

Analysing Supply Chain Strategy Using Case-Based Reasoning

Surjeet Dalal*, Vijay Athavale**

**Research Scholar, Suresh Gyan Vihar University, Rajasthan, India*

***Director, Devraj Groups Technical Campus, Punjab, India*

ABSTRACT

The supply chain is one of the emerging fields of the business activities. The supply chain strategy has a great impact on the performance of supply chain process. The phenomenon of analysing supply chain strategy is critical task which pay attention to various supply chain performance evaluation factors. The case-based reasoning supports lazy learning through exploitation of past problems solution's in solving original complication.

In this paper, the case-based supply chain strategy analysis model is being proposed which generates the cases oriented on various factors involved in supply chain process performance evaluation. It is designed in Java language having platform-independent, secure, robust, object-oriented features. Various similarity functions are implemented to find the similar cases from the case base. This model computes performance of the strategy of the supply chain management system.

Keywords: Supply Chain Management System, Supply Chain Strategy, Case-Based Reasoning, Similarity Functions and Strategy Analysis.

1. INTRODUCTION

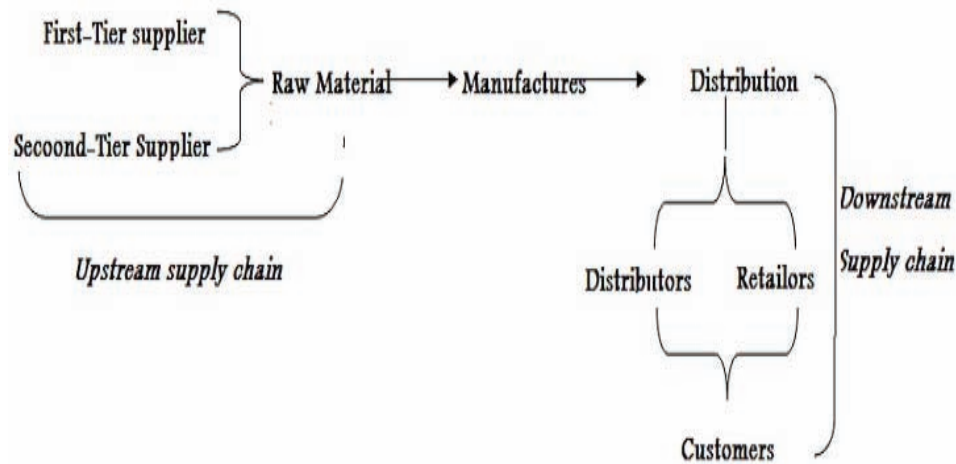
The supply chain has grown to be the focal ingredient of global business progression. In recent years, the supply chain term is being implied in various ways. The supply chain may be defined as "A network of manufacturers and service providers that work together to convert and move goods from raw materials stage through to be the end user. These manufacturers and the service providers are linked together through physical flows, information flows and monetary flows" (Bozarth and Handfield, 2008). The supply chain process initializes from supply of raw material required to manufacture the desired product & end with delivery of product to the customers (Johnson, 1995).

The supply chain process can be further disunitd into two phases: upstream supply chain & downstream supply chain. The upstream supply chain involves all activities that take place before the production of the goods oriented on delivery of the raw materials needed for manufacturing the product. The suppliers' selection issue is majorly resolved in this phase. The downstream supply chain involves all actions that take place after the production of the goods oriented on delivery of the goods to end users. The reliable & efficient distribution channel selection issue is majorly resolved in this phase.

The figure I illustrates the various components of supply chain process. This figure explains the flow between the supply chain components i.e. suppliers, manufacturers, distributors, retailers & buyer-seller. The figure I is given as below.

The figure I indicates that the supply chain does not only involve the flow of goods from manufacturers but also concerns with various perceptive. The material flow, information flow & buyer-seller relation are the key perceptive of the supply chain system. At initial stage, the manufacturers concern regarding the availability of raw materials to manufacture the goods. In second perceptive, the information flow is concerned which is utilized in the complex business decisions making process. Last perceptive is related to the buyer & seller's relation. This perceptive improves the product quality, customer's satisfaction & their partnerships (Zarandi, 2002).

The seller's selection is major issue in the upstream supply chain phase that plays critical role in quality & cost of the goods. There exist a lot of evaluation techniques for supplier selection in the supply chain process. Traditionally, the linear weighting models and mathematical programming were used for selecting the suppliers but recently incorporate fuzzy set theory and analytic hierarchy process (AHP) concepts are used in

Figure I: Supply chain process (Lambert, 2001)

the supplier's selection process. The main challenge of this process is to make the linkage between supplier's evaluation criterion and the organization's supply chain strategy. The major criterions in supplier's evaluation process are the cost, quality, reliability, responsiveness, flexibility and re-configurability (Xia, 2008).

Lee and Ng et al. (1994) defined Supply Chain Management as "A network of entities that starts with the supplier's supplier and ends with customer's customer the production and delivery of goods and services" (Sahay and Gupta, 2007). There exist various elements of the business process that affect the decision making in the business organizations. These elements are further divided into structural & infrastructural elements. The structural elements are tangible resources by nature & very difficult to reverse like buildings & equipments. The infrastructural elements are intangible resources by nature & can be easily modified or changed like employees & organization policies. The business strategy is the core of business decision process aiming at maximized profits through utilization of structural elements of business organizations. The business organization can face the market competition challenges successfully behalf of efficient business strategy. The supply chain strategy builds the linkage between the business strategy and all the supply chain activities. There are following objectives of the supply chain strategy as given below.

- To utilize the structural & infrastructural elements of business organization.
- To fulfil the objectives of business strategy in the organization.
- To enhance the customer's satisfaction through fast & reliable product delivery.

A lot of other aspects of business process are successfully handled by the supply chain strategy. There exist various types of supply chain strategies as given below:

1.1 Push-based Supply chain strategy

Such strategy forecasts the customer's demand for long period. It is simple approach to handle the demand in the supply chain system which is easily implemented. But this approach is totally impractical because of ignorance of the changing pattern of the customers' demand in midterm of the period. This strategy causes more inventory cost, higher selling rate & less customer satisfaction efficient etc.

1.2 Pull-Based Supply Chain Strategy

Such strategy emphasises on true customer's demand rather than demand forecasting. There is no need of inventory buffering that's causes no inventory cost. The system is being operated with regards of the current customers demand through the demand information. This approach handles the variability in the customers' demand successfully. But it is very complex task of reacting to the demand information.

1.3 Push-Pull Supply Chain Strategy

It is combination of above mentioned strategies. Initially this strategy operates through the push-based concept which operates all upstream supply chain activities and after it works like the pull-based strategy that handles other

downstream activities. Push-pull boundary differentiates the scope of both strategies. It minimizes the inventory cost and transportation & provides higher level of reliable product delivery & customer's satisfaction. The demand forecasting errors affect the performance of supply chain management.

1.4 Demand-Driven Supply Chain Strategy

In such type strategy, customers' demand is calculated by two different processes: demand forecasting & demand shaping. These processes eliminate the demand forecasting error. It provides more balance between supply of goods & demand (Levi, 2008).

All these strategies are used to control the supply chain process providing fulfilment of the organization goals. Measuring performance supply chain performance is a powerful tool to evaluate the answer availability to actual global markets. The artificial intelligence methodologies can play important role in the supply chain strategies analysis. In this paper, the approach of case based reasoning is being applied to evaluate the performance of the supply chain strategy.

2. LITERATURE REVIEW

The supply chain strategy has great impact on the whole supply chain system performance. The supply chain is not just a process of conversion of raw materials to end users' products. Hence there is a lot of work done in this field.

Matthias Schnetzler (2004) discussed about the implementation of business strategy that was considered as the mandatory element for the success of the business. In the development of the supply chain strategy, the facts of fundamental decisions & objectives were emphasized. The whole strategy was implemented through repetitive development of strategies at the sublevels. Chan(2002) proposed five models for supply chain system. These models were divided into 3 categories such as inter-organizational, network and regional clustering supply chain. He has also introduced SIMPROCESS simulation tool that evaluated the performance of the supply chain system. Udin(2008) developed the knowledge-based collaborative supply chain Management. The concepts of Knowledge Based, GAP analysis and AHP approach were utilized to intend this system. He used the knowledge-based system to hold all information gathered from customers. To outline the dissimilarity among present & past standing of the firm the GAP analysis was being applied in this framework.

Yuhua(2011) discussed the causes of instability of pear supply chain system. He emphasized on the information system as the weak information system & inaccurate market demand caused the instability of pear. To strength the stability of pear supply chain system he suggested various factors such as common logistic distribution center. Wang (2007) developed the case-based conceptual model for assisting process of supply chain strategy expansion in small & medium-scaled enterprises. This model enhanced decision-making between strategic choices in process of supply chain management (SCM).

Liya(2010) integrated the fuzzy reasoning with case-based reasoning to evaluate the risks in military supply chains. In the military supply chain, the main aim was to fulfill the military need. The cases were represented with the help of fuzzy logic concept. On receiving the new problem, the similarity was determined by using fuzzy similarity mechanism. Keramati(2011) proposed knowledge based framework for analysing and improving the capabilities of supply chain models. For simulation of business process, this framework used meta-interpreter and workflow engine to understand business scenarios. This framework used Fundamental Business Process Modeling Language(FBPML) which had capabilities of modeling the commerce procedure.

All these major finding showed that the artificial intelligence approaches are extremely constructive in the analysis of the supply chain management performance. Hence in forthcoming section of this paper, the case-based reasoning is being applied to evaluate the strategy of the supply chain management system.

2.1 Case-Based Reasoning

The case-based reasoning is one of the most shining fields in the artificial intelligence. It provides the way of automating the human thinking. According to Douglas Adams "Human beings, who are almost unique in having the ability to learn from the experience of others, are also remarkable for their apparent disinclination to do so". Hence the experience is the valuable fact & can be used in various manners. There exists various real time example in which many problems are being solved with past experiences i.e. physician, financial consultant & drilling engineer. If someone wants to modulate the human reasoning then it is necessary to emphasis on the utilization of past experiences.

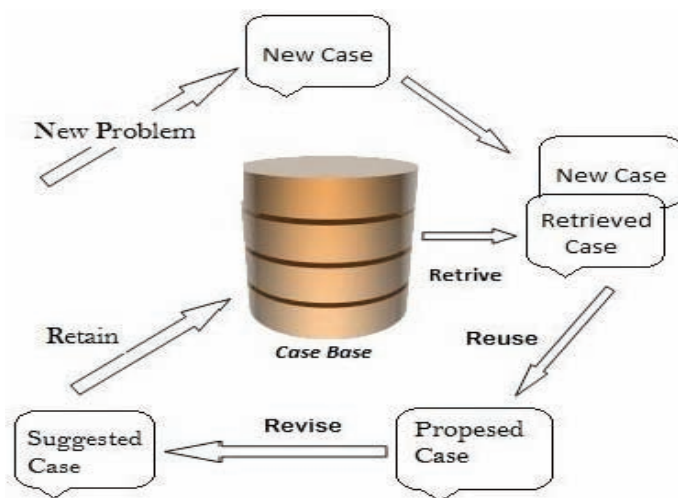
The case-based reasoning is more appropriate preference for these situations. The case-based reasoning is the

problem-solving approach which solves the new problem by searching the similar solutions among stored past problems solutions. It also investigates the proposed solution according to the particular problem's constraints. All information about the solution of past problems is stored in case form. The upcoming problem is considered as new case containing all information regarding upcoming problem. The case-based reasoning problem solving cycle is divided into 4 phases as given below:

- *Retrieve phase*: The similar cases are selected from case base regarding the new problem.
- *Reuse phase*: The knowledge of selected cases is utilized to build proposed case.
- *Revise phase*: The proposed case is verified if it fulfil the all constraints of new problem. If not, then it is modified to fulfil all constraints of the problem.
- *Retain phase*: The modified case is stored in the case base for future use (Aamodt and Plaza, 1994).

The figure II demonstrates the 4 REs phases of case-based reasoning cycle. In figure II, the cases are represented with help of rectangle shape with labelled its types. The figure II is given as below:

Figure II: Case-based reasoning cycle (Aamodt and Plaza, 1994)



It solves the upcoming problems in 4 REs phases. The retrieve phase is divided into 2 sub-phases. First of all,

the relevant cases are preferred on the basis of indexing. Then the similarity measurement algorithms are applied to explore the relevant cases concerning new problem. The nearest neighbour, induction retrieval algorithm & knowledge-intensive similarity measures can be accomplished to estimate the similarity between the cases stored in the case base (Stahl, 2006).

This approach has many advantages over other reasoning approaches. It does not allow propagating the past mistakes in upcoming decisions as it revises proposed solutions regarding the constraints. It provides more approximate solution. It enables the user to learn from the experience. It comes under the category of lazy learning. It is more flexible and more efficient in comparison of rule-based reasoning. Hence it is the best approach to automate the human reasoning (Sebestyénová, 2007).

2.2 Components of Supply Chain Strategies

There are various facets to confirm the effectiveness of the supply chain strategy. For success of the organization in competitive market scenario, it depends on the effective supply chain strategy. Hence these facts should be crosschecked to verify its quality. There are following factors that should be satisfied as given below:

- *Organization goals*: The supply chain strategy should be oriented on the organization goals. It should be defined in term of products & customers' needs. It should concern the competition issue of growing market.
- *Customers Satisfaction*: This fact calculates the satisfaction of the related customers. This satisfaction may be measured in all states: before the buying, distribution of the products & during the usage of products. The supply chain strategy should grow maximum customer's satisfaction in all stages.
- *Flexibility*: It may be defined as the capability of the supply chain strategy to respond the dynamic change in the market demand. The supply chain strategy should equilibrium the influence in the markets.
- *Inventory Cost*: The cost may be defined as the financial amount required for transforming the raw material to deliver the desired products to the end customer in completion of supply chain cycle. The cost should be minimized during the whole supply chain process.

- *Sale*: The sale may be measured as the quantitative measure of the sold products. The supply chain strategy should be emphasised on the maximum sale of the products.
- *Profit*: It may be calculated as the difference between the total costs required for manufacturing the products & sale of the product. It is major facet that should be most fretful.
- *Fill rate*: It may be defined as the ration of fulfilling the customer's requirements. It defines how much your strategy is capable of fulfilling the customer's needs in the time. The fill rate should be practically lofty.
- *Product Lateness*: It may be defined as the time required in delivering the product regarding the customer's requirements. The late deliveries of the product construct terrible impact on the customer's contentment. The strategy should generate the system which has minimum product lateness value.
- *Risk Management*: It may be concerned with capability of managing the possessions of the market risks efficiently. It should be proficient of running bullwhip effect of this process. It means that the strategy should have effectual risk administration.
- *Supplier's Selection*: It may be defined as the decision taking capability for selecting the supplier which is capable of providing the raw material at minimum cost & at time. The inefficient supplier's selection stumps the goods production & increase the production costs. Hence strategy should select the appreciative supplier.
- *Information Flow*: This factor concerns with flow of information among various components of supply chain management systems (suppliers, manufacturers, retailers, distributors & customers) etc. There should be proficient information flow systems
- Consequently the effective supply chain strategy should maintain the considerable value of all these factors.

3. CASE-BASED SUPPLY CHAIN STRATEGY ANALYSIS MODEL

The analysis of the supply chain strategy plays extremely imperative responsibility in evaluating the performance of supply chain management system. The artificial intelligence technique may be proficient in analysis of

the overall performance of this system. These intelligent techniques are capable of taking the decision on imperfect information accessible & become skilled itself from the environment. The case-based reasoning approach is one of the efficient artificial intelligence technologies. In this approach, the various types of cases are constructed for utilizing the past experience of problem solving. In phenomena of analysing the supply chain strategy, the case should contain the scope of every supply chain performance's evaluation factors.

The table I exhibits the weight value of each field of the supply chain strategy. The weight value represents the impact of that field on supply chain process's performance. This table summarizes all fields with its particular type of value i.e. Integer, String, floating-point, Double, Boolean etc. All these details are being represented in table I as given below:

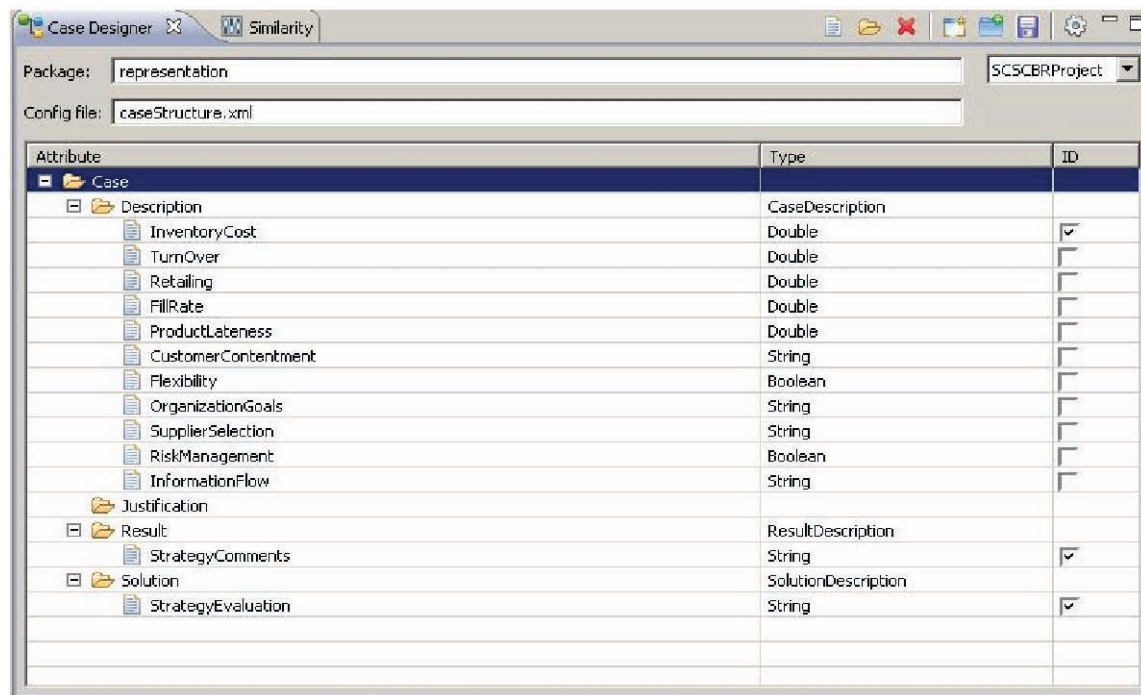
The figure III highlights the structure of case with showing different data types of values assigned with these fields. The case field depends on the information shown in table I. For example, the Inventory cost field have floating-point value & string value is being held by the information flow field in figure III. After assigning the weight value to the supply chain strategy evaluation factors, the case is being designed as shown below in the figure III.

As shown in the figure III, there are two tabs: Case Designer & Similarity. In the project, the structure of case is saved in the configuration file named as *caseStructure.xml* & it imports the representation package. The case structure is divided into 4 sub categories- Description, Justification, Result and Solution. After designing the case in the model, the similarity measurement is performed with the help of the similarity function. Depending on the type of particular field value, the specific similarity function is applied. These functions are imported from the package *jcolibri.method.retrieve.NNretrieval.similarity*. This package contains *GlobalSimilarityFunction* interface which computes the global similarity & contains the definition of the global similarity function's methods & *LocalSimilarityFunction* interface which computes the local similarity contains the definition of the local similarity function's methods. This model contains various similarity functions' methods which are assigned with various elements of supply chain strategy evaluation process.

The figure IV highlights the various similarity functions concerned with the every attributes of supply chain strategy. The *similarityConfig.xml* maintains the information about the linkage of supply chain strategy fields and associated similarity functions as configuration file. The figure IV is given as below:

Table I: Case structure of Supply chain strategy analysis model (Mukhtar, 2009)

S.No.	Name of Field	Type of value
1.	Inventory Cost	Floating point
2.	Turnover	Floating point
3.	Retailing	Floating point
4.	Fill rate	Floating point
5.	Product Lateness	Floating point
6.	Customer contentment	String
7.	Flexibility	Boolean
8.	Organization goals	String
9.	Supplier selection	String
10.	Risk Management	Boolean
11.	Information Flow	String

Figure III: Case structure

This model is being implemented using Java language. Java language supports various features like portability, robust, secure, distributed & garbage collection etc. the supply chain strategy analysis model is composed of various methods which define the case-based reasoning phases as described below:

- The configuration method to build up the application at initial stage.

```
// obtain configuration for KNN
simDialog.setVisible(true);
```

```
NNConfig sim = similarityDialog.
getSimilarityConfig();
sim.setDescriptionSimFunction(new Average());
// Execute NN
Collection<RetrievalResult>eval =
NNScoringMethod.evaluateSimilarity(_caseBase.
getCases(), query, sim);
// Select k cases
Collection<CBRCCase>selectedcases=SelectCases.
```

```
selectTopK(eval, simDialog.getK());
```

- ThepreCycle loads cases and prepares the application to run.

```
public CBR Case Basepre Cycle () throws Execution Exception {
```

```
// Load cases from connector into the case base
_caseBase.init(_connector);
```

- The cycle methodsexcute a CBR step using the given query.

```
// Show result
```

Figure IV: Similarity function used

Attribute	Similarity Function	Weight
Case		
Description	jcolibri.method.retrieve.NNretrieval.similarity.global.Average	
InventoryCost	jcolibri.method.retrieve.NNretrieval.similarity.local.Table	0.80
TurnOver	jcolibri.method.retrieve.NNretrieval.similarity.local.Table	0.40
Retailing	jcolibri.method.retrieve.NNretrieval.similarity.local.Table	0.60
FillRate	jcolibri.method.retrieve.NNretrieval.similarity.local.Table	0.40
ProductLateness	jcolibri.method.retrieve.NNretrieval.similarity.local.Table	0.70
CustomerContentment	jcolibri.method.retrieve.NNretrieval.similarity.local.EnumDistance	0.70
Flexibility	jcolibri.method.retrieve.NNretrieval.similarity.local.Equal	0.50
OrganizationGoals	jcolibri.method.retrieve.NNretrieval.similarity.local.EnumCyclicDistance	0.90
SupplierSelection	jcolibri.method.retrieve.NNretrieval.similarity.local.EnumCyclicDistance	0.0
RiskManagement	jcolibri.method.retrieve.NNretrieval.similarity.local.Equal	0.70
InformationFlow	jcolibri.method.retrieve.NNretrieval.similarity.local.EnumDistance	0.70
Justification		
Result	jcolibri.method.retrieve.NNretrieval.similarity.global.Average	
StrategyComments	jcolibri.method.retrieve.NNretrieval.similarity.local.EnumDistance	0.85
Solution	jcolibri.method.retrieve.NNretrieval.similarity.global.Average	
StrategyEvaluation	jcolibri.method.retrieve.NNretrieval.similarity.local.EnumCyclicDistance	0.85

```
res.showCases(eval, selectedcases);
res.setVisible(true);
// Show adaptation dialog
autoAdaptDialog.setVisible(true);
// Adapt depending on user selection
if(autoAdaptDialog.adapt_Evaluation())
{
// Compute a direct proportion between the "Fill
Rate" and Strategy Evaluation" factors.
NumericDirectProportionMethod.directProportion
(new Attribute("FillRate",StrategyDescription
n.class),
```

```
new Attribute("strategyEvaluation",StrategySoluti
on.class), query, selectedcases);}
// Revise
revDialog.showCases(selectedcases);
revDialog.setVisible(true);
// Retain
retDialog.showCases(selectedcases, _caseBase.
getCases().size());
retDialog.setVisible(true);
Collection<CBRCASE>casesToRetain = retainDia
log.getCasestoRetain();
_caseBase.learnCases(casesToRetain); }
```

- ThepostCycle in charge of finishing the application.

```
public void postCycle() throws ExecutionException
{
    connector.close();
    jcolibri.test.database.HSQLDBserver.shutdown();
}
```

This model analyses the efficiency level of supply chain strategy. It evaluates efficiency of strategy on the weight of the factors. It provides the results as category of supply chain strategy if it is effective, good, average, bad or worst. On the basis of this result, the managers can judge particular strategy in business competition.

4. CONCLUSIONS

The case-based supply chain strategy analysis model is oriented on the case-based reasoning approach having capability of taking the decisions in real time applications. The model generates the cases regarding to the constraints of the new problem. This model is implemented in Java language provided the features of portability, secure & robustness to the applications. It calculates the similarity among various factors of the supply chain strategy using K-Nearest Neighbor algorithms. The various similarity functions can be assigned with individual factor of supply chain strategy in simple manner. This model is capable of performing the evaluation of the supply chain strategies. The evaluation result is being stored in case base for utilizing it in the future. This model is more efficient in overcoming the problem of finding the more similar cases mostly found in case-based reasoning applications. It resolves this problem by linkage with various similarity functions with different elements of the supply chain strategies.

The model faces one major limitation due to the accessibility of K-NN algorithms in purpose of retrieving the similar cases from the case base. When the number of the case increase, then the system becomes slow as the size of case base grows. To overcome this problem, the approach of knowledge-intensive similarity may be applied in the future.

REFERENCE

- Aamodt, A. & Plaza, E. (1994). Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches. 7(1), (pp. 39-59). AI Communications,
- Armin, S. (2006). Optimizing Similarity Assessment in Case-Based Reasoning, Proceeding of the 21st National Conference on Artificial Intelligence, 2, pp. 1667 - 1670.
- Bozarth, C. C. & Handfield, R. B. (2008). Introduction to Operations and Supply Chain Management, (2nd ed.). U.S.A.: Pearson Education Inc.
- Chan, F. T. S. (2002). Comparative Evaluation of Supply Chain Management Strategies: A Simulation Approach. Proceeding of Seventh International Conference on Control, Antamation, Robties and Vision (ICARCV'OZ), (pp. 78-83). Singapore.
- Douglas, L. (2001). Supply Chain Metrics. International Journal of Logistics Management, 12(1), pp. 1 - 19.
- Jin, L. (2010). Risk Evaluation of Military Supply Chains Based on Case and Fuzzy Reasoning. Proceeding of International Conference on Logistics Systems and Intelligent Management, (pp. 102 - 104). Harbin.
- Johnson, P. (1995). Supply Chain Management: The Past, the Present and the Future. Manufacturing Engineer, 74(5), pp. 213 - 217.
- Keramati, A. (2011). Supply Chain Integration: Modelling Approach, Proceeding of European, Mediterranean & Middle Eastern Conference on Information Systems (EMCIS2011), pp. 75-85. Athens, Greece.
- Mukhtar, M. (2009). A Framework for Analyzing E-Supply Chains. European Journal of Scientific Research, 25(4), pp. 649 - 662.
- Simchi, L. D. & Kaminsky, P. (2008). Designing and Managing the Supply Chain, (3rd ed). India: Tata McGraw-Hill Edition.
- Sahay, B. S. & Gupta, A. K. (2007). Supply Chain Modeling and Solutions, (1sted.). New Delhi: Macmillan India Ltd.
- Schnetzler, M. (2004). Supply Chain Strategies for Business Success, Proceedings of the International IMS Forum 2004 Global Challenges in Manufacturing, (pp. 691-698.) Cernobbio, Italy.
- Sebestyénová, J. (2007). Case-Based Reasoning in Agent-Based Decision Support System, ActaPolytechnicaHungarica, 4(1), pp. 127 - 138.
- Udin, Z. (2008). Collaborative Supply Chain Management: The Hybrid Knowledge-Based Development Approach of Suppliers-Customers Perspective Operations and Supply Chain Management, 1(2), pp. 130 - 141.
- Wang, C. (2007). A Conceptual Case Based Model Supporting ASME'S Strategic Supply Chain Decision. Proceeding of IET International Conference on Agile Manufacturing, ICAM 2007, pp. 189 - 196.

- Xia, L. (2008). Supplier Performance Measurement in a Supply Chain, Proceeding of The IEEE International Conference on Industrial Informatics (INDIN 2008) DCC, (pp. 877 - 881). Daejeon, Korea.
- Yuhua, H. (2011). The Study on the Strengthening Strategy of the Stability of Pear Supply Chain, Proceeding of

- 8th International Conference on Service Systems and Service Management (ICSSSM), (pp. 1 – 4). Tianjin.
- Zarandi, Md. (2002). Supply Chain: Crisp and Fuzzy Aspects. *International Journal of Applied Mathematics and Computer Science*, 12(3), pp. 423 - 435.