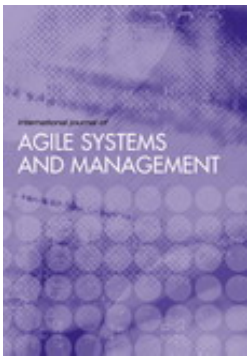

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Agility strategies in manufacturing companies using a hybrid MCDM based on ANP and TOPSIS

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Abstract: The goal of the present research is to investigate agility strategies in manufacturing companies using a hybrid model of multi-criteria decision making (MCDM) based on an analytical network process (ANP) and technique for order preference by similarity to ideal solution (TOPSIS). The statistical population of this study are experts of manufacturing firms located in Industrial Township. The questionnaires were used to indicate cross-relationships and ranking strategies. Ten experts were chosen to be studied. Regarding the findings using ANP, the scale of agility criteria related to the cooperation were chosen as the best criteria by experts of firms. Also, considering the viewpoints of experts, the sub-scale criteria of agility related to the knowledge of the individuals with the amount of 0.9994 obtained the first rank. Furthermore, the sub-criteria of agility related to the organisation with an amount of 0.4803, cooperation criteria amounting to 0.308, and product-relatedness criteria of agility with an amount of zero were ranked second, third, and fourth, respectively.

Keywords: strategies; product; cooperation; organisation; knowledge of individuals; MCDM; ANP; analytical network process; TOPSIS; technique for order preference by similarity to ideal solution.

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1 Introduction

The word agility means fast moving, agile, active, and the ability to move quickly and easily, and to be able to think fast and in a clever way. But in the current environment, agility means reacting effectively to a changing and unpredictable environment and using those changes as opportunities for organisational advancement. According to Sharifi and Zhang (1999) agility means the ability of any organisation to sense, perceive and predict changes in the workplace. Such an organisation must be able to recognise environmental changes and look at them as factors for growth and prosperity. Organisations should therefore not be afraid of and avoid changes in their work environment; rather, they should see change as an opportunity to gain a competitive advantage in a market environment.

The best way for organisations to survive and succeed in this turbulent market is to focus on organisational agility. Organisational agility is an informed and comprehensive response to the ever-changing needs of competitive markets and the success of the opportunities that the organisation acquires. Agility strategies are one of the best options to deal with the uncertainty of organisations. An organisation that is not agile will soon be out of the competition, because capable and highly adaptable organisations can respond to increasing changes in the environment.

Today organisations work in a competitive and dynamic environment and encounter several challenges (Hosseinzadeh et al., 2021). One of the most important challenges for the organisations in current markets is how to design, produce, and deliver the products and services required by the customers, meanwhile the production efficiency should be increased and operational costs must be reduced (Kalejahi et al., 2019). The organisations have developed a new approach called agility to fight against such business challenges. In fact, the complex environment and constantly changing context has made it inevitable to utilise creativity and innovation in organisations and jobs to increase competitiveness and to improve work conditions. Agility makes it possible for the organisations to prepare rapid, innovative, and creative responses to guarantee their survival Organisational agility is one of the best choices to fight against lack of assurance in organisations. Also, some organisational variables as empowering variables affect agility, in which, paying attention to the work structure and agility of human resources, should be considered. The

organisation which is not agile will be put aside from the competition soon because capable organisations with high compatibility can respond ever changing conditions in the environment. Agile organisations require informed and skillful personnel who are flexible, stimulated, and responsive towards changes. To achieve organisational agility, ignorance of human resources is critically erroneous because lack of agile human force is known as one of the most fundamental reasons of failure in organisations along with changes in the market and technology. In today's environment, every organisation must have the ability to simultaneously produce different and short-lived products, redesign products, change production methods and be able to react efficiently to changes to be called an agile organisation. Several models have been proposed and different studies have been carried out regarding organisational agility. Some of them are as follows: (Dove, 1999; Bottani, 2009; Arteta and Giachetti, 2004; Lin et al., 2006, Meredith and Francis, 2000). The paper proceeds as follows. In Section 1, the related literature on agility strategies in manufacturing companies reviewed. In Section 2, research methodology presented. In Section 3, the data analysis with ANP method they were given weights in order to determine agility strategies criteria ranking, TOPSIS method was used to rank agility strategies criteria and results provided and finally in Section 4, conclusion and suggestion of the study for future research clarified.

2 Literature review

The term agility means rapid movement, nimble, and being active in dictionaries and agility refers to the rapid and easy movement ability, and rapid thinking capability using a smart method. The concept of agility stems back from the flexibility in economics and was first proposed by a group of researchers in 1991 in Yacoca institution in Lee Hai University in order to explain methods that should be considered as the vital aspects of manufacturing processes. Agility refers to the successful recognition of the bases of competition, (speed, flexibility, innovation, quality, and profitability), coherence of resources and appropriate operations and rapid changes to provide products and services for any customer. Agility means the ability of each organisation to be sensitive, percept and predict current changes in business environment. Such an organisation should be able to recognise environmental changes and consider them as development and flourishment constituents (Sherehiy and Karwowski, 2016). Research has shown that organisations should permanently adjust themselves with changes in business environment and need factors such as speed, flexibility, responsiveness.

The goal of next generation manufacturing (NGM) project initiated in 1995 was to provide a framework for manufacturing companies in US to help them react rapidly against technology changes and to increase the global competitiveness. The process of NGM could be considered as a method to devise a novel strategy for manufacturing companies (through the integration of Michael Porter's competitiveness theories and based on resource-oriented theory focusing on fundamental merits). NGM process entails activities and suggestions for every single company and organisation and its' framework has been represented in the following figure. According to this model, the global stimulants were considered as factors to indicate pressures and challenges and formed the competitive environment in firms and NGM was utilised to recognise them. These stimulants were as follows: free and without charge access to the data, technologies with rapid changes, the presence of rapid technological changes, the existence of global

markets, global competition regarding salaries and wages and employment requirements, environmental responsiveness, and the increase of customer expectations regarding quality and services amount and products. Goldman et al. (1995) stated that agility refers to the integrative use of technologies and developed and well-known manufacturing approaches. In other words, agility has a reciprocal adjustment with top production, comprehensive quality management, materials requirement planning, reengineering of processes, and the production of capable staff. They believed that agile manufacturing accords with a complete range of flexible manufacturing technologies through lessons learnt from comprehensive quality management, in time production, and outstanding (experts) manufacturing approaches.

One of the most comprehensive models to reach agility is the model proposed by Sharifi and Zhang (1999). This model has been designed and proposed based on the literature and entails three major components: the first part is agility stimulants which in fact refer to those changes that occur within the business environment and can lead the firm to achieve novel opportunities and to gain competitive advantages. The second part refers to agility capabilities that provide the required power to respond the changes. The third part refer to agility providers which are in fact some tools through which we can achieve the required capabilities. Based on twenty agility criteria, Devadasan et al. (2007) concluded that agile production is a function of flexible production and an outstanding production system. They believed that the presence of numerous definitions for agile production in the related literature does not mean they differ because the major foundation of all is that agile production refers to the capability of manufacturing companies for rapid reactions due to the market requirements. Therefore, agile production welcomes the fundamental and critical changes in the system, managerial culture and styles present in traditional manufacturing environments. Ashrafia et al. (2019) stated the role of business analysis capabilities in agility reinforcement and firms' performance. Many of firms invest considerable resources to develop business analysis ability to improve their performance. Business analysis can affect performance in different ways. Kumar et al. (2018) analysed of factors creating ability in agile production. The goal of this paper is to do strategic selection and to focus on enabling agile production, agile manufacturing enablers (AMEs) to increase flexibility and agility. An analytic method has been proposed using analytic-interpretative modelling fuzzy cross-impact matrix multiplication applied to classification (FMICMAC) to analyse AMEs regarding the stimulant forces and their dependence. Chan et al. (2017) studied the effects of strategic and manufacturing flexibility and agility of supply chain on the performance of firms in fashion industry. Being responsive to the customers and markets is the basic requirement for all industries, specifically fashion industry. Walter (2021) provided a systematic literature review and conceptualisation about organisational agility. Atkinson et al. (2020) tried to investigate about attaining organisational agility through competitive intelligence: the roles of strategic flexibility and organisational innovation. Kumar et al. (2018) probed about analysis of agile manufacturing enablers: a case study. The aim of this research project is to strategically select and focus the right AMEs for agility enhancement.

2.1 Agility dimensions

Businesses are complicated phenomena that should be investigated systematically and agility is a complicated concept and to understand it, four different aspects were proposed

(Dove, 1999). Output (products are known as a comprehensive resolution to satisfy customers): the ability to manufacture a product does not identify a competitive capability. The reduction of machinery costs, access of product designers to powerful computerised designing tools, and the increases in global business has made the distribution of these products widespread and the manufacturers have been led to think of things beyond the products and to provide a distinctive combination of the product, information, and long-term services for each customer. Data (cooperation to increase competitiveness or the creation of virtual organisation): it is impossible to provide a complete resolution for each specific customer with the resources of a company. This specifically becomes true when the company focuses on its own major merit. Therefore, cooperation to create a resolution for customers seems necessary. In fact, the intended strategies are the internal and external cooperation and the goal is to supply the products to the market within the least possible time by levering resources through cooperation. External effective factors (change and lack of confidence): the most problematic factor that companies encounter is rapid and without stop change. Factors such as the reduction of product cycle, reduction of concept creation time till sales time, improvement in technology development rate, increase of business globalisation, increase of the condense electronic communications, and increase of the rapid population growth all help the change atmosphere. We can also consider the enforced external changes within the two parts as follows: – macro and historical social changes that cannot be affected by a business unit; -changes enforced by a rival company on a business unit. Internal operations (pyramid state effects of individuals and data): it refers to the capability of a company in more rapid reactions towards changes compared with other rivals. Of course, this could be done using provocation, individuals' entrepreneurship and organising permanently compatible teams. Meanwhile, the organisational structure permanently is reformed. In future, individuals and data would act as key departing agents. Thus, agility entails decentralising authority and leverage of human resource value and information. Such organisations are called knowledge-based organisations. Gligor et al. (2019), carried out a multidisciplinary literature review to identify the six major dimensions of agility, the ability to quickly change direction, speed/accelerate operations, scan the environment/anticipate, empower the customer/customise, adjust tactics and operations (flexibility), and integrate processes within and across firms.

2.2 Agility strategy

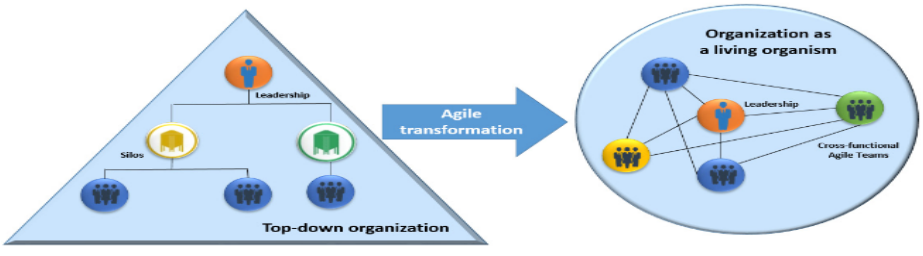
The term strategic agility refers to the ability to, dynamically, review or rediscover the company and its strategy considering changes in the business environment (Doz and Kosonen, 2008). Using a strategic orientation to choose the proper one among alternative strategies can be achieved through strategic agility and long-term strategies. Agility is directly related to human performance, processes and technologies of the organisation (Al-Azzam et al., 2017). As Doz and Kosonen (2010) have stated; the presence of three meta-skills (strategic sensitivity, leadership unity and resource fluidity) is due to strategic agility implementation and it will lead to more agile organisations. Furthermore, the requirement of strategic agility is that the predictions about the internal and external environment of the business, perceptions, flexibility and strategic sensitivity must be maintained more sensitively and without losing speed. It focuses towards the goal that to get information about the expected changes in the market, inter-company cooperation should be used. Strategic agility is knowledge-based and proactive, and this differentiates

it from reactivity-based production agility (Ojha, 2008). Some studies claim that through creating competitive advantage, strategic agility increases the firm performance. Kumkale (2016) presupposed that strategic agility is known a means of providing competitive advantage. She also stated that, to ensure strategic agility, the internal and external environments should constantly be examined, information should be gathered and used quickly, and there should be rapid responses to market changes. She indicated that when businesses become strategically agile, a competitive edge could be represented and this improves their performance. Ofoegbu and Akanbi (2012) and Yang and Liu (2012) concluded that strategic agility has an outstanding effect on business performance and to gain a competitive edge, it is a critical resource for businesses (Esmaeili et al., 2014; Kale et al., 2019).

2.3 The difference between traditional organisations and agile organisations

The so-called 'traditional' organisations are typically hierarchical, and static, where goals and decisions flow through the hierarchy, with leadership at the top of that hierarchy. These organisations work using linear planning and control. On the other hand, an agile organisation is a network of teams with a people-centered culture. This type of organisation is characterised by the existence of rapid cycles of learning and decision, enabled by technologies, guided by a strong common purpose to co-create value for all the stakeholders. Thus agile organisations, unlike traditional organisations, mobilise quickly. By analogy, and according to Aghina et al. (2015), an "agile organisation is a living organism" (Figure 1).

Figure 1 Traditional organisation vs. agile organisation (see online version for colours)



Source: Adapted from Aghina et al. (2015)

Ramesh and Devadasan (2007) believe that there is difference between traditional organisations and agile organisations regarding features such as structure, investment, quality, staff status, staff cooperation, management status, utilised information technology, and time management. They state that regarding organisational structure, traditional organisations use vertical and hierarchical structures, while agile organisations have flat and team-based structures. Unlike traditional organisations through which the staff cooperate a little, staffs' skills are very low, management is in the form of dictatorship and the manufacturing cycle is long term and inflexible, in agile organisations, staffs take part in organisational decision makings actively, staffs' skills are high, cooperative management dominates the organisation and manufacturing cycle of the products is shorter and flexible.

2.4 Factors causing organisation agility

Organisational agility capability causes are a set of basic factors that affect the internal parts of an organisation (Gunasekaran et al., 2008). In other words, organisation's internal factors create agility capabilities within organisations along with being affected by agility stimulants.

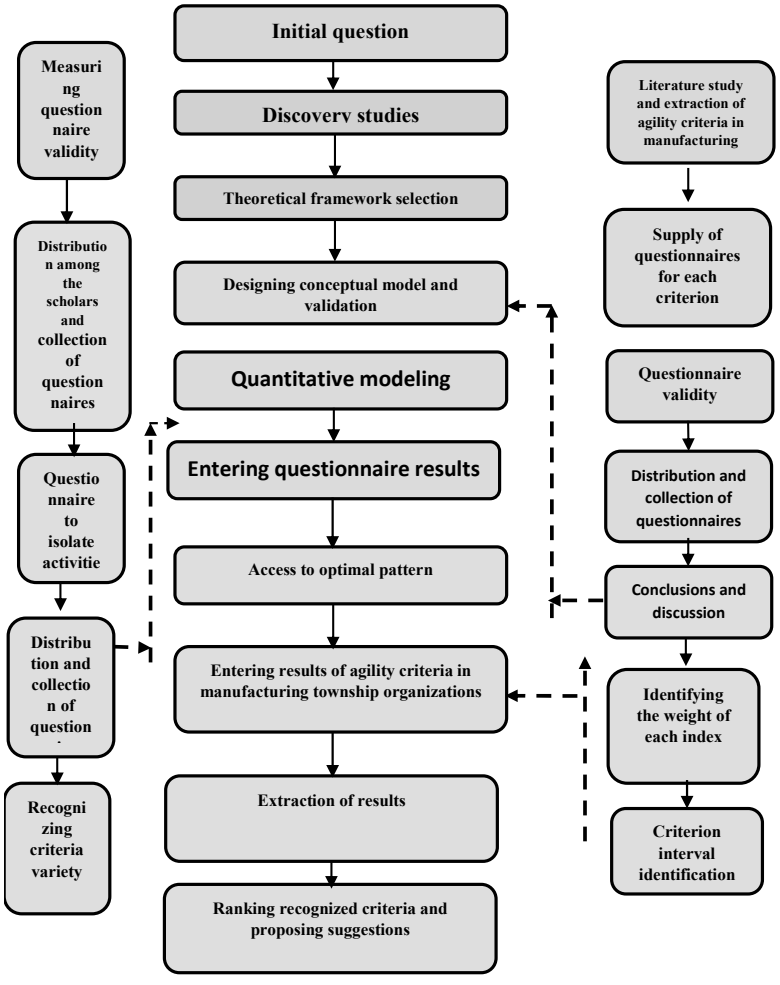
Agility is a result of being aware to change, as a whole (identification of opportunities and challenges) in both the internal and the external environment and with proper capabilities in the use of resources to meet these changes at the right time and flexible form relevant that organisation able to run it, is effectively (Braunscheidel and Suresh, 2009). The aim of agile organisation is to enrich and honouring customers, maintaining employees, survival and market share that basically have a set of capabilities to respond appropriately to changes occurred in the business environment. Kanani (2016) suggested analysis of factors affecting organisational agility. He also mentioned that organisations cannot have stable vital in society unless they accept changes and comply with internal and external changes. Agility is one new way to respond to organisational changing and development factors. Bathaei et al. (2021) investigated the evaluation of organisations agility using fuzzy analytical network process (ANP) and fuzzy Više Kriterijumska optimizacija i Kompromisno Rešenje (VIKOR) method in dairy companies. They also suggested that recently, most organisations forced to quit the competition, because they cannot compete with the environment, and they are not responsible to customers. Most of them forced to find a new strategy to reserve. In this research agile model designed by reliable research results and experts' recommendations whit using the fuzzy ANP which they were working on the respective companies. After finding proper factors, this research sort these companies from an agility point of view with using the fuzzy technique for order preference by similarity to ideal solution (TOPSIS). The results of this study showed the best factors that can help dairy companies' to be agile. Bathaei et al. (2019) studied the application of fuzzy ANP and VIKOR for the assessment of green agility critical success factors in dairy companies. They also suggested that manufacturing companies are facing rapid and unanticipated changes in their business environment. Most of these companies need to find new strategies to remain competitive in the market. Therefore, the main purpose of this study is to integrate the fuzzy ANP and VIKOR methods to evaluate the green agile factors and sub-factors in the dairy company. The results of this study showed that the most important green agility factors are: trust-based relationship with suppliers, flexible production capacity, versatile workers, compliance with quality standards for a new product, and workers' willingness to learn. To validate the results, this study used four methods, including TOPSIS, additive ratio assessment (ARAS) (Rostamzadeh et al., 2020), evaluation based on distance from average solution (EDAS), and multi-attributive border approximation area comparison (MABAC). Kumar and Singh (2019) presented a combined analytical hierarchy process (AHP) and TOPSIS approach for prioritising the attributes for successful implementation of agile manufacturing in Indian industry. They also suggested that the concept of agile manufacturing is becoming critically important to manufacturing industry due to rapid industrialisation, fluctuating customer demand, and turbulent business environment. The experts from different manufacturing industry have been asked to provide data for pairwise comparison of attributes. Afterward, an integrated AHP and TOPSIS approach is employed. The AHP is used to drive the priority weights of the attributes, and TOPSIS is used for prioritising the attributes. The result shows that Information technology,"

'human resource management-related issues', 'customer-related issues', 'leadership support', and 'organisational related-issues' have been ranked as the top five significant and contributing attributes, which can pave the path for top management to concentrate on the critical areas and allocate significant resources to ensure successful implementation of agile manufacturing.

3 Research method

First the administrative model of this research representing the steps fulfilled by the researcher has been proposed and regarding the research title, data collection has been explained. Then, the mathematical model designing algorithm has been represented. Also, based on the relationships between the variables, the conceptual model has been defined using math language. The tools to measure the optimal ranking pattern of agility criteria have been explained afterwards. The research framework presented in Figure 2.

Figure 2 Research framework



3.1 Research questions

In this research and due to the use of multiple criteria decision-making approaches to investigate about agility strategies in manufacturing firms located in Industrial Township in using an integrative mode, we have not provided any hypotheses. Therefore, the researcher does not propose any presupposition to be assessed through research administration process using statistical tests. Thus, the researcher has utilised several research questions as follows:

- How does agility related to the product affect the firms?
- How does agility related to the cooperation affect the firms?
- How does agility related to the organisation affect the firms?
- How does agility related to the individuals' knowledge affect the firms?

3.3 Data collection tools

In this research and regarding the nature of the issue, we have used questionnaires to collect data through field study and interviews with the experts. During the research period we have used two questionnaires as follows:

The first questionnaire was designed to identify agility strategies criteria after literature review of the criteria. Then, a researcher made questionnaire was utilised to determine their weight compared with each other and ranking was done using ANP method. Also, the researcher devised the second questionnaire to rank agility strategies through which the experts were asked to identify the amounts of each of agility strategy ranking criteria. This questionnaire was administered using a BT SOLVER TOPSIS method.

3.4 Statistical population

The statistical population of the present research includes all industry experts' ideas such as manufacturing managers, manufacturing planning managers, and industry engineers working in industrial firms located in Maragheh Industrial Township of East Azerbaijan, Iran. Based on Thomas Saaty idea, 10 experts were selected as our statistical population.

3.5 Data analysis methods and techniques

In analysing the collected data, an MADM approach and a network analysis process were used as the major data analysis methods. To do data analysis, the criteria were first identified through Super Decision V2.10 software and using an ANP method they were given weights in order to determine agility strategies criteria ranking. Also, to conclude the ideas of industry experts to couple comparison of each of the criteria in ANP method, a mathematical average was utilised and finally a BT TOPSIS SOLVER method was used to rank agility strategies criteria.

3.6 ANP method

ANP is a comprehensive decision-making technique through which the output follows the criterion. AHP is the starting point in ANP. Identifying the priorities are similar and fixed in both methods. In AHP it is used in the form of couple comparisons. ANP is comprised of four steps.

First step: hierarchical construction and problem structure

The problem structure in any hierarchy entails some levels as: goals, viewpoints, criteria, and choices. Hierarchy, goal comparison, levels of elements, and the relationship between elements could be identified through investigating the ideas of decision makers or brainstorming or other appropriate methods such as literature review.

Second step: determining criteria weight and viewpoints

In this step, the decision-making committee creates a series of couple comparisons related with the importance of criteria and viewpoints. In these comparisons, an index of 1–9 is utilised to

$$w_i = \frac{1}{\lambda_{max}} \sum_{i=1}^{n} a_{ij} w_j \quad 1, 2, \ldots n \tag{1}$$

λ_{max} : Largest value of special vector

a_{ij} : Pair of matrix comparison

$$CR = \frac{CI}{RI} \tag{2}$$

$$\text{CI = Compatibility Index} = \frac{\lambda_{max-n}}{n-1} \tag{3}$$

RI = Random Index

compare the viewpoint or criterion based on within group viewpoints. In this level, the weight of criteria and viewpoints is supplied using a specific super matrix vector and they will be used in super matrix. Saaty introduced compatibility rate (C.R.) through approving couple matric comparison. If the value of C.R ≤ 0.01, the compatibility of couple matrix comparison is acceptable.

Third step: the construction and resolution of super matrix

The concept of super matrix is similar to Markov's chain process. Criteria and viewpoints weights use the second step to calculate super matrix column.

$$W = \begin{bmatrix} W_{11} & W_{12} & \ldots & W_{1N} \\ W_{21} & W_{22} & & W_{2N} \\ & & & \\ W_{N1} & W_{N2} & & W_{NN} \end{bmatrix}$$

The ultimate preference for each element of each subgroup, according to the Saaty argument based on Markov processes, can be expressed through the following limit:

$$W_C = \lim_{l \to \infty} W^{2l+1} \tag{4}$$

In this case, the elements of the super matrix converge to a single value whose values in each row of the super matrix will be equal. In this way, the priority of the options of comparing and arranging w_c in each row is possible.

Finally, super matrix would be calculated through the multiplication of super matrix by itself until the time the values of super matrix rows converge with the similar value of each of matrix columns. We call this result a limited matrix.

Fourth step: the selection of the best option

Considering the limited matrix and weights of options regarding the criteria we can integrate the total weight of each option. Due to the priority of weights, we rank the option (Andrea Genovese et al., 2015).

3.7 TOPSIS method

In 1981, TOPSIS was proposed by Howang and Yoon and it was utilised to identify the ideal positive solution (A^*) and ideal negative solution (A^-) for decision making. The basis of TOPSIS is to select an option which should have the least distance with positive ideal solution and the largest distance with negative ideal solution. The calculation approach is as follows:

First step: calculating normalised decision matrix

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{5}$$

i is option index, j represents criterion selection, and x_{ij} is mean of the option i in the presence of criterion j.

Second step: calculating harmonic decision matrix (without an criteria)

The weights of criteria selection, $\omega = (\omega_1, \omega_2 ..., \omega_n)$, could be expressed through the multiplication of standard assessment matrix in the form below:

$$v = \begin{bmatrix} v_{11} & v_{12} & \dots & v_{1n} \\ v_{21} & v_{22} & \dots & v_{2n} \\ \vdots & \vdots & \dots & \vdots \\ v_{m1} & v_{m2} & \dots & v_{mn} \end{bmatrix} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \dots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \dots & w_n r_{2n} \\ \vdots & \vdots & \dots & \vdots \\ w_1 r_{m1} & w_2 r_{m2} & \dots & w_n r_{mn} \end{bmatrix} \tag{6}$$

Third step: recognising ideal positive solution and ideal negative solution

$$A^* = \{v_1^*, v_1^*, \dots, v_j^*, \dots, v_n^*\} = \{(\max v_{ij} \mid j \in J) \mid i = i, \dots, m\}$$

$$A^- = \{v_1^-, v_2^-, \dots, v_n^-\} = \{(\min v_{ij} \mid j \in J) \mid i = i, \dots, m) \tag{7}$$

Fourth step: calculating the size of distance based on Euclid norm for each ideal positive solution (S^*_i) and ideal negative solution (S^-_i) for each option

$$S_i^* = \sqrt{\sum_{i=1}^{m}(v_{ij} - v_i^*)^2}\ i = 1, \ldots, m,$$

$$S_j^- = \sqrt{\sum_{i=1}^{m}(v_{ij} - v_i^*)^2}\ i = 1, \ldots, m, \tag{8}$$

Fifth step: calculating relative closeness to ideal positive solution for each option

$$C_i^* = \frac{S_j^-}{S_i^* + S_j^-} \tag{9}$$

Based on the formula is 3 and is farther than A^-. A^* is closer to A_i

Sixth step ranking based on C^*_i arrangement

C^*_i is the biggest index value and represents the best performance for the options.

Therefore, in this research and to create weights we have used ANP technique and to do ranking the options we have used TOPSIS technique.

3.8 Shanon entropy

In this research and after collecting the viewpoints of industry experts in firms through questionnaires, the weight of criteria was identified using Shanon Entropy. Entropy is considered to be a very important concept in social sciences, physics and theory of information. When the data of a decision-making matrix are clarified completely, we can use entropy method to measure the weights. The idea in the method mentioned above is that the more dispersion in values of a criterion means the higher importance of that criterion. Entropy in information theory is a criterion to measure lack of confidence which is expressed through probability distribution P_i as follows:

$$E_{i=}\ S(P_1, P_2, \ldots..P_n) = -K\sum_{i=1}^{n}\left[P_1 * lnP_i\right] \tag{10}$$

where K is a fixed amount and it is implemented to force E_i to reside between zero and one. E is calculated through P_i probability distribution based on the statistical mechanism and its amount will be the maximum probable value if P_is are equal (i.e., $P_i = 1/n$) and it is calculated as follows:

$$-k\sum_{i=1}^{n} pi - \ln pi = -k\left\{\frac{1}{n}\ln\frac{1}{n} + \frac{1}{n}\ln\frac{1}{n}\ln\frac{1}{n} + \ldots + \frac{1}{n}\ln\frac{1}{n}\right\}\left\{\frac{1}{n}ln\frac{1}{n}\left(\frac{n}{n}\right)\right\})$$

$$= -k*\ln\frac{1}{n} \tag{11}$$

where, K is a fixed amount and it is calculated as follows:

$$k = \frac{1}{\ln(m)} \tag{12}$$

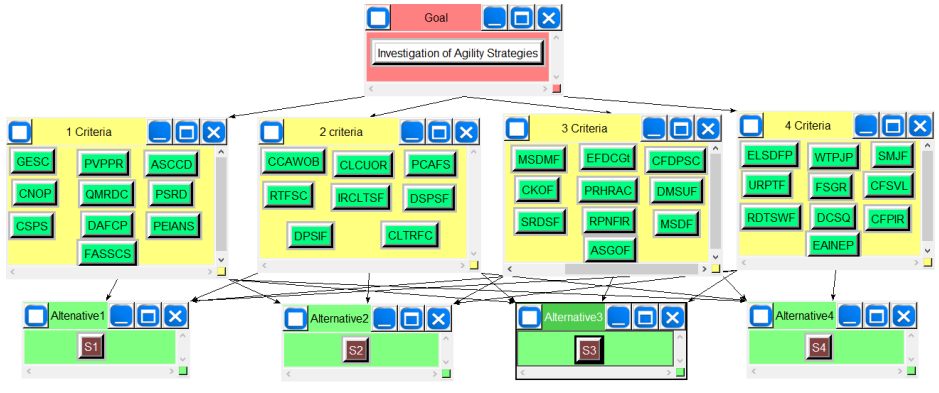
4 Data analysis

For this means, first the following step was carried out to clarify the design of ANP network.

- *ANP network*

ANP network could be represented based on Figure 3 as follows:

Figure 3 ANP network (see online version for colours)

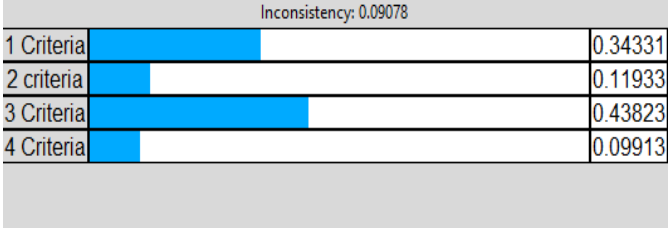


4.1 Decision making criteria comparison

- *Agility strategies dimensions' graph*

Decision making dimensions of the selection of the best agility strategies in firms are represented based on Figure 4 as follows:

Figure 4 Decision making dimensions' comparison (see online version for colours)



Regarding Figure 4, it could be observed that the compatibility rate is less than 0.1 and therefore there is not any incompatibility between different dimensions of agility strategy. In this chart, the sub-criteria dimensions of agility related to the organisation amounts to

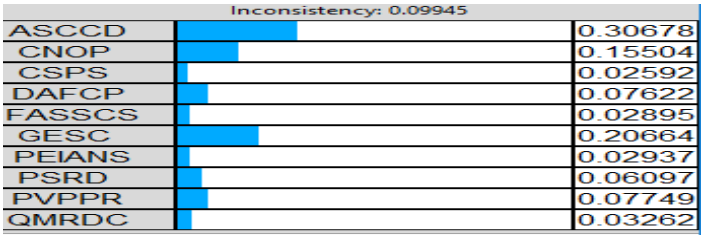
0.43 and has appropriated greater amounts to itself compared to other dimensions and it shows that this aspect has a high importance among firms selected. Also, sub-criteria dimensions of agility related to the product, sub-criteria dimensions related to cooperation and sub-criteria dimensions related to knowledge of individuals fall in other ranks of 0.343, 0.119, and 0.099, respectively.

4.2 Priority charts of decision-making criteria

- *Priority chart of decision-making criteria regarding agility dimensions related to the products*

The priority of decision-making criteria considering agility dimensions related with products have been represented in Figure 5.

Figure 5 The comparison of priority of decision-making criteria regarding the agility criteria dimensions related to the product (see online version for colours)



Regarding Figure 5, it could be observed that the compatibility rate is less than 0.1 and therefore there is not any incompatibility between decision making criteria priority and different dimensions of agility index related to the product. In this chart, and considering agility criteria dimensions related to the product, the first criterion (ASCCD) of assessment of customers compared with data given by the firm amounting to 0.30678 has appropriated the highest amounts to itself compared to other criteria and this shows that this aspect has a high importance among firms selected. Also the sixth criterion (GESC) of greater efforts to support customers, second criterion (CNOP) the creation of a new opportunity for profitability and creating special orders for services and products by the firm, ninth criterion (PVPPR) providing value added to the product in return to services and data provided for the customers of the firm, fourth criterion (DAFCP) the adjustable amount and flexibility of products of the firm, eighth criterion (PSRD) proposing specific and rapid demands on the part of customers to the firm, tenth criterion (QMRDC) quality based on fault rate measurement and customer satisfaction by the firm, seventh criterion (PEIANS) the products entry importance amount and entry of new services to the market by the firm, fourth criterion (FASSCS) focus on after sales service support considering the satisfaction of customer needs by the firm, and third criterion (CSPS) concentration on standard products' sales amounting to 0.02592 were ranked next, respectively.

Regarding Figure 6, it could be observed that the compatibility rate is less than 0.1 and therefore there is not any incompatibility between decision making criteria priority and different dimensions of agility criteria related to the product. In this chart, and

considering agility criteria dimensions related to cooperation, the seventh criterion (PCAFS) of provoke to cooperation among firm staff amounting to 0.24220 has appropriated the highest amounts to itself compared to other criteria and this shows that this aspect has a high importance among firms selected. Also the fourth criterion (DPSIF) of development of products and services by internal firm teams, second criterion (CLCUOR) the creation of least cooperation between units and offices with each other in order to resolve problems of the firm, eighth criterion (RTFSC) reliable treatment with firm's major suppliers and considering the firm to be reliable as a counterpart of the firm, first criterion (CCAWOB) cooperation and concurrent activities throughout the whole organisational borders, third criterion (CLTRFC) the creation of close and long term relations with firm customers, fifth criterion (DSPSF) designing and supply of products and services with cooperation on the part of firm customers, and sixth criterion (IRCLTSF) interactions, renegotiations and creation of long term contracts with major suppliers of the firm amounting to 0.04312 were ranked next, respectively.

Figure 6 The comparison of priority of decision-making criteria regarding the agility criteria dimensions related to cooperation (see online version for colours)

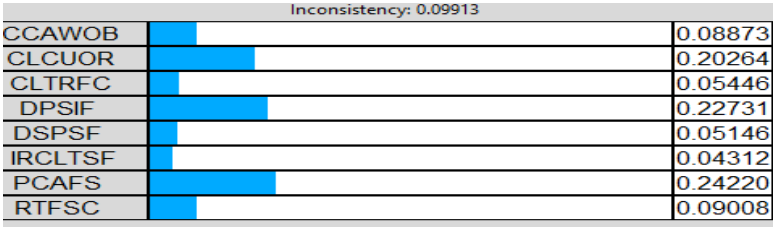
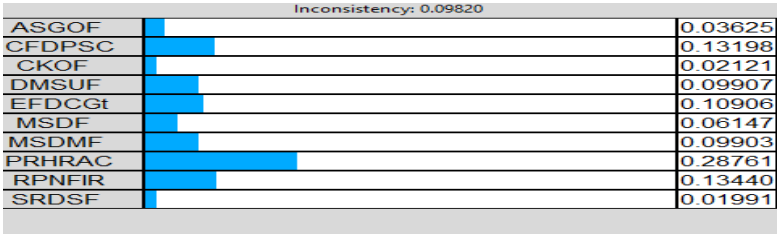


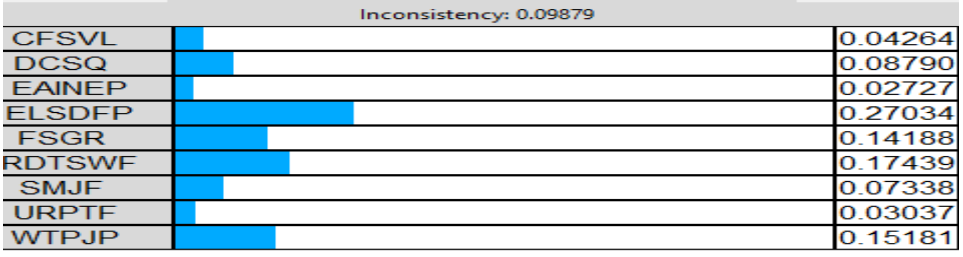
Figure 7 The comparison of priority of decision-making criteria regarding the agility criteria dimensions related to organisation (see online version for colours)



Regarding Figure 7, it could be observed that the compatibility rate is less than 0.1 and therefore there is not any incompatibility between decision making criteria priority and different dimensions of agility criteria related to the organisation. In this chart, and considering agility criteria dimensions related to organisation, the seventh criterion (PRHRAC) of physical reconfiguration and human resources to alleviate customers' needs by the firm amounting to 0.28761 has appropriated the highest amounts to itself compared to other criteria and this shows that this aspect has a high importance among firms selected. Also the ninth criterion (RPNFIR) regarding the problematic nature of finding information related to the firm and lack of sharing among firms, second criterion

(CFDPSC) compatibility of firm in designing the products and services considering customers' needs, fifth criterion (EFDCGT) efficiency of the firm in dealing with changes in goals and targets, fourth criterion (DMSUF) difficulty of moving staffs between the units in a firm, seventh criterion (MSDMF) measuring the speed of decision making in a daily format in the firm, sixth criterion (MSDF) easy access to information needed to have an efficient performance along with firm requirements, first criterion (ASGOF) announcement of strategies and goals of the organisation to the staff by the firm, third criterion (CKOF) changes as a known opportunity in the firm, and the tenth criterion (SRDSF) of the slow rate of decision making speed in the firm amounting to 0.01991 were ranked next, respectively.

Figure 8 The comparison of priority of decision-making criteria regarding the agility criteria dimensions related to knowledge of individuals (see online version for colours)



Regarding Figure 8, it could be observed that the compatibility rate is less than 0.1 and therefore there is not any incompatibility between decision making criteria priority and different dimensions of agility index related to the knowledge of individuals. In this chart, and considering agility criteria dimensions related to the knowledge of individuals, the fifth criterion (EAINEP) easy access to information needed to have an efficient performance along with firm requirements, fourth criterion (ELSDFP) of encouraging all staffs in different levels of the firm within the decision making process and presenting ideas and information exchange by the firm amounting to 0.27034 has appropriated the highest amounts to itself compared to other criteria and this shows that this aspect has a high importance among firms selected. Also, the sixth criterion (RDTSWF) regarding the development and training staffs to favour staffs working in the firm, ninth creation (WTPJP) work and time planning and job assessment along with production planning by the firm, fifth criterion (FSGR) focus of staffs on goals and organisational success by the firm, second criterion (DCSQ) dependence of compensating staffs' losses to quality of the performance of the staffs in the firm, seventh criterion (SMJF) shop staff movement between jobs in the firm, first criterion (CFSVL) controlling the firm staffs to avoid them to violate the laws, eighth criterion (URPTF) using reciprocal performance teams in the firm, and the third criterion (EAINEP) of low or high applicants for reciprocal jobs in the firm amounting to 0.02727 were ranked next, respectively.

- *Final chart of the priority of the selection of best strategy for firms regarding four aspects (product, cooperation, organisation, and knowledge of individuals)*

Considering total calculations carried out through pairwise comparisons based on Figures 9 and 10, the agility criteria strategy related to cooperation (S_2) was chosen as the best strategy.

4.3 Ranking agility strategies in firms using TOPSIS technique

In 1981, TOPSIS was proposed by Hwang and Yoon and it was utilised to identify the ideal positive solution (A^*) and ideal negative solution (A^-) for decision making. The basis of TOPSIS is to select an option which should have the least distance with positive ideal solution and the largest distance with negative ideal solution.

Figure 9 Cluster matrix for ANP model (see online version for colours)

Cluster Node Labels	1 Criteria	2 criteria	3 Criteria	4 Criteria	Altenative1	Alternative2	Alternative3	Alternative4	Goal
1 Criteria	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.343310
2 criteria	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.119328
3 Criteria	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.438233
4 Criteria	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.099128
Altenative1	0.277255	0.448224	0.190732	0.292382	0.000000	0.000000	0.000000	0.000000	0.000000
Alternative2	0.315279	0.240509	0.234914	0.213778	0.000000	0.000000	0.000000	0.000000	0.000000
Alternative3	0.084556	0.118586	0.213545	0.285143	0.000000	0.000000	0.000000	0.000000	0.000000
Alternative4	0.322910	0.192682	0.360809	0.208697	0.000000	0.000000	0.000000	0.000000	0.000000

Figure 10 The selection of best agility strategies for firms within decision making network (see online version for colours)

Here are the overall synthesized priorities for the alternatives.
You synthesized from the network Super Decisions Main Window: teddeyyon Anp.sdmod

Name	Graphic	Ideals	Normals	Raw
S2		1.000000	1.000000	0.172158

In the present study and based on the idea posed by Thomas Saaty, 10 persons were chosen as scholars from among the industry workers in firms through a questionnaire of ranking criteria for agility strategies in firms and after screening the data though BT TOPSIS SOLVER software, they were analysed. The results were represented through tables after calculating the weight of criteria using Shanon Entropy.

4.4 Data weight

- *Forming decision making table for weights of the indexes*

In this section, each of the agility strategies dimensions are measured based on different criteria. Results of decision-making matrix are represented in Table 1.

Table 1 Scholars' decision-making matrix based on weights of indexes

	Agility criteria related to product	*Agility criteria Related to cooperation*	*Agility criteria related to organisation*	*Agility criteria related to knowledge of individuals*
Weight related to criteria	0	0	0	0
Expert 1	0.25	0.35	0.27	0.13
Expert 2	0.35	0.27	0.13	0.25
Expert 3	0.27	0.35	0.25	0.13
Expert 4	0.11	0.12	0.13	0.22
Expert 5	0.23	0.13	0.12	0.11
Expert 6	0.22	0.24	0.22	0.32
Expert 7	0.22	0.13	0.15	0.17
Expert 8	0.22	0.12	0.31	0.41
Expert 9	0.12	0.14	0.21	0.12
Expert 10	0.12	0.12	0.22	0.13
Total	2.11	1.97	2.01	1.99

First step of calculating P_{ij}

In this step and using the following formula, we calculate the amount of P_{ij} for all criteria:

$$P_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \tag{13}$$

$$P_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} = \frac{0.25}{2.11} = 0.12$$

And to calculate the rest of criteria we used formula (13) and the results were represented in Table 2.

Table 2 Calculating criteria

	Agility criteria related to product	*Agility criteria related to cooperation*	*Agility criteria related to organisation*	*Agility criteria related to knowledge of individuals*
Weight related to criteria	0	0	0	0
Expert 1	0.12	0.18	0.13	0.07
Expert 2	0.17	0.14	0.06	0.13
Expert 3	0.13	0.18	0.12	0.07
Expert 4	0.052	0.06	0.06	0.06
Expert 5	0.11	0.06	0.06	0.06
Expert 6	0.1	0.12	0.11	0.2
Expert 7	0.1	0.07	0.07	0.085
Expert 8	0.1	0.06	0.15	0.2
Expert 9	0.057	0.07	0.10	0.06
Expert 10	0.057	0.12	0.11	0.07

Second step: Calculating the amount of entropy E_{ij}

In this step and using the following formula, the amount of E_{ij} (amount of confidence) calculated and results shown in Table 3.

$$-k = \ln\frac{1}{n} \tag{14}$$

$$\rightarrow -k = \frac{1}{\ln 10} = 0.492$$

$$E_j = S(P_1, P_2, \ldots, P_{n,}) = -K\sum_{i=1}^{n}\left[P_1 * \ln P_i\right] \tag{15}$$

$$E_{11} = -0.0492\left[0.12\ln(0.12) + 0.17\ln(0.17) + 0.13\ln(0.13) + 0.052\ln(0.052)\right.$$
$$\left. +0.11\ln(0.11) + 0.1\ln(0.1) + 0.1\ln(0.1) + 0.057\ln(0.057) + 0.057\ln(0.057)\right]$$
$$=0.066$$

Table 3 Results of confidence amounts e_j

E_1	E_2	E_3	E_4
0.066	0.07	0.969	0.91

Third step: in this step, the amount of lack of confidence d_j was calculated based on the formula below:

$$-d_j = 1 - E_j \tag{16}$$

$1 - 0.066 = 0934$

And to calculate the rest of E_js, formula (16) has been utilised and the results are represented in Table 4.

Table 4 Results of confidence amounts d_j

d_j	d_1	d_2	d_3	d_4	$\sum d_j$
$1-E_j$	0.934	0.093	0.031	0.09	1.985

Fourth step: weight of indexes is calculated using the following formula:

$$w_j = \frac{dj}{\sum d_j} \tag{17}$$

$1 - 0.066 = 0934$

$$w_j = \frac{dj}{\sum d_j} \rightarrow w_1 = \frac{0.934}{1.985} = 0.47$$

And for the rest of the criteria's, we used formula (17) and the results of indexes are represented in Table 5.

Table 5 Weight of criteria

w_1	w_2	w_3	w_4
0.47	0.46	0.015	0.045

Considering the results of Table 5, the sum of $W_j s$ is equal to 1.

At the end of fourth step, the weight of indexes of 10 experts was calculated and then we tried to rank agility criteria using TOPSIS method through steps 1 to 6 based on viewpoints of the scholars mentioned.

4.5 Ranking agility criteria of industrial using TOPSIS technique

First step: mean of scholars' viewpoints

In this matrix the index with a positive optimal position is the profitability index and cost criteria is a criterion with a negative optimal position.

Based on viewpoints of experts in industry shown in Table 6 (mean experts' viewpoints) considering ranking of agility criteria in firms, considering the agility criterion related to the product, sub-criteria of agility criterion related to knowledge of individuals amounting to 0.386 has appropriated the highest rank to itself. Also regarding agility sub- criteria related to cooperation amounting to 0.262, agility sub-criteria criterion related to the organisation and agility sub-index criterion related with knowledge of individuals, sub-criteria criterion related with knowledge of individuals amounting to 0.258 and 0.381 were ranked next due to the viewpoints of scholars in industry, respectively.

Table 6 Scholars' mean viewpoint matrix

Criterion type	*Positive*	*Positive*	*Positive*	*Positive*
Criterion weight	*0.47*	*0.46*	*0.015*	*0.045*
Matrix	Agility criteria related to product	Agility sub-criteria related to cooperation	Agility sub-criteria related to organisation	Agility sub-criteria related to knowledge of individuals
Agility criteria related to product	0.222	0.198	0.191	0.197
Agility criteria related to cooperation	0.239	0.255	0.244	0.209
Agility criteria related to organisation	0.285	0.262	0.261	0.215
Agility criteria related to knowledge of individuals	0.386	0.278	0.258	0.381

Second step: Normalising or de-indexing the matrix

In this step the criteria in the decision matrix are de-indexed. In this way, each of the values is divided by the size of the related vector in the same criteria.

Considering Table 7 (normalised matrix), regarding the agility criterion related to the product, agility sub-criterion related to knowledge of individuals amounting to 0.6653 has had appropriated the highest rank among other criteria in firms to itself. Also, regarding agility sub-criterion related to cooperation, agility sub-criterion related to organisation amounting to 0.5434 and agility sub criterion related to knowledge of individuals, and agility sub-criterion related to knowledge of individuals amounting to 0.5371 and 0.728 were ranked next due to the viewpoints of scholars in industry, respectively.

Table 7 Normalising matrix

De-indexed matrix	*Agility criteria related to product*	*Agility sub-criteria related to cooperation*	*Agility sub-criteria related to organisation*	*Agility sub-criteria related to knowledge of individuals*
Agility criteria related to product	0.3826	0.3959	0.3977	0.3764
Agility sub-criteria related to cooperation	0.4119	0.5098	0.508	0.3994
Agility sub-criteria related to organisation	0.4912	0.5238	0.5434	0.4108
Agility sub-criteria related to knowledge of individuals	0.6653	0.5558	0.5371	0.728

Third step: giving weights to the normalised matrix

Decision matrix is in fact a parametric matrix and it should be quantified. To do so, the decision maker identifies a weight for each criterion. The set of weights is multiplied in the normalised matrix. Considering Table 8 (normalised weighing matrix), regarding the agility criterion related to the product, agility sub-criterion related to knowledge of individuals amounting to 0.3127 has had appropriated the highest rank among agility criteria in firms to itself. Also, regarding agility sub-criterion related to cooperation, agility sub-criterion related to cooperation, and agility sub-criterion related to knowledge of individuals amounting to 0.2557 and 0.0328, and agility sub-criterion related to organisation amounting to 0.5371 were ranked next due to the viewpoints of scholars in industry, respectively.

Table 8 Normalised weighting matrix

De-indexed matrix	*Agility criteria related to product*	*Agility sub-criteria related to cooperation*	*Agility sub-criteria related to organisation*	*Agility sub-criteria related to knowledge of individuals*
Agility criteria related to product	0.1798	0.1821	0.006	0.0169
Agility sub-criteria related to cooperation	0.1936	0.2345	0.0076	0.018
Agility sub-criteria related to organisation	0.2309	0.241	0.0082	0.0185
Agility sub-criteria related to knowledge of individuals	0.3127	0.2557	0.0081	0.0328

Fourth step: Identifying positive ideal solution and negative ideal solution

The two virtual options created are in fact the worst and the best solutions. As it can be observed in Table 9 (positive and negative optimal solutions) agility criterion ranking criteria of firms shows that the agility criterion related to the product amounting to 0.3127 has appropriated the highest amount of positive optimal solutions (the most ideal solution) to itself among the criteria present. Also, agility sub-criterion related to organisation amounting to 0.006 has appropriated the least negative optimal solutions to itself among the criteria present.

Table 9 Positive and negative optimal solutions matrix

Optimal solution	*Agility criteria related to product*	*Agility sub-criteria related to cooperation*	*Agility sub-index related to organisation*	*Agility sub-criteria related to knowledge of individuals*
Positive	0.3127	0.2557	0.0082	0.0328
Negative	0.1798	0.1821	0.006	0.0169

Fifth step: identifying the distance from positive and negative optimal solutions

The distance between each option is measured through the use of Euclid method. This means that the distance between options could be determined considering positive and negative ideal options. As it can be observed in Table 10 (identifying the distance size of positive and negative optimal solutions) agility criterion ranking criteria of firms shows that the agility criterion related to the product amounting to 0.1527 has appropriated the highest amount of positive optimal solutions (the most ideal solution) to itself among the criteria present. Also, agility sub-criterion related to cooperation amounting to 0.0542 has appropriated the least negative optimal solutions to itself among the criteria present.

Table 10 Identifying the distance from positive and negative ideal solutions

Distance size	*Positive*	*Negative*
Agility criterion related to product	0.1527	0
Agility sub-criterion related to cooperation	0.1218	0.0542
Agility sub-criterion related to organisation	0.0843	0.078
Agility sub criterion related to knowledge of individuals	0.0001	0.1527

Sixth step: calculating closeness to positive and negative ideal solutions and ranking options

As it can be observed in Table 11 (closeness to positive and negative ideal solutions and ranking options) agility criterion ranking criteria of shows that the agility sub-criterion related to knowledge of individuals amounting to 0.9994 ranked first, agility sub-criterion related to organisation amounting to 0.4803 ranked second, agility sub- criterion related to cooperation amounting to 0.308 ranked third, and agility criterion related to product amounting to 0 ranked fourth.

Table 11 Ranking options

Result	*Closeness coefficient*
Agility sub-criterion related to knowledge of individuals	0.9994
Agility sub criterion related to organisation	0.4803
Agility sub-criterion related to cooperation	0.308
Agility criterion related to product	0

5 Conclusion

According to results of the first question in ANP method, the first achieved criterion obtained from the product-related agility scale, customer evaluation against the information provided by the company (CEVIPC) with a value of 0.30678 has been achieved. This criterion the greatest amount to itself and thus has been chosen as the best criterion for priority in firms due to its high importance compared to other criteria.

Also regarding TOPSIS method, the option 4 (product agility criterion) was chosen as the last decision-making rank among the related options. However, organisations generally compete against each other due to different competitive aspects such as quality,

cost, in time delivery, flexibility and so on. Although today we are exposed to extraordinary competitive environments and conditions, market is identified through permanent and unpredictable changes, and this has forced firms to consider agility in manufacturing products in their business. To do so, manufacturing companies have done fundamental changes in production lines along with training manufacturing personnel to be able to satisfy the needs of their customers in their competitive markets. Also, as production lines are reformed, the variety of products is increased, flexibility in utilising these changes increases, a considerable reduction of faults happens in product manufacturing, the quality of manufactured products increases and products are delivered to the customer in time. According to results of the second question in ANP, the third criterion obtained from agility criteria related to cooperation, encouraging cooperation between staff's company (ECBCW) amounting to 0.24221 has been obtained. This criterion obtained the greatest amount to itself and thus has been chosen as the best criterion for priority in firms due to its high importance compared to other criteria.

The results of the third question in ANP method, the third achieved criterion obtained from agility criterion related with organisation, the physical and human resources reconfiguration to satisfy the needs of customers by the firm (CHRACP) amounting to 0.28761 has been achieved. This criterion obtained the greatest amount and thus has been chosen as the best criterion for priority in firms due to its high importance compared to other criteria.

The results of the fourth question, the fourth achieved criterion obtained from the agility criterion related with knowledge of individuals (ELEIP), with the amount of 0.27034 has been achieved. This criterion obtained the greatest amount to itself and thus has been chosen as the best criterion for priority in firms due to its high importance compared to other criteria.

5.1 Discussion

In TOPSIS method the first option 1 (agility criterion related to knowledge of individuals) was chosen as the first decision making rank among the related options. Thus, in an organisation focusing on human workforce there may be provided some opportunities in future and the organisation may survive from the risks. Therefore, this may lead to performance enhancement in long term under changing conditions and lack of confidence. Accordingly, the major part of agility is human resources. To make human resources agile there is a need to reinforce the relationship between individuals in an organisation and also to harmonise their knowledge to achieve the goals of organisation within the least possible time span and this cannot be realised without flexibility in an organisation.

Also, the second option 2 (agility criterion related to organisation) was chosen as the second decision making rank among the related options. However, organisational agility entails a set of functional features and previous paradigms' principles and is accepted as the novel philosophy in organisational management literature. Following the notices of organisations, there have been great efforts carried out to achieve an optimal and appropriate level of agility. But many of such efforts faded away due to ignorance towards the basic competition constituents through inappropriate movement routes. Meanwhile, one of the most outstanding fields and the one emphasised by comprehensive quality management is human resources and how to lead and manage individuals.

Further, in TOPSIS method the third option 3 (agility criterion related to cooperation) was chosen as the third decision making rank among the related options. However, agility can be defined along with the needs of the business variables in order to gain competitive advantages. In such an organisation, the goals of staff's accord with organisational goals and these both try to respond the needs of customers.

Atkinson et al. (2020) investigated attaining organisational agility through competitive intelligence: the roles of strategic flexibility and organisational innovation. They are suggested to organisational agility can play an important role in an organisation's emergent strategy for survival in an increasingly competitive market-place. Thus, it could be suggested for firms located in Industrial Township to greatly take this into consideration in order to be responsive regarding environmental changes and to increase agility of their manufactured products. Otherwise, there would be irreparable harms in competitive environments. Finally, they should apply fundamental changes in their manufacturing lines to achieve long-term competitive capabilities. Nouri and Mir Mousavi (2019) investigated effect of cooperative management on organisational agility with the mediating role of employee empowerment in public transportation sector. They are suggested to cooperative management and employee empowerment as emerging managerial concepts can play an important role in promoting agility in a variety of firms, including in the transportation sector. In agility related with cooperation to achieve business development and team performance of the firms and business smartness and team performance of firms include important issues related with emphasising at agility related with cooperation to be important.

These include items as follows:

- Understanding the effective change power on organisational beliefs through experience and the capability of utilising information to improve cooperation in the organisation
- Compatibility: The capability to affect the changes in the systems and organisational structure to foster information and communication between the staffs
- *Flexibility*: The ability to create variety and changeability and covering the permanent changes to respond internal and external needs of an organisation
- *Speedy actions*: The capability to achieve goals in short time with a speed through which changes are done successfully. Regarding what was said above, it could be suggested for firms located in Industrial Township to greatly notice this issue and challenge with the current complex and competitive environment. Environmental compatibility should be considered very important and to alleviate the problem there is a need for cooperation among the staff in an organisation. The staff should participate in decision making process to achieve higher amounts of success.

It is suggested that, superior business performance is a central objective of any firm in an unpredictable environment (Esmaeili et al., 2015). Organisational agility constitutes one option for prospering in this environment. Although research confirms a positive effect of Organisational agility on business performance, studies show conceptual imprecision. Therefore, achieving any success in an organisation is impossible without considering human resources and how to enter them in the processes to realise the goals (Walter, 2020). Thus, it is necessary to reinvestigate about agility in organisations considering all its aspects (specifically human force) to help the organisation to utilise agility related to

the organisation to achieve goals. Therefore, it could be suggested that firms could utilise powerful tools such as enabling agility in order to achieve agility and gain permanent organisational improvement and one of the options could be the participation of staffs in decision making. Tooranloo and Saghafi (2018) investigated the relationship between organisational agility and applying knowledge management. They are suggested to the agility is a relatively new concept in today's business that has become a critical capability for the organisations. In fact, it is the most important factor for organisation in the dynamic and turbulent environment. The agile organisations need to adaptability strategies for applying knowledge management tools to overcome uncertainty. Also, the basis of agility in an organisation is to use individuals' knowledge who can do works without any problem and also though movements in their positions. So, it could be suggested for firms to program training plans in order to increase knowledge of individuals in the organisation to consider current requirements of the environment and following a specific attention towards the role of knowledge of the individuals they can help organisation continue its survival. Future works could develop fuzzy cognitive map or other fuzzy decision making techniques.

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