Case-based Reasoning System for Prediction of Collaboration Level using Balanced Scorecard: A Dyadic Approach form Distributing and Manufacturing Companies

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Summary
A decision support for forecasting of collaboration level of supply chain management (SCM) has attracted lots of important decision making in the SCM managers and chief executive officers (CEOs) However, there are no guidelines and prediction models for SCM collaboration. Therefore, the company which pursues SCM can't execute control of collaboration systematically and scientifically In this research, we developed the SCM prediction models which were analyzed a balanced scorecard (BSC) based an SCM performance and an SCM collaboration using case-based reasoning (CBR). This model developed considering manufacturing and distributing companies perspective. The decision making model of SCM collaboration level suggests useful information to SCM managers and CEOs regarding collaboration decision.

Key words:
Balanced Scorecard, Supply Chain Management, Cased-Based Reasoning

1. Introduction

The collaboration of firms which pursue supply chain management (SCM) is very important issue of successful SCM implementation. The successful collaborations of pursuing SCM represent business success. Thus many enterprises regard decision making of collaboration as important business issues under SCM.

However, there are no guidelines and technical and managerial indicators to determine the level for SCM collaboration. Therefore, many chief executive officers (CEOs) and SCM managers have difficulty in making decision of collaboration.

In this study, we suggest the control model of SCM collaboration based balanced scorecard (BSC) in distributing and manufacturing firm perspective. We especially adopted case-based reasoning (CBR) algorithms. The CBR algorithms are very popular algorithms in business forecasting and making decision. Also CBR algorithms suggest excellent solutions for small data sets and complex problems. [Virkki-Hatakka, Kraslawski, Koiranen, Nystrom, 1997; Schmidt, 1998; Gardingen, Watson, 1999; Jung, Han, Suh, 1999; Shin, Han, 1999; Kim, Han, 2000; Lee, Han, 2000; Haque, Belecheanu, Barson, Pawar, 2000; Sadek, Smith, Demetsky, 2001; Chiu, 2002; Kwon, Shin, 2003; Hsu, Chiu, Hsu, 2004 Lin, 2005]. Therefore, we developed CBR systems for predicting SCM collaboration level using CBR algorithms. These results are to maximize efficient SCM control performance and propose guidelines of successful SCM implementation.

This study is structured as follows. Section 2 introduces basic concepts of CBR and previous research applications. In section 3, we described BSC variables to forecast SCM sustainable collaboration. Section 4 analyzes empirical results. Finally, this article concludes and mentions limitations of the study.

2. Research Background

A CBR algorithm is widely used to apply business forecasting. Generally, CBR is composed of following five steps [Kolodner, 1993].

- Step 1: Index assignment
- Step 2: Case retrieval in the case-base
- Step 3: Old case adaptation
- Step 4: New case evaluation
- Step 5: Case storage

In this study, we reviewed data mining studies employing CBR in the area of finance and business application such as customer churning, bankruptcy prediction, and stock price prediction, and bond rating.

- Virkki-Hatakka, Kraslawski, Koiranen, Nystrom(1997): Equipment Selection Process.
- Schmidt(1998): Production Scheduling
- Gardingen, Watson(1999): Air Condition Sales Supporting
- Jung, Han, Suh(1999): Risk Analysis.
- Shin, Han(1999): Bond Rating
- Lee, Han(2000): EDI controls

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- Haque, Belecheanu, Barson, Pawar(2000): Concurrent Engineering
- Chiu(2002): Direct Marketing for Customer Classification
- Kwon, Shin(2003): ERP Project Planning Support System
- Hsu, Chiu, Hsu(2004): Outsourcing Forecasting
- Kim, Han(2001): Bond Rating
- Chow, Choy, Lee, Lau(2006): Design of a RFID resource management systems for warehouse operation.

This article adopts the CBR algorithm to develop a decision making model in SCM collaboration level.

3. Research Method

In this study, we uses measurement tool which was developed by Brew, Shep(2000). Each measurement items were given values over a 7-point Likert type scale.

For developing control model in SCM collaboration purposes, a dependent variable, that is, sustainable collaboration, was measured with a 7 Likert types items, such as '1' in strongly non-sustainable collaboration and '7' in strongly sustainable collaboration SCM. The research data is collected distributing and manufacturing companies that are carrying out SCM.

Out of 300 questionnairs distributed, 120 were collected and 108 of them were used in the analysis after discarding questionnairs with incomplete answers.

4. Experimental Result and Discussion

4.1. Description Information

In this study, we analyzed our data set. The statistical information of the variables is follows. BSC components are composed of SCM learning perspective, SCM internal process perspective, SCM customer perspective, and SCM financial perspective. First, SCM learning performance is composed of (1) product and process innovation (mean = 4.36, S.D. = 1.18), (2) partnership management (4.33, 1.06), (3) Information flows (4.23, 1.12), and (4) threats and substitutes (4.43, 1.16). Second, SCM internal process performance is composed of (1) waste reduction (4.28, 1.09), (2) time compression (4.31, 1.12), (3) flexible response (4.31, 1.15), and (4) unit cost reduction (4.34, 1.15). Third, SCM customer performance is composed of (1) view of product and service (4.31, 1.13), (2) view of timeliness (4.26, 1.11), (3) view of flexibility (4.35, 1.09), and (4) view of customer value (4.17, 1.05). Fourth, SCM financial performance is composed of (1) profit margins (4.42, 1.09), (2) cash flow (4.27, 1.05), (3) revenue growth (4.24, 1.01), and (4) return on assets (4.20, 1.04).

4.2. CBR model for forecasting collaboration level

In this study, we suggest CBR model for forecasting collaboration level. For CBR model, about 20% of the data is used for holdout and 80% for the data is used for case base. And then, we separate distributing and manufacturing companies respectively. These experiments are done by Excel 2003 software. The 1-NN algorithm is used for selecting nearest neighbor.

<Table 1> Test Result of Distribution Companies

Model	SV	RV1	RV2	H1(%)	H2(%)
C1	3	2	6	66	0
C2	4	4	5	100	75
C3	4	4	5	100	75
C4	4	5	5	75	75
C5	5	5	5	100	100
C6	5	5	5	100	100
C7	5	5	6	100	80
C8	5	4	4	80	80
C9	5	1	2	20	40
C10	7	5	5	71.4	71.4
C11	6	5	5	83.3	83.3

※ C is case companies
※ Recommendation Value (RV): Nearest neighbor K=1.
※ Hit Ratio: Survey Value (SV) > RV, RV/SV.
※ Hit Ratio: SV < RV, SV - (RV – SV) / SV.
※ Hit Ratio 1 (H1): Seperate holdout data and training data of distributing and manufacturing companies.
※ Hit Ratio 2 (H2): Don't separate holdout data and training data of distributing and manufacturing companies.

<Table 2> Test Result of Manufacturing Companies

Model	SV	C1	C2	H1(%)	H2(%)
C12	5	6	5	80	100
C13	5	6	2	80	40
C14	6	5	6	83.3	100
C15	6	6	6	100	100
C16	6	6	5	100	83.3
C17	6	6	4	100	66.6
C18	6	6	5	100	83.3
C19	6	6	2	100	33.3
C20	6	6	6	100	100
C21	6	6	6	100	100
C22	7	5	5	71.4	71.4

The results are follows in <Table 1> and <Table 2>. In <Table 1> the hit ratio of distributing companies showed 83% and that of manufacturing companies showed 93.5% and total hit ratio showed 88.2%. We tested additionally of total data set including manufacturing and distributing companies. The result of hit ratio showed 76.8%. The hit

ratio of separate model is outperformed hit ratio of total model about 11.4%. In this fact, we suggest that for forecasting model of excellent SCM collaboration and will separately develop in distributing and manufacturing perspective.

4.3. SCM collaboration control using CBR

This research suggests CBR systems for forecasting SCM collaboration level. We suggested case study for using this model. In <Table 3>, [1] is SCM learning perspective, [2] is SCM internal process perspective, [3] is SCM customer perspective, [4] is SCM financial perspective.

<Table 3> Case of CBR Model

Variable Name		Case 1	Case 2
[1]	Product and process innovation	5	5
	Partnership management	4	4
	Information flows	5	6
	Threats and substitutes	4	7
[2]	Waste reduction	5	6
	Time compression	6	5
	Flexible response	3	6
	Unit cost reduction	4	6
[3]	View of product/service	1	4
	View of timeliness	5	7
	View of flexibility	6	7
	View of customer value	3	4
[4]	Profit margins	6	5
	Cash flow	7	3
	Revenue growth	4	3
	Return on assets	7	5

<Table 4> Case Study Result

Feature	Case 1	Case 2
Control Level	7	5

In <Table 3> and <Table 4>, Case 1 and Case 2 showed the SCM collaboration forecasting results. The case companies 1 will be control the 7 of collaboration level and case companies 2 will be control the 5.

5. Conclusion

In this research, we applied CBR algorithm for developing prediction systems of SCM collaboration level between distributor and manufacturer. These results suggest practical connotation to SCM managers and CEO for various organization context best. However, the research featured some limitations. First, the sample data set is small. Second, we used Peter, Thomas framework. Thus, we can't various performance factors. Therefore, the future research is necessary to measurement more factors of SCM performance and collaboration.

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