

Supply Chain Contract Selection Using Delphi-Based AHP: A Case Study in the Bangladeshi Super Shop

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ABSTRACT

Selection of the best supply chain contract plays a significant role as a strategic feature and factor of better coordination of all stages in a supply chain. As a variety of uncontrollable and unpredictable factors affect the evaluation and decision-making process at different levels, identification of the most appropriate contract is usually very complex and unstructured. In this paper, Delphi-based analytic hierarchy process (AHP) approach has been proposed to tackle the problem. The sole purpose of the paper is to analyse the existing contracts of the organisation and recommend the best one. Necessary data of powdered milk item were collected from a renowned super shop in Bangladesh, namely, Swapno superstore, Dhaka. In order to demonstrate the applicability of the proposed approach, an illustrative example is presented; the result is analysed at the end of this paper. This work can be a guide for Bangladeshi planners as well as other researchers to identify the most suitable agreement for their supply chain.

Keywords: AHP, Delphi, Multi-Criteria Decision-Making, Supply Chain Contract

INTRODUCTION

Supply chain contracts are the form of agreement employed between supplier and retailer whose main objective is to ensure the availability of the right quantity and right quality of goods and services at the right time with the lowest possible cost. In today's competitive market, it plays a vital role in smooth production flows as well as improving better coordination among all stages in a supply chain (Li et al., 2017). An effective supply chain contract ensures a supply of raw materials, components, subassemblies and finished goods at a stable and known price between parties. It makes the buyers capable to meet their customers' uncertain and changing demand. Buyers want to have such a contract that will provide some mechanisms so that suppliers (manufacturers) and buyer share system's risks and costs mutually. In today's business, suppliers are considered as one of the parts of the supply chain; also, for better design collaboration, their presence is a must (Forkmann et al., 2016; O'Brien, 2018).

In the last few decades, a significant increase in the level of outsourcing and decentralisation practice is seen in

many industries. This increase in the level of outsourcing increases the importance of implementing effective contracts in supply chains. In a decentralised environment, each independent entity, having its own plans and objectives needs to purchase required components, raw materials, subassemblies and finished products from each other. Typically, each entity is interested in obtaining a smooth relationship with the buyer that will ensure the availability of the inputs of the right quality, at the right time.

To maximise the overall surplus of the supply chain, better coordination among all stages of the chain is very necessary (Matsuo, 2015). But the process is very complex and challenging. There are many reasons behind this problem such as longer production lead time, the uncertainty of supply and demand, etc. One of the important difficulties is that procurement managers are forced to place order long before the actual demand for products. Their orders are made based on forecasts that have a great chance not to be accurate. As a result, supply chain faces unnecessary build-up of inventories that do not add any value. The local objective of the supply chain is another factor that hinders the level of coordination. Each entity is interested

in maximising its own objective and, thus, it results in poorer supply chain value. Supply chain contract is a coordination mechanism that provides incentives to all of its members so that the decentralised supply chain behaves nearly or exactly the same as the integrated one. Strategic sourcing contracts offer several advantages and are a common practice in many industries. Supply chain contracts come in various shades of price, commitments, duration, terms, flexibility, lead time, quality, discounts, product bundling, etc. (Jin et al., 2015; Becker-Peth & Thonemann, 2016; Liu et al., 2017). However, selecting the best one for a multi-national company's sites in an integrated and global business environment is very vital.

Several works have been performed for improving internal supply chain operations of the organisation (Al-Odeh, 2016; Chandak et al., 2018; Kailash et al., 2019). Enhancing supply chain management practice helps supply chain managers to improve efficiency, curtail unnecessary cost as well as showing outstanding performance. Selection of the best supply chain contract is considered an effective task to improve the supply chain as well as smooth the operation. That is why, the authors have focused on this topic. Recently, a vast literature on supply chain contracts has been seen. As there is a lot of literature in this field, it is a mammoth task to cover all of those. That is why, the authors have tried to review some of the major works in this field. Tsay et al. (1999) provided a literature review on contracts from a modelling perspective. In the paper, the authors made a classification of the literature on contracts by eight contract clauses, which were the specification of decision rights, pricing, minimum purchase commitments, quantity flexibility, buyback or returns policies, allocation rules, lead time and quality. Wang (2002) developed a general framework for supply chain contract model. The contribution of the work is providing a framework that synthesises existing results for a variety of supply chain contract forms. Park et al. (2006) modelled the purchase and sales contracts for supply chain optimisation. They applied disjunctive programming, which is very useful for suppliers and customers, for modelling three types of quantity-based contracts.

Bansal et al. (2007) worked on optimal contract selection for the global supply and distribution of raw materials. In the research, the authors proposed a comprehensive classification system for material supply contracts and used a multi-period mathematical programming model for selecting optimal contracts. The sole objective of the research was to determine optimal contract that minimises total production cost considering some practical factors like different contract types, multitier prices, and

discounts, logistics and inventory costs, quantity/dollar purchase commitments, spot market, product bundling, etc. Another contribution is that the model also identifies the optimal distribution channel of materials from various suppliers to plant sites. Khalilpour and Karimi (2011) addressed the optimal contract selection for a liquefied natural gas (LNG) buyer company in Singapore. They proposed a mixed-integer linear programming formalism for selecting the best combination of suppliers and contracts. The proposed approach was illustrated by using three different real-life examples. The contribution of the work is that it helps a buyer to select a product in an integrated manner, which addresses several issues such as contract timings and lengths, demands, price formulations, volume discounts, delivery terms, shipment costs, purchase commitments, etc. Khalilpour and Karimi (2012) extended the previous work and published it. However, the aforementioned works have only considered deterministic formulations.

Some authors, however, have considered uncertainty in the contract selection problem. For instance, Rodríguez and Vecchietti (2009) worked on supplier and contracts optimisation in a supply chain under provision uncertainty. Here, quantity-based contracts were modelled using logical and generalised disjunctive programming, and a decision tree approach was used to model the uncertain amount supplied by the suppliers. Another research paper was published on contracts optimisation by Rodríguez and Vecchietti (2012). They proposed a mid-term planning optimisation model with sales contracts. In the paper, they assumed demand as a function of selling price using piece-wise linear price-response models and safety stock was considered to meet the fluctuating demand requirement in the absence of sales contract. Feng et al. (2013) proposed a stochastic programming approach to coordinate contract selection in a three-tier manufacturing supply chain of the oriented strand board industry. The uncertain parameters of the proposed model were the price and quantity of materials. Calfa and Grossmann (2015) developed an optimal procurement contract selection for a chemical process network in an uncertain environment. The researchers considered three quantity-based contract models and used general regression models to describe the relationship among several indicators. A mixed-integer nonlinear two-stage stochastic programming was used that accounts for uncertainty in both supply (e.g., raw material spot market price) and demand for the planning of the process network. The contribution of the research is optimal procurement contract selection and regression demand-response models for price optimisation.

Multi-criteria decision-making methods (MCDM) are very useful mathematical and computational tools for selecting the best alternative among a set of alternatives having a finite number of performance criteria (Lootsma, 1999). Different MCDM approaches have been used for evaluation of suppliers (Karmaker, 2016; Azadfallah, 2017; Joseph & James, 2018). Determining the selected attributes is nontrivial in MCDM as they play a very substantial role in the decision-making process. Proper technique must be adopted for selecting criteria based on which alternatives are evaluated. To prevent the biases as well as ensuring fairness in the decision-making process, aggregation of expert opinions from the relevant field is appreciated. Aguezzoul and Pires (2016) applied MCDM techniques to evaluate the performance of third-party logistics providers. Integrated MCDM approaches have been used by many researchers to select the best supplier and evaluate their performance (Prakash & Barua, 2016; Raut et al., 2018; Li et al., 2018). One of the popular MCDM methods, analytic hierarchy process (AHP) has many applications in supply chain performance evaluation and alternative selections.

Supply chain contract selection problem has three main phases, which are criteria identification, determining the weights of the selected criteria and, finally, the alternatives are ranked based on their performance in the selected criteria. At the first stage, criteria have to be identified based on which possible contracts are going to be evaluated. In this paper, the Delphi method is used to determine the possible criteria. Different criteria are obtained from different personnel involved in the decision-making process. Decision-makers assign different weights to all criteria and they have also weights based on their positions, educational background, experiences, etc. Criteria are sorted out as an aggregation of the weights given to them by the decision-makers and the weights hold by different personnel. In the second phase, the weights of the selected criteria in the first phase are to be determined. Finally, alternatives (supply chain contracts) are ranked properly based on their performance in the selected criteria. The authors have tried to present a framework that combines the above-mentioned three phases in the contract selection process using a Delphi-based AHP approach. Delphi method is proposed to find out the suitable criteria first. Then, the AHP approach is applied to estimate the weights of each selected criteria and evaluate supply chain contracts.

The rest of the paper is organised as follows: the next portion highlights the theories of the proposed approach with appropriate explanations. To illustrate the decision

procedure, a numerical example is given, and finally, a conclusion is drawn with managerial insights of the proposed model and providing some future research directions.

MATERIALS AND METHODOLOGY

The proposed approach is aimed to explain a systematic supply chain contract selection process of a superstore in Bangladesh using a Delphi-based AHP method. Here, the Delphi method has been applied to collect all necessary information and AHP method has been applied to select the best contract based on some criteria. Fig. 1 represents the methodology of current research.

Delphi Method

Delphi method plays a vital role in the selection process by sorting out the important criteria. It helps to identify the unimportant criteria that can be eliminated from further consideration. It involves preparing a structured series of questionnaires and circulating them among experts and group members who possess profound knowledge and expertise in the relevant field. Then, they are asked to specify the importance of each criterion to shortlist them. The team of experts from industry (decision-makers) and academic should aid the selection process through identification of the most important criteria and eliminate the unnecessary one. This method tends to encourage honest responses as well as reduce biases.

Analytical Hierarchy Process (AHP)

In MCDM approach, one of the pivotal issues is to make prioritisation of criteria. In the literature, there are several techniques for calculating the criteria weights including AHP, entropy analysis, eigenvector method, weighted least square method, linear programming for multi-dimensions of analysis preference, etc. In this study, the method of AHP is applied for determining the weights of criteria. The AHP was developed by Thomas L. Saaty in the 1980s for dealing with amorphous problems with multiple criteria. The method helps the decision-makers to solve complex problems creating hierarchical forms of different elements as principle goal, the goal affected by those criteria or the criteria that are affected by sub-criteria and not but the least the different substitutes available to the problem. The first step of this method is to use Saaty 1-9 preference scale (Table 1) for forming the pairwise comparison matrix.

Table 1: Saaty’s Pairwise Comparison Scale (Saaty, 1994)

Scale	Linguistic Variable
1	Equally Important
3	Weakly Important
5	Strongly Important
7	Very strongly Important
9	Extremely Important
2,4,6,8	Intermediate value between adjacent scales

The following section outlines the stepwise procedure of AHP.

Step 1: Construct the structural hierarchy.

Step 2: Construct the pairwise comparison matrix.

Assuming n attributes, the pairwise comparison of attribute i with attribute j yields a square matrix $A_{n \times n}$ where a_{ij} denotes the comparative importance of attribute i with respect to attribute j . In the matrix, $a_{ij} = 1$ when $i = j$ and $a_{ji} = 1/a_{ij}$.

$$A_{n \times n} = \begin{matrix} \text{Attribute} \\ \begin{matrix} 1 \\ 2 \\ 3 \\ \dots \\ \dots \\ n \end{matrix} \end{matrix} \begin{bmatrix} a_{11} & a_{12} & a_{13} & \dots & \dots & a_{1n} \\ a_{21} & a_{22} & a_{23} & \dots & \dots & a_{2n} \\ a_{31} & a_{32} & a_{33} & \dots & \dots & a_{3n} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & a_{n3} & \dots & \dots & a_{nn} \end{bmatrix}$$

Step 3: Construct normalised decision matrix.

$$c_{ij} = \frac{a_{ij}}{\sum_{j=1}^n a_{ij}} \quad i = 1, 2, 3, \dots, n; \quad j = 1, 2, 3, \dots, n \quad (1)$$

Step 4: Construct the weighted normalised decision matrix.

$$w_i = \frac{\sum_{j=1}^n c_{ij}}{n} \quad i = 1, 2, 3, \dots, n \quad (2)$$

$$W = \begin{bmatrix} w_1 \\ w_2 \\ \cdot \\ \cdot \\ w_n \end{bmatrix} \quad (3)$$

Step 5: Calculate eigenvector and row matrix.

$$E = N^{th} \text{rootvalue} / \sum N^{th} \text{rootvalue} \quad (4)$$

$$\text{Rowmatrix} = \sum_{j=1}^n a_{ij} * e_{j1} \quad (5)$$

Step 6: Calculate the maximum eigenvalue λ_{max} .

$$\lambda_{max} = \text{Rowmatrix} / E \quad (6)$$

Step 7: Calculate the consistency index and consistency ratio (CR).

$$CI = (\lambda_{max} - n) / (n - 1) \quad (7)$$

$$CR = CI / RI \quad (8)$$

where n and RI (Table 2) denote the order of matrix and Randomly Generated Consistency Index, respectively.

Table 2: Average Random Index

Order of Matrix	1	2	3	4	5	6	7	8	9	10
Random Index	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

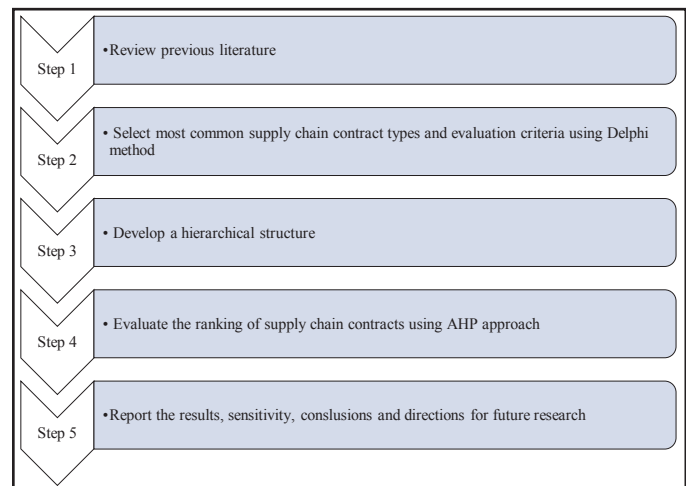


Fig. 1: Step by Step Procedure of Present Research

AN EXEMPLARY APPLICATION

Supply Chain Contract Types and Evaluation of Selected Criteria

To demonstrate the proposed framework, first of all, the suitable criteria need to be determined based on whose supply chain contracts can be evaluated. To sort out

criteria, the Delphi method has been suggested. A decision team is formed consisting of four experts involved in the functional areas (one from material management department, one from the planning department, one from logistics department and one from procurement department) of four different superstores in Bangladesh. Four decision teams having experts have sufficient expertise and hold the proper right to finalise the decision process. Based on discussion with concerned personnel and experts from supply chain contracts optimisation field, they came to a point to adopt 8 initial evaluation criteria for contracts selection problem. The criteria were flexibility, demand fluctuation, uncertainty, information distortion, excessive inventory, responsiveness, product

quality, smooth relationship with suppliers, etc. Then, a structured questionnaire was prepared and circulated among the decision team of the superstores in which they were asked to specify the importance of each evaluation criteria. Based on their judgement and weights, six evaluation criteria were selected except product quality and smooth relationship with suppliers. The reason for not considering the product quality is that the superstores have a reasonable margin for product quality. They do not accept a product which fails to reach the level of quality. However, the final selected criteria by expert's judgements are flexibility, demand fluctuation, uncertainty, information distortion, excessive inventory and responsiveness.

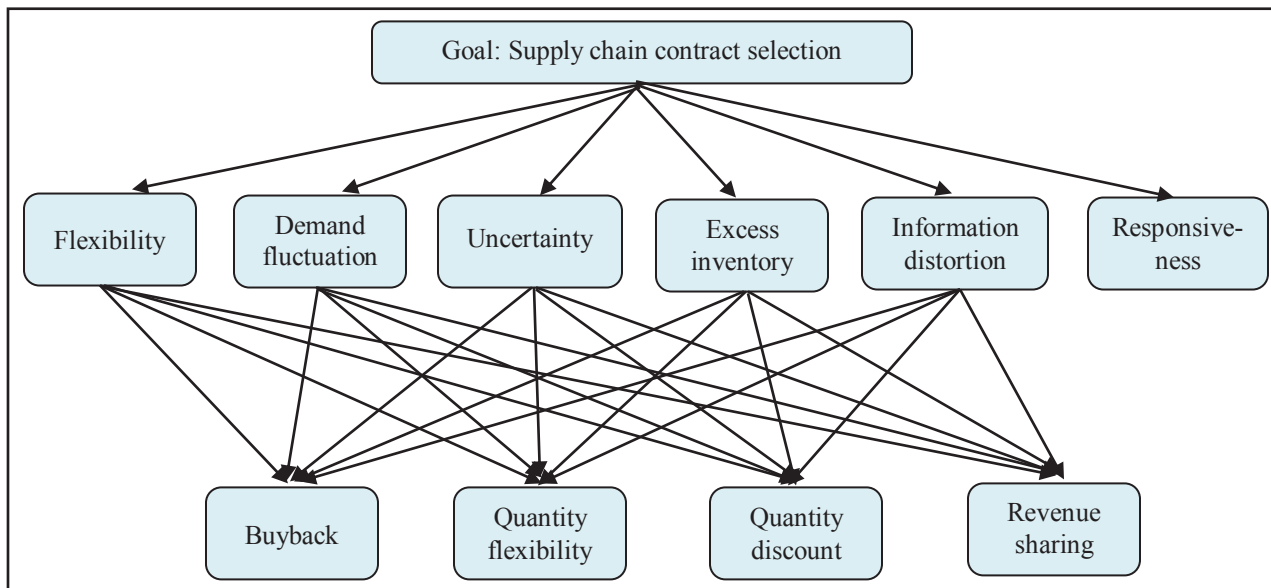


Fig. 2: Hierarchical Structure of Supply Chain Contract Type

Next step is to apply the AHP method for determining the prioritisation weights of the selected criteria and ranking them, which dominate much on the overall contract selection problem. From the Delphi method, six evaluation criteria are selected based on whose four alternatives (Buyback, Quantity Flexibility, Quantity Discount and Revenue Sharing) are evaluated. To measure the weights of six evaluation attributes, firstly a pairwise comparison matrix, an input, is developed using Saaty's 1-9 priority scale. For all criteria, normalised weights have been calculated using Eq. (2) which is shown in Table 3 along with pairwise comparison matrix.

Now, it is time to check the validity of the decision-maker's judgments by calculating CR. Equation (6) gives the five estimates of λ_{\max} and the mean of these values 6.12 is the estimated λ_{\max} . Consistency Index (CI) and CR are calculated through Eqs. (7) and (8), respectively, (for RI = 1.24). As the value of CR (0.02) is lower than 0.10, so it is accepted. Table 4 shows the normalised weights of the selected criteria. Flexibility criteria show the highest weight value (0.37) followed by demand fluctuation (0.23). A responsiveness criterion holds the lowest weight value.

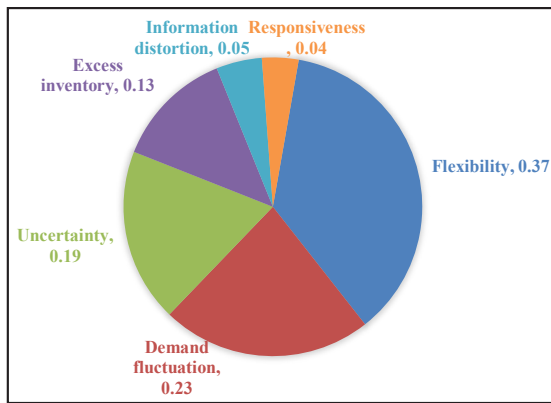


Fig. 3: Weights of Evaluation Criteria for Supply Chain Contract

Now, some evaluations on four alternatives like Buyback, Quantity Flexibility, Quantity Discount and Revenue Sharing, etc., are carried out to identify which contract should be designed for profit maximisation of the company.

Supply Chain Contract Evaluation Using AHP

For all alternatives, separate pairwise comparison matrices with respect to different attributes are formed. Here also,

geometric means and normalised weights are calculated. For example, at level two, a pairwise comparison matrix of each alternative against each other with respect to flexibility attribute is developed. A comparison matrix, along with geometric means and normalised weights, is shown in Table 3. To validity the decision process, eigenvector (λ_{max}) and CR are calculated using necessary equations, which are 4.02 and 0.01, respectively, with those values the authors are satisfied.

Similarly, other pairwise comparison matrices are formed. The eigenvectors, as well as CR, are also determined, which are highly acceptable. Necessary comparison matrices are presented in Table A2, A3, A4, A5 and A6 in the appendix section. On the basis of the above matrices, final evaluation is formed considering the weights of four alternatives and six measuring criteria which are shown in Table 4. The bracketed value shows the weights of the criterion and the cell values shows the weight of alternatives against each criterion. From the results, it is quite obvious that quantity flexibility contract is ranked one among four alternatives. Thus, managers should give much attention on quantity flexibility contract while designing an agreement with suppliers.

Table 3: Pairwise Comparison Matrix of Supply Chain Contract Types for Flexibility

Contract Type	Buyback	Quantity Flexibility	Quantity Discount	Revenue Sharing	Normalised Weight
Buyback	1	0.5	3	2	0.27
Quantity flexibility	2	1	5	4	0.51
Quantity discount	0.33	0.2	1	0.5	0.09
Revenue sharing	0.5	0.25	2	1	0.14

Consistency ratio = 0.01 < 0.10

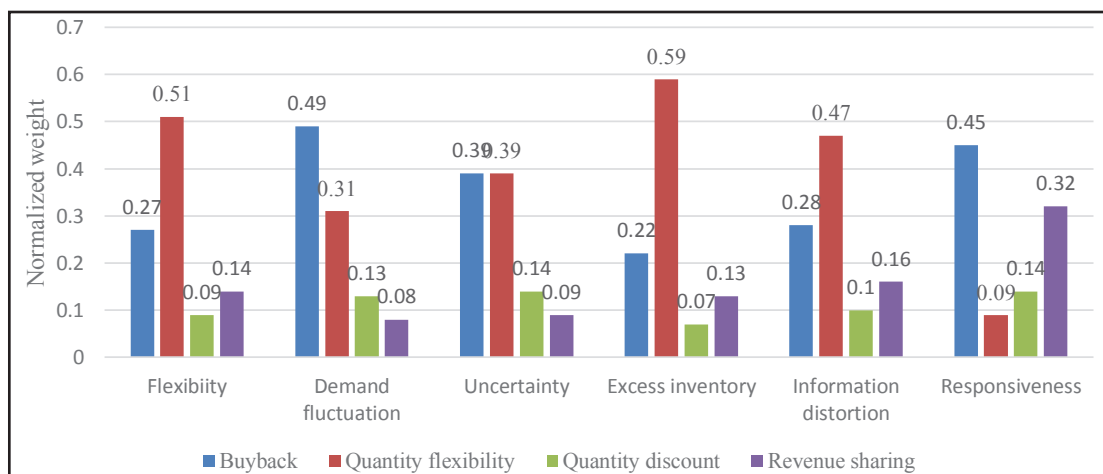


Fig. 4: Normalised Weights of Supply Chain Contracts Under Different Evaluation Criteria

Table 4: Final Calculation of Supply Chain Contract Evaluation Under AHP Approach

	Flexibility (0.37)	Demand Fluctuation (0.23)	Uncertainty (0.19)	Excess Inventory (0.13)	Information Distortion (0.05)	Responsiveness (0.04)	Composite Weight	Rank
Buyback	0.27	0.49	0.39	0.22	0.28	0.45	0.35	2
Quantity Flexibility	0.51	0.31	0.39	0.59	0.47	0.09	0.44	1
Quantity Discount	0.09	0.13	0.14	0.07	0.1	0.14	0.11	4
Revenue Sharing	0.14	0.08	0.09	0.13	0.16	0.32	0.13	3

SENSITIVITY ANALYSIS

In any MCDM analysis, data inaccuracy and vagueness, and experts' opinion may affect the results. Small changes in relative weights of criteria may also lead to a different ranking of alternatives. Govindan et al. (2014) analysed ranking by sensitivity and showed that small changes in criteria's weight may change the final ranking. Therefore, it is imperative to investigate the robustness of the ranking. In this study, robustness has been studied by performing

a sensitivity analysis to investigate the final ranking of different supply chain contracts.

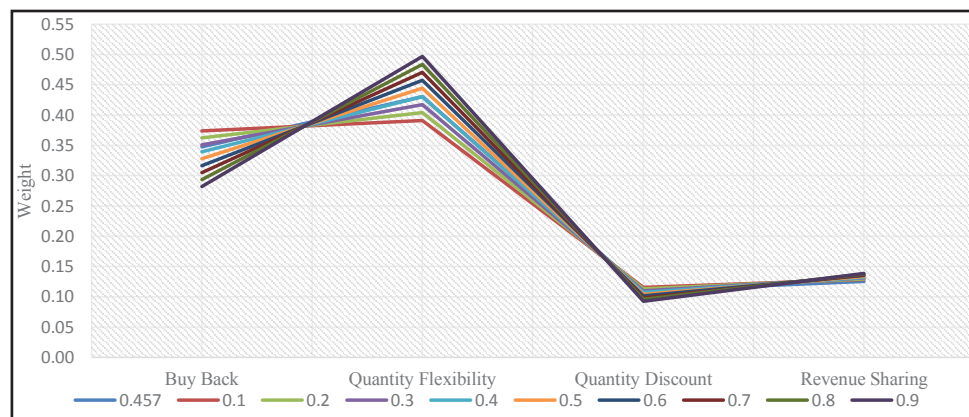
In this work, flexibility criteria got the highest relative weight among six evaluation criteria. Therefore, it was selected for analysis by changing the weights of criteria. The weight of these criteria was varied from 0.1 to 0.9 in increments of 0.1. Simultaneously, corresponding changes in the weights of the other criteria were made. The changes of weights of evaluation criteria were shown in Table 5.

Table 5: Weights of Criteria After Increasing 'Flexibility' Criteria from 0.1 to 0.9

Criteria	Weights of Criteria									
	0.37	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Flexibility	0.37	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Demand Fluctuation	0.23	0.3102	0.2757	0.2413	0.2068	0.1723	0.1379	0.1034	0.0689	0.0345
Uncertainty	0.19	0.2147	0.1908	0.1670	0.1431	0.1193	0.0954	0.0716	0.0477	0.0239
Excess Inventory	0.13	0.1639	0.1457	0.1275	0.1093	0.0911	0.0728	0.0546	0.0364	0.0182
Information Distortion	0.05	0.1167	0.1037	0.0908	0.0778	0.0648	0.0519	0.0389	0.0259	0.0130
Responsiveness	0.04	0.0945	0.0840	0.0735	0.0630	0.0525	0.0420	0.0315	0.0210	0.0105
Total	1	1	1	1	1	1	1	1	1	1

From Fig. 5, it is evident that the weights of supply chain contract types have changed as the weights of evaluation criteria are varied. Although the ranking of alternatives remains the same, fluctuation of relative weights has

occurred. It is evident that when the weight of flexibility criteria is increased, weights of quantity flexibility type of supply chain contract are also increased, respectively.

**Fig. 5: Sensitivity Analysis of Contract Selection Criteria (for AHP)**

CONCLUSIONS

Supply chain contracts provide long-term relationship between different parties in a supply chain. It should be designed in such a way that induces coordination through appropriate provisions for information and incentives such that supply chain performance will be optimised. As a variety of uncontrollable and unpredictable factors affect the evaluation and decision-making process at different levels, identification of the most appropriate contract is usually very complex and unstructured. In the literature, several methods have been portrayed for optimising contracts. Sometimes, managers fail to apply the model as most of the existing methods are highly mathematical models and managers lack appropriate depth for using it. This research has aimed to address the following questions:

- Which are the prominent selection criteria for supply chain contract evaluation process that influence the supply chain performance?
- What is the prioritisation of these criteria?
- Which supply chain contract is the best one?

To address the above research questions, this study has the following objectives:

- To identify criteria affecting supply chain contract selection in the context of retail store supershop of Bangladesh.
- To sort out different supply chain contracts applying Delphi method.
- To prioritise those with the help of AHP approach.

The current research has proposed a framework to identify different supply chain contracts in the context of superstore business in Bangladesh and to rank them. The proposed approach in this paper is very realistic and user-friendly technique for the managers. To select the possible criteria for the contract selection process, the Delphi method was suggested. This activity helps to reduce biases in the decision-making process and provides better result through the aggregation of expert's opinion. To determine the relative priorities of the selected criteria, the AHP algorithm was used which explore performance-based

individual numerical scale and prioritisation method. Finally, different types of supply chain contracts were evaluated using AHP. The study found out that '*quantity flexibility contract*' among several alternatives the best contract for the product line of powdered milk, although '*buyback contract*' is the most used contract. The study recommends the superstore's management to find out factors affecting contracts and use the best one that curtails procurement cost through proper implementation of the proposed model. Through applying the most appropriate contracts, there is a chance to improve coordination of all stages as well as maximise their profit.

Limitations of the Research

The work has some limitations, which can be described as follows:

- In this study, only six criteria were considered for selecting the best supply chain contract.
- Delphi-based AHP approach was used to rank the contracts, which is dependent on human judgements.
- Feedbacks were collected from four groups (each group contains 10 experts). This might not reveal the real picture of the business.
- The proposed methodology was applied in a superstore which may not be applicable to other company.

The limitations can provide a new way for future research.

Direction of Future Research

- In future, more selection criteria of supply chain contract evaluation can be considered.
- The evaluation process can be assessed using other MCDM techniques like VIKOR, PROMETHEE, MOORA; TOPSIS; ORESTE, SAW, etc.
- They may be assessed considering uncertainty using fuzzy AHP, fuzzy VIKOR and fuzzy DEMATEL approach.

APPENDIX A

Table A1: Weight Calculation of Criteria at Level 1

	Flexibility	Demand Fluctuation	Uncertainty	Excess Inventory	Information Distortion	Responsive-Ness	Weight
Flexibility	1	2	2	4	7	7	0.37
Demand fluctuation	0.5	1	1	3	5	6	0.23
Uncertainty	0.5	1	1	2	3	5	0.19
Excess inventory	0.25	0.33	0.5	4	4	5	0.13
Information distortion	0.14	0.33	0.33	0.25	1	1	0.05
Responsiveness	0.14	0.12	0.2	0.2	1	1	0.04

Consistency ratio = 0.02 < 0.10

Table A2: Weight Calculation of Contract Evaluation Criteria for Demand Fluctuation (Under AHP)

	Buyback	Quantity Flexibility	Quantity Discount	Revenue Sharing	Normalised Weight
Buyback	1	2	4	5	0.49
Quantity flexibility	0.5	1	3	4	0.31
Quantity discount	0.25	0.33	1	2	0.13
Revenue sharing	0.2	0.25	0.5	1	0.08

Consistency ratio = 0.02 < 0.10

Table A3: Weight Calculation of Contract Evaluation Criteria for Uncertainty (Under AHP)

	Buyback	Quantity Flexibility	Quantity Discount	Revenue Sharing	Normalised Weight
Buyback	1.00	1.00	3.00	4.00	0.39
Quantity flexibility	1.00	1.00	3.00	4.00	0.39
Quantity discount	0.33	0.33	1.00	2.00	0.14
Revenue sharing	0.25	0.25	0.50	1.00	0.09

Consistency ratio = 0.008 < 0.10

Table A4: Weight Calculation of Contract Evaluation Criteria for Excess Inventory (Under AHP)

	Buyback	Quantity Flexibility	Quantity Discount	Revenue Sharing	Normalised Weight
Buyback	1.00	0.25	4.00	2.00	0.22
Quantity flexibility	4.00	1.00	7.00	4.00	0.59
Quantity discount	0.25	0.14	1.00	0.50	0.07
Revenue sharing	0.50	0.25	2.00	1.00	0.13

Consistency ratio = 0.02 < 0.10

Table A5: Weight Calculation of Contract Evaluation Criteria for Information Distortion (Under AHP)

	Buyback	Quantity Flexibility	Quantity Discount	Revenue Sharing	Normalised Weight
Buyback	1.00	0.50	3.00	2.00	0.28
Quantity flexibility	2.00	1.00	4.00	3.00	0.47
Quantity discount	0.33	0.25	1.00	0.50	0.10
Revenue sharing	0.50	0.33	2.00	1.00	0.16

Consistency ratio = 0.01 < 0.10

Table A6: Weight Calculation of Contract Evaluation Criteria for Responsiveness (Under AHP)

	Buyback	Quantity Flexibility	Quantity Discount	Revenue Sharing	Normalised Weight
Buyback	1.00	4.00	3.00	2.00	0.45
Quantity flexibility	0.25	1.00	0.50	0.25	0.09
Quantity discount	0.33	2.00	1.00	0.33	0.14
Revenue sharing	0.50	4.00	3.00	1.00	0.32

Consistency ratio = 0.01 < 0.10

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