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Implementing SWOT-FTOPSIS Methods for Selection of the Best Strategy: Pharmaceutical Industry in Bangladesh

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Pharmaceutical industry in Bangladesh is one of the most developing industrial sectors. As a promising sector, pharmaceutical industry needs some empirical studies for its future development. In this research work, it is tried to analyze the current condition of the pharmaceutical sector and selects different strategies that are necessary for the development of this sector. The SWOT analysis is done to find out the strength, weakness, opportunity and threat (four factors) of the pharmaceutical sector; that may affect strategic planning and decision-making. Then four sub factors are selected for each of the four factors. These sub factors are used to form the SWOT matrix which gives four strategies such as SO (strengths-opportunities) strategies, WO (weaknesses-opportunities) strategies, ST (strengths-threats) strategies and WT (weaknesses-threats) strategies. After this, fuzzy TOPSIS method is implemented to find out the best strategy. According to the concept of the fuzzy TOPSIS in multiple-criteria group decision making (MCGDM) problem, an index of closeness coefficient (CC) is defined to determine the ranking order of all strategies by calculating the distance to the both fuzzy positive ideal solution and fuzzy negative ideal solution. It is found that WO (weaknesses-opportunities) strategy possess the higher closeness coefficient which makes it most appropriate strategy for the pharmaceutical industry in Bangladesh.

Keywords: SWOT, fuzzy TOPSIS, Pharmaceutical sector, Strategy.

Field of Research: Industrial Engineering

1. Introduction

Pharmaceutical is the core of healthcare sector and serves as one of the most important manufacturing industry. The industry is the second highest contributor to the national exchequer after garments, and it is the largest white-collar intensive employment sector of the country. There are about 300 companies in this sector and the approximate total market size is about 1.19 billion US dollars per year of which about 98% of the total requirement of medicines is created by the local companies and the rest 2% is imported. Presently, the industry exports to more than 80 countries. The industry has been experiencing robust growth over the last few years. A local industry supporting drug policy and effective regulatory framework, along with TRIPS (Trade Related Intellectual Property Rights) relaxations are the key reasons for success of the industry.

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While the industry is achieving self-sufficiency, it yet procures 70% of raw materials from abroad. The growth rate of pharmaceutical sector is 8 percent per year which is a good indicator of the continuous development of this sector. As a promising sector for a developing country like Bangladesh, pharmaceutical industry is one of the key issues of the country. This study aims to identify the potential of pharmaceutical sector of Bangladesh, strategize pharmaceutical industry development, determining the best strategy for prioritized in the decision making process. The process of developing a policy strategy selection of pharmaceutical sector is the most appropriate to use a combination of methods SWOT - FTOPSIS. SWOT analysis is used to capture the perceptions of an expert assessment of the internal and external factors of pharmaceutical sector, which in turn obtained the power factor, factor weaknesses, opportunities factors, the threat factor. Assessment of the weight of IFAS (Internal Factor Analysis System) and EFAS (External Factor Analysis System) obtained some alternative strategies that can be used in the development of pharmaceutical sector of Bangladesh. Having obtained some alternative strategies, it is necessary to priority under the selection criteria set. This prioritization needs to be done as to make the whole strategy that has been obtained through the SWOT analysis will require enormous resources, and not all of them can be accommodated by the Government. To perform the selection of strategic priorities, then used the approach of Fuzzy Technique for Order Preference by Similarity to Ideal Solution (FTOPSIS) based on consideration of 4 (four) criteria, 16 (sixteen) sub criteria and 4 (four) alternatives. In previous research work, only conventional SWOT analysis is done to determine the strategy for pharmaceutical sector of Bangladesh which does not provide an analytical means to determine the relative importance of the factors, or the ability to assess the appropriateness of decision alternatives. In this study, SWOT analysis is performed using Fuzzy TOPSIS, which allows finding the best alternative among possible strategic alternatives in uncertain environment. In this work, the relative weight of every criterion is calculated and four strategies are ranked accordingly considering uncertainty.

The paper is organized as follows; after the introduction section a detailed review on the different literature is provided in Section 2, Section 3 outlines research methodologies and theoretical background. Data calculation and result analysis are provided in section 4. Section 5 focuses on conclusion.

2. Literature Review

SWOT analysis is a tool that can be used in an organization's strategic planning process for environmental scanning. SWOT analysis was popularized by Andrews (1965) who combined the ideas of Peter Drucker, Philip Selznick and Alfred Chandler. SWOT matrix provides a framework for identifying and formulating strategies. TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), was proposed by Hwang and Yoon (1981). The basic principle of TOPSIS is that, chosen alternatives should have the shortest distance from the ideal solution and the farthest distance from the negative-ideal solution. FTOPSIS is TOPSIS extended to fuzzy environment. Osita et al. (2014) worked on the role of SWOT analysis an acronym for strength, weakness, opportunities and threat and on the actual meaning and what the acronym stands for and its evaluation in two private schools. Hoq et al. (2013) discussed of a study on SWOT analysis of pharmaceutical industry for

the Bangladesh context. Liu (2010) discussed an analysis on the international competitiveness of China's traditional medicine industry based on the SWOT model. A SWOT Study of the Development Strategy of Haier Group was discussed by Chan (2011). George and Pramodm (2013) researched on SWOT analysis of steel re rolling mills and make a comparative analysis of a local brand with an international brand. Markovska (2009) worked on the SWOT analyses of the national energy sector for sustainable energy development. Shariatmadari (2013) researched on using of SWOT analysis and SEM to prioritize strategies in Foreign exchange market and Ayub and Razzaq (2013) has done their research work on evaluating SWOT analysis as the mediator in strategic marketing planning through marketing intelligence. Vaidyanathan and Sabbaghi (2011) worked on taxonomy of multiple levels of SWOT analysis in project management. Awais and Samin (2012) researched on advanced SWOT Analysis of E-commerce. This research paper describes the invention and accessibility of internet connectivity and powerful online tools has resulted a new commerce era. Mirzakhani et al. (2014) worked Strategy formulation with SWOT matrix as a case study of an Iranian company. The aim of this paper is to examine the use of the strategic management tool strengths, weaknesses, opportunities and threats of P.S. Taha company. Farhangi et al. (2012) developed a SWOT matrix for strategic planning in media organizations. Jeyaraj et al. (2012) applied the SWOT and Principal Component Analysis in a Textile Company. This article seeks to identify the SWOT variables to make better strategic planning through empirical study. Gorener et al. (2012) described the application of combined SWOT and AHP which was applied in a manufacturing firm. Chaghooshi (2011) worked on Integration of FPM, fuzzy AHP and ANP Methods in formulation of software industry strategy. Alptekin (2013) described the integration of SWOT analysis and TOPSIS method in strategic decision making process. In this study, SWOT analysis is performed using TOPSIS (the Technique for Order Preference by Similarity to Ideal Solution), which allows to find the best alternative among possible strategic alternatives. Hatami-Marbini and Saati (2009) worked on application of fuzzy TOPSIS method in an SWOT analysis. This paper represents the most closeness coefficient of SWOT matrix.

Ghorbani et al. (2011) researched on using of fuzzy TOPSIS to determine strategy priorities by SWOT analysis. Tahernejad et al. (2012) worked on Selection of the best strategy for Iran's quarries by SWOT-FAHP method. The purpose of this study is to evaluate and determine the best strategies for Iran's quarries. Lumaksono (2014) worked on the implementation of SWOT-FAHP method to determine the best strategy on development of traditional shipyard in Sumenep. Hashemi worked on formulating and choosing strategies using SWOT analysis and QSPM matrix as a case study of Hamadan Glass Company. In this paper, the process of formulating strategic planning is presented for this company and the way the proposed strategies are provided. Yuksel and Dagdeviren (2007) have done their research work on the using of analytic network process (ANP) in a SWOT analysis in the case of textile industry. Sevklia et al (2012) worked on the development of a fuzzy ANP based SWOT analysis for the airline industry in Turkey. This paper SWOT analysis is done to create a suitable strategy for different sector and multi criteria decision making technique is used with it to broad the result find from SWOT analysis. In literature review, some papers used fuzzy environment to consider the uncertain condition. TOPSIS is used in many papers for selection of different strategies and criteria. SWOT matrix is done in some paper to find the four strategies of SWOT factors. In this research paper, the SWOT analysis and SWOT matrix of pharmaceutical sector

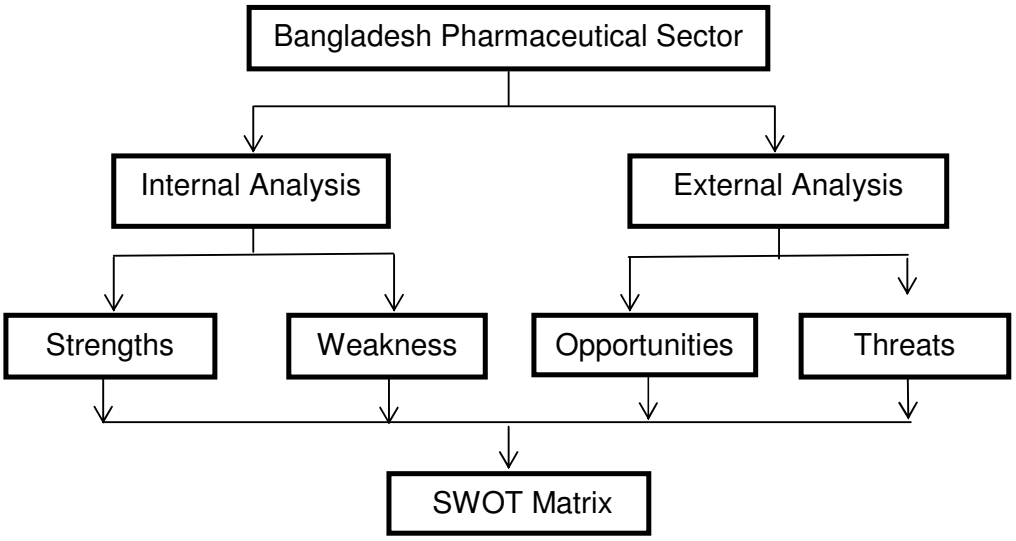
in Bangladesh is done and best strategy is select by fuzzy TOPSIS method under uncertain environment.

3. Research Methodology and Theoretical Background

3.1 SWOT Analysis

SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. SWOT analysis can be used in an organization's strategic planning process for environmental scanning and it can serve a dual function: it can be used for both internal and external environment scanning. The internal and external factors are referred to as strategic factors, and they are summarized within the SWOT analysis. Strengths and weaknesses constitute factors within the system that enable and hinder the organization from achieving its goal, respectively. Opportunities and threats were considered as external factors that facilitate and limit the organization in attaining its goals. SWOT analysis suggests the appropriate strategies in four categories SO, ST, WO and WT. The strategies identified as SO, involve making good use of opportunities by using the existing strengths. The ST is the strategies associated with using the strengths to remove or reduce the effects of threats. Similarly, the WO strategies seek to gain benefit from the opportunities presented by the external environmental factors by taking into account the weaknesses. The fourth and last is WT, in which the organization tries to reduce the effects of its threats by taking its weaknesses into account. Figure1 shows how SWOT analysis fits into Bangladesh pharmaceutical sector. The final goal of a strategic planning processis to develop and adopt a strategy resulting in a good fit between internal and external factors.

Figure1: SWOT Analysis Framework



3.2 Fuzzy Technique for Order Preference by Similarity to Ideal Solution (FTOPSIS)

In fuzzy TOPSIS, the fuzziness in the decision data and group decision-making process is considered. In addition, linguistic variables are used to assess the weights of all criteria and the performance ratings of each alternative strategy with respect to each criterion. The weighted normalized fuzzy decision matrix is constructed. In this approach, the distance values of each alternative from ideal and anti-ideal solutions are calculated by using concept of ranking fuzzy numbers. Finally, the closeness coefficients are defined to attain the ranking order of all alternative strategies. The various steps of fuzzy TOPSIS are presented as follows:

3.2.1 Assignment of Ratings to the Criteria and the Alternatives

Let us assume there are J possible candidates called A = {A1, A2,…, Aj} which are to evaluated against m criteria, C = {C1, C2,.., Cm}. The criteria weights are denoted by wi (i = 1, 2,…, m). The performance ratings of each decision maker Dk (k = 1, 2,…, K) for each alternative Aj (j = 1, 2,…, n) with respect to criteria Ci (i = 1, 2,…, m) are denoted by $\tilde{R}k = \tilde{x}ijk$ (i = 1, 2,…, m; j = 1, 2,…, n; k = 1, 2,…, K) with membership function $\mu\tilde{R}k(x)$.

3.2.2 Compute Aggregate Fuzzy Ratings for the Criteria and the Alternatives

If the fuzzy ratings of all decision makers are described as triangular fuzzy numbers $\tilde{R}k = (ak, bk, ck, dk)$, k = 1, 2,…, K, then the aggregated fuzzy rating is given by $\tilde{R} = (a, b, c, d)$, k = 1, 2,…, K,

Where, $a = \min_k\{a_k\}$, $b = \frac{1}{k}\sum_{k=1}^{k} b_k$, $c = \frac{1}{k}\sum_{k=1}^{k} c_k$, $d = \max_k\{d_k\}$.

If the fuzzy rating and importance weight of the kth decision maker are $\tilde{x}ijk = (aijk, bijk, cijk, dijk)$ and $\tilde{w}ijk = (wjk1, wjk2, wjk3, wjk4)$, i = 1, 2,…, m, j = 1, 2,…, n, respectively, then the aggregated fuzzy ratings ($\tilde{x}ij$) of alternatives with respect to each criterion are given by $\tilde{x}ij = (aij, bij, cij, dij)$ where,

$$aij = \min_k\{a_{ijk}\}, \quad bij = \frac{1}{k}\sum_{k=1}^{k} b_{ijk}, \quad cij = \frac{1}{k}\sum_{k=1}^{k} c_{ijk} \quad dij = \max_k\{d_{ijk}\}$$

The aggregated fuzzy weights ($\tilde{w}ij$) of each criterion are calculated as $\tilde{w}j = (wj1, wj2, wj3, wj3)$ where,

$$wj1 = \min_k\{w_{jk1}\}, \quad wj2 = \frac{1}{k}\sum_{k=1}^{k} w_{jk2}, \quad wj3 = \frac{1}{k}\sum_{k=1}^{k} w_{jk3}, \quad wj4 = \max_k\{w_{jk4}\}$$

3.2.3 Compute the Fuzzy Decision Matrix

The fuzzy decision matrix for the alternatives ($\tilde{D}$) and the criteria ($\tilde{W}$) is constructed as follows:

$$c_1 \quad c_2 \quad \cdots \quad c_n$$

$$\tilde{D}= \begin{matrix} A_1 \\ A_2 \\ A_3 \\ A_4 \end{matrix} \begin{bmatrix} X_{11} & X_{21} & \cdots\cdots & X_{1n} \\ X_{21} & X_{22} & \cdots\cdots & X_{1m} \\ \cdots & \cdots & & \cdots \\ X_{m1} & X_{m2} & \cdots\cdots & X_{mn} \end{bmatrix}$$

$\tilde{W}$ = ($\tilde{w}$1, $\tilde{w}$2,…, $\tilde{w}$n).

3.2.4 Normalize the Fuzzy Decision Matrix

The raw data are normalized using a linear scale transformation to bring the various criteria scales onto a comparable scale. The normalized fuzzy decision matrix $\tilde{R}$ is given by

$\tilde{R}$ = [$\tilde{r}$ij]mxn, i = 1, 2,…, m; j = 1, 2,…, n

Where, $\tilde{r}ij = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}, \frac{d_{ij}}{c_j^*}\right)$ and $c_j^* = \max_i c_{ij}$

3.2.5 Compute the Weighted Normalized Matrix

The weighted normalized matrix $\tilde{V}$ for criteria is computed by multiplying the weights ($\tilde{w}$j) of evaluation criteria with the normalized fuzzy decision matrix $\tilde{r}$ij:

V = [$\tilde{v}$ij] mxn, i = 1, 2,…, m; j = 1, 2,…, n where $\tilde{v}ij = \tilde{r}ij$ (.) $\tilde{w}$j

3.2.6 Compute the Fuzzy Ideal Solution (FPIS) and the Fuzzy Negative Ideal Solution (FNIS)

The FPIS and FNIS of the alternatives are computed as follows:

A*= ($\tilde{v}$*1, $\tilde{v}$*2,….,$\tilde{v}$*n) where v_j^*= maxi{vij3}, i = 1, 2,…, m; j = 1, 2,…, n

A$^-$ = ($\tilde{v}$1, $\tilde{v}$2,…, $\tilde{v}$n) where v_j^- = mini{vij1}, i = 1, 2,…, m; j = 1, 2,…, n.

3.2.7 Compute the Distance of Each Alternative from FPIS and FNIS

The distance (d*i, d$^-$ i) of each weighted alternative i = 1, 2,…, m from the FPIS and the FNIS is computed as follows:

$d_i^* = \sqrt{1/4[(S_i - A^*) + \cdots]}$, i = 1, 2,…, m ,

$d_i^- = \sqrt{1/4[(S_i - A^-) + \cdots]}$ i = 1, 2,…., m

Where dv ($\tilde{a}$, $\tilde{b}$) is the distance measurement between two fuzzy numbers $\tilde{a}$ and $\tilde{b}$.

3.2.8 Compute the Closeness Coefficient (CCi) of Each Alternative

The closeness coefficient CCi represents the distances to the fuzzy positive ideal solution (A*) and the fuzzy negative ideal solution (A^-) simultaneously. The closeness coefficient of each alternative is calculated as

$$CCi = \frac{d_i^-}{d_i^- + d_i^*}, \qquad i = 1, 2, \ldots, m$$

3.2.9 Rank the Alternatives

Rank the alternatives according to the closeness coefficient (CCi) in decreasing order and select the alternative with the highest closeness coefficient for final implementation. The best alternative is closest to the FPIS and farthest from the FNIS.

4. Data Calculation and Result Analysis

4.1 Implementing the SWOT- FTOPSIS Analysis for Pharmaceutical Sector

To implement the SWOT-FTOPSIS analysis for pharmaceutical sector in Bangladesh, first an external environment analysis is performed with the help of an expert team familiar with the pharmaceutical sector. In this way, external SWOT sub-factors (opportunities, threats) are identified. In addition, an internal analysis is performed to determine the internal sub-factors (strengths, weaknesses). Based on these analyses, the strategically important sub-factors can be determined. Alternative strategies based on the SWOT factors and sub-factors are developed using the SWOT matrix. Four alternative strategy groups exist in SWOT matrix which is shown in Table 1.

Table 1: SWOT Matrix with Factors and Sub-Factors for the Strategy Selection

Internal factor / External factor	**Strengths(S)** S1.Pharmaceutical industry possess skilled workforce. S2. Good reputation in the market. S3. Good growth rate. S4. Production cost of drugs is comparatively low in the world.	**Weakness(W)** W1. Non-availability of high technology. W2. Pharmaceutical sector has been marred by lack of product patent. W3. Time consuming decision making process. W4. Innovative effectiveness is low.
Opportunities (O) O1. Government support. O2. The constant growth of the number of people taking medication. O3. Expansion of export market. O4. Pharmaceuticals have a strong manufacturing base.	**SO Strategy:** Increasing growth rate and export market expansion.	**WO Strategy:** Need to develop the current technological process & increase time optimization.
Threats (T) T1. Threats from other low cost countries. T2. Industry Rivalry. T3. Prevalent of illegal and unlicensed drug stores. T4. Price Hike of Raw materials.	**ST Strategy:** Minimization of unlicensed drug stores and increasing skilled workforce.	**WT Strategy:** Increasing innovative system and maintain good business environment.

4.2 Numerical Illustration

The below criteria (C1, C2…….C16) have been sent to different pharmaceutical industry of Bangladesh. Different Decision maker (DM) confirms their decision based on their individual company. Different criteria (C1…C16) have been ranked with Very high (VH), High (H), and Medium (M) by the decision makers, shown in Table 2.

Table 2: Criteria Ranking For 16 Criteria

Criteria	DM1	DM2	DM3	DM4	Criteria	DM1	DM2	DM3	DM4
C1	VH	VH	VH	VH	C9	VH	H	MH	H
C2	H	VH	H	H	C10	H	H	H	H
C3	VH	VH	MH	VH	C11	VH	M	VH	H
C4	L	M	M	ML	C12	MH	MH	H	MH
C5	M	L	VL	L	C13	ML	L	L	ML
C6	L	L	VL	L	C14	L	L	ML	L
C7	VL	VL	L	VL	C15	L	VL	ML	VL
C8	L	VL	VL	L	C16	M	M	ML	M

The sixteen sub-factor of SWOT analysis and four strategies in SWOT matrix are done by surveying and collecting secondary data. The below criteria (VL, L, ML…..) are selected according to fuzzy TOPSIS method. The different weight of the criteria are used for criteria ranking and also used for further calculation for determining the required step is shown in Table 3.

Table 3: Linguistic Variable for the Importance Weight of the Criteria

	Linguistic Variable	Trapezoidal Fuzzy Number
1.	Very low(VL)	(0,0,0.1,0.2)
2.	Low (L)	(0.1,0.2,0.2,0.3)
3.	Medium low (ML)	(0.2,0.3,0.4,0.5)
4.	Medium (M)	(0.4,0.5,0.5,0.6)
5.	Medium high (MH)	(0.5,0.6,0.7,0.8)
6.	High (H)	(0,7,0.8,0.8,0.9)
7.	Very high (VH)	(0.8,0.9,0.9,1)

Linguistic variable for the consequence rating of Strategies are shown in Table 4.

Table 4: Linguistic Variable for the Consequence Rating of Strategies

	Linguistic Variable	Trapezoidal Fuzzy Number
1.	Very good(VG)	(0,0,1,2)
2.	Good (G)	(1,2,2,3)
3.	Medium good (MG)	(2,3,4,5)
4.	Fair (F)	(4,5,5,6)
5.	Medium poor (MP)	(5,6,7,8)
6.	Poor (P)	(7,8,8,9)
7.	Very poor (VP)	(8,9,9,10)

Based on the sixteen criteria (C1, C2, C3, …… and C16) and their alternative strategies SO, WO, ST and WT it is sent to different pharmaceutical industry of Bangladesh. Different Decision maker (DM) of different industries confirms their decision based on their individual company. Different criteria (C1…C16) and their alternative strategies (SO…WT) have been ranked with VH, H and M by decision maker which are shown in Table 5.

Table 5: Linguistic Assessment for the Four Alternatives Strategies

Criteria	Alternative strategies	DM1	DM2	DM3	DM4	Criteria	Alternative strategies	DM1	DM2	DM3	DM4
C1	SO	VG	VG	VG	VG	C9	SO	G	VG	G	VG
	ST	MP	P	VP	P		ST	P	P	MG	P
	WO	P	P	P	MP		WO	VP	P	P	P
	WT	VP	P	MP	P		WT	MP	P	VP	MP
C2	SO	MG	VG	G	G	C10	SO	G	G	VG	G
	ST	G	F	MG	F		ST	VP	P	P	P
	WO	VP	P	F	P		WO	P	P	VP	VP
	WT	P	VP	P	P		WT	P	P	MP	P
C3	SO	G	VG	VG	VG	C11	SO	VG	G	MG	VG
	ST	P	P	P	P		ST	P	P	VP	P
	WO	MP	P	VP	F		WO	VP	P	P	MP
	WT	P	VP	F	VP		WT	MP	P	VP	P
C4	SO	G	MG	G	G	C12	SO	MG	VG	VG	G
	ST	P	MP	MP	MP		ST	VP	P	MG	P
	WO	MP	P	VP	P		WO	P	P	P	P
	WT	P	P	P	P		WT	F	P	MP	F
C5	SO	MP	P	VP	P	C13	SO	F	P	P	MP
	ST	P	P	P	P		ST	P	P	MP	P
	WO	MP	P	MP	MP		WO	P	P	VP	P
	WT	P	VP	F	VP		WT	MP	P	P	P
C6	SO	P	P	P	P	C14	SO	MG	G	VG	G
	ST	VP	VP	MP	VP		ST	G	MG	MG	MG
	WO	MP	P	VP	P		WO	VP	P	F	VP
	WT	F	VP	MG	MP		WT	P	P	P	P
C7	SO	F	P	F	F	C15	SO	P	VP	G	P
	ST	VP	VP	P	VP		ST	F	P	F	P
	WO	MG	P	VP	P		WO	VP	P	P	P
	WT	P	VP	P	P		WT	MG	P	MP	MG
C8	SO	VP	P	P	VP	C16	SO	F	MG	G	MG
	ST	F	VP	VP	MP		ST	P	P	MG	P
	WO	P	P	MP	P		WO	VP	P	P	P
	WT	VP	VP	F	VP		WT	P	P	VP	MP

Aggregate fuzzy weights for criteria calculation according to fuzzy TOPSIS step is shown in Table 6.Here, 4 elements are used. According to fuzzy TOPSIS step, minimum of 1st element, average of 2nd & 3rd element, maximum of 4th element have been calculated by MATLAB software. Also compute the Aggregate fuzzy weights for alternatives.

Table 6: Aggregate Fuzzy Weights for Criteria

Criteria	DM1	DM2	DM3	DM4	Aggregate fuzzy weights
C1	(0.8,0.9,0.9,1)	(0.8,0.9,0.9,1)	(0.8,0.9,0.9,1)	(0.8,0.9,0.9,1)	(0.8,0.9,0.9,1)
C2	(0.7,0.8,0.8,0.9)	(0.8,0.9,0.9,1)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.7,0.83,0.83,1)
C3	(0.8,0.9,0.9,1)	(0.8,0.9,0.9,1)	(0.5,0.6,0.7,0.8)	(0.8,0.9,0.9,1)	(0.5,0.83,0.85,1)
C4	(0.1,0.2,0.2,0.3)	(0.4,0.5,0.5,0.6)	(0.4,0.5,0.5,0.6)	(0.2,0.3,0.4,0.5)	(0.1,0.38,0.4,0.6)
C5	(0.4,0.5,0.5,0.6)	(0.1,0.2,0.2,0.3)	(0,0,0.1,0.2)	(0.1,0.2,0.2,0.3)	(0,0.23,0.25,0.6)
C6	(0.1,0.2,0.2,0.3)	(0.1,0.2,0.2,0.3)	(0,0,0.1,0.2)	(0.1,0.2,0.2,0.3)	(0,0.15,0.18,0.3)
C7	(0,0,0.1,0.2)	(0,0,0.1,0.2)	(0.1,0.2,0.2,0.3)	(0,0,0.1,0.2)	(0,0.05,0.13,0.3)
C8	(0.1,0.2,0.2,0.3)	(0,0,0.1,0.2)	(0,0,0.1,0.2)	(0.1,0.2,0.2,0.3)	(0,0.1,0.15,0.3)
C9	(0.8,0.9,0.9,1)	(0.7,0.8,0.8,0.9)	(0.5,0.6,0.7,0.8)	(0.7,0.8,0.8,0.9)	(0.5,0.78,0.8,1)
C10	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)	(0.7,0.8,0.8,0.9)
C11	(0.8,0.9,0.9,1)	(0.4,0.5,0.5,0.6)	(0.8,0.9,0.9,1)	(0.7,0.8,0.8,0.9)	(0.4,0.78,0.78,1)
C12	(0.5,0.6,0.7,0.8)	(0.5,0.6,0.7,0.8)	(0.7,0.8,0.8,0.9)	(0.5,0.6,0.7,0.8)	(0.5,0.65,0.73,0.9)
C13	(0.2,0.3,0.4,0.5)	(0.1,0.2,0.2,0.3)	(0.1,0.2,0.2,0.3)	(0.2,0.3,0.4,0.5)	(0.1,0.25,0.3,0.5)
C14	(0.1,0.2,0.2,0.3)	(0.1,0.2,0.2,0.3)	(0.2,0.3,0.4,0.5)	(0.1,0.2,0.2,0.3)	(0.1,0.23,0.25,0.5)
C15	(0.1,0.2,0.2,0.3)	(0,0,0.1,0.2)	(0.2,0.3,0.4,0.5)	(0,0,0.1,0.2)	(0,0.13,0.2,0.5)
C16	(0.4,0.5,0.5,0.6)	(0.4,0.5,0.5,0.6)	(0.2,0.3,0.4,0.5)	(0.4,0.5,0.5,0.6)	(0.2,0.45,0.48,0.6)

After calculating aggregate fuzzy weights for alternatives, normalized fuzzy decision matrix for alternative strategies is calculated, shown in Table 7.

Table 7: Normalized Fuzzy Decision Matrix for Alternative Strategies

Criteria	C_J^*	Normalized ratings			
		SO	ST	WO	WT
C1	10	(0,0,0.1,0.2)	(0.5,0.78,0.8,1)	(0.5,0.75,0.78,0.9)	(0.5,0.78,0.8,1)
C2	10	(0,0.18,0.23,0.5)	(0.1,0.38,0.4,.6)	(0.4,0.75,0.75,1)	(0.7,0.83,0.83,1)
C3	10	(0,0.05,0.13,0.3)	(0.7,0.8,0.8,0.9)	(0.4,0.7,0.73,1)	(0.4,0.78,0.78,1)
C4	10	(0.1,0.23,0.25,0.5)	(0.5,0.65,0.73,0.9)	(0.5,0.78,0.8,1)	(0.7,0.8,0.8,0.9)
C5	10	(0.5,0.78,0.8,1)	(0.7,0.8,0.8,0.9)	(0.5,0.65,0.73,0.9)	(0.4,0.78,0.78,1)
C6	10	(0.7,0.8,0.8,0.9)	(0.5,0.83,0.85,1)	(0.5,0.78,0.8,1)	(0.2,0.58,0.63,1)
C7	10	(0.4,0.58,0.58,0.9)	(0.7,0.88,0.88,1)	(0.2,0.7,0.73,1)	(0.7,0.83,0.83,1)
C8	10	(0.7,0.85,0.85,1)	(0.4,0.73,0.75,1)	(0.5,0.75,0.78,0.9)	(0.4,0.8,0.8,1)
C9	10	(0,0.1,0.15,.3)	(0.2,0.68,0.7,0.9)	(0.7,0.83,0.83,1)	(0.5,0.73,0.78,1)
C10	10	(0,0.15,0.18,0.3)	(0.7,0.83,0.83,1)	(0.7,0.85,0.85,1)	(0.5,0.75,0.78,.9)
C11	10	(0,0.13,0.2,0.5)	(0.7,0.83,0.83,1)	(0.5,0.78,0.8,1)	(0.5,0.78,0.8,1)
C12	10	(0,0.13,0.2,0.5)	(0.2,0.7,0.73,1)	(0.7,0.8,0.8,0.9)	(0.4,0.6,0.63,0.9)
C13	10	(0.4,0.68,0.7,0.9)	(0.5,0.75,0.78,0.9)	(0.7,0.83,0.83,1)	(0.5,0.75,0.78,0.9)
C14	10	(0,0.18,0.23,0.5)	(0.1,0.28,0.35,0.5)	(0.4,0.78,0.78,1)	(0.7,0.8,0.8,0.9)
C15	10	(0.1,0.68,0.68,1)	(0.4,0.65,0.65,0.9)	(0.7,0.83,0.83,1)	(0.2,0.5,0.58,0.9)
C16	10	(0.1,0.33,0.38,0.6)	(0.2,0.68,0.7,0.9)	(0.7,0.83,0.83,1)	(0.5,0.78,0.8,1)

After calculating Weighted normalized alternatives, FPIS & FNIS; Distance d_v (S_i, A^*) & d_u (S_i, A^-) for alternatives is calculated which are shown in Table 8.

Table 8: Distance D_v (S_i, A*) & D_u (S_i, A^-) for Alternatives

Criteria	(d_v) SO, A^-	(d_v) ST, A^-	(d_v) WO, A^-	(d_v) WT, A^-	(d_v) SO, A*	(d_v) ST, A*	(d_v) WO, A*	(d_v) WT, A*
C1	0.11	0.74	0.69	0.74	0.92	0.36	0.38	0.36
C2	0.28	0.38	0.68	0.73	0.81	0.70	0.45	0.34
C3	0.16	0.68	0.66	0.69	0.89	0.40	0.49	0.47
C4	0.16	0.32	0.36	0.34	0.49	0.36	0.35	0.34
C5	0.33	0.30	0.29	0.33	0.42	0.42	0.43	0.42
C6	0.16	0.18	0.18	0.17	0.19	0.19	0.19	0.21
C7	0.14	0.16	0.16	0.16	0.23	0.22	0.23	0.22
C8	0.17	0.16	0.15	0.17	0.20	0.21	0.21	0.21
C9	0.17	0.59	0.70	0.67	0.88	0.56	0.41	0.47
C10	0.16	0.70	0.70	0.62	0.77	0.26	0.26	0.35
C11	0.27	0.69	0.67	0.67	0.83	0.44	0.48	0.48
C12	0.24	0.57	0.59	0.51	0.75	0.49	0.37	0.49
C13	0.23	0.24	0.27	0.24	0.32	0.31	0.29	0.29
C14	0.13	0.14	0.28	0.27	0.42	0.41	0.32	0.31
C15	0.26	0.24	0.27	0.24	0.37	0.37	0.36	0.38
C16	0.20	0.34	0.39	0.38	0.44	0.34	0.27	0.30

Table 9: Closeness Co-Efficient (Cc_i) of the Four Alternative Strategies

Distance	SO	ST	WO	WT	Ranking
d^-_i	3.16	6.41	7.04	6.89	WO>WT>ST>SO
d^*_i	8.97	6.05	5.5	5.66	
Cc_i	0.2604	0.5140	0.5617	0.5492	

From above calculation it is found that weakness-opportunity (WO) is the best strategy for pharmaceutical industries in Bangladesh. Fuzzy positive ideal solution is composed of the best performance values for each attribute whereas fuzzy negative ideal solution consists of worst performance values. Distance for negative & positive ideal solution has been shown. The closeness coefficient represents the distances to the fuzzy negative & positive ideal solution simultaneously. According to fuzzy TOPSIS method, for closeness coefficient the range is 0 to 1. From the calculation we can see that our highest closeness coefficient is 0.5617 (WO). It means that the value is so close to 1 and so farthest from 0. Closeness coefficient for strength opportunity strategy represents the value 0.2604. It means that the value is so close to 0 and so farthest from 1. Similarly other strategies (ST-WT) closeness coefficient has been determined.

5. Conclusion

This work addresses a novel SWOT analysis of Pharmaceutical sector in Bangladesh. There are four sub factors for each SWOT factors. Based on the research results best strategy of the pharmaceutical sector of Bangladesh is the weakness opportunities strategy and priorities obtained as follows: (i) Increasing weakness and reducing threats (WT = 0.5492), (ii) Optimizing strengths and maximize opportunities (SO = 0.2604), (iii) Optimizing the power to reduce the threat

(ST = 0.5140), (iv) reduces the weakness to increase opportunities (WO = 0.5617). For better development of pharmaceutical sector, the weakness-opportunity needs to develop. The researchers have made enough efforts to ensure finding the best strategy in pharmaceutical sector with some limitations. For simplicity less number of alternatives and decision makers are taken, here sixteen criteria and four decision makers are used to determine the strategy. Another limitation is that, this is a country specific study. In future research, more comprehensive studies can be conducted by dealing with the pharmaceutical sector of different countries.

References

Alptekin, N. 2013, 'Integration of SWOT Analysis and TOPSIS Method In Strategic Decision Making Process', *The Macrotheme Review,* Vol. 2, Issue. 7, Pp. 1-8.

Awais, M., and Samin, T. 2012, 'Advanced SWOT Analysis of E-Commerce', *International Journal of Computer Science*, Vol. 9, No 2, Pp. 569-574.

Ayub, A., and Razzaq, A. 2013, 'Evaluating SWOT analysis as the mediator in strategic marketing planning through marketing intelligence'*, European Journal of Business and Social Sciences,* Vol. 2, No. 1, Pp. 91-98.

Chan, X. 2011, 'A SWOT Study of the Development Strategy of Haier Group as One of the Most Successful Chinese Enterprises', *International Journal of Business and Social Science,* Vol. 2, No. 11, Pp. 147-153.

Chaghooshi A. J. 2011, 'Integration of FPM, fuzzy AHP and ANP Methods in Formulation of Software Industry Strategy (Case study: System Group Company)'*, Australian Journal of Basic and Applied Sciences*, Vol. 5, No. 9, Pp. 1232-1247.

Farhangi, A. A., Far, M. S., and Danaei, A. 2012, 'SWOT matrix for strategic planning in media organizations'*, Journal of Information and Control*, Vol. 8, No. 2, Pp. 338–353.

George, J.P., and Pramodm, V.R. 2013, 'SWOT analysis of steel re-rolling mills', *International Journal of Scientific and Research Publications*, Vol. 3, No. 12, Pp. 1-15.

Ghorbani, M., Velayati, R., and Ghorbani, M. M. 2011, 'Using Fuzzy TOPSIS to Determine Strategy Priorities by SWOT Analysis', *International Conference on Financial Management and Economics*, Hong Kong, 2-3 July, China, IPEDR, Pp. 135-139.

Gorener, A., Toker, K., and Ulucay, K. 2012, 'Application of combined SWOT and AHP in a manufacturing firm', *Journal of Mathematical Sciences*, Vol. 3, No. 2, Pp.176-195.

Hashemi, N. F. 2011 'Formulating and choosing strategies using SWOT analysis and QSPM matrix: a case study of Hamadan glass company', *Proceedings of the 41st International Conference on Computers & Industrial Engineering,* Computers and Industrial Engineering, Los Angeles, California, USA, Viewed 08 October 2015, <http://www.iust.ac.ir/files/ie/file_maghaleh_asatid/dr.mahdavi_/6.pdf>

Hatami-Marbini, A., and Saati, S. 2009, 'Application of fuzzy TOPSIS method in an SWOT analysis', *Journal of Mathematical Sciences*, Vol. 3, No. 2, Pp. 173-190.

Hoq, M. R., Ahsan, M. A., and Tabassum, T. A. 2013, 'A Study on SWOT Analysis of Pharmaceutical Industry: The Bangladesh Context', *Global Disclosure of* Economics *and Business*, Vol. 2, No. 2, Pp. 133-142.

Jeyaraj, K.L., Muralidharan, C., Senthilvelan, T., and Deshmukh, S.G., 2012, 'Application of SWOT and Principal Component Analysis in a Textile Company - A Case Study', *International Journal of Engineering Research and Development*, Vol. 1, No. 9, Pp.46-54.

Liu, Y., Xu, C., and Zhang, Y. 2010, 'An Analysis on the International Competitiveness of China's Traditional Medicine Industry Based on the SWOT Model', *International Journal of Business and Management*, Vol. 5, No. 7, Pp.225-229.

Lumaksono, H. 2014, 'Implementation of SWOT-FAHP Method To Determine The Best Strategy on Development of Traditional Shipyard in Sumenep', *Academic Research International*, Vol. 5, No. 5, Pp. 56-67.

Markovska, N., 2009, 'SWOT analyses of the national energy sector for sustainable energy development', *European Journal of Operational Research*, Vol. 74, Pp. 426 - 447.

Mirzakhani, M., Parsaamal, E., and Golza, A. 2014, 'Strategy Formulation with SWOT Matrix: A Case Study of an Iranian Company', *International Journal of Global Business and Management Research*, Vol. 6, No. 2, Pp. 150-167.

Osita, I. C., Onyebuchi, I. R., and Justina, N. 2014, 'Role of SWOT analysis an acronym for strength, weakness, opportunities and threat', *The Journal of the South African Institute of Mining and Metallurgy*, Vol. 105, No. 7, Pp. 507 – 514.

Shariatmadari, M. 2013, 'Using SWOT analysis and SEM to prioritize strategies in Foreign exchange market in Iran', *Procedia Social and Behavioral Sciences*, Vol. 99, Pp. 886 – 892.

Sevklia, M., Oztekin, A., and Delen, D. 2012, 'Development of a fuzzy ANP based SWOT analysis for the airline industry in Turkey', *Expert Systems with Applications: An International Journal,* Vol. 39, Issue. 1, Pp. 14-24.

Tahernejad, M.M., Ataei, M., and Khalokakaie, R. 2012, 'Selection of the best strategy for Iran's quarries: SWOT-FAHP method', *Journal of Mining & Environment*, Vol.3, No.1, Pp. 1-13.

Vaidyanathan, G., and Sabbaghi, A. 2011, 'Taxonomy of multiple levels of SWOT analysis in project management', *Issues in Information Systems*, Vol. 12, No. 1, Pp. 237-245.

Yuksel, I., and Dagdeviren, M. 2007, 'Analytic network process (ANP) in a SWOT analysis in the case of textile industry', *International Journal of Management Science*, Vol. 27, Pp. 661 – 677.