Int. J. Nonlinear Anal. Appl. 14 (2023) 5, 303–323
ISSN: 2008-6822 (electronic)
http://dx.doi.org/10.22075/ijnaa.2022.28417.3882

Planning an analytical model for assessing supply chain resilience to various types of risks: Case study of Iran petrochemical industries

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(Communicated by Ehsan Kozegar)

Abstract

The examination aims to create and test a scientific model for strength appraisal of production network chances against the dangers of framework and its individual levels. In such manner a multi-technique research approach is received as follows: By utilizing information envelopment investigation (DEA) and fluffy set hypothesis, a fluffy organization DEA model has been proposed to survey danger in generally supply chains and their individual levels. The proposed model is tried by studying of 130 individuals in specific petrochemical organizations in Iran. The overview results show a generous variety in flexibility evaluations between the general petrochemical supply chains and their individual levels. The examination aims to create and test a scientific model for strength appraisal of production network chances against the dangers of framework and its individual levels. In such manner a multi-technique research approach is received as follows: By utilizing information envelopment investigation (DEA) and fluffy set hypothesis, a fluffy organization DEA model has been proposed to survey danger in generally supply chains and their individual levels. The proposed model is tried by studying of 130 individuals in specific petrochemical organizations in Iran. The overview results show a generous variety in flexibility evaluations between the general petrochemical supply chains and their individual levels.

Keywords: Supply chain, Resilience, Data envelopment analysis, Petrochemical industry
2020 MSC: 90C08

1 Introduction

These days supply chains have gotten one of the prevailing standards in the realm of business. Forster who many distinguished him as the author of the subject of supply chains, in 1958 noticed that "the achievement of associations relies upon the effective cooperation and trade of data, material, capital, HR and hardware among them." Over time, this thought has become prevailing and unquestionable hypotheses in the domain of business [18]. The expansiveness of this thought is with the end goal that today one can't envision an association without considering its situation in a production network. Numerous specialists accept that the opposition among associations and organizations over the previous many years has become a competition between chains in the current period. Indeed, a huge piec.e of the speculation and development of this field has occurred over the most recent twenty years, and numerous global associations, for example, Cisco, Dell, Nike, Proctor and Gamble and Zara have profited by it [18].

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Received: June 2022 *Accepted:* September 2022

Because of the job and significance of inventory network the executives, this idea experiences numerous issues and difficulties. Yet, an outline of the hypothetical establishments of this field shows that issues, for example, data frameworks, advertising, monetary administration, coordinations issues, and between authoritative relations have been the subject of interest by specialists in this field [28]. Wessner, Ton, and Leung [28] have taken a gander at the main components in inventory network the board and their issues in four phases: buy, activity, dissemination, and joining.

Today, associations are obliged to diminish the weakness and increment the capacity to withstand store network because of expanded vulnerability in the inventory network and the development of elements, for example, policy centered issues, request variances, innovative changes, monetary flimsiness and cataclysmic events spend assets to foresee request, supply and inside vulnerabilities. As indicated by these vulnerabilities and danger factors prompted the issue of danger the board in the inventory network [28].

The presence of danger and disappointment in the production network can significantly affect short-run execution just as a negative long haul impact on monetary execution of the association. Hence, production network hazard the executives is important to lessen the dangers of different dangers, for example, questionable financial cycles, temperamental client interest, and unusual normal and human occasions [26].

Production network execution assessment models have been ordered into four zones: quality, time, cost and adaptability (strength). Furthermore, they are arranged based on quantitative and subjective, cost or non-cost and spotlight on specialized/operational/vital levels and inventory network measures [3].

Today, endeavors face the difficulties and pressing factors of the serious market, including globalization, rivalry and participation, expansion of client needs and short item life cycle, and the store network has been considered as a significant standard. Thusly, to have the option to accomplish the organization's key and vital objectives, it is important to evaluate the inventory network from a utilitarian perspective, along these lines, distinguishing qualities and shortcomings and for fortifying, improving or eliminating them [26].

As to job of the petrochemical business in Iran's economy, improving the inventory network execution of petrochemical enterprises can be a significant advance towards accomplishing the macroeconomic objectives of the nation's economy and because of the absence of examination in the field of compelling quality variables in the production network it is crucial to inspect the store network versatility in the petrochemical business [3].

Danger the executives requires distinguishing, assessing and rating different dangers. Danger evaluation is one of the mainstays of danger the executives and its motivation is to quantify the dangers dependent on various pointers, for example, the degree of the impact and the likelihood of event. What's more, the aftereffects of this stage are more exact, we can say that the administration cycle Risk with more serious level of assurance [26].

To precisely examine the outcomes of mishaps that can prompt interruptions and in this manner adversely affect the store network framework, reference models in the inventory network writing, (for example, the SCOR store network operational reference model) [1] ways to deal with production network hazard appraisal basically center around fast ID and assessment of dangers, improvement of danger reaction techniques, and observing and understanding of danger [**?**].

Then, with the expanding multifaceted nature and weakness of supply chains, more investigations center around connecting the appraisal of inventory network execution as a feature of the production network the board [4, 23]. Numerous analysts confirm the significance of resilience in the store network framework despite surprising and sudden dangers.

Distinguishing the principle dangers and creating future capacities for overseeing recognized dangers are key factors that influence the degree of store network execution [22].

The need of this examination can be generally because of the expanding improvement of staggered frameworks alongside the improvement of production network conversations and progressed programming subjects. Today, numerous business associations are coordinated as organizations of makers and wholesalers that give crude materials change them into completed items and disperse them among clients. The term staggered creation/circulation networks is indeed inseparable from such organizations, which are otherwise called supply chains, and allude to the circumstances where a pen arrives at various stages prior to arriving at the last client [22].

In a store network, choices are facilitated and considering the necessities and attributes of the different phases of the chain is vital. This significance can be clarified by taking a gander at the impact of whipping cowhide. Numerous providers and retailers have discovered that, regardless of the slight changes in client interest, stock levels and return orders have changed a great deal all through the inventory network. This increment in vacillations along the chain is classified "whip". To control the impacts of the bullwhip impact on the chain, its representatives ought to be distinguished.

In a more straightforward plan and considering a staggered framework, it tends to be contended that the ideal dynamic at single levels of this chain doesn't prompt the optimality of the entire chain, and the accomplishment of by and large enhancement requires the abuse of models that at the same time point and Constraints of all levels of the chain are thought of.

Likewise, associations in the store network have progressively recognized the requirement for arranging and dynamic dependent on participation and coordination, considering the attributes of each stage and the qualities controlled by the chain for its stages. For instance, the Planning, Prediction, and Procurement Modeling (CPFR) model is one of the systems utilized in inventory chains to improve the arranging banter.

The need of planning a model for assessing the expense work in staggered stock frameworks can be disclosed by the mentality to the previously mentioned things. As referenced, there are staggered primary inventory chains. Accentuation on collaboration and cooperation in the store network the executives because of the irreconcilable circumstance between various areas from one viewpoint and the presence of bothersome impacts of bullwhip because of irregularity between the different phases of the chain on the other.

The evaluation of inventory network flexibility to startling perils and occasions is an issue of significance and numerous analysts have reaffirmed its significance. Incorporated evaluation of this

issue includes surveying the store network framework just as its parts. This is significant in light of the fact that, as indicated by new production network hypotheses, the exhibition of this chain isn't centered exclusively around the presentation assessment framework, yet rather on every part. Given the intricacy of this area, giving an extraordinary and native model for evaluating the ability of suffering inventory network hazards in the field of petrochemical industry has not been concentrated inside and out as of not long ago. It is considered as an inventive part of this examination.

This examination can be considered as the principal exploration to utilize the information model envelopment displaying model to assess the inventory network capacity to hazard.

Since there has been no examination in the exploration network models to give improvement headings to the assessed units, in the current investigation, utilizing more limited based methodologies and thinking about unfriendly results, another way to deal with deciding the ideal levels of every one of the factors The sources of info and yields and the interface will be introduced, which is the advancement of this examination.

2 Theoretical Foundations

In this examination, a proposed model for assessing versatility with regards to a three-section inventory network is introduced. The general model diagram is introduced as Fig. 1. Here is the accompanying:

Fig. 1 addresses a three-section production network model that incorporates upstream, downstream and downstream cycles, and the related danger and versatility levels, just as the sources of info and yields between and among authoritative cycles.

Conceivably, hazards influence each of the three parts of the production network and can likewise meddle with operational cycles, which at last will devastatingly affect the whole inventory network. Henceforth, the more noteworthy the weakness of the segments of the production network (counting providers, makers and wholesalers), the versatility of these segments in operational issues will likewise be less [13].

Figure 1: Proposed Model for Assessing Supply Chain to Risks

The unwavering quality levels for segments are considered as yields of each model cycle. A particular segment (as the provider) is more helpless against dangers, and unsettling influences brought about by these dangers in a specific segment can negatively affect the following segments of the production network. For instance, if a provider, because

of a sudden occasion, would upset the key business measures, can't give the crude material of the maker at the ideal time and consequently the impact of the pernicious occasion can be on the producer's activity (from Such as declining creation and increasing expenses) [22]. Thus, the degrees of upstream store network segments that are alluded to as yields can be considered as contributions of downstream production network segments.

3 Review of Literature

The contemporary time can be viewed as the time of developing rivalry for organizations with an end goal to acquire, keep up, and increment piece of the overall industry. A glance at the historical backdrop of business and business shows how the exercises of industry and administration associations have changed from proprietor overseen and losing connections to shared administration and mutual benefit connections.

The historical backdrop of Supply Chain Management Discussion has returned to themes, for example, coordinations. The issue of coordinations has been raised just as the manner in which individuals put together and sort out different associations. Its high level records can be found in military exercises that used progressed coordinations and supply chains as a feature of their store network procedures.

To precisely consider the outcomes of interruptions that can prompt disturbances and consequently contrarily affect the inventory network framework, reference models in the store network writing, (for example, the SCOR production network operational reference model) [4] and ways to deal with production network hazard appraisal fundamentally center around quick recognizable proof and assessment of dangers, advancement of danger reaction systems, and checking and understanding of danger [**?** 31].

Then, with the expanding multifaceted nature and weakness of supply chains, more examinations center around connecting the appraisal of inventory network execution as a component of the production network the executives [31].

As of late, a few examinations [10, 14] have efficiently checked on the writing on store network reverberation, definitions, and traits Related to this perplexing development (reverberation). In the interim, in spite of the fact that distinguishing and reacting all the more effectively to production network hazards is exceptionally attractive [27], the vulnerability encompassing the present store network climate overall requires preparation and inciting a snappy reaction to unusual occasions is unavoidable [9, 14].

Meanwhile, a few analysts zeroed in on the speed of reaction to these occasions (time) just as on expense decrease techniques [20].

Hence, the principle idea of versatility comes from the capacity of the framework to re-visitation of the post-jumble dependability circumstance. This issue has been tended to by new teaches, for example, inventory network hazards the executives and supportable store network the board [17, 25].

Models and foundations identified with Fuzzy Network Data Envelopment Analysis can be introduced in Table 1.

Table 1: Models and Literature review of Fuzzy Network DEA

Criteria	**Model**	**Case Study**	**Journal**	**Research Subject**	**References**
Performance of safety	Dynamic Network Data Envelopment	Iran Airlines	Applied Soft Computing	Dynami network data envelopment analysis	[24]
improvements in the rail transport system	Analysis in a Fuzzy Network (Fuzzy DNDEA Model)			model with fuzzy inputs and outputs: An application for Iranian Airlines	
Choosing the right supplier on the supply side	Combined research model hybrid DEA-boost model Multi-Object Database Model: fuzzy multi-objective DEA	Supply Chain to Select Suppliers	IFAC-Papers Online	A Hybrid DEA-boost Model in Supplier Selection for Fuzzy Variable and Multiple Objectives	[5]
Evaluation of proposed improvement solutions to enhance the supply chain efficiency	Combined programming of data envelopment analysis (GP-DEA) model		Journal of Cleaner Production	A robust fuzzy possibility programming for a new network GPDEA model to evaluate sustainable supply chains	[29]

Performance Evaluation of Medical Centers	Fuzzy data envelopment analysis and intuitive hierarchical analysis process fuzzy DEA and IF-AHP	61 hospitals in Istanbul	Knowledge-Based Systems	Multi-expert performance evaluation of healthcare institutions using an integrated intuitionistic fuzzy AHP and DEA methodology	[22]
China's industry service performance assessment	1-dynamic black-box data envelopment analysis (DBDA) 2-static network data envelopment analysis(SNDE)	China service industry	Applied Mathematics and Computation	Evaluation of cloud service industry with dynamic and network DEA models	[16]
Measuring Efficiency, Effectiveness and Relative Fuzzy Productivity of Decision-making Units in the Supply Chain with the aim of balancing the economic, social and environmental variables.	fuzzy DEA		Applied Soft Computing	Type-2 fuzzy multi-objective DEA model: An application to sustainable supplier evaluation	[30]
Solving the design of the efficient supply chain continuity scheme by the method of weighting the target functions	DEA, MDEA		Industrial Engineering Journal	Presenting a Multi-objective Planning Model to Design a Supply Chain Networking with Producers and Distributors Efficiently	[21]
Calculating the optimistic and cynical efficiency of sustainable supply chains	Network DEA (NDEA)	Resin production plants	Computers and Operations Research	A new fuzzy DEA model for evaluation resilience of efficiency and effectiveness of suppliers in sustainable supply chain management context	[2]

As indicated by new inventory network speculations, the exhibition of this chain isn't centered exclusively around execution assessment frameworks, yet on every part. In this examination, a multivariate methodology (Data Envelopment Analysis, Data Envelopment Analysis, and Linear Programming) has been utilized, which is another way to deal with execution assessment.

In the audit of the above examinations, the entirety of the investigations did depend on information envelopment examination, albeit the models and information utilized for this reason for existing were extraordinary.

Since there has been no exploration in the examination network to give improvement bearings to the assessed units, in the current investigation, utilizing a lack based methodology and thinking about unfavorable results, another way to deal with deciding the ideal levels of every one of the factors Input and yield and interface will be given.

Past examinations have indicated that albeit the effectiveness of inventory network parts is viewed as alluring, this limitedly affects the general proficiency of the store network. In this manner, the specialist accepts that to survey the versatility (flexibility) of the production network, it is important to all the while inspect the segments of the inventory network and production network framework.

Despite the fact that hazard appraisal contemplates have regularly been performed quantitatively or to some extent, hazard distinguishing proof is exceptionally restricted, and, then again, the high danger openness isn't communicated dependent on various pointers, and accordingly the danger level is basic are not identified with one another and are additionally more worried about contextual investigation. Hence, the consequences of the audit of past investigations and explores and the examinations did show that a large portion of the papers and investigates (more than 70% of them) center around the ideas of production network hazard the board, the arrangement of field and contextual analyses, and the survey of writing and issues, for example, the utilization of demonstrating and reproduction approaches are

exceptionally restricted [11].

Among different issues to be tended to in this investigation, there is an absence of exploration direction on surveying hazard versatility in the inventory network. Up until now, little exploration has been done to address this by creating insightful structures and zeroing in on the intricate errand of surveying inventory network reverberation [3, 5, 19, 22, 24]. In any case, large numbers of these examinations don't focus on the pre-upsetting period of the production network framework (which incorporates hazard appraisal) [12].

Despite the fact that it has been demonstrated that utilizing these models to perform hazard appraisal of the inventory network is wasteful, they don't straightforwardly survey the production network reverberation. Likewise, customary information envelopment demonstrating regularly depicts the reproduction of a "black box" [6], in which the presentation and the idea of the connection between the fundamental cycles of the inventory network framework are inspected. Take up Such requirements could raise issues with the appraisal of the individual levels (segments) of the inventory network and the production network framework in general. Organization information displaying of information envelopment examination [6] in this investigation has been utilized to defeat such boundaries and impediments.

4 Analysis

In the past areas of this paper, it clarifies its displaying approach by exhibiting the need to consolidate the customary methodology of distinguishing, overseeing, and decreasing production network hazards with current store network flexibility moves toward that are readied, responsive, and revived. The store network was routed to expected misfortunes. What's more, in the writing, there is likewise the absence of quantitative assessment models of production network strength [10]. Quantitative models that can quantify the store network and the assessment of the strength are likewise tended to.

To accomplish the reason for this examination, a multi-strategy approach has been chosen that permits planning and testing an insightful model for surveying store network hazard strength. To build up a scientific model for chance and assess the strength in a three-stage inventory network, information envelopment examination and fluffy hypothesis have been utilized. As examined later in this segment, in this examination, information envelopment investigation empowers the reconciliation of danger and feasibility standards as production network information and base camp, just as it is conceivable to look at the current degree of vibration for various dangers of production network with the ideal degrees of instability that the chiefs are focusing on it. Furthermore, information envelopment examination gives three correlations at the cycle level (to act as an illustration of the inventory network organizations) and at the framework level (production network as substance).

The information envelopment investigation, presented by Charnes et al., quantifies the overall proficiency of the quantity of n leader units (DMUs) that utilization m information to create yield s. The difference model for the kM chief, DMUk, introduced by Charles, Cooper, and Rhodes (CCR) is introduced as follows:

$$\begin{aligned} E_k &= \max \sum_{r=1}^{s} u_r Y_{rk} / \sum_{i=1}^{m} v_i X_{ik} \\ s.t. \quad \sum_{r=1}^{s} u_r Y_{rj} / \sum_{i=1}^{m} v_i X_{ij} &\le 1, \ j = 1, 2, ..., n \\ u_r &\ge \varepsilon > 0, \quad r = 1, 2, ..., s \\ v_i &\ge \varepsilon > 0, \quad i = 1, 2, ..., m \end{aligned} \tag{4.1}$$

In this model,

s the quantity of yield factors;

m Number of info factors;

r Index of yield factors $(r = 1, 2, ..., s)$;

I is the list of information factors $(I = 1, 2, ..., m)$;

j The units of the leader $(j = 1, 2, ..., n)$;

Y_{rk} The yield esteem $rM(r = 1, 2, ..., s)$ The leader k;

X_{ik} Input esteem $iM(I = 1, 2, ..., m)$ The leader k;

u_r The yield coefficient $rM(r = 1, 2, ..., s)$ in the evaluation of the proficiency of the leader k;

v_i The $I - th$ input factor $(I = 1, 2, ..., m)$ in the assessment of the unit's proficiency k;

Furthermore, ε is a modest quantity of Archimedean.

Utilizing the change of theCharnes and Cooper factors , the model (4.1) turns into a straight programming model as follows:

$$\begin{aligned} E_k &= \max \sum_{r=1}^{s} u_r Y_{rk} \\ s.t. \quad & \sum_{i=1}^{m} v_i X_{ik} = 1 \\ \sum_{r=1}^{s} u_r Y_{rj} / - \sum_{i=1}^{m} & v_i X_{ij} \leq 0, \ j = 1, 2, ..., n \\ u_r &\geq \varepsilon > 0, \quad r = 1, 2, ..., s \\ v_i &\geq \varepsilon > 0, \quad i = 1, 2, ..., m \end{aligned} \tag{4.2}$$

This model, which is the main model of information envelopment examination, is known as the information hub multiplicative model. This model really gives a nonparametric assessment of the creation work, expecting that the set delivers an arched set with a consistent scale return. In the wake of introducing this model, different types of the different sorts of information envelopment investigation models were introduced by different scientists.

The current investigation presents a proposed model for assessing the strength in a three-stage inventory network as demonstrated in Fig. 1. Because of the organization idea of the issue under investigation, we need to utilize an organization of information envelopment examination models. By building up the model number ((4.2)–(5.2)) into the Data Envelopment Analysis Model, it is conceivable to compute a danger and vibration variable in a three-stage store network has been given. What's more, it has been demonstrated that the examination of the information network is more grounded than the conventional non-network model and subsequently the exactness of the model outcomes increments [14].

4.1 Data Envelopment Analysis Network Models

Old style information envelopment investigation models consider assessed units as a black box that converts contributions to yields. These models don't focus on the design and stream of the units. Models of the overall organization depend on these traditional models that consider the interior design of the units. These models were first presented by [6]. An overall gander at the information catch models can be classified as demonstrated in Fig. 2.

In view of Fig. 2, network information envelopment examination is part into two multi-stage and multi-part gatherings. At least two phase models are utilized in the appraisal of the effectiveness of supply chains in a few associations [3]. While multi-sectional models identify with the interior construction of an association that is made out of various parts. This construction can be in arrangement, equal or mix.

Consider the two-venture measure appeared in Fig. 3. Assume that the DMU should be assessed and each $DMU_j(j = 1, 2, ..., n)$ has m info () and yield () in the main stage. This yield will at that point be the contributions of the subsequent stage, and they are called interstitial items. The yields of the subsequent stage are appeared as (). The DMU_j exhibitions are characterized and characterized in the first and second stages separately, where () and (), individually, the information and yield loads in the main stage and () and () separately the info and yield loads in the subsequent stage are. In light of execution in every one of the two phases, the general productivity of the entire cycle can be characterized somehow or another.

4.2 DEA model for evaluating the supply chain resilience to its risks

The three-stage store network model, which incorporates upstream, hierarchical, and downstream cycles, their related dangers and their strength levels (as data sources and yields of between authoritative cycles) has been appeared. Thus, the upstream levels of the production network layers are appeared as yields and can be considered as contributions of the lower layers.

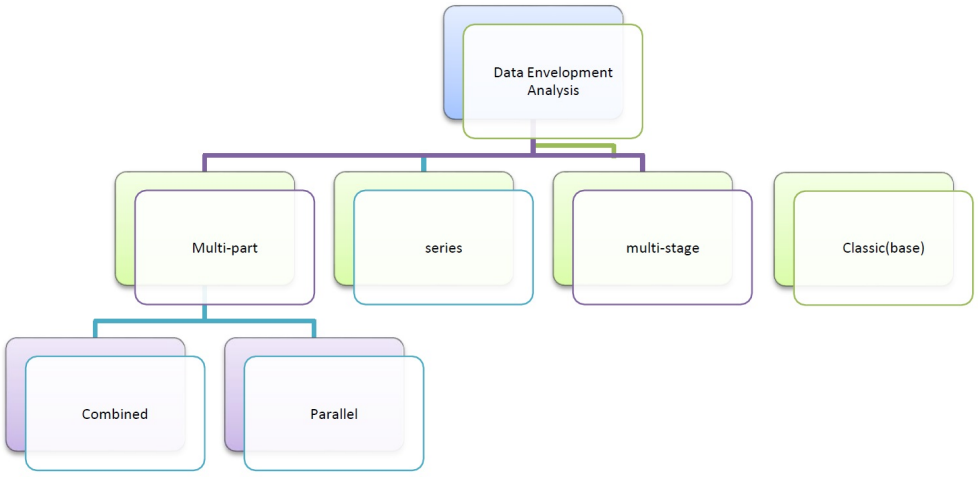

Figure 2: Classification of Data Envelopment Analysis Models in terms of the decision maker's structure [14]

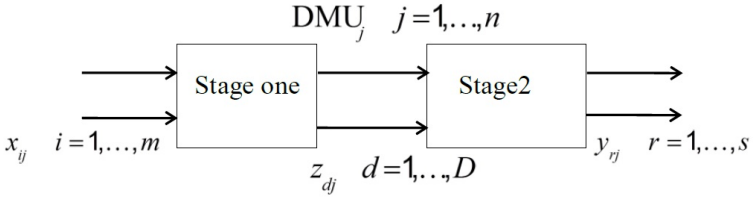

Figure 3: Two-step process

It has been appeared from the figure that the upstream dangers (X_{11}), the outside (X_{12}), the organization (X_{12}) as info and the stockpile flexibility to (Z_1) the yield of the interface of the upstream cycle, affects the provider activity. Essentially, hierarchical dangers (X_{21}), outside (X_{22}), organization (X_{23}), input are thought of, and maker's versatility (Z_2) is considered as the yield of the interfaces of authoritative cycles. At last, the downstream dangers (X_{31}), outside (X_{32}), organization (X_{33}), as conveyance info and circulation (Y_3), as yield of upstream cycles have been taken. The "$\sim$" sign addresses the fluffy estimations of danger levels and unpredictability.

4.3 Symbol

To build up a resampling network model for hazard appraisal, this part presents the images utilized for displaying in the segment underneath.

Boundaries

X_{11}^j Fuzzy Estimated Value Upstream Risk Upstream Processes in JM Decision Unit (Petrochemical);

X_{12}^j Fuzzy Estimated Risk External Processes Upstream Processes in the JM Decision Unit (Petrochemical);

X_{13}^j Fuzzy Estimated Value of Network Risks of Upstream Processes in the JM Decision Unit (Petrochemical);

X_{21}^j Fuzzy Estimated Risk Organizational Processes in the JM Decision Unit (Petrochemical);

X_{22}^j Fuzzy Estimated Value of External Risks of Organizational Processes in the JM Decision Unit (Petrochemical);

X_{23}^j Fuzzy Estimated Value of Network Risks of Organizational Processes in the JM Decision Unit (Petrochemical);

X_{31}^j Fuzzy Estimated Value of Downstream Risks Downstream Processes in the JM Decision Unit (Petrochemical);

X_{32}^j Fuzzy Estimated Value of External Risks Downstream Processes in the JM Decision Unit (Petrochemical);

X_{33}^j Fuzzy Estimated Value of Network Risks for Downstream Processes in the JM Decision Unit (Petrochemical);

Z_1^j Fuzzy Estimated Value of Provider Resonance in Highly Handled Processes in the JM Decision Unit (Petrochemical);

Z_2^j Fuzzy Estimated Value of Provider Resilience in Organizational Processes in the JM Decision producer (Petrochemical);

Z_3^j Fuzzy Estimated Value of Provider Resilience in Downstream Processes in the JM Decision Unit (Petrochemical).

Factors

v_{1i}: Weight of upstream sorts of danger ($I = 1$), outside ($I = 2$) and organization ($I = 1$) upstream cycles in strength evaluation;

v_{2i}: The heaviness of hierarchical dangers ($I = 1$), outer ($I = 2$) and organization ($I = 1$) of authoritative cycles in the evaluation of flexibility;

v_{3i}: Weight of drawback hazard types ($I = 1$), outer ($I = 2$) and organization ($I = 1$) downstream cycles in reverberation evaluation;

w_1: Weight of provider reverberation in overbearing cycles in versatile appraisal;

w_2: Supply Resonant Weight in Organizational Processes in Resilience Evaluation;

u_3: Weight of provider flexibility in downstream cycles in strength appraisal;

5 Modeling

5.1 Overall Performance Model

In this exploration, an organization model has been utilized to evaluate the productivity of upstream, downstream and downstream cycles of petrochemical organizations to survey chain reverberation. For every one of the store network measure layers, four execution scores have been determined: the presentation of upstream cycles, hierarchical cycles and downstream cycles alongside the general exhibition of the production network framework.

To appraise in general effectiveness, consider the three-venture measure model as Fig. 1.

The cycles inside the crate are expected to be secret elements and the general exhibition of the chain is formed utilizing traditional models. As indicated by Kao and Hwang [15] the general exhibition of the DMUk store network framework will be defined as follows:

$$\begin{aligned} E_k &= \max \frac{u_3 \widetilde{Y}_3^k}{\sum_{t=1}^{3}\sum_{i=1}^{3} v_{ti}\widetilde{X}_{ti}^k} \\ s.t.\ & \frac{u_3 \widetilde{Y}_3^j}{(\sum_{t=1}^{3}\sum_{i=1}^{3} v_{ti}\widetilde{X}_{ti}^j)} \le 0, \quad j = 1, 2, ..., n \\ & v_{ti}, u_3 \ge \varepsilon,\ i = 1, 2, 3;\ t = 1, 2, 3 \end{aligned} \tag{5.1}$$

In the above model, the target work tries to amplify the general proficiency of DMUk, and the requirements of the issue show that the effectiveness of all dynamic units ought to be short of what one. This is the increase factor of the CCR deficiency. By adjusting the Charness-Cooper variable, the straight model is defined as follows.

$$\begin{aligned} \widetilde{E}_k &= \max u_3 \widetilde{Y}_3^k \\ s.t.\ & \sum_{t=1}^{3}\sum_{i=1}^{3} v_{ti}\widetilde{X}_{ti}^k = 1 \\ & u_3\widetilde{Y}_3^j - (\sum_{t=1}^{3}\sum_{i=1}^{3} v_{ti}\widetilde{X}_{ti}^j) \le 0, \quad j = 1, 2, ..., n \\ & v_{ti}, u_3 \ge \varepsilon,\ i = 1, 2, 3;\ t = 1, 2, 3 \end{aligned} \tag{5.2}$$

5.2 Partly Functionalities

Also, one can accept every one of the upstream, downstream and downstream cycles, as to the info and yield chances. Assume that E_k^1, E_k^2, and E_k^3, separately, are to survey the upstream, downstream, and authoritative cycles

of the petrochemical organization viable.

Think about the upstream cycles. In these cycles, three sorts of upstream, hierarchical and network hazards are characterized as info and strength as yield. In like manner, the productivity of this piece of the framework can be characterized as follows:

$$\widetilde{E}_k^1 = w_1^* \widetilde{Z}_1^k / \sum_{i=1}^{3} v_{1i}^* \widetilde{X}_{1i}^k \tag{5.3}$$

Essentially, authoritative cycles produce versatility to upstream cycles just as corporate, outside, and network chances as information sources and flexibility as yields. Utilizing the images in this part, the hierarchical cycles' inspiration is detailed as follows.

$$\widetilde{E}_k^2 = w_2^* \widetilde{Z}_2^k / w_1^* \widetilde{Z}_1^k + \sum_{i=1}^{3} v_{2i}^* \widetilde{X}_{2i}^k \tag{5.4}$$

A comparable condition can be made for downstream cycles. These cycles produce flexibility to hierarchical cycles, alongside downstream, endeavor, and organization based danger as information and yield as yield. Thus, the flexibility of these cycles is defined as follows:

$$\widetilde{E}_k^3 = u_3^* \widetilde{Y}_3^k / w_2^* \widetilde{Z}_2^k + \sum_{i=1}^{3} v_{3i}^* \widetilde{X}_{3i}^k \tag{5.5}$$

Given the lower value of efficiency, relations (5.3)–(5.5) can be considered as the model constraints.

$$\begin{aligned} & w_1^* \widetilde{Z}_1^k / \sum_{i=1}^{3} v_{1i}^* \widetilde{X}_{1i}^k \le 1 \\ & w_2^* \widetilde{Z}_2^k / w_1^* \widetilde{Z}_1^k + \sum_{i=1}^{3} v_{2i}^* \widetilde{X}_{2i}^k \le 1 \\ & u_3^* \widetilde{Y}_3^k / w_2^* \widetilde{Z}_2^k + \sum_{i=1}^{3} v_{3i}^* \widetilde{X}_{3i}^k \le 1 \end{aligned} \tag{5.6}$$

The final model of the resilience assessment of petrochemical processes is formulated by linearizing the above constraints and adding them to model (5.2), as follows.

$$\begin{aligned} \widetilde{E}_k &= \max u_3 \widetilde{Y}_3^k \\ s.t. \ & \sum_{t=1}^{3} \sum_{i=1}^{3} v_{ti} \widetilde{X}_{ti}^k = 1 \\ & u_3 \widetilde{Y}_3^j - (\sum_{t=1}^{3} \sum_{i=1}^{3} v_{ti} \widetilde{X}_{ti}^j) \le 0, \quad j = 1, 2, ..., n \\ & v_{ti}, u_3 \ge \varepsilon, \ i = 1, 2, 3; \ t = 1, 2, 3 \end{aligned} \tag{5.7}$$

$$w_1 \widetilde{Z}_1^j - \sum_{i=1}^{3} v_{1i} \widetilde{X}_{1i}^j \le 0, \quad j = 1, 2, ..., n$$

$$w_2 \widetilde{Z}_2^j - (w_1 \widetilde{Z}_1^j + \sum_{i=1}^{3} v_{2i} \widetilde{X}_{2i}^j) \le 0, \quad j = 1, 2, ..., n$$

$$u_3\widetilde{Y}_3^0 - (w_2\widetilde{Z}_2^j + \sum_{i=1}^{3} v_{3i}\widetilde{X}_{3i}^j) \leq 0, \quad j = 1, 2, ..., n$$
$$v_{ti}, u_3, w_1, w_2 \geq \varepsilon, \ i = 1, 2, 3; \ t = 1, 2, 3 \tag{5.8}$$

Model (5.8) is a fluffy straight programming model whose arrangement requires the advancement of explicit strategies. In the current examination, to settle the fluffy straight model, an alpha-based methodology is utilized which is portrayed beneath.

Utilizing fluffy sets and the α-cut methodology for the proposed DEA model different ways to deal with taking care of fluffy direct programming issues are introduced by specialists. Perhaps the most generally utilized strategies, which depends on Hatami Mabbini, the present amazing and strong is likewise broadly utilized in fluffy information envelopment investigation, the alpha-based methodology. In this methodology, fluffy numbers are supplanted with their alpha cuts and the issue is tackled for various alpha qualities. By definition, the alpha cut of a fluffy set contains all components of the reference set, whose participation in the reference set is at any rate equivalent to the estimation of α.

Given that the fluffy numbers considered in this examination are to assess the kinds of danger and reverberation files of three-sided fluffy numbers, fluffy cuts will be considered for these numbers. For a three-sided fluffy number (l, m, u), the participation work is characterized as follows.

$$\mu = \begin{cases} 0, & x \leq 1 \\ \frac{x-l}{m-l}, & l \leq x \leq m \\ \frac{u-x}{u-m}, & m \leq x \leq u \\ 0, & x \geq u \end{cases}$$

Given the definition of the alpha cut for the membership function, we have:

$$\frac{x-l}{m-l} \geq \alpha \longrightarrow x \geq l(1-\alpha) + \alpha m$$

and

$$\frac{u-x}{u-m} \geq \alpha \longrightarrow x \leq u(1-\alpha) + \alpha m.$$

Subsequently, the alpha remove the three-sided fluffy number contains all the qualities at the stretch $[l(1-\alpha) + \alpha m, u(1-\alpha) + \alpha m]$. By applying the above definition to three-sided fluffy quantities of sorts of dangers and flexibility lists, the alpha cuts of the above files are determined as follows.

$$\begin{aligned}
(X_{11})_\alpha &= [(X_{11})_\alpha^L, (X_{11})_\alpha^U] = [(1-\alpha)X_{11}^1 + \alpha X_{11}^2, \alpha X_{11}^2 + (1-\alpha)X_{11}^3] \\
(X_{12})_\alpha &= [(X_{12})_\alpha^L, (X_{12})_\alpha^U] = [(1-\alpha)X_{12}^1 + \alpha X_{12}^2, \alpha X_{12}^2 + (1-\alpha)X_{12}^3] \\
(X_{13})_\alpha &= [(X_{13})_\alpha^L, (X_{13})_\alpha^U] = [(1-\alpha)X_{13}^1 + \alpha X_{13}^2, \alpha X_{13}^2 + (1-\alpha)X_{13}^3] \\
(X_{21})_\alpha &= [(X_{21})_\alpha^L, (X_{21})_\alpha^U] = [(1-\alpha)X_{21}^1 + \alpha X_{21}^2, \alpha X_{21}^2 + (1-\alpha)X_{21}^3] \\
(X_{22})_\alpha &= [(X_{22})_\alpha^L, (X_{22})_\alpha^U] = [(1-\alpha)X_{22}^1 + \alpha X_{22}^2, \alpha X_{22}^2 + (1-\alpha)X_{22}^3] \\
(X_{23})_\alpha &= [(X_{23})_\alpha^L, (X_{23})_\alpha^U] = [(1-\alpha)X_{23}^1 + \alpha X_{23}^2, \alpha X_{23}^2 + (1-\alpha)X_{23}^3] \\
(X_{31})_\alpha &= [(X_{31})_\alpha^L, (X_{31})_\alpha^U] = [(1-\alpha)X_{31}^1 + \alpha X_{31}^2, \alpha X_{31}^2 + (1-\alpha)X_{31}^3] \\
(X_{32})_\alpha &= [(X_{32})_\alpha^L, (X_{32})_\alpha^U] = [(1-\alpha)X_{32}^1 + \alpha X_{32}^2, \alpha X_{32}^2 + (1-\alpha)X_{32}^3] \\
(X_{33})_\alpha &= [(X_{33})_\alpha^L, (X_{33})_\alpha^U] = [(1-\alpha)X_{33}^1 + \alpha X_{33}^2, \alpha X_{33}^2 + (1-\alpha)X_{33}^3] \\
(Z_1)_\alpha &= [(Z_1)_\alpha^L, (Z_1)_\alpha^U] = [(1-\alpha)Z_1^1 + \alpha Z_1^2, \alpha Z_1^2 + (1-\alpha)Z_1^3] \\
(Z_2)_\alpha &= [(Z_2)_\alpha^L, (Z_2)_\alpha^U] = [(1-\alpha)Z_2^1 + \alpha Z_2^2, \alpha Z_2^2 + (1-\alpha)Z_2^3] \\
(Y_3)_\alpha &= [(Y_3)_\alpha^L, (Y_3)_\alpha^U] = [(1-\alpha)Y_3^1 + \alpha Y_3^2, \alpha Y_3^2 + (1-\alpha)Y_3^3]
\end{aligned} \tag{5.9}$$

The connections of the above condition show the alpha cuts of information, yield, and interface lists in the strength evaluation model. By applying these cuts in the flexibility appraisal model, to discover the DMUk participation work, it is important to figure the upper and lower breaking point of α-cut for the capacity E_k, i.e. $(E_k)_\alpha = [(E_k)_\alpha^L, (E_k)_\alpha^U]$.

In light of the models, Kao [30], and Kao and Hwang [21], the furthest reaches of the model (5.7) will be determined utilizing the model (5.10).

$$
\begin{aligned}
(E_k)_\alpha^U &= \max u_3(Y_3^k)_\alpha^U \\
s.t.\ &\sum_{t=1}^{3}\sum_{i=1}^{3} v_{ti}(X_{ti}^k)_\alpha^L = 1 \\
u_3(Y_3^k)_\alpha^L &- \left(\sum_{t=1}^{3}\sum_{i=1}^{3} v_{ti}(X_{ti}^k)_\alpha^U\right) \\
u_3(Y_3^j)_\alpha^L &- \left(\sum_{t=1}^{3}\sum_{i=1}^{3} v_{ti}(X_{ti}^j)_\alpha^U\right) \le 0,\ j=1,2,...,n,\ j\neq k \\
\widehat{z}_1^k &- \sum_{i=1}^{3} v_{1i}(X_{1i}^k)_\alpha^L \le 0 \\
\widehat{z}_1^j &- \left(\sum_{i=1}^{3} v_{1i}(X_{1i}^j)_\alpha^U\right) \le 0,\ j=1,2,...,n,\ j\neq k \\
\widehat{z}_2^k &- \left(\widehat{z}_1^j + \sum_{i=1}^{3} v_{1i}(X_{2i}^k)_\alpha^L\right) \le 0 \\
\widehat{z}_2^j &- \left(\widehat{z}_1^j + \sum_{i=1}^{3} v_{1i}(X_{2i}^j)_\alpha^U\right) \le 0,\ j=1,2,...,n,\ j\neq k \\
u_3(Y_3^k)_\alpha^U &- \left(\widehat{z}_2^k + \sum_{i=1}^{3} v_{1i}(X_{3i}^k)_\alpha^L\right) \le 0 \\
u_3(Y_3^j)_\alpha^L &- \left(\widehat{z}_2^j + \sum_{i=1}^{3} v_{1i}(X_{3i}^j)_\alpha^U\right) \le 0,\ j=1,2,...,n,\ j\neq k \\
w_1(Z_1^j)_\alpha^L &\le \widehat{z}_1^j \le w_1(Z_1^j)_\alpha^U,\ j=1,2,...,n \\
w_2(Z_2^j)_\alpha^L &\le \widehat{z}_2^j \le w_2(Z_2^j)_\alpha^U,\ j=1,2,...,n \\
v_{ti}, u_3, w_1, w_2 &\ge \varepsilon,\ i=1,2,3;\ t=1,2,3
\end{aligned}
\tag{5.10}
$$

Subsequent to computing the ideal qualities for $v_{ti}^*, u_3^*, w_1^*, w_2^*, z_1^*$ and z_2^*, the model (5.10) gives the exhibition to the entire organization and the three cycle levels as per the accompanying recipe: Suggests:

$$
\begin{aligned}
(E_k)_\alpha^U &= u_3^*(Y_3^k)_\alpha^U \Big/ \sum_{t=1}^{3}\sum_{i=1}^{3} v_{ti}^*(X_{ti}^k)_\alpha^L \\
(E_k^1)_\alpha^U &= z_1^{*k} \Big/ \sum_{i=1}^{3} v_{1i}^*(X_{1i}^k)_\alpha^L \\
(E_k^2)_\alpha^U &= z_2^{*k} \Big/ \left(z_1^{*k} + \sum_{i=1}^{3} v_{2i}^*(X_{2i}^k)_\alpha^L\right) \\
(E_k^3)_\alpha^U &= u_3^*(Y_3^k)_\alpha^U \Big/ \left(z_2^{*k} + \sum_{i=1}^{3} v_{3i}^*(X_{3i}^k)_\alpha^L\right)
\end{aligned}
\tag{5.11}
$$

The plan of the lower furthest reaches of α-cut exhibitions of the proposed model in Figure 3 requires a double capacity of the model (5.12) to get fluffy. Thus, the two-edged and changed rendition of the (5.12)-model is figured and the main concern α-cut is determined as the general effectiveness, alongside the presentation of the three upstream, authoritative and lower-level cycles.

The two-dimensional model of model number (5.1) for the all out dynamic units (DMUk) is determined as follows by Kao and Hwang [21].

$$\begin{aligned}
\widetilde{E}_k &= \min \theta - \varepsilon \left(\left(\sum_{t=1}^{3} \sum_{i=1}^{3} s_{ti}^{v} \right) + s_1^w + s_2^w + s_3^u \right) \\
s.t.\ \theta \widetilde{X}_{1i}^k - \sum_{j=1}^{n} \alpha_j \widetilde{X}_{1i}^j - \sum_{j=1}^{n} \beta_j \widetilde{X}_{1i}^j - s_{1i}^v &= 0,\ i = 1,2,3 \\
\theta \widetilde{X}_{2i}^k - \sum_{j=1}^{n} \alpha_j \widetilde{X}_{2i}^j - \sum_{j=1}^{n} \gamma_j \widetilde{X}_{2i}^j - s_{2i}^v &= 0,\ i = 1,2,3 \\
\theta \widetilde{X}_{3i}^k - \sum_{j=1}^{n} \alpha_j \widetilde{X}_{3i}^j - \sum_{j=1}^{n} \delta_j \widetilde{X}_{3i}^j - s_{3i}^v &= 0,\ i = 1,2,3 \\
\sum_{j=1}^{n} \beta_j \widetilde{Z}_1^j - \sum_{j=1}^{n} \gamma_j \widetilde{Z}_1^j - s_1^w &= 0 \\
\sum_{j=1}^{n} \gamma_j \widetilde{Z}_2^j - \sum_{j=1}^{n} \delta_j \widetilde{Z}_2^j - s_2^w &= 0 \\
\sum_{j=1}^{n} \alpha_j \widetilde{Y}_3^j - \sum_{j=1}^{n} \delta_j \widetilde{Y}_3^j - s_3^u &= \widetilde{Y}_3^k \\
\alpha_j, \beta_j, \gamma_j, \delta_j, s_{ti}^v, s_1^w, s_2^w, s_3^u \geq 0,\ j = 1,2,...,n;\ i = 1,2,3;\ t = 1,2,3 &
\end{aligned} \tag{5.12}$$

Therefore, the lower limit of α-cut of the overall efficiency model (5.13) is:

$$\begin{aligned}
(E_k)_\alpha^L &= \min \varepsilon \left(\left(\sum_{t=1}^{3} \sum_{i=1}^{3} s_{ti}^{v} \right) + s_1^w + s_2^w + s_3^u \right) \\
s.t.\ \theta (X_{1i}^k)_\alpha^U - \left[\alpha_k (X_{1i}^k)_\alpha^U + \sum_{j=1, j\neq k}^{n} \alpha_j (X_{1i}^j)_\alpha^L \right] - \left[\beta_k (X_{1i}^k)_\alpha^U + \sum_{j=1, j\neq k}^{n} \beta_j (X_{1i}^j)_\alpha^L \right] - s_{1i}^v &= 0,\ i = 1,2,3 \\
\theta (X_{2i}^k)_\alpha^U - \left[\alpha_k (X_{2i}^k)_\alpha^U + \sum_{j=1, j\neq k}^{n} \alpha_j (X_{2i}^j)_\alpha^L \right] - \left[\gamma_k (X_{2i}^k)_\alpha^U + \sum_{j=1, j\neq k}^{n} \gamma_j (X_{2i}^j)_\alpha^L \right] - s_{2i}^v &= 0,\ i = 1,2,3 \\
\theta (X_{3i}^k)_\alpha^U - \left[\alpha_k (X_{3i}^k)_\alpha^U + \sum_{j=1, j\neq k}^{n} \alpha_j (X_{3i}^j)_\alpha^L \right] - \left[\delta_k (X_{3i}^k)_\alpha^U + \sum_{j=1, j\neq k}^{n} \delta_j (X_{3i}^j)_\alpha^L \right] - s_{3i}^v &= 0,\ i = 1,2,3 \\
\sum_{j=1}^{n} \beta_j Z_1^j - \sum_{j=1}^{n} \gamma_j Z_1^j - s_1^w &= 0 \\
\sum_{j=1}^{n} \gamma_j Z_2^j - \sum_{j=1}^{n} \delta_j Z_2^j - s_2^w &= 0 \\
\left[\alpha_k (Y_3^k)_\alpha^L + \sum_{j=1, j\neq k}^{n} \alpha_j (Y_3^j)_\alpha^U \right] + \left[\delta_k (Y_3^k)_\alpha^L + \sum_{j=1, j\neq k}^{n} \delta_j (Y_3^j)_\alpha^U \right] - s_3^u &= (Y_3^k)_\alpha^L \\
(Z_1^j)_\alpha^L \leq z_1^j \leq (Z_1^j)_\alpha^U,\ j = 1,2,...,n & \\
(Z_2^j)_\alpha^L \leq z_2^j \leq (Z_2^j)_\alpha^U,\ j = 1,2,...,n & \\
\alpha_j, \beta_j, \gamma_j, \delta_j, s_{ti}^v, s_1^w, s_2^w, s_3^u \geq 0,\ j = 1,2,...,n;\ i = 1,2,3;\ t = 1,2,3 &
\end{aligned} \tag{5.13}$$

By acquiring the ideal arrangement of model number (5.13), the estimations of $s_{ti}^{*v}, s_1^{*w}, s_2^{*w}, s_3^{*u}$ are given to

$v_{ti}^*, w_1^*, w_2^*, u_3^*$ and henceforth, the low framework effectiveness and low execution levels of upstream, authoritative and downstream cycles are determined at the α-cut level as follows:

$$
\begin{aligned}
(E_k)_\alpha^L &= u_3^*(Y_3^k)_\alpha^L / \sum_{t=1}^{3}\sum_{i=1}^{3} v_{ti}^*(X_{ti}^k)_\alpha^U \\
(E_k^1)_\alpha^L &= w_1^* z_1^{*k} / \sum_{i=1}^{3} v_{1i}^*(X_{1i}^k)_\alpha^U \\
(E_k^2)_\alpha^L &= w_2^* z_2^{*k} / \left(w_1^* z_1^{*k} + \sum_{i=1}^{3} v_{2i}^*(X_{2i}^k)_\alpha^U \right) \\
(E_k^3)_\alpha^L &= u_3^*(Y_3^k)_\alpha^L / \left(w_2^* z_2^{*k} + \sum_{i=1}^{3} v_{3i}^*(X_{3i}^k)_\alpha^U \right)
\end{aligned}
\tag{5.14}
$$

The variable estimations of α in models of (5.10) and (5.13) are 0 and 1, separately. These qualities are significant and used to cover the result of these two models. On the off chance that alpha is zero ($\alpha = 0$), at that point the scope of all conceivable exhibition scores for various alpha qualities is resolved. Also, at alpha level 1 ($\alpha = 1$), the most plausible presentation scores are gotten for dynamic units. Hence, utilizing execution scores for various alpha qualities and imparting underneath or more these exhibition scores, the enrollment capacity of the fluffy flexibility levels of the store network chances is resolved. This prompts the estimation of danger and framework strength (the whole inventory network) and the appraisal of the inventory network layers and, at last, the danger/reasonability proportions between the dynamic units and the different cycles of the climate.

In the following segment, the proposed DEA network fluffy model is tried utilizing 150 transitional and ranking directors of nine Iranian petrochemical organizations.

The petrochemical organizations studied are:

1. Kharkov Petrochemical Company
2. Isfahan Petrochemical Company
3. Shazand Petrochemical Company
4. Bandar Imam Petrochemical Company
5. Shiraz Petrochemical Company
6. Tabriz Petrochemical Company
7. Khorasan Petrochemical Company
8. Kermanshah Petrochemical Company
9. Bisotun Petrochemical Company

5.3 Tools for research and data collection

The principle technique used to gather the information required for the current examination is the set of experiences, hypothetical foundation and library reports identified with the subject, which can be utilized from their discoveries and discoveries at various phases of the exploration.

To test and present the exhibition assessment model, we can utilize an affixed or snowball inspecting strategy (which means recognizing individuals who are qualified and have important data for the chose people).

The development of the examination model is utilized to choose the example from the blend of deliberate making a decision about techniques and snowball strategy, which is a non-probabilistic technique. Along these lines, the work starts with individuals who are specialists in the field and have the vital models, and, while asking questions, they are approached to be acquainted with different specialists in this field. Along these lines, aside from the initial not many individuals who are straightforwardly chosen by the specialist based on the measures being referred to, different specialists are chosen notwithstanding the standards of greatness by different specialists. Then again, examining sufficiency will be accomplished by hypothetical inspecting technique. In this strategy, the examining proceeds to the degree that the model arrives at the restriction of creation and immersion.

The underlying trial of the model shows the satisfactory degree of interior supportability, with Cronbach's alpha higher than 0.8 [5] and the focalized legitimacy is above 0.7 [7].

Furthermore, all heap factors were above 0.45 and no proof of cross-reference stacking was found. Since factors have an alternate recurrence dispersion, this investigation utilized Tabachnick and Fidel's Threshold Levels [**?**], with the end goal that: 0.32 equivalent to the frail, 0.45 reasonable, 0.55 great, 0.63 Very great and 0.71 was viewed as phenomenal. Taking into account that the example size was 150, this number had the important capacity to accomplish significant outcomes [8].

To test the model, 150 senior and center chiefs from 9 Iranian petrochemical organizations, to rank the danger versatility of the organizations they were utilized, just as danger and danger evaluation of

upstream, hierarchical and the disadvantage of these organizations was analyzed. In any case, the motivation behind this examination was to focus on danger and model suitability.

The base, greatest and normal work insight of the members in this test was 3, 15, and 6.5 years, individually. The segment data of people is appeared in Table 2.

Table 2: Demographic data of participants n=130

	No	**percentage of whole**	**Aggregate percentage**
Sex			
Woman	22	17	17
Man	108	83	100
Total	130	100	
Age			
30 >	7	6	6
30-60	84	67	72
60 <	35	28	100
Total	126	100	
Petrochemistry			
Khark	9	7	7
Esfahan	15	12	19
Shazand	17	13	33
Bandar Imam	11	9	41
Shiraz	13	10	52
Tabriz	20	16	67
Khorasan	16	13	80
Kermanshah	11	9	89
Bistoon	14	11	100
Total	126	100	

6 Results

In Table 3, the upper and lower scores of the store network are utilized for nothing and one alpha (three for each layer).

Table 3: Normal three-sided fluffy numbers extricated for information sources, yields and info/yield interfaces of the three-layer store network

Petrochemistry	x_{11}	x_{12}	x_{13}	x_{21}	x_{22}	x_{23}	x_{31}	x_{32}	x_{33}	z_1	z_2	y_3
Jam	(3,5,5.3,7)	(4,5,8,7.4)	(4.1,5.8,7.1)	(3.6,5.5,7)	(4.4,6.1,7.8)	(4.1,6,7.4)	(2.5,4,5.9)	(3.1,4.6,6.1)	(2.9,4.1,5.9)	(2.6,3.9,5.6)	(2.1,2.4,5.3)	(3,4.4,5.9)
Bandar Imam	(2.9,4.5,6.1)	(2.6,4.1,6.1)	(3.9,5.4,6.8)	(2.1,3.4,5.1)	(2.8,4,5.8)	(3.5,5.1,6.5)	(2.4,5,6.6)	(2.8,4.4,6.3)	(3.6,5.5,6.9)	(3.9,5.5,7)	(2.8,4.3,6.1)	(3.8,5.4,6.9)
Esfahan	(3.5,5.1,6.8)	(3.5,5.1,6.9)	(4.3,6,7.3)	(3.4,5,6.6)	(3.3,5.3,7)	(3.1,4.6,6.1)	(2.4,4.1,6)	(3.3,5,6.8)	(3,4.4,6)	(4,5.5,6.9)	(3.5,5.1,7)	(3.9,5.6,7.1)

Alongside the announced outcomes in the chain of significant worth chain identified with "Bandar Imam" petrochemicals demonstrated the greatest generally speaking flexibility with hazard, so its productivity score $\widetilde{E}_k = 0.76$ in

Shiraz	(3.4,5,6.5)	(2.7,4.3,5.9)	(3.9,5.4,6.9)	(3.8,5.6,7.1)	(3.1,4.8,6,3)	(4.3,6.3,7.8)	(4,5.9,7.4)	(4,6.7,3)	(3.1,4.9,6.6)	(2.8,4,5.8)	(4,5.8,7.1)	(4.8,6.6,8.1)
Qeshm	(2.8,4,5.6)	(3.5,4.9,6.5)	(4.4,6,7.5)	(2.4,3.8,5.8)	(3.3,4.9,6.6)	(4.1,6,7.5)	(3,8,5.1,6.5)	(3.4,4.9,6.4)	(3.4,4.6,6.4)	(3.5,5,6.4)	(3,4.6,6.4)	(4,5.8,7.1)
Shazand	(3.1,4.6,6.4)	(3.5,4.6,6.4)	(3.3,4.8,6.4)	(2.9,4.5,6.5)	(5.4,7.4,8.4)	(2.1,4.8,6.3)	(3.3,4.9,6.5)	(2.3,3.4,5.1)	(3.1,4.9,6.4)	(4.3,5.9,7)	(2.4,4.5,9)	(2.9,4.6,6.5)
Tabriz	(2.9,4.3,6.1)	(3.6,5.5,7.1)	(4.5,5.6,8)	(2.9,4.3,6.1)	(4.1,5.9,7.4)	(3.9,5.4,6.6)	(4,6,7.5)	(3.1,4.9,6.6)	(2.8,4.4,6.1)	(3.1,4.6,6.5)	(3.8,5.4,6.9)	(3.3,4.5,6)
Maroun	(2.9,4.5,6.1)	(2.9,4.1,5.9)	(2.9,4.5,6.3)	(4.1,6.1,7.8)	(3.8,5,6.3)	(3.4,4.8,6.4)	(3.1,4.5,6.3)	(3.4,9,6.8)	(3.6,5.4,6.9)	(2.3,3.6,5.5)	(4.3,4.9,6.6)	(3.3,4.5,5.6)
Fanavaran	(4,5.6,7)	(3.3,4.7,6.4)	(4,5.8,7.5)	(3.4,5.1,6.8)	(3.7,5.5,7.2)	(3.7,5.5,6.9)	(3.2,4.6,6.1)	(3.4,4.8,6.5)	(3.4,5.16.7)	(3.9,5.8,7.5)	(3.2,4.5,6.4)	(3.5,5.1,6.6)

alpha was 1. At that point, there were Shazand petrochemical production network $\widetilde{E}_k = 0.69$ and Shiraz petrochemical supply chain $\widetilde{E}_k = 0.63$ in the following levels regarding flexibility. These outcomes demonstrate is a generally serious level of versatility to the store network danger in these organizations. Besides, the outcomes for each layer of the worth chain are contrasted with one another to rank the effectiveness of every one of the worth chain layers. As showed in Table 3, these scores don't really need to coordinate the general productivity rating of the worth chain. Given that the estimations of $\alpha = 0$ and $\alpha = 1$ decide the left, right and center of the three-sided fluffy numbers, in light of this, the computation of the effectiveness scores in these estimations of the absolute fluffy proficiency score will be resolved. For instance, albeit the "Jam" petrochemical chain is in fourth spot, as far as flexibility to the danger of downstream cycles ($\widetilde{E}_k^2 = 0.58$), was at a superior status Compared to the next two stock chains (which rank second and third). In another model, Qeshm petrochemical production network, positioned seventh, has the second-most noteworthy score ($\widetilde{E}_k^1 = 0.84$) as far as the effectiveness of downstream cycles. As demonstrated in the table, there are huge contrasts in the effectiveness of the three fundamental layers for the three best-performing supply chains. Shazand petrochemical inventory network which is positioned second, has assigned a higher strength to chance than the upstream cycles of Bandar Imam petrochemical production network which positioned first. In addition, Tabriz Petrochemical Supply Chain is positioned first in the store network strength to authoritative dangers.

Table 4: The scores of fuzzy efficiency in the three-layer supply chain

	a=0					**a=1**			
petrochemistry	Total ranking	Total (LB,UB)	Layer 1 (LB,UB)	Layer 2 (LB,UB)	Layer 3 (LB,UB)	Total (LB,UB)	Layer 1 (LB,UB)	Layer 2 (LB,UB)	Layer 3 (LB,UB)
Jam	4	(0.2,1)	(0.05,0.76)	(0.09,0.54)	(0.51,0.68)	(0.58,0.58)	(0.06,0.06)	(0.11,0.11)	(0.58,0.58)
Bandar Imam	1	(0.27,1)	(0.07,0.74)	(0.12,0.82)	(0.49,0.97)	(0.76,0.76)	(0.09,0.09)	(0.15,0.15)	(0.97,0.97)
Esfahan	6	(0.27,1)	(0.06,0.86)	(0.18,0.88)	(0.29,0.61)	(0.46,0.46)	(0.09,0.09)	(0.18,0.18)	(0.46,0.46)
Shiraz	3	(0.34,1)	(0.05,0.88)	(0.20,0.95)	(0.13,0.56)	(0.63,0.63)	(0.06,0.06)	(0.21,0.21)	(0.34,0.34)
Qeshm	7	(0.30,1)	(0.06,0.83)	(0.15,0.57)	(0.28,0.88)	(0.44,0.44)	(0.08,0.08)	(0.16,0.18)	(0.84,0.84)
Shazand	2	(0.21,1)	(0.08,0.90)	(0.10,0.38)	(0.19,1)	(0.69,0.69)	(0.10,0.10)	(0.13,0.13)	(0.53,0.53)
Tabriz	5	(0.21,1)	(0.06,0.80)	(0.18,0.53)	(0.33,0.91)	(0.48,0.48)	(0.08,0.08)	(0.21,0.21)	(0.7,0.7)
Maroon	9	(0.24,1)	(0.05,0.64)	(0.10,0.66)	(0.19,0.88)	(0.36,0.36)	(0.05,0.05)	(0.16,0.16)	(0.58,0.58)
Fanavaran	8	(0.23,1)	(0.07,0.92)	(0.16,0.76)	(0.18,0.70)	(0.44,0.44)	(0.08,0.08)	(0.16,0.16)	(0.46,0.46)

Table 4: Fluffy effectiveness scores in the three-layer production network as indicated by the consequences of Table 5, the overall productivity of the aggregate and the layers of the units are summed up as per the table.

Table 5: The scores of fuzzy efficiency in the three-layer supply chain

petrochemistry	**Total ranking**	**Total**	**Layer 1**	**Layer 2**	**Layer 3**
Jam	4	(0.2,0.58,1)	(0.05,0.06,0.76)	(0.09,0.11,0.543)	(0.51,0.58,0.68)
Bandar Imam	6	(0.27,0.76,1)	(0.07,0.09,0.74)	(0.12,0.15,0.82)	(0.50,0.97,0.97)
Esfahan	6	(0.27,0.46,1)	(0.06,0.09,0.86)	(0.18,0.18,0.88)	(0.29,0.46,0.61)
Shiraz	3	(0.34,0.63,1)	(0.05,0.06,0.88)	(0.20,0.21,0.95)	(0.13,0.34,0.56)
Qeshm	7	(0.30,0.44,1)	(0.06,0.08,0.84)	(0.15,0.16,0.57)	(0.28,0.84,0.88)
Shazand	2	(0.21,0.69,1)	(0.08,0.10,0.90)	(0.10,0.13,0.38)	(0.19,0.53,1)
Tabriz	5	(0.21,0.48,1)	(0.06,0.07,0.8)	(0.18,0.21,0.53)	(0.33,0.7,0.91)
Maroon	9	(0.24,0.36,1)	(0.05,0.05,0.64)	(0.10,0.16,0.66)	(0.19,0.58,0.88)
Fanavaran	8	(0.23,0.44,1)	(0.07,0.08,0.91)	(0.16,0.16,0.76)	(0.18,0.46,0.70)

From Table 4 and 5, albeit a production network framework might be exceptionally strong to its danger chiefs, its layers are still in danger, and this necessitates that the flexibility model be utilized properly to cover all dangers.

In the event that these dangers are not decreased appropriately and at the correct time, they can influence inventory network versatility and give potential to store network weakness. In this way, albeit a store network might be at an ideal level regarding by and large flexibility and danger reaction, it should in any case be delicate to its weaknesses and weaknesses in various layers. As indicated by new inventory network speculations, the effectiveness of this chain isn't centered exclusively around proficiency assessment frameworks, yet on every part. Hence, appraisal of production network strength against startling dangers and occasions is a significant issue. Danger and disappointment in the production network can significantly affect short-run effectiveness just as a negative since quite a while ago run impact on monetary proficiency of the association. Thusly, store network hazard the board is important to diminish the dangers of different dangers, for example, questionable financial cycles, dubious client interest, and erratic regular and human occasions, and numerous scientists have accentuated its significance. Incorporated appraisal of this issue includes assessing the inventory network framework just as its segments. This is critical in light of the fact that, as per new production network hypotheses, the proficiency of this chain isn't centered simply around the productivity assessment framework, however on every segment.

7 Research questions

What design does the petrochemical inventory network have?

In light of the figure underneath, the three-section production network model incorporates upstream, hierarchical, and downstream cycles, and the degrees of danger and flexibility related with them, just as the sources of info and yields between and among the cycles of the association. The accompanying figure shows the three-section store network model, including upstream, downstream and downstream cycles, and their connected danger and versatility levels, just as data sources and yields between and among authoritative cycles. Conceivably, hazards influence every one of the three parts of the store network, and can meddle with operational cycles, which eventually will devastatingly affect the whole inventory network. Accordingly, the more noteworthy the weakness of the parts of the inventory network (counting providers, producers and wholesalers), the flexibility of these segments in operational issue will be less [10]. Subsequent to examining various sources identified with the elements or ideas influencing the cycles of production network of the petrochemical business in the country and contrasting it internationally with conclude it to give a far reaching model proper to the cycles of the native inventory of this industry, and to gather various gatherings with specialists Related and with the displaying of the reference model and the reasonable changes in it, the rundown of the accompanying as a factor or related ideas for use and usage, considering the issues of the store network in the nation, is proposed in the structure of the SCOR model.

Table 6: Variables identified with production network measures in the petrochemical business dependent on well-qualified assessment

Upstream processes (supplier)	**Organizational processes (manufacturer)**	**Downstream processes (distributor)**
Upstream risks	Organizational risks	Downstream risks
Output risks	Output risks	Output risks
Network risks	Network risks	Network risks
Supplier resilience	Manufacturer resilience	distributer resilience

Accordingly, the cycle of this present industry's work is at the upstream level (provider) or maker level, and eventually the downstream (wholesaler) level having its own intricacy prerequisites, which in this setting need not be definite or their particular qualification. The utilization of the SCOR model is a diagram of the general work process of the inventory network interaction of the petrochemical business, as demonstrated in Figure 4.

What are the information, yield, and middle markers between the various strides of this chain?

In the accompanying, a three-venture production network model that incorporates upstream, authoritative and downstream cycles, their related dangers and their versatility levels (as sources of info and yields of between hierarchical cycles) it has been appeared. Consequently, the flexibility levels of the upstream layers of the store network are appeared as yields and can be considered as contributions of the downstream layers. Fig. 5. As demonstrated in the figure, upstream dangers ($\widetilde{X}_{11}$), yield ($\widetilde{X}_{12}$), network ($\widetilde{X}_{13}$), as the information and strength of provider ($\widetilde{Z}_1$) as the interface yield of the upstream interaction influences the provider activities. This strength is truth be told the yield of upstream cycles and the moderate contributions of authoritative cycles. Thus, hierarchical dangers ($\widetilde{X}_{21}$), yield ($\widetilde{X}_{22}$), and organization ($\widetilde{X}_{23}$), were viewed as information and the producer flexibility ($\widetilde{Z}_2$) was considered as the as the yield of the interfaces of authoritative cycles or a middle person job, the part of the yield of these cycles

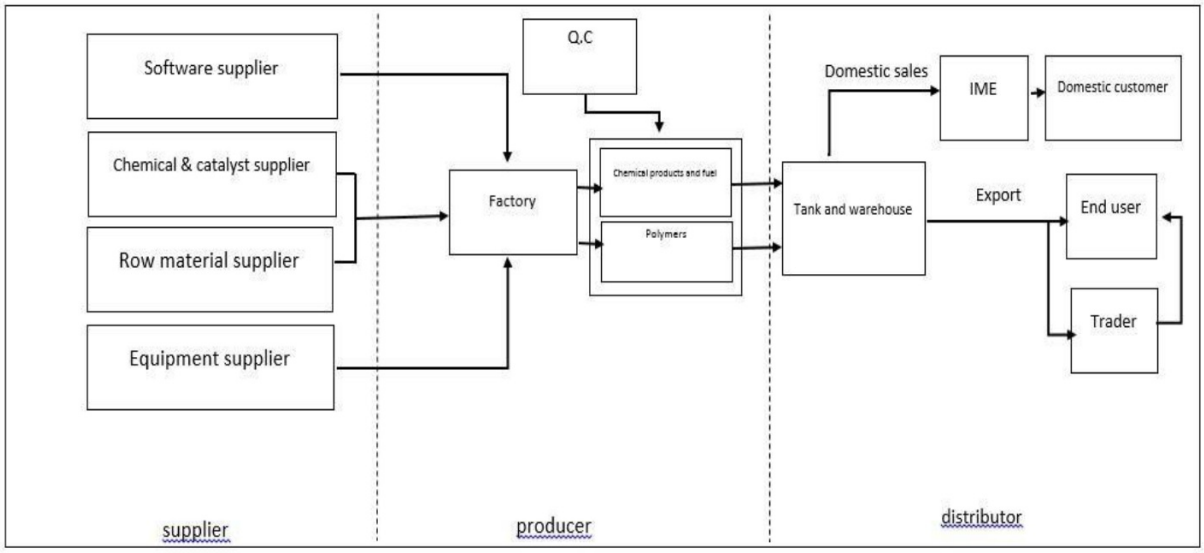

Figure 4: Generality of the cycle of the store network of the petrochemical business

and the contribution of downstream cycles. At long last, considering the maker flexibility as a middle information and downstream danger ($\widetilde{X}_{31}$), yield ($\widetilde{X}_{32}$), and organization ($\widetilde{X}_{33}$) were considered as the information and producer strength ($\widetilde{Y}_3$) was considered as the yield of downstream cycles the sign " $\sim$ " Represents fluffy estimations of danger and versatility levels.

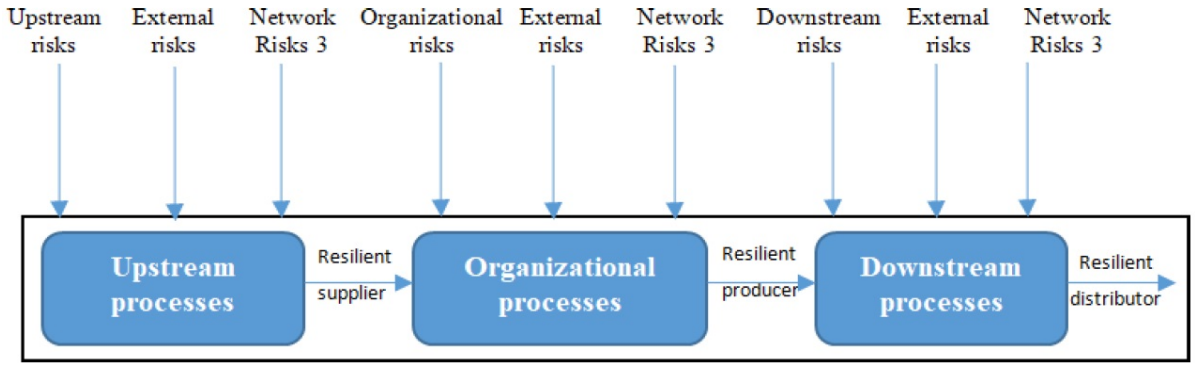

Figure 5: Three-step of Supply Chain Model

What numerical model is utilized in organization information envelopment examination to assess the versatility of dangers in this chain?

In the current examination, an organization model was utilized to assess the strength of production network, an organization model was utilized for investigating the productivity of upstream, hierarchical, and downstream cycles of petrochemical organizations. For each layer of inventory network measures, four productivity scores are estimated. Effectiveness of upstream, hierarchical, and downstream cycles alongside the general proficiency of the production network framework. The whole cycle of the framework is considered as a black box and the entire chain productivity is formed utilizing the Kao and Hwang [15] model of model number (5.14), in which the target work looks to boost the all-out choice units. The requirements of the issue demonstrate that the viability of all dynamic units ought to be short of what one.

Partial efficiencies

Also, one can pass judgment on the strength of every one of the upstream, downstream and downstream cycles with respect to the info dangers and yield flexibility. In the upstream cycles, three classes of upstream, hierarchical, and network-characterized hazards as info and flexibility are characterized as yield, as defined in model (5.3). Also, hierarchical cycles create upstream cycles, alongside authoritative, yield, and organization chances as data sources and flexibility as yields. versatility of hierarchical cycles is defined as model (5.4). A comparable arrangement is made

according to downstream cycles, these cycles create flexibility to authoritative cycles, alongside downstream, venture, and organization hazard as info and strength as yields. Subsequently, the versatility of these cycles is formed as per Model (5.5). Given the more modest incentive than the presence of the productivity esteems, relations (5.3)–(5.5) can be considered as the type of the limits of model (5.6). By linearizing the above limitations and adding them to the model (5.2), a definitive model (5.6) for ascertaining the versatility of petrochemical measures has been detailed, being a fluffy direct programming model, which we can extricate layer parts from this model. The answer for this model requires the advancement of explicit techniques, given that the information gathered is of a fluffy sort. In view of the standards of the frameworks of vulnerability, the arrangement got was dubious. In the current investigation, to address the fluffy straight model, an alpha-based way to deal with fluffy critical thinking is utilized. Various methodologies were proposed by specialists to take care of the fluffy direct programming issues. Quite possibly the most pragmatic methodologies is the alpha-based methodology. In this methodology, fluffy numbers are supplanted by their alpha cuts and the issue is settled for different alpha qualities. Alpha cutting a fluffy set comprises of all components of the reference set, whose participation in the reference set is in any event equivalent to the alpha worth. As to utilization of three-sided fluffy numbers, by addressing the planned model at the levels $\alpha = 0$ and $\alpha = 1$, the lower and upper requirements and the center proficiency of the petrochemical organizations were acquired.

How is the effectiveness of petrochemical organizations assessed as far as versatility to chances dependent on the planned model?

To assess the productivity of organizations, file information is gathered through a poll. For this reason, a survey was disseminated among 50 senior and center directors of the petrochemical business. At that point, the normal assessments of every petrochemical master in the significant record were estimated dependent on table 5. In the following stage, the planned model is settled utilizing MATLAB programming and the outcomes are acquired. By alluding to the table in the general rating section, the position of every petrochemical organization is from 1 to 9 alongside the detailed outcomes in the chain of significant worth chain identified with "Bandar Imam" demonstrated the most elevated by and large versatility with hazard. These outcomes demonstrate that there is a moderately serious level of versatility to the store network danger in these organizations. Notwithstanding, the outcomes for each worth chain layer are contrasted with one another to rank the productivity of every one of the worth chain layers. As demonstrated in Table 4, these scores don't really need to coordinate the general productivity rating of the worth chain. Given that the estimations of $\alpha = 0$ and $\alpha = 1$ decide the left, right and center of the three-sided fluffy numbers, in like manner, the count of the productivity scores in these estimations of the absolute fluffy effectiveness score will be resolved. As shown in the table, there are critical contrasts in the proficiency of the three principle layers for the three upstream stockpile chains. The Shazand Petrochemical Supply Chain, which is positioned second, was protected to a higher danger than the upstream petrochemical production network, Bandar Imam, which positioned first. Furthermore, Tabriz petrochemical production network is positioned first in the store network strength with hierarchical dangers. In the interim, with respect to the yield of the models in the table, the effectiveness of this model, the two parts of the inventory network framework and its segments, is incorporated and it was demonstrated that the conversation of the entire framework and separate segments ought to be respected. We need to assess the entire set and the parts, and for various segments or separate layers we can have a particular related proposition. Table 5 demonstrates the effectiveness scores of the three best inventory chains (counting the Imam Port Band, Shazand Petrochemical Complex and Shiraz Petrochemical Complex).

8 Conclusion

As indicated by the outcomes got in the model, the aftereffects of the store network consequences of the three organizations with a higher worth chain than distinguishing factors with higher dangers in various layers and to arrive at the ideal level can be applied at information sources and outlets roll out the important improvements. Since conceivably, the danger influences every one of the three parts of the production network and can meddle with operational cycles, which at last will damagingly affect the whole production network. Subsequently, the degree to which the parts of the production network including providers, makers, and merchants), the flexibility of these segments in the operational issues will be lower, segment dependability levels are considered as yields of each model interaction that are considered as contributions for the following cycle. In a specific segment (as the provider) it is more powerless against chances, the disturbance of these dangers in a specific segment can contrarily affect the following parts of the inventory network, for instance, if a provider is because of unforeseen occasions It can prompt interruptions in the key business measures, it is unimaginable to expect to give the maker's crude materials at the ideal time, and consequently the effect of the malignant occasion can influence the producer's activities, (for example, lessening creation and expanding costs). Furthermore, as per Table 5, which shows that albeit a production network framework might be hazard disinclined to its chiefs, its layers are still in danger. In light of the consequences of Table 5 underneath, in the upstream dangers, the

most genuine danger to the store network of every one of the three petrochemicals, in particular, is belonged to Bandar Imam Khomeini, Shazand and Shiraz. In Imam Khomeini's petrochemicals, the most undermined is the principal layer and the subsequent layer, while in the third layer, the dangers are exceptionally acceptable. In this unique situation, the speculation should be made in the upstream and hierarchical cycle. In the Shazand petrochemicals, the greatest danger to the principal layer is the necessity to contribute a ton on the provider's layer, and in the third-positioned petrochemical organization "Shiraz", it is as yet the most worry for the main layer requiring greater venture while in the primary layer between these three petrochemicals, the greatest danger is to Shiraz petrochemicals, while in the subsequent layer, Shazand petrochemicals are more defenseless and in the third layer, albeit every one of the three are in a superior condition, however the petrochemicals "Shiraz" is more helpless than the others. At long last, the outcomes recommend that albeit a store network framework may have a higher danger than different dangers while its layers are still at improved danger.

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