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SUPPLY CHAIN MANAGEMENT AND ANALYSIS OF PHARMACEUTICAL DISTRIBUTION MODELS IN PHARMACEUTICAL COMPANIES

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ABSTRACT

The pharmaceutical industry is defined as a set of processes, operations, and organizations involved in the discovery, creation, and production of drugs. Given the extent of the drug supply chain, this article focuses on supplier selection and what factors should be considered to select a supplier in a supply chain to reduce the risk involved in the supply chain. This study seeks to understand the factors affecting the drug supply chain in the country. This research is practical and developmental in terms of goal and it is descriptive in terms of performance. The data collection method uses interviews and questionnaires. The content validity was used to determine the validity and reliability of the questionnaire and the professors and experts were asked about the relation of question with topic and the visibility and clarity of the question. Cronbach's alpha gives reliability estimation higher than 0.7 using SPSS software. Data were analyzed by factor analysis of SPSS software. MADM algorithm was used with Fuzzy TOPSIS method for weighting the components. In this study, according to risk reduction strategies in supply chain and consulting of supply chain professors and experts and pharmacy, a checklist was obtained for supplier selection with eight main indexes and 30 sub-indexes in the field of selecting top supplier and four main indexes and 9 sub-indexes in the field of influential environmental risks. Finally, seven main indexes "quality, flexibility, delivery, technology, communication, and Information technology system, cost and background" with 24 sub-indexes on top supplier selection and four main indexes "economic, political, natural and cultural/social disasters" with 8 sub-indexes in the field of environmental risks were obtained. This research can be used by pharmaceutical industry activists, professors, researchers, and students to improve the current status of supplier selection.

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1. INTRODUCTION

Organizations were trying to take an effective step towards increasing their customers by standardizing and improving processes in order to increase competitiveness, in the '60s and '70s. In the '90s, these efforts continued with the development of human resources management strategies suppliers and logistics operations. (Ferazelle, 2001)

Continuously improving performance in a dynamic business has become a complex task for most suppliers, manufacturers, and retailers, that are seeking to compete and continue it. A complicated performance management system includes a wide range of management processes such as identification of criteria, defining Goals, planning, communication, monitoring, reporting, and feedback. Since the supply chain includes all of these, therefore, supply chain and its proper management are essential for the business.

Uncertainty in the supply chain affects the performance of the supply chain. Supply chain uncertainty comes from three sources:

- a) The uncertainty of supplier results from the supplier's inability in providing production unit need;
- b) The uncertainty of the process that results from the distrust of the production process and is due to the failure of the machinery;
- c) The uncertainty of demand results from the inability to accurately predicting demand.

To decrease the uncertainty, there is a missing link called risk management throughout the chain that enables us to act more confidently in the value chain for our own selection by identifying the risks involved in the chain, particularly in the suppliers' section. According to these cases, supply chain risk analysis is one of the main scientific issues of the present era.

The drug supply chain includes organizations with facilities, equipment, and activities that have activity in the production and presentation or service units. A typical drug supply chain includes the following components: primary manufacturing, secondary production, market warehouses/distribution centers, wholesalers, retailers/hospitals and patients (Shah, 2004).

Outsourcing organizations and companies are facing a variety of choice situations, during selecting an external source because of increasing the number of service providers outside of the main organization in recent years. Along with this issue, increasing commercial competitiveness and expanding global markets has been led to organizations focus more on optimizing their business processes across all aspects of competitiveness, which has also been included in the choice of suppliers. Outsourcing decision-makers, when they are selecting a supplier, try to select an option that can supply all needs of the outsourced process from among the volunteer resources (suppliers). (Razny, Jaafar et al., 2008)

Since supply chain risks are very widespread, this article seeks to identify the risks involved in the selection of drug suppliers through targeted research and present a model for selecting suppliers with a risk reduction approach. The following questions are raised in this regard:

What are the effective factors on the selection of suppliers in the pharmaceutical industry of the country?

What are the risks in the supply chain?

What is a suitable algorithm for decreasing the risks in the supply chain?

2. THEORETICAL FOUNDATIONS

2.1 SUPPLY CHAIN MANAGEMENT

Intensifying competition, since the 1990s, put companies under pressure to improve their performance in all aspects. On the other hand, increasing variables led to dedicating more resources to predict demand and supply to more strengthening of the supply chain.

Researchers believe that effective supply chain management empowers the performance of the organization strongly and also, is a valuable way to protect competitive advantage. (Childerhouse et al., 2003) Supply chain management as an integrated approach to the suitable management of materials and goods flow, information and money flow is capable of responding to these conditions. The supply chain of an integrated system is from related processes and in order to:

- 1) Accessing to needed materials and components
- 2) Converting primary materials into product
- 3) Products Valuation
- 4) Distributing products to customers
- 5) Simplifying the transfer of information between components of a chain (suppliers, manufacturers, distributors, intermediaries, retailers, and customers). (Shafizadeh, 2004)

2.2 RISK

The actions that produce profitable effects often include risks. Richie and Brandley define business risk as to the level of exposure to uncertainties that a company must understand and manages it effectively to access its business goals during implementing its strategies. (Ritchie and Brindley, 2007).

2.3 SUPPLY CHAIN RISK MANAGEMENT (SCRM)

(SCRM) is an important issue in supply chain management. The importance of this is related to increasing outsourcing strategy in factories, globalization of markets, increasing confidence in suppliers for specific capabilities and innovations, relying on the supply chain for competitive advantage and emergence of information technology that enables control and expansion of the supply chain. (Narasimhan, R., Tallur, S, 2009)

(SCRM) can be considered as a management strategy activity that affects the executive, marketing and financial performance of the factory. (Duncan, 1972)

As long as the outsourcing process is an important strategy in the factories, works continue on both identification and evaluation of risk and decreasing risk (methods and theories). (Narasimhan, R., Tallur, S., 2009)

Fizal et al., and Tang (2006) believe that nowadays, Supply chain effective risk management is a necessity for factories. Factors like Ericsson and Nokia have realized this for a long time. Primary researches, in any field, begin with identifying and introducing concepts and determining categories or classifications. Primary works about (SCRM) also followed this approach. Lee (2002) provided a framework based on supply chain risks and demand risks in a range of basic or innovative products for the first time. He also said that supply chain strategies need to connect to a correct and specific level of supply and demand risks. (Oke and Gopalakrishnan, 2009).

Supply chains are exposed to risks that increase in association with supply problems. (Kleindorfer, P.R., Saad, G.H., 2005). Supply chains are also exposed to distribution risks or risks with high impact and low possibility of occurrence or low impact and high possibility of occurrence.

These risks affect the organization extensively. (Chopra, S., Sodhi, M.S., 2004)

2.4 THE MAIN RISK FACTORS IN THE SUPPLY CHAIN

Micheli et al. (2008) studied the relationship between (SCRM) and suppliers' selection at the Polytechnic University of Milan. According to them, the risks in the supply chain can be divided into three categories: product risks, market risks, and suppliers' risks. Manuj & Mentzer (2008) classified supply chain risks based on many others' works.

Table 1: Supply Chain Risks.

| Risk | Definition |
|------------------------------|---|
| Financial | Change of currency rate |
| Transit time | Changes in transit time that includes transportation and discharge |
| Prediction | Error in estimating needs leading to a lack of inventory or excess inventory |
| Quality | Wrong, corrupted and unfinished products, components and materials in different places |
| Safety | Products that endanger the safety |
| Business disruption | Inability to produce products or sell to customers |
| Survival | The bankruptcy of the factory |
| Tool and inventory ownership | Arguing over inventory ownership; arguing over excessive use of device owned by another |
| Culture | Insufficient information about people, culture and language |
| Opportunism | Supplier or customer with opportunistic behavior |
| Oil price | Changes in oil price |

Zsidisin focused only on the supply risk in his article. He divided supply risk into two categories: supplier failures and market limitations. But motives of risk can result from three sources: the primary goods or material, the supplier and the whole supply market. (Zsidisin, 2003)

Christopher (2004) divides supply chain risks into five categories: supply risk, process risk, demand risk, control risk, and environmental risk:

Supply Risk: is the most important supply chain risk that it can be the source of other risks. When we pay for a product or service, we expose ourselves to this risk that the supplier will not deliver the order in a timely and accurate manner that is called the supply risk.

Process Risk: a product is not produced in a specific part in a timely manner with the required quantity and quality.

Demand Risk: There is no demand for a product or facing a lack of demand.

Risk control: a result from inadequate quality control.

Environmental Risk: The risk result from environmental effects that can arise from the physical, social, political, legal, operational and economic environment.

2.5 SUPPLY CHAIN MANAGEMENT IN THE PHARMACEUTICAL INDUSTRY

The pharmaceutical market is regulated by the nature of supply and demand for the drug in many countries. Given the competitiveness of the drug market, governments must balance economic and health benefits. (Hakonsen and Horn, 2009)

The pharmaceutical part plays an important role in the medical and health system. The pharmaceutical industry is rapidly expanding due to increasing the population and ages, the economy's rapid growth and increasing the prevalence of chronic diseases (such as cardiovascular diseases, cancer, and chronic respiratory diseases). (Wang et al., 2005)

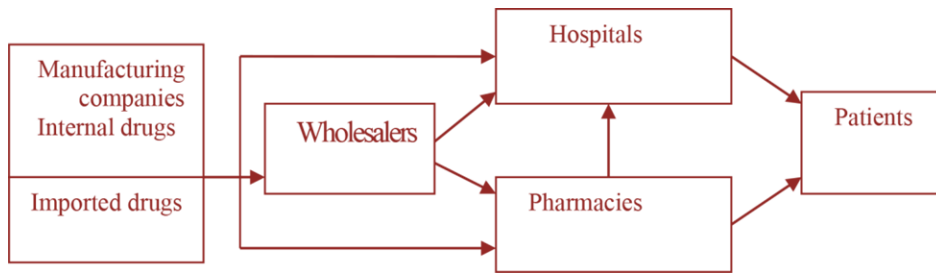


Figure 1: The supply chain of the drug.

Some of the problems that may arise in the transition from a planned economy to a strong supply chain in the pharmaceutical industry include:

Ineffective and no result supervision

A higher price for a drug equals more benefit for manufacturers

Violation and departure from approved and fixed prices

Lack of reliable pharmaceutical instruction (Yu X., Li a B., Shib Y., Yua M., 2010)

3. THEORETICAL FRAMEWORK OF RESEARCH

In order to manage risk in the supply chain, it is necessary to identify, evaluate and implement the necessary risks in all four areas of "supply, process, demand, and environment:"



Figure 2: Four areas of supply chain risk management.

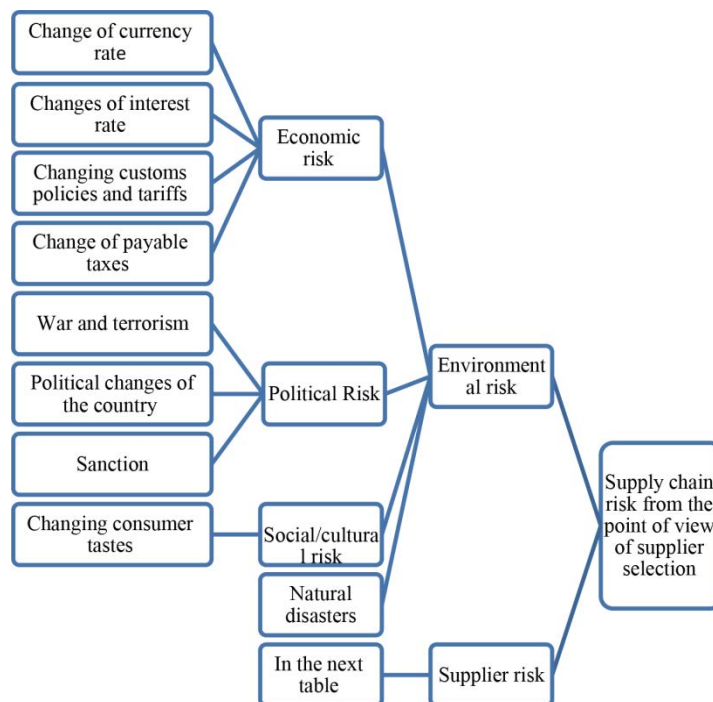


Figure 3: Effective factors in the supply chain risk management from an environmental risk point of view.

Considering the literature and the subject of risk management research in the area of "supplier

selection is pursued in the supply chain" and environmental risks affect all three parts of the supply chain including "supply risk", therefore, environmental risks management is also considered.

From the point of view of supplier selection, supply chain risk is divided into two distinct parts (Figure 4). The first is an environmental risk, which is divided into four sub-categories: "economic, political, cultural/social and natural disasters". The second part considers the factors influencing the selection of the top supplier, which consists of eight distinct areas: quality, environmental issues, flexibility, delivery, supplier technology, communication, and information technology systems, and product cost and supplier history.

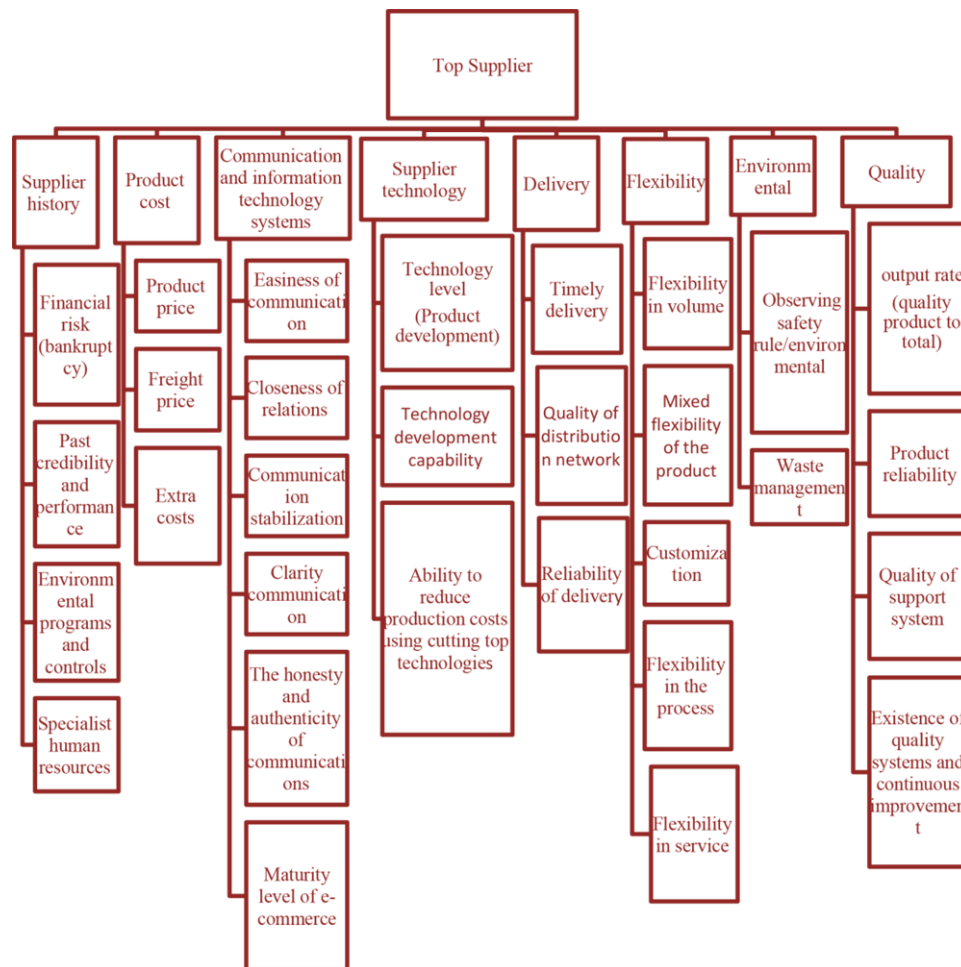


Figure 4: Effective factors in supply chain risk management from a supplier selection point of view.

4. RESEARCH METHOD

Since the present study seeks to understand the effective factors on the pharmaceutical supply chain of the country, the type of this research is practical in terms of goal and it is developmental from exploratory type developmental purpose and it is descriptive in terms of performance. The pharmaceutical industry is the statistical population in this study. In the sampling, the questionnaires are collected and evaluated from three major drug holdings of the country Drou Pakhsh, Alborz and Pars Darou. The reasons for choosing these three holdings as a statistical sample are as follows: There are four pharmaceutical holding in the country that manages more than 75% of the country's pharmaceutical industry, including the supply pharmaceutical group (TPICO), is consists of Daroupakhsh,Pars Darou group, Shafadarou group, Alborz group and HITT group. This study evaluates three groups of pharmaceuticals: Daroupakhsh, Pars Darou and Alborz, which include

about 65% of the country's pharmaceutical market share, which is a significant sample in the country's pharmaceutical industry. The market share of each of these groups in the production and distribution of drugs will be as follows.

Table 2: Market share of the holdings under study.

| Holding | Production market share | Distribution market share |
|--------------|-------------------------|---------------------------|
| Darou Pakhsh | 22.90 | 30.65 |
| Alborz | 15.86 | 21.47 |
| Parsdarou | 6.55 | 8.91 |

It should be noted that, since suppliers do not operate separately and independently and are a subsidiary or part of the producer companies, they do not have a separate market share. The sampling method is available sampling and our sampling is purposive/judgmental.

Considering the research literature and focusing on suppliers selection in the supply chain, effective factors were extracted from the articles on supplier selection in order to decrease risk and main Indexes and its subsections were categorized in consultation with professors and experts of supply and pharmacy chain as there are eight main indexes about supplier risk: quality, environmental issues, flexibility, delivery, technology, communication, and information technology systems, cost and history. Each of these indexes was divided into other sub-categories, in which 30 sub-indexes of question were evaluated totally. Environmental risks were also divided into four categories: economic, political, natural disasters and cultural/social issues, which were also evaluated by 9 sub-indexes of question. In the following, based on previous studies, a conceptual model was presented for risk management supplier selection in the supply chain and it was expressed as the final research model at the end.

In this study, content validity is used to determine the validity and reliability of the questionnaire, and the professors and experts are asked into two options about the relationship of the question with the topic and the clarity and transparency of the question. After making corrections and confirming the validity and reliability of the questionnaire, it will be used as a data collection tool. Cronbach's alpha coefficient was calculated 0.80 in the questionnaire of managers and experts in the pharmaceutical industry, Tables 3 and 4. Therefore, the questionnaire is valid because it is more than 0.7.

Table 3: Cronbach's alpha coefficient between indexes.

| Cronbach's alpha coefficient | Number of questions |
|------------------------------|---------------------|
| 0.806 | 39 |

Table 4: Cronbach's alpha coefficient between groups.

| Cronbach's alpha coefficient | Number of groups |
|------------------------------|------------------|
| 0.732 | 9 |

The MADM algorithm is used to prioritize the risks that considering the type of problem and the number of factors and other issues in this study, the Fuzzy TOPSIS technique is selected. In the risk management algorithm, there are four phases of identification, evaluation, control, and tracking. The potential risks in the supply chain and the sources of risks need to be identified, structured and documented in the supply chain risk identification which is the first phase. The classification of risks

identified at this point seems suitable. Then, the potential risks have to be evaluated in the supply chain risk evaluation phase. A suitable way is to draw the possibility and effect of risk sources on the risk map. The possibility of occurrence and its severity can be qualitative or quantitative. Based on this evaluation, the decision is made on how to deal with these risks. Supply chain risk control phase after evaluating and estimating and selecting, it is the action for controlling the risks and lastly, supply chain risk tracking phase evaluated implementation and effect of selected actions and enables the company to have a clear view of the status of supply chain risks at all times.

Table 5: Linguistic variables.

| | | |
|-----------|---|----------------|
| Very low | 1 | 0, 0.1, 0.2 |
| Low | 2 | 0.1, 0.25, 0.4 |
| Medium | 3 | 0.3, 0.5, 0.7 |
| Very | 4 | 0.6, 0.75, 0.9 |
| Very much | 5 | 0.8, 0.9, 1.0 |

Table 6: Prioritization of supplier risks based on the Fuzzy Topsis technique.

| Question | Subgroup | Ci |
|--|--|-------|
| 12-Just in time delivery | Delivery | 0.140 |
| 23-Low price of the product compared to supplier competitors | Cost | 0.158 |
| 14-Reliability of delivery (No interruption of the product at once) | Delivery | 0.169 |
| 5-Having valid GMP certificates | Quality | 0.185 |
| 1-Having a high output rate of the product received from the supplier | Quality | 0.207 |
| 25-Decreasing extra costs compared to supplier competitors | Cost | 0.215 |
| 27-Having positive performance and positive credit in work history | History | 0.227 |
| 21-Clear and honest communications with each other (Mutual trust) | Communicational and information technology systems | 0.237 |
| 18-Easiness of communication with each other | Communicational and information technology systems | 0.248 |
| 2-The suitable quality of the supplier's support system | Quality | 0.248 |
| 24-Decreasing freight price compared to supplier competitors | Cost | 0.262 |
| 13-Quality of the distribution network (correct transportation) of supplier | Delivery | 0.284 |
| 10-Customization | Flexibility | 0.306 |
| 29-Specialist human resources | History | 0.329 |
| 3-Quality management systems and continuous improvement in the supplier factory | Quality | 0.339 |
| 4- Existence of sense and bilateral partnership | Quality | 0.344 |
| 11- Flexibility in service | Flexibility | 0.362 |
| 26- No bankruptcy (financial risk) in work history | History | 0.367 |
| 15- The level of technology (product development) in the supplier factory | Technology | 0.374 |
| 8- Flexibility in volume | Flexibility | 0.391 |
| 20- Relationships stability | Communicational and information technology systems | 0.397 |
| 17- Ability to decrease production costs using top technologies | Technology | 0.399 |
| 9- Flexibility in the variety of products and received primary materials | Flexibility | 0.414 |
| 19- Closeness of relationships with each other | Communicational and information technology systems | 0.452 |
| 22- The maturity level of IT e-commerce | Communicational and information technology systems | 0.490 |
| 6- Observing environmental standards in the supplier factory | Environmental | 0.498 |
| 28- Having programs to control environmental factors | History | 0.515 |
| 16- The ability to develop technology in the near future at the supplier factory | Technology | 0.533 |
| 7. Waste management in the supplier factory | Environmental | 0.567 |
| 30- Number of supplier agreements with multinational companies | History | 0.597 |

5. RESEARCH RESULT

The questionnaire components have been classified by the Fuzzy TOPSIS technique. Fuzzy theory is used in uncertainty conditions, mathematical model for ambiguous priorities. (Khavarpour et al., 2009). The questionnaire uses Likert with options as very high, high, medium, low and very low, which is assigned to very low number 1 and very high number 5. In order to use triangular Fuzzy numbers, based on the studies conducted on various articles linguistic numbers are used as see in Table 5 . All the questions have a positive aspect and the weight of all questionnaires is equal to 1. Table 6 shows the final results of the components in order of priority (the most important component to the least important component), with Consistency Index (Ci).

Table 7: Prioritization of environmental risks based on the Fuzzy TOPSIS technique.

| Question | Subgroup | Ci |
|---|---------------------|-------|
| 31-Change of currency rate | Environmental risks | 0.156 |
| 36- Sanctions | Environmental risks | 0.207 |
| 33- Changing customs policies and tariffs | Environmental risks | 0.254 |
| 32- Change of interest rate | Environmental risks | 0.326 |
| 35- Political changes in the country | Environmental risks | 0.329 |
| 37- War and terrorism | Environmental risks | 0.385 |
| 34- Change of paid tax | Environmental risks | 0.402 |
| 37- War and terrorism | Environmental risks | 0.493 |
| 39- Changing consumer's tastes | Environmental risks | 0.680 |

Table 8: Average priority of groups, respectively, in supplier selection.

| Group | Component | Ci average |
|--|--|------------|
| Delivery | 12-Timely delivery | 40.96% |
| | 13- Quality of the distribution network (correct transportation) of supplier | 83.09% |
| | 14-Reliability of delivery (No interruption of the product at once) | 49.44% |
| Cost | 23-Low price of the product compared to supplier competitors | 46.23% |
| | 24-Decreasing freight price compared to supplier competitors | 76.65% |
| | 25-Decreasing extra costs compared to supplier competitors | 62.90% |
| Quality | 1-Having a high output rate of the product/ primary material received from the supplier | 60.56% |
| | 2-The suitable quality of the supplier's support system | 72.56% |
| | 3-Existence of quality management systems and continuous improvement in the supplier factory | 99.18% |
| | 4- Existence of sense and bilateral partnership | 100.64% |
| | 5-Having valid GMP certificates | 54.13% |
| Communicational and information technology systems | 18-Easiness of communication with each other | 72.56% |
| | 19- Closeness of relationships with each other | 132.24% |
| | 20- Relationships stability | 116.15% |
| | 21-Clear and honest communications with each other (Mutual trust) | 69.34% |
| | 22- The maturity level of IT e-commerce | 143.36% |
| Flexibility | 10-Customization | 89.53% |
| | 11- Flexibility in service | 105.91% |
| | 8- Flexibility in volume | 114.39% |
| | 9- Flexibility in the variety of products and received primary materials | 121.12% |
| History | 26- No bankruptcy (financial risk) in work history | 107.37% |
| | 27-Having positive performance and positive credit in work history | 66.41% |
| | 28- Having programs to control environmental factors | 150.67% |
| | 29-Specialist human resources | 96.26% |
| | 30- The number of supplier agreements with multinational companies | 174.66% |
| Technology | 15- The level of technology (product development) in the supplier factory | 109.42% |
| | 16- The ability to develop technology in the near future at the supplier factory | 155.94% |
| | 17- Ability to decrease production costs using top technologies | 116.73% |
| Environmental | 6- Observing environmental standards in the supplier factory | 145.70% |
| | 7. Waste management in the supplier factory | 165.89% |
| Total | | 100% |

Due to the advantages achieved in the Fuzzy TOPSIS technique, data that are above the 20% average are eliminated. (The reason for the top 20% removal is the removal of the least important ones)

6. DISCUSSION

Answering the first question: What are the effective factors on the suppliers' selection in the country's pharmaceutical industry?

Answering the second question: What risks are there in the supply chain?

Table 9: The average priority of groups, respectively, in the environmental risks.

| Group | Component | Ci average |
|-------------------|---|------------|
| Economic | 31-Change of currency rate | 43.44% |
| | 33- Changing customs policies and tariffs | 70.73% |
| | 32- Change of interest rate | 90.78% |
| | 34- Change of paid tax | 111.94% |
| Political | 36- Sanctions | 57.64% |
| | 35- Political changes in the country | 91.62% |
| | 37- War and terrorism | 107.21% |
| Natural disasters | 37- War and terrorism | 137.28% |
| Cultural / Social | 39- Changing consumer's tastes | 189.36% |
| Total | | 100% |

As stated in the Ci averages Table 8, "the level of e-commerce maturity, having plans to control environmental factors, supplier agreements with multinationals companies, the ability to develop technology in the near future of supplier factory and overall environmental index, such as observing environmental standards and waste management at the supplier's factory, have less important in the selection of the supplier, according to the experts of the pharmaceutical industry in the country, and it is better to be removed from the top supplier selection indexes in the country's pharmaceutical industry.

According to the Ci averages Table 9 in the environmental risks, "changing consumer tastes" has no effect on the country's pharmaceutical industry, in other words, according to the expert of this industry, the consumer's attention in the pharmaceutical industry has low value for the management of environmental risks.

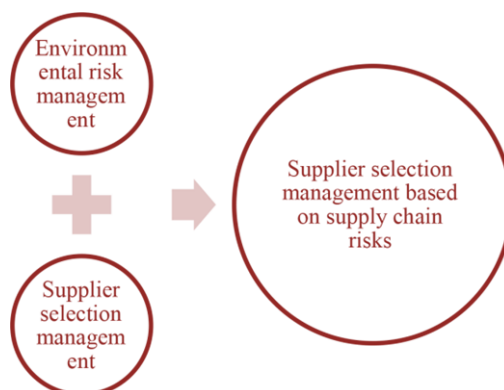


Figure 5: the final model of suppliers' selection management based on supply chain risks.

6.1 THE FINAL MODEL OF RESEARCH

The final model is presented based on these findings (Figures 5, 6).



Figure 6: The final model of environmental risk management in the supply chain.

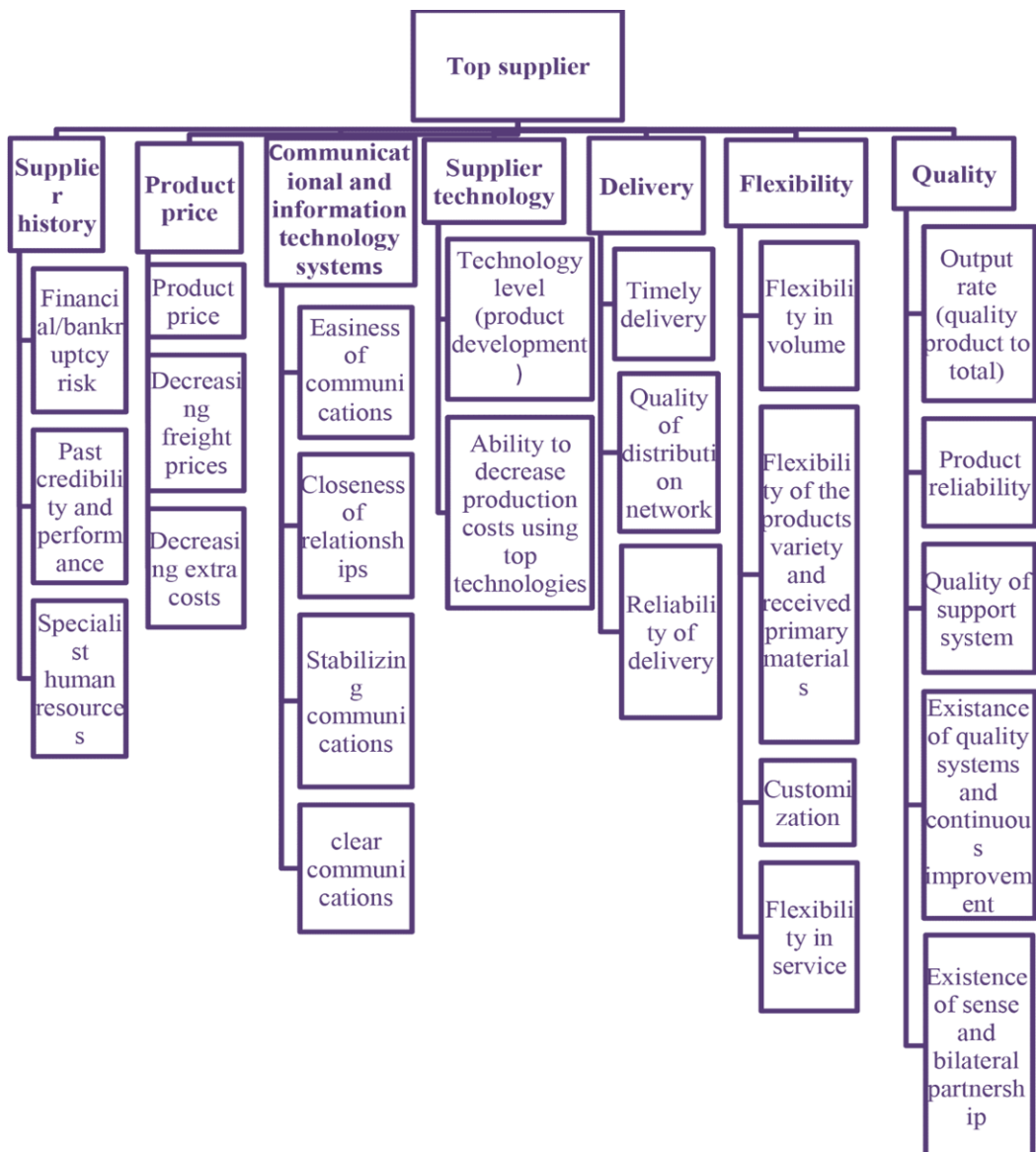


Figure 7: The final model of top supplier selection management.

According to the presented model of top supplier selection and environmental risks, the top supplier selection indexes should be used in order to manage supplier selection risk and the three

effective main indexes should be controlled on the supply chain environmental risks. Also, be controlled. So, suppliers are the top priorities who have plans to manage these risks.

Answering the third question: What is the suitable algorithm for decreasing the supply chain risks?

6.2 IDENTIFICATION PHASE

According to Chopra & Sodhi's (2004) theory, the main risks in the supply chain include inventory, capacity, receipt, something which are received, supplies, prediction, delay and disruption risks, *see* Table 10.

Table 10: Supply chain risks and its derivatives based on the article by Chopra & Sodhi (2004).

| Risk classification | Their derivatives |
|---------------------------------------|--|
| Disruptions | Natural disasters Workers argue Supplier bankruptcy War and terrorism |
| Delay | Use all supplier capacity No flexibility in the supplier Poor/low-quality product of the supplier Excessive displacement due to changes in transportation model |
| Prediction | False prediction due to long lead time, seasonality and variety of products, short life cycle, small customer base, "BULLWHIP EFFECT" or false information based on sales promotion, encouragers, lack of supply chain clarity and demand exaggeration in times of product shortages |
| Supplies, customers (Collection risk) | Currency rate risk Percentage of main elements and raw materials prepared from a supplier Using full capacity Long-term contracts versus short-term contracts |
| Something which received | The number of customers Financial ability of customers |
| Inventory | The rate of obsolescence of products Cost of inventory property Product value Supply and demand uncertainty |
| Capacity | Cost of capacity Flexible capacity |

6.3 EVALUATION PHASE

Evaluating risks in the supply chain, the area of action is determined after determining the possibility of occurrence (impossible, low, medium, high and very high) and the severity of the effect (ineffective, low, medium, severe, catastrophic), Figure 8. According to the risk evaluation, the risks are either within the safe range, or need to immediate action, or need continuous monitoring to increase the possibility of occurrence or the high number of events.

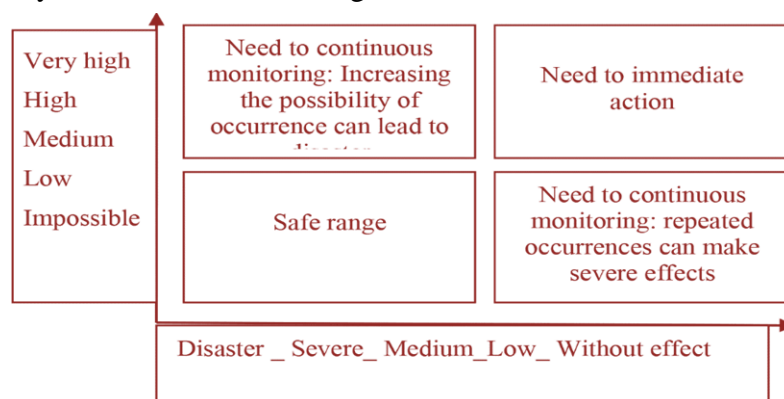


Figure 8: Matrix risk.

6.4 CONTROL PHASE

After the risk evaluation by the experts, it is time for the reductive approaches. To decrease each of the risks, Chopra & Sodhi (2004) presented approaches and expressed the effect of each of these reductive strategies on the different risks. (Chopra, S., Sodhi, M.S., 2004)

Table 11: Suitable strategies for risk reduction in the supply chain.

| Reduction approach | Suitable strategies |
|----------------------------------|--|
| Increasing capacity | Focus on the low-cost and decentralized capacity for predictable demand Creating a centralized capacity for unpredictable demand Increasing decentralization during reducing capacity costs |
| Using additional supplier | Paying more attention to high-number products compared with low-number products, focus on the excessive supply on low-number products with limited suppliers |
| Increasing speed in the reaction | Paying attention to the cost rather than the speed for interaction for consumable products Paying attention to the speed in the reaction rather than the cost for short-lived products |
| Increasing inventory | Decentralization in the inventory of predictable low-value products Focus on the inventory of high-value products with less predictability |
| Increasing flexibility | Preferring the cost rather than flexibility for high-number products and predictable Preferring flexibility for unpredictable low-number products Focus on flexibility in a few places if it is possible |
| Merging demand | Increasing merge during unpredictable grows. |
| Increasing capability | Preferring the ability over the cost for high-risk and high-value products Preferring the cost over the ability for low-value consumables products Focus on the high ability for flexible source if it is possible |

Linking to Table 11, Table 12 shows the effect of each of the strategies on the risks stated in terms of the effect of increasing or decreasing the risk, which, according to the factory's capabilities and expert opinions, is the best option to extract from the strategies. Control and prevention programs and measures will be adopted according to the selected strategy.

Table 12: Supply chain risk reduction strategies.

| Reduction strategies | Disruption | Delay | Prediction risk | Supplies risk | Risk of something which is received | Capacity risk | Inventory risk |
|------------------------------|------------|-------|-----------------|---------------|-------------------------------------|---------------|----------------|
| Increasing capacity | | ↓ | | ↓ | | ↑ | ↓ |
| Increasing inventory | ↓ | ↓ | | ↓ | | ↓ | ↑ |
| Alternative suppliers | ↓ | | | ↓ | | ↑ | |
| Increasing response speed | | ↓ | ↓ | | | | ↓ |
| Increasing flexibility | | ↓ | | ↓ | | ↓ | ↓ |
| Tensile or integrated demand | | ↓ | | | | ↓ | ↓ |
| Increasing ability | | ↓ | | | | | ↓ |
| Having more customers | | | | | ↓ | | |

| | | |
|-------|----------------------------|----------------------------|
| Note: | High decreasing the risk ↑ | High increasing the risk ↓ |
| | Decreasing the risk ↑ | Increasing the risk ↓ |

6.5 TRACKING PHASE

The supply chain risk tracking phase evaluates the implementation and effect of selected actions and enables the company to have a clear view of the supply chain risk situation at all times. This stage should not be neglected because, given today's dynamic business world, the risks that may be evaluated in the safe evaluation phase will become completely disruptive, after some time. Therefore, managers must continuously monitor their own internal and external conditions of the supply chain.

7. CONCLUSION

To decrease the risk of supplier selection in the supply chain, the following points should be considered. In supplier selection, priority is given to those who do delivery and cost indexes best so, they must deliver in a timely manner, their distribution network has the necessary qualifications, and not hanging up presenting the primary material/product suddenly. On the other hand, their finished price has lower quality than their competitors.

Having valid certifications, such as those from the Ministry of Health and GMP, etc. is also a priority for decision making, though it is necessary to obtain a Ministry of Health license for pharmaceutical ingredients. In the pharmaceutical industry, flexibility in the volume and service and variety of received products is of little use because pharmaceutical primary materials follow certain standards and conditions that are not desirable to the consumer under the circumstances.

Considering the desirable conditions of supplier selection, environmental risks should not be neglected. Accordingly, suppliers are the top choice to plan for economic-political risks. If a change of currency rate, sanctions, change of customs tariffs, and so on, be done without previous prediction can lead to disrupting presenting the product. The change of consumer tastes is not an invaluable factor in the pharmaceutical industry.

8. AVAILABILITY OF DATA AND MATERIAL

Data can be made available by contacting the corresponding authors.

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