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Application of PCA in Controlling and Reducing Enterprise Logistic Cost

Zhi-Ming QU

School of Civil Engineering, Hebei University of Engineering, Handan, Hebei Province, 056038, China

chinaqzm@163.com

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Abstract. Logistic cost is accompanied by logistic activities. A logistic cost is an important indicator to measure the production efficiency of an enterprise. With strengthening the logistic management awareness, how to effectively reduce logistic cost has become a core mission. Using primary components analysis (PCA) and its advantages, influential factors on logistic cost reduction in enterprise material conveying is analyzed. On the basis of PCA model and scores by the experts, the authors computed some results that can reflect logistic cost reduction. Through case study, it can be seen that some factors play very important role and all the reasons should be taken into account because logistic cost reduction depends on the interaction of all the factors. Through analysis and deduction, it is concluded that, under the premise of minimizing the information loss of data, the application of PCA in the investigation on logistic cost reduction in enterprise material conveying approves to be practicable.

Introduction

Logistics, the operation of supply chain to meet customer requirements, is the process of planning, implementing and controlling the positive and negative circulation and storage, which is highly efficient and low cost to goods, services and related information between the supply and demand [1]. Through management process, costs can be effectively reduced, efficiency raised and resources efficiently allocated. The purpose of logistic cost management and control is to reduce costs and enhance enterprises competitiveness. However, from the practice, some problems plague many enterprises. There are not logistic cost subjects in the enterprise accounting system, which results in difficulties all enterprises controlling their own logistic cost. The logistic cost is distributed in many function sectors, which increases difficulties of the logistic cost accounting and management. Many enterprises have improperly understood the logistic costs [2, 3].

Only dominant costs such as external payments transport and warehousing can be seen, but a large number of loading and unloading activities, mobile, packaging and other expenses are attributed to production or management fees in the internal enterprise consumption. Spending a lot of time to account the logistic cost data can only play a role in the financial budget, and cost accounting is just to know how much the logistic is, which does not apply the logistic cost data. It is unable to grasp the relationship among different logistic patterns, service levels and the logistic cost. Widespread anti-back relationship of logistic cost will result in lower quality of enterprise logistic service [4].

A completely theoretical, technical and management methods has been initially formed in modern enterprise logistic system which become an independent and comprehensive discipline to improve efficiency of modern enterprise logistic system. Reducing logistic costs is not only a technical problem but also related to a series of logistic system management. The ultimate goal of enterprise material conveying system is to ensure that the enterprises, under the premise of normal production, can reduce conveying costs in order to guarantee their products' sufficient competitiveness in international market. Thus, reduction of material conveying system cost is a way to increase the profits of enterprise [2, 5]. PCA is used to study the impact on the factors influencing cost reduction in

the material conveying system. Then, the factors are classified and sorted in order to obtain primary and secondary factors influencing cost reduction and propose management measurement.

PCA and Mathematical Model

PCA is used to find out some synthetic indexes representing numerous indexes by linear transformation and abandoning a small part of information, to make these indexes reflect the information of all the primary indexes possibly, to ascertain the weights of index objectively and to avoid the subjectivity ensuring the principle that the data information lost is the least. PCA has some advantages [6, 7]. Principal components are independent each other after primary indexes are transformed, and it can eliminate the related influence of the indexes and reduce work load to choose the indexes. Each primary component is to be ranked by the size of their variance for PCA. When the problem is analyzed, some primary components are abandoned and those components having larger variance are chosen, thus, the calculation is reduced. It is assumed that there are n samples, one of which has p observed variables, $X_1, X_2, \cdots, X_p$. Then the data base will be used [6]. It is assumed that there are n appraisable schemes and p indexes, and there are $n \times p$ primitive data. Reference [6] gives the procedures and steps which are not stated.

Using PCA to Analyze the Factors' Effect on Enterprise Logistic Cost Control

From the illustration above, some factors influencing enterprise logistic cost control are discussed. Through summarization, the factors are listed in detail. As a variable, each item is defined. For instance, the variable of item (1) is defined as x_1, the rest are similar by analogy. The items are as follow.

(1) Lineation of material conveying system (x_1), (2) Materials assembly and Unitization (x_2), (3) Mechanization of staple material convey (x_3), (4) Reliability of gravity (x_4), (5) Reasonable allocation of material activity index and convey index of equipment (x_5), (6) Seamless docking of material conveying system (x_6), (7) Reasonable, appropriate and practical mechanization and automation (x_7), (8) Balanced conveying of material (x_8), (9) Reasonable allocation of conveying equipment (x_9), (10) Security principles (x_{10}), (11) Unitization of minimum conveying (x_{11}) and (12) Maximum space use (x_{12}).

Using the items listed above, thirteen problems will be analyzed and discussed using the mathematical model provided by Reference [6]. The factors influencing enterprise logistic cost reduction in the process of material conveying can be analyzed and accessed. According to the importance of factors, the experts can score. The highest score of each item is 10, thus, the experts can give different scores about the importance of each item. x_i (i=1, 2, …, 12) are used to represent the different items respectively. The primitive data is shown in Table 1. The steps are as follow. (1) Standardize primitive data. (2) Compute through PCA. (3) Factor analysis and factor analysis with contribution rate of 85%. The data are listed in tables 2 and 3 respectively.

Table 1 Primitive data

Score	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12
1	9.9	9.4	9.3	9.6	9.1	9.1	9.3	9.8	9.9	9.7	9.2	9.5
2	9.5	9.5	9.1	9.7	9.9	9.5	9.5	9.3	9.9	9.0	9.1	9.2
3	9.8	9.9	9.1	9.7	9.5	9.5	9.5	9.3	9.6	9.9	9.7	9.7
4	9.1	9.5	9.2	9.5	9.2	9.5	9.6	9.3	9.3	9.5	9.5	9.3
5	9.2	9.8	9.6	9.4	9.2	9.4	9.3	9.2	9.5	9.5	9.6	9.3
6	9.9	9.8	9.0	9.8	9.8	9.8	9.5	9.6	9.9	9.4	9.3	9.2
7	9.0	9.7	9.5	9.2	9.7	9.7	9.2	9.5	9.5	9.8	9.5	9.6
8	9.8	9.5	9.5	9.0	9.4	9.0	9.1	9.2	9.1	9.1	9.3	9.8

9	9.5	9.6	9.4	9.2	9.0	9.9	9.7	9.7	9.5	9.5	9.5	9.3
10	9.8	9.9	9.1	9.7	9.5	9.5	9.5	9.3	9.6	9.5	9.5	9.3
11	9.1	9.5	9.2	9.5	9.2	9.5	9.6	9.3	9.3	9.5	9.6	9.3
12	9.2	9.8	9.6	9.4	9.2	9.4	9.3	9.2	9.5	9.4	9.3	9.2

Table 2 Data after standardization

Data ID	x1	x2	x 3	x 4	x 5	x 6
1	1.2655	-1.6009	0.1090	0.4136	-1.1193	-1.6341
2	0.0239	-1.0063	-0.8354	0.8272	1.6523	-0.0308
3	0.9551	1.3722	-0.8354	0.8272	0.2665	0.0308
4	-1..2177	-1.0063	-0.3632	0.0000	-0.7729	-0.4308
5	-0.9073	0.7776	1.5255	-0.4136	-0.7729	-0.4316
6	0.3343	0.7776	-1.3076	1.2408	1.1716	1.1716
7	-1.5281	0.1830	1.0533	-1.2408	0.9594	0.7708
8	0.9551	-1.0063	1.0533	-2.0679	-0.0800	2.0349
9	0.0239	-0.4117	0.5811	-1.2408	1.4658	1.5724
10	0.9551	1.3722	-0.8354	0.8272	0.2665	-0.0308
11	-1.2177	-1.0063	-0.3632	0.0000	-0.7729	-0.0308
12	-0.9073	0.7776	1.5255	-0.4136	-0.7729	-0.4316

Table 2 Data after standardization (continued)

x 7	x 8	x 9	x 10	x 11	x 12
-0.7776	1.9882	1.2840	-0.7716	-1.3722	0.4664
0.4117	-0.5441	1.2840	-2.0349	-1.9668	-1.0494
0.4117	-0.5441	0.0917	1.5724	1.6009	1.4769
1.0063	-0.5441	-0.4117	-0.0308	0.4117	-0.5441
-0.7776	-1.0494	-0.3057	-0.0308	1.0063	-0.5441
0.4117	0.9717	1.2840	0.4316	-0.7776	-1.0494
-1.3722	0.4664	-0.3057	1.1716	0.4117	0.9717
1.9668	-1.0494	-1.8954	-1.6341	-0.7776	1.9882
1.0063	1.4769	-0.3057	-0.0308	0.4117	-0.5441
0.4117	-0.5441	0.0917	-0.0308	0.4117	-0.5441
1.0063	-0.5441	-1.1006	-0.0308	1.0063	-0.5441
-0.7776	-1.0494	-0.3057	-0.4316	-0.7776	-1.0494

Table 3 Results after PCA

Ranked by components	variance	Eigenvalues	Contribution rate (%)	Accumulation rate (%)	x1	x 2	x 3	x 4
1	x3	3.9370	30.28	30.28	-0.1998	-0.1855	0.4325	-0.4523
2	x11	2.5409	19.55	49.83	0.0689	0.2700	0.0408	-0.1198
3	x12	2.2258	17.12	66.95	0.4848	-0.1553	-0.0576	-0.0126
4	x8	1.5296	11.77	78.72	-0.0530	-0.4983	0.0512	-0.1736

5	x5	1.0625	8.17	86.89	-0.3194	0.1897	0.2193	-0.2502
6	x9	0.8787	6.76	93.65	-0.1482	0.2458	0.4252	0.1288
7	x7	0.5711	4.39	98.04	0.5365	0.5114	0.1709	-0.0738
8	x4	0.1591	1.22	99.26	-0.2561	0.0562	-0.2999	0.3746
9	x10	0.0611	0.47	99.73	-0.0355	-0.0989	0.2970	0.0755
10	x2	0.0249	0.19	99.92	-0.0774	0.3918	-0.2468	-0.327
11	x6	0.0082	0.06	99.98	-0.1578	0.0584	0.0[illegible]78	0.51[illegible]
12	x1	0.0010	0.01	99.99	0.4544	-0.2862	0.208[illegible]	0.1351

Table 3 Results after PCA (continued)

x 5	x 6	x 7	x 8	x 9	x 10	x 11	x 12
-0.2749	-0.3081	-0.3004	-0.2308	-0.4153	-0.[illegible]	0.0025	0.1312
-0.0639	0.2027	-0.0102	0.1558	-0.1238	0.[illegible]014	0.4589	0.3817
0.2080	-0.3063	-0.3760	0.2385	0.2090	-0.0390	[illegible]698	0.4163
-0.3891	0.1716	0.2886	0.5901	0.061[illegible]	0.0402	-0.1704	-0.1642
0.4682	0.4725	-0.2215	0.0907	0.11[illegible]	-0.2074	-0.2660	-0.1515
-0.2394	-0.1384	-0.3754	0.2134	0.4066	0.410[illegible]	-0.0702	-0.1984
-0.3687	0.0250	0.1346	-0.0438	-0.0040	-0.3229	-0.0966	-0.3001
-0.0978	-0.2721	-0.1558	-0.0930	-0.[illegible]	0.2295	-0.3014	-0.3277
-0.0869	0.0988	0.4258	-0.5265	0.2890	0.2524	-0.4068	0.2836
-0.0414	0.0201	0.1602	[illegible]926	0.3524	0.2338	-0.5086	0.1973
-0.3770	0.3928	-0.250[illegible]	0.[illegible]895	-0.1560	-0.3390	-0.1033	0.4357
0.1370	0.4079	0.2693	0.1285	-0.4297	0.3392	-0.1131	-0.2531

Results and discussion

The contribution rate used in the paper is 85%. It can be different if we have different purpose to handle the problem of logistic cost reduction in enterprise material conveying. If the contribution rate is 85%, the primary components are x_3, x_{11}, x_{12}, x_8 and x_5. If the contribution rate is 100 percent, we must consider all the factors influencing enterprise logistic cost reduction. From Table IV, the contribution rate of 12th primary components is zero, which doesn't mean the 12th primary component takes no effects. Sometimes, when we solve some problems of cost reduction such as improving material activity index, materials assembly and unitization, and so on, other factors will be considered naturally.

Analyzing the importance and logistic cost reduction in enterprise material conveying system, the primary components take great effects after observing the results from Table 4. The first primary component is x_3, which means mechanization of staple material convey will play most important role while the contribution rate is 85%. The 2nd and 3rd are x_{11} and x_{12} respectively, which illustrates that optimization and mechanization are the first items to be considered. The following primary components are x_5, x_9, x_7 and x_{12} are similar to that of x_3. As to enterprises, logistic rationalization is the key to reduce logistic cost. Under normal circumstances, enterprises should, according to industry and goods characteristics, fully coordinate with the customer, explore the combination of logistic and distribution and the best way to reduce logistic costs. In practice, companies can choose one or several

logistic models, which should rely on the final objective to minimize logistic costs and balance from the highly integrated strategy.

Table 4 Factor analysis with the contribution rate of 85%

Components Sample ID	NO. 1 [x3]	NO. 2 [x11]	NO. 3 [x12]	NO. 4 [x8]
1	-0.1544	-0.5099	-0.0187	0.7933
2	-0.1302	-0.6718	0.3114	0.4221
3	0.6815	0.4831	-0.6764	-0.6871
4	0.2194	0.1785	-0.3626	0.1814
5	-0.0397	0.5297	0.4671	-0.1272
6	-0.8469	-0.5427	-0.1933	-0.2738
7	-0.3413	0.1062	0.5844	0.6655
8	1.2877	0.0743	0.5138	0.[illegible]4
9	-0.6929	0.0457	-0.0744	0.0501
10	0.0281	0.0796	-0.3[illegible]	-0.1[illegible]80
11	0.1091	0.3390	0.4349	-0.1[illegible]49
12	0.0727	0.0274	0.7732	0.7358

Conclusions

Logistic cost management has become key factors for enterprises to gain a competitive advantage. Based on enterprise logistic cost management status and problems, innovative logistic cost management mechanism, the logistic costs of building satisfications system, multi-joint lower logistic costs are becoming management strategy enterprise logistic cost reduction. Using PCA, the factors influencing logistic cost in enterprise material conveying system are analyzed. In analyzing the importance and logistic cost reduction in enterprise material conveying system, the primary component takes great effects after observing the results. The first primary components are sorted by x_3, x_5, x_9, x_7, x_{12} and so on. Through analysis and discussion, it can be found that the mechanization, reasonability, allocation, automation and mechanization become more and more important in reducing logistic cost and enterprise logistic management. All the factors should be considered to reduce enterprise logistic cost. Finally, the measurements of reducing logistic cost are proposed.

References

[1] ZHANG [illegible]: Management of logistic cost based on activity analysis, Commercial Economic, Vol. 22(2[illegible]7), p. 21

[2] YIN [illegible]ngfa: Analysis and solutions of enterprises logistic cost management, Management world, [illegible]. 3 (2007), p. 36

[3] Zh[illegible]g Yuqin: Measures on Reducing Enterprise Logistic Cost, Logistic Economy, Vol. 33 (2007), p. 59

[4] Wu Zhankun and Zhao Yingshu: Value Chain Analysis in Cost Control of Enterprise Logistic, Logistic Economy, Vol. 23 (2007), p. 62

[5] GU Yu: Analyzing Logistic Cost Level and Exploring Ways of Optimization, Modern logistic, (2005), p. 16

[6] YU Xiulin, and REN Xuesong in: *Multivariate Statistical Analysis* (The publishing house of statistics, China, 2003).