrality; 7. analysis of the causality map; 8 come up with relevant conclusions.

#### 4. Investigation of Key Success Factors of Selecting Green Medical Reverse Logistics Supplier

The medical logistics in has China started relatively late. In recent years, a large amount of manpower and material resources have been invested in order to achieve the goal to furnish the establishment of comprehensive medical care of the society, resulting in the rapid integration and development of medical material supply chain, so that the health of Chinese people has been further protected. However, it has also brought about problems regarding the recovery and handling of expired and deteriorated drugs as well as medical wastes because of the mass production and use of medical materials. In order to solve such problems, it is necessary to integrate green logistics and medical reversal logistics so as to explore the crucial success factors selecting and evaluating service providers for green medical reversal logistics. As such, it would not only help select reversal logistics operators with sufficient recycling and processing capabilities, but also render contributions as it establishes a conservation-oriented society for medical resources.

Based upon relevant literature review as well as content of this paper, the selection and evaluation of key factors for green medical reversal logistics suppliers are divided into five major dimensions and twenty-four major criteria to be the research structure of this paper. This study will list the five major dimensions, 24 major criteria as well as guidelines for the selection and evaluation of key factors for green medical reversal logistics suppliers. The elaboration is briefed as follows.

Table-1. Aspects and Criteria

Aspects	Criterion	Connotation	Literature
A Operation level	F1 Transportation capability	The reversal logistics of the city has a short-distance transportation capacity, so that it can receive the goods returned by the customer, and dispatch It quickly	Wang (2011) Xiang (2011)
	F2 Circulation processing level	Mainly for goods that need to be recycled for re processing, so that it must be equipped with certain circulation processing standards	
	F3 Network coverage level	The area covered by the region of the reversal logistics business of the company	
	F4 Warehousing level	Include storage capability, classification capability, and special cargo storage capability	
	F5 Quality of employee	Include professional skill level, service awareness, environmental protection awareness, and experience dealing with reversal logistics objects	
B Service quality	F6 Response timeliness	Respond quickly and in a timely manner to customer needs so as enhance customer satisfaction	Wang (2011)
	F7 Resolution capability of contingent situations	For resolution capability regarding contingent situations, can one quickly and appropriately respond to it for dealing	
	F8 Service price	If the reasonable service price acceptable to customers	
	F9 After-sales service	Handle customer complaints in a timely manner, and provide certain protection to the goods re-processed	
	F10 ability to provide personalized value-added needs	Provide customers with unconventional and personalized needs	
C Information level	F11 Advancement of information system	The advancement of corporate information system will affect the progress of reversal logistics activities	Guo (2009); Wang (2011)
	F12 Logistic tracking capability	Real-time logistic tracking capabilities to inquire logistics information	
	F13 Information integration and sharing capabilities	The ability to integrate and share information with partners	
	F14 Information security	Secure the safety of information	
D	F15 Corporate visibility	Status and prestige in industry	Guo (2009)

Cooperation attribute	F16 Corporate reputation	Reputation with past partners and current partners affects partner selection	Wang (2011) Cao (2016)
	F17 Corporate culture	Corporate culture affects the future development of the company, and is realized in its business activities.	
	F18 Development potential	The future development potential of the company affects the selection of subsequent partners	
	F19 Strategic decision-making capability of enterprise	Is the strategic decision-making of the enterprise long-term and ambitious?	
	F20 Corporate capability for cost control	Control costs reasonably and resort to cost minimization so as to create the greatest revenue	
E Green activity	F21 Operation level of green process	If the operation and working of green process in logistics activities is mature, and how well is the extent of its operation	Xiang (2011) Cao (2016)
	F22 Greenness of facility and equipment	Environmental protection standards of the facilities and equipment	
	F23 Greenness of object handling process	If the process of unrecyclable objects is environmentally friendly, and if resources wastes and environmental pollution are minimized or even eliminated, and how well it is operated	
	F24 Greenness of recycling and re-use process	Is the recycling process environmentally friendly, and if resources waste and environmental pollution are minimized or even eliminated, and how well it is operated	

This paper has designed the DEMATEL questionnaire based on the above-mentioned five major dimensions and twenty-four major criteria, and improves the questionnaire design through experts and scholars. Before filling in the questionnaire, sufficient communication with experts and scholars is conducted to fully explain the core and content of the questionnaire so as to successfully realize the filling of effective answer. The questionnaire is completed and retrieved, in other words, the evaluation data in the questionnaire is sorted out and organized. Each of table values in the following is through DEMATEL calculation program.

Table-2. Initial Matrix

Initial	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24
F1	0	2	3	2	1	3	3	3	2	3	3	3	3	1	2	2	1	2	2	3	2	2	2	2
F2	2	0	2	2	2	3	2	3	2	3	2	1	2	1	1	1	1	2	1	2	2	2	2	2
F3	3	2	0	3	1	4	3	2	2	3	3	3	3	2	2	2	1	3	2	3	2	2	2	2
F4	3	3	2	0	1	2	3	3	2	2	3	2	2	2	2	2	1	2	3	3	2	2	2	2
F5	2	2	1	2	0	3	3	1	2	2	1	2	1	1	2	3	3	3	2	3	3	2	2	2
F6	3	2	3	3	2	0	3	3	3	3	2	3	2	2	2	2	2	3	3	3	2	2	2	2
F7	2	1	2	2	2	4	0	2	2	2	2	3	2	2	2	2	2	2	2	2	1	1	1	1
F8	3	3	3	3	3	3	2	0	3	3	3	3	2	2	3	2	2	2	2	3	2	2	2	2
F9	2	2	2	2	3	3	2	3	0	3	2	2	2	1	3	3	3	2	2	3	2	2	2	2
F10	2	2	2	2	2	2	2	3	3	0	2	1	2	2	3	3	2	3	2	2	2	1	1	1
F11	3	3	4	3	2	3	3	3	3	4	0	4	4	3	2	2	2	3	3	3	2	2	2	2
F12	3	2	2	2	1	3	3	3	2	2	3	0	2	2	2	2	2	2	2	2	1	1	2	2
F13	3	2	3	2	1	3	3	2	3	3	4	3	0	3	2	2	2	3	2	2	2	2	2	2
F14	2	1	2	2	1	2	2	2	2	1	3	2	3	0	2	2	1	2	2	2	1	1	1	1
F15	2	1	2	2	2	2	2	3	2	2	1	1	2	1	0	3	3	3	2	2	2	2	2	2
F16	2	1	2	2	3	2	3	3	3	3	1	1	2	2	3	0	3	3	2	2	2	2	2	2
F17	1	1	1	1	3	2	1	2	3	3	1	1	1	1	3	3	0	3	2	1	2	2	2	2
F18	3	2	3	3	3	2	2	3	3	3	2	2	3	3	3	2	2	0	3	3	3	2	2	2
F19	3	3	3	3	2	3	3	2	3	2	2	2	2	2	2	2	2	2	0	3	2	2	2	2
F20	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	3	3	2	0	2	2	2	2
F21	2	2	2	2	1	1	2	3	2	2	2	2	2	2	2	2	2	3	2	3	0	3	3	3
F22	2	2	2	2	1	2	2	3	3	2	2	1	2	1	3	2	3	3	3	3	3	0	3	3
F23	2	2	2	2	1	2	2	3	2	2	2	2	2	1	3	3	2	3	2	3	3	4	0	4
F24	1	2	2	2	1	2	1	3	2	2	2	1	2	1	3	3	2	3	2	3	3	3	3	0

Table-3. Total Impact Matrix

Total	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24
F1	0.14 2249	0.15 1074	0.18 4359	0.16 6638	0.12 6746	0.19 809	0.18 771	0.20 2558	0.17 8227	0.19 6251	0.17 8261	0.17 2055	0.17 791	0.12 2176	0.16 9498	0.16 3499	0.13 753	0.18 4036	0.16 0033	0.19 6793	0.15 6148	0.14 8114	0.14 8461	0.15 0644
F2	0.14 7246	0.10 0752	0.14 5547	0.14 316	0.12 2398	0.17 1193	0.14 8185	0.17 5493	0.15 2914	0.17 0247	0.14 0486	0.12 0864	0.14 015	0.10 3231	0.13 1699	0.12 6704	0.11 6665	0.15 7945	0.12 3549	0.15 7066	0.13 5536	0.12 862	0.12 8508	0.13 0397
F3	0.19 4058	0.15 7253	0.14 7632	0.18 8158	0.13 2315	0.21 99	0.19 5456	0.19 6855	0.18 5967	0.20 3912	0.18 5403	0.18 8713	0.18 5253	0.14 2437	0.17 667	0.17 042	0.14 3532	0.20 6267	0.16 7438	0.20 4931	0.16 2755	0.15 4176	0.15 4531	0.15 6804
F4	0.18 2573	0.16 2639	0.16 6555	0.13 3317	0.12 4187	0.17 9798	0.18 3892	0.19 863	0.17 4291	0.17 7771	0.17 4653	0.15 4092	0.16 0437	0.13 3364	0.16 5723	0.15 9848	0.13 4139	0.17 9571	0.17 0943	0.19 3214	0.15 3106	0.14 5462	0.14 5587	0.14 7728
F5	0.15 7134	0.13 8431	0.14 0604	0.15 2791	0.10 2388	0.18 2011	0.17 3287	0.15 9191	0.16 4409	0.18 6963	0.13 4271	0.14 324	0.11 5039	0.11 081	0.15 7284	0.16 6412	0.15 632	0.18 4508	0.14 7995	0.18 2202	0.15 9873	0.13 7975	0.13 8051	0.14 0081
F6	0.19 7484	0.16 0688	0.19 4698	0.19 1714	0.15 0772	0.16 604	0.19 8944	0.21 4975	0.20 4297	0.20 7826	0.17 4108	0.18 1364	0.17 3793	0.14 4452	0.18 1219	0.17 4864	0.16 1812	0.21 0288	0.18 4947	0.20 929	0.16 662	0.15 7652	0.15 7995	0.16 0319
F7	0.15 2065	0.11 8905	0.14 9652	0.14 7195	0.12 6107	0.19 0385	0.12 364	0.16 5509	0.15 7442	0.16 0156	0.14 4248	0.15 391	0.14 4115	0.12 1501	0.14 9873	0.14 519	0.13 5055	0.16 2362	0.14 2148	0.16 0817	0.13 8026	0.11 6627	0.11 7167	0.11 8891
F8	0.19 9446	0.17 6883	0.19 6638	0.19 3623	0.16 6677	0.21 2474	0.18 707	0.17 3478	0.20 6381	0.21 0574	0.19 0016	0.18 3126	0.17 586	0.14 5565	0.19 7271	0.17 7189	0.16 3997	0.19 9021	0.17 2523	0.21 1617	0.16 8663	0.15 9792	0.16 013	0.16 2485
F9	0.17 1392	0.15 0814	0.16 8942	0.16 6416	0.15 7795	0.19 7624	0.17 3193	0.20 287	0.14 9346	0.19 6732	0.16 2106	0.15 6108	0.16 2474	0.12 1196	0.18 5462	0.17 9875	0.16 8415	0.18 5495	0.16 0504	0.19 71	0.15 7612	0.14 9321	0.14 9419	0.15 1616
F10	0.15 6459	0.13 7436	0.15 4393	0.15 1891	0.13 147	0.16 678	0.15 7725	0.18 5524	0.17 7209	0.13 6091	0.14 8163	0.12 8462	0.14 8898	0.12 4895	0.16 9867	0.16 461	0.13 9892	0.18 2129	0.14 6268	0.16 6219	0.14 3184	0.12 1331	0.12 1435	0.12 3221
F11	0.21 8386	0.19 2362	0.22 9415	0.21 1362	0.16 6073	0.23 2818	0.22 0.22	0.23 7535	0.22 5722	0.24 4138	0.16 4632	0.21 4445	0.22 2079	0.17 4923	0.20 082	0.19 3788	0.17 871	0.23 2572	0.20 3461	0.23 0781	0.18 424	0.17 4122	0.17 4706	0.17 7275
F12	0.17 4288	0.14 0587	0.15 8355	0.15 5116	0.11 8146	0.18 5445	0.17 5556	0.18 9349	0.16 591	0.16 9429	0.16 6722	0.11 726	0.15 252	0.12 7364	0.15 8153	0.15 277	0.14 1452	0.17 0909	0.15 9342	0.14 9707	0.16 1215	0.13 3925	0.12 8322	0.14 0356
F13	0.19 5093	0.15 8087	0.19 3178	0.17 5093	0.13 3977	0.20 7599	0.19 6511	0.19 8464	0.20 1994	0.20 5891	0.20 0815	0.18 0013	0.14 2928	0.15 786	0.17 8791	0.17 2497	0.15 9359	0.20 8092	0.16 8812	0.19 2219	0.16 4104	0.15 5447	0.15 5803	0.15 8095
F14	0.14 0711	0.10 9302	0.13 9085	0.13 6148	0.10 207	0.14 953	0.15 1826	0.15 2381	0.14 5162	0.13 3634	0.14 861	0.12 9715	0.14 8648	0.08 346	0.13 808	0.13 3573	0.11 0134	0.14 9272	0.12 1265	0.14 8264	0.11 3055	0.10 6885	0.10 7216	0.10 8792
F15	0.15 3336	0.12 0815	0.15 1335	0.14 91	0.12 9063	0.16 3465	0.15 4566	0.18 2707	0.16 0439	0.13 2934	0.12 1081	0.12 5499	0.14 5711	0.10 8009	0.12 4059	0.16 276	0.15 2504	0.17 9998	0.14 4227	0.16 3665	0.14 1895	0.13 4659	0.13 4526	0.13 6505
F16	0.16 4773	0.13 0446	0.16 2403	0.16 0195	0.15 2884	0.17 6499	0.18 0591	0.19 5435	0.18 6815	0.14 9311	0.13 1925	0.15 5961	0.13 6581	0.13 0978	0.17 9949	0.13 0255	0.16 2942	0.19 2701	0.15 4935	0.17 6233	0.15 2362	0.14 3955	0.14 3839	0.14 5955
F17	0.12 7047	0.11 0794	0.12 5183	0.12 3603	0.13 5071	0.15 0481	0.12 8405	0.15 6035	0.16 2967	0.11 4789	0.11 8928	0.12 3963	0.12 0162	0.09 8922	0.15 7646	0.15 3023	0.09 9656	0.16 8105	0.13 3832	0.13 7348	0.13 2221	0.12 5291	0.12 5127	0.12 6967
F18	0.20 1701	0.16 4389	0.19 8877	0.19 5815	0.16 8337	0.20 0182	0.18 9139	0.21 9658	0.20 894	0.21 2327	0.17 8323	0.17 0714	0.19 2308	0.16 2062	0.19 9944	0.17 9577	0.16 603	0.17 1609	0.18 8916	0.21 4239	0.18 5218	0.16 1993	0.16 212	0.16 4504
F19	0.18 8886	0.16 7768	0.18 6423	0.18 3578	0.14 3975	0.20 1427	0.19 069	0.19 1556	0.19 5392	0.18 4911	0.16 6126	0.15 9618	0.16 6008	0.13 7736	0.17 249	0.16 6813	0.15 4537	0.18 7263	0.13 2984	0.13 0397	0.20 9374	0.15 1204	0.15 1326	0.15 3552
F20	0.20 7131	0.18 3227	0.20 422	0.20 0868	0.17 3066	0.22 108	0.20 8881	0.22 5786	0.21 4777	0.21 9107	0.19 7534	0.19 0377	0.19 724	0.15 1923	0.19 0833	0.18 4358	0.18 4697	0.22 1523	0.17 9721	0.17 5455	0.17 5688	0.16 6038	0.16 639	0.16 8837
F21	0.16 4323	0.14 5226	0.16 2647	0.15 9756	0.12 1924	0.16 0884	0.16 5177	0.19 556	0.17 138	0.17 4115	0.15 6935	0.14 9861	0.15 7061	0.13 064	0.16 4309	0.15 808	0.14 6873	0.19 1506	0.15 4049	0.19 0002	0.12 1632	0.15 848	0.15 8355	0.16 0684
F22	0.17 2016	0.15 2005	0.17 0429	0.16 7449	0.12 9224	0.18 3591	0.17 2948	0.20 4478	0.19 4341	0.18 3146	0.16 3362	0.14 2355	0.12 3929	0.12 1809	0.18 673	0.16 6182	0.16 8716	0.20 0491	0.17 5753	0.19 8676	0.17 3301	0.12 1529	0.16 5309	0.16 774
F23	0.17 4545	0.15 4024	0.17 2951	0.16 9911	0.13 0471	0.18 6068	0.17 5682	0.20 7899	0.18 2714	0.18 5618	0.16 5994	0.15 8518	0.16 6565	0.12 3826	0.18 9471	0.18 2659	0.15 6903	0.20 3631	0.16 4066	0.20 1587	0.17 5834	0.18 2135	0.12 3821	0.18 4466
F24	0.14 8239	0.14 3639	0.16 0838	0.15 8225	0.12 133	0.17 2393	0.14 908	0.19 3844	0.16 998	0.17 2653	0.15 413	0.13 3241	0.15 4898	0.11 4889	0.17 7098	0.17 0916	0.14 6183	0.19 0277	0.15 2597	0.18 8144	0.16 4609	0.15 7608	0.15 7255	0.11 545

If the value of D+R is greater, it tells that the weight of the criteria is higher in terms of the overall evaluation and so as its impact on other criteria. As shown in Table 4 in the following, the importance of factors affecting the selection and evaluation of reversal logistics service providers in green cities is respectively as the corporate capability for cost control, service price, development potential, response timeliness, advancement of information system, after-sales service, network coverage level, information integration and sharing capabilities, transportation capability, ability to provide personalized value-added needs, strategic decision-making capability of enterprise, warehousing level, corporate reputation, resolution capability for contingent situations, corporate visibility, greenness of object handling process, operation level of green process, greenness of facility equipment, logistic tracking capability, greenness of recycling and re-use process, quality of employees, circulation processing level, corporate culture, and information security.



**Table-4.** Value Ranking Table of Selection and Evaluation Factor Centrality (D + R) That Affects Green Medical Reversal Logistic Service Provider

<b>F20</b>	<b>Corporate capability for cost control</b>	<b>9.07472</b>
F8	Service price	9.016271
F18	Development potential	8.976493
F6	Response timeliness	8.801919
F11	Advancement of information system	8.791194
F9	After-sales service	8.358842
F3	Network coverage level	8.275199
F13	Information integration and sharing capabilities	8.151292
F1	Transportation capability	8.129639
F10	Ability to provide personalized value-added needs	8.012078
F19	Strategic decision-making capability of enterprise	7.904341
F4	Warehousing level	7.882642
F16	Corporate reputation	7.783786
F7	Resolution capability of contingent situations	7.619143
F15	Corporate visibility	7.615797
F23	Greenness of object handling process	7.604757
F21	Operation level of green process	7.535729
F22	Greenness of facility and equipment	7.527849
F12	Logistic tracking capability	7.365674
F24	Greenness of recycling and re-use process	7.318877
F5	Quality of employee	6.897737
F2	Circulation processing level	6.846102
F17	Corporate culture	6.781621
F14	Information security	6.200846

When the positive value of D-R (cause degree) is higher, it indicates that the direct impact of criterion on remaining criteria is higher, and when the negative value is higher, it indicates that the criterion is affected higher by the rest. For the analysis regarding the primary influences and impacts of the key factors in selection and evaluation of green medical reversal logistics service providers, please refer to [Table 5](#) in the following. The criteria of primary impact are respectively as greenness of facilities and equipment, advancement of information systems, greenness of object handling process, information integration and sharing capabilities, quality of employees, strategic decision-making capability of enterprise, greenness of recycling and re-use process, network coverage level, corporate capability for control cost, operation level of green process, and information security. As for the affected criteria, they are respectively as logistic tracking capability, development potential, warehousing level, corporate reputation, transportation capability, response timeliness, circulation processing level, service price, after-sales service, corporate culture, corporate visibility, resolution capability for contingent situations, and the ability to personalized value-added needs.

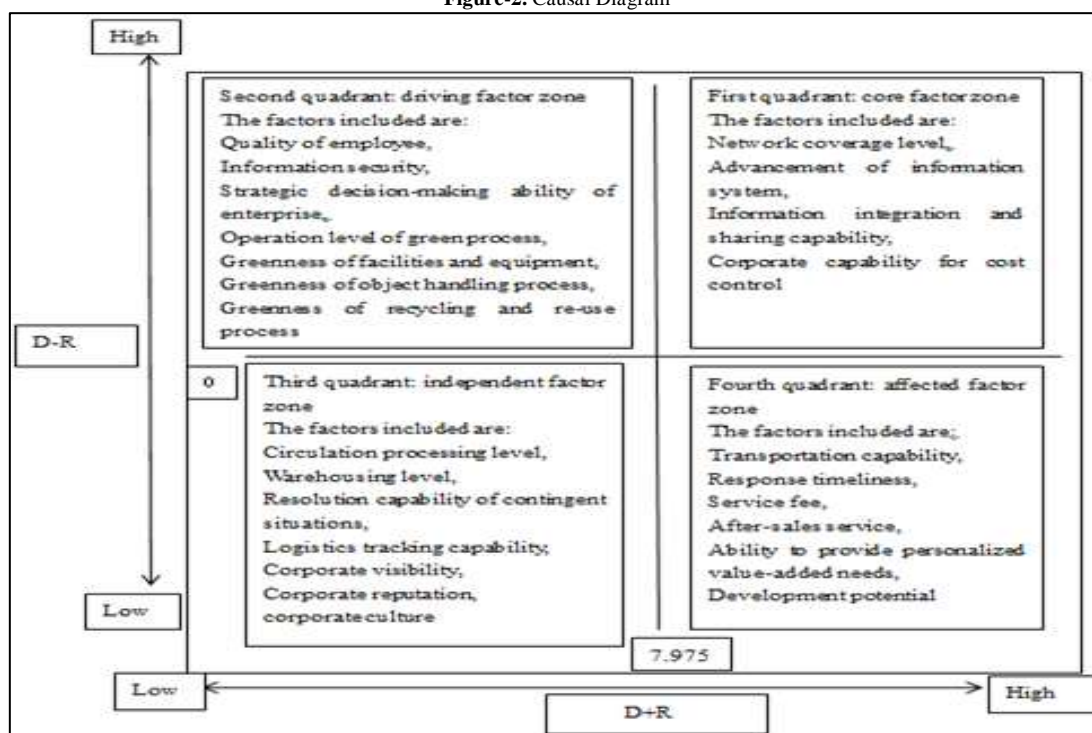
**Table-5.** Value Ranking Table of Selection and Evaluation Factor Centrality (D-R) That Affects Green Medical Reversal Logistic Service Provider

<b>F22</b>	<b>Greenness of facility and equipment</b>	<b>3.48234</b>
F11	Advancement of information system	1.017532
F23	Greenness of object handling process	0.633957
F13	Information integration and sharing capabilities	0.370152
F5	Quality of employee	0.364803
F19	Strategic decision-making capability of enterprise	0.283726
F24	Greenness of recycling and re-use process	0.216153
F3	Network coverage level	0.146476
F20	Corporate capability for cost control	0.14279
F21	Operation level of green process	0.103186
F14	Information security	0.012791
F12	Logistic tracking capability	-0.02127
F18	Development potential	-0.06265
F4	Warehousing level	-0.0796
F16	Corporate reputation	-0.08794
F1	Transportation capability	-0.13152
F6	Response timeliness	-0.1496
F2	Circulation processing level	-0.20899
F8	Service price	-0.23527
F9	After-sales service	-0.31519
F17	Corporate culture	-0.39048
F15	Corporate visibility	-0.59008
F7	Resolution capability of contingent situations	-0.73717
F10	Ability to provide personalized value-added needs	-0.84497

According to the above-mentioned analysis of the centrality and degree of cause, the following causality map can be obtained (figure. 2). In the first quadrant, we can find is core factor zone, which is characterized by high centrality as well as high degree of cause so that they exert great influence on other factors. As viewed, these crucial factors are considered the main body of the research, in which the enterprise should focus on. In the second quadrant, it is the driving factor zone with low centrality, high degree of cause, and much independence, so that they exert minimal impact on other factors. In the third quadrant, it is the independent factor zone, which is characterized by low centrality, low degree of cause, and low impact on other factors, so that it is enough to well manage this part of the factors on its own. In the fourth quadrant, it is the affected factor zone, which is characterized by high centrality and low degree of cause, so that it is easily affected by remaining factors. As such, when the factors in the first, second, and third quadrant are improved the factors in the fourth quadrant can be linked for improvement.

The factors of the first quadrant are network coverage level, advancement of information system, information integration and sharing capabilities, and corporate capability for control cost. The factors of the second quadrant are quality of employees, information security, and strategic decision-making capability of enterprise, operational level of green process, greenness of facilities and equipment, greenness of object handling process, and greenness of recycling and re-use process. The factors of the third quadrant are circulation processing level, warehousing level, resolution capability of contingent situations, logistic tracking ability, corporate visibility, corporate reputation, and corporate culture. factors of the fourth quadrant are transportation capability, response timeliness, service price, after-sales service, ability to provide personalized value-added needs, and development potential.

Figure-2. Causal Diagram



## 5. Conclusions

In this paper, we should achieve some conclusions on the selection and evaluation factors towards green medical reverse logistics service providers in terms of severe environmental resources today. Through literature review of scholars as well as questionnaire survey with experts and scholars, we have established the factors of impact into five major dimensions, and twenty-four major criteria. As DEMATEL is used to analyze the results, the following conclusions are drawn as followed:

1. With rapid development of logistic enterprises and big data, the key elements when considering the selection of enterprises have changed from previously basic logistic characteristics such as the transportation capacity and warehousing level to the overall information level as stressed by enterprises, regardless if it is traditional corporate cooperation or strategic cooperation that can more effectively create benefits. For now, the role of information standards in the logistic arena has been receiving more and more attention.
2. As can be clearly seen from the five major dimension in the causality map, all the criteria encompassed in green activity are found in the second quadrant, which are respectively as operation level of green process, greenness of facility equipment, greenness of object handling process, and greenness of recycling and re-use process. With characteristics of the second quadrant combined, enterprises can independently develop this feature, for it will not affect the remaining features of the enterprise to a large extent, but will, on the contrary, increase the business scope of the enterprise.

Green logistic would not only help enterprise to expand economic benefit, but also echo to the needs of circular economy, considered to be a win-win scenario.

3. The three factors of corporate visibility, corporate reputation, and corporate culture in the dimension of cooperation attribute are distributed in independent factor zone, and their interaction with other factors is low, so that the enterprise can carry out management on its own.
4. The factors of affected factor zone are respectively as transportation capability, response timeliness, service price, after-sales service, ability to provide personalized value-added needs, and development potential. It is obvious that these factors cannot be composed independently. Take for example, after-sales service requires enterprises with certain level of information standards, high-quality staff, certain level of circulation processing standards, and a more comprehensive feedback system. Therefore, these factors cannot be rendered with “self-improvement” on its own, but they can be improved in the context of improvement as linked to other three factors.

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