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Research Article

Green Supply Chain Management for Condensate Storage Tanks Using Integrated Methods of DEMATEL and ANP (Case Study: Gas Phases of South Pars Area)

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Abstract
Recently, in most of the condensate tank production projects, two main activities of welding and painting are done in manual and automatic ways. The purpose of this study is "green supply chain management" of these activities in order to select the best production method. For this purpose, by literature reviews and using Delphi and DEMATEL techniques, the indicators and sub-indicators of green supply chain of condensate storage tanks and their internal relations were identified. The indicators were weighted and ranked by ANP method. Ultimately, the best way to build "condensate storage tanks" was determined. Among the 8 main indicators and 35 sub-indicators, “financial risk” was recognized as the most influential indicator and categorized in the cause group. The “reverse logistics” was found to be the most effective indicator and classified in the effect group. The “environmental management” was the indicator engaged in most interaction with the other factors. Overall, the environmental management indicator, with a weight of 0.35172, ranked first and “supply risk” indicator, with a weight of 0.00357, was recognized as the least important indicator. The strategy of “automatic painting and welding of large tanks”, with a weight of 0.21537, was selected as the best construction method of the tanks. The results showed that, by the integrated use of DEMATEL and ANP methods, more accurate ranking of options would be achieved.

Key words: Green supply chain management, Condensate storage tanks, DEMATEL, ANP

Introduction
Oil industry and revenues from the export and sale of crude oil have a very important place in the economic policies and interactions at international and national levels. Iran is a developing country whose economy is heavily dependent on oil and gas exports (Ardestani et al. 2017). Accordingly, the following goals have been outlined in the 20-year Vision Plan of Iran in the field of petroleum industry by the year 2025:

- Maintain Iran's position as the second largest producer of crude oil in OPEC, which requires keeping a good distance, in terms of production capacity, with other competitors;

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- Achieve second place in the global natural gas production capacity, according to the necessity of using common gas fields; and
- Achieve first place in the Middle East in terms of refining capacity and production value of petrochemicals in order to create the highest added value from the country's hydrocarbon resources (PBOI, 2003).

In recent years, environmental issues have severely affected the everyday life of human beings, and green activities are suggested as one of the approaches to reducing the problems caused by these issues. (Jing et al. 2019, Abdollahzade et al. 2018). Increased competition, stringent environmental regulations, and public pressure are forcing companies to consider environmental factors in their strategic planning (Kazancoglu et al. 2018). Accordingly, establishing sustainable industries is one of the main goals of organizations at present time. To achieve this sustainability, organizations must play a vital role and regard their external environment as a concern. Recently, companies have considered green supply chain management (SCM) as a competitive advantage over their competitors.

Among the reasons for this approach can be pointed to "increasing number of international conventions on climate change", "strengthening global environmental protection regulations", "environmental demands of stakeholders and investors", and "preference of consumers for environmentally friendly products" (Chun et al, 2015).

The supply chain is an important part of “operations management” and has significant impacts, such as the release of materials and pollutants into the environment, health risks, etc. Organizations are trying to minimize the environmental impacts by integrating environmental concerns into their supply chain operations, which is referred to as Green Supply Chain Management (GSCM) (Sarkis, 2012; Tseng et al. 2019; Asgharizadeh et al. 2019). Although the concept of GSCM can be traced back to the early 1990s, it has gained popularity in the scientific journals after 2000 (Fahimnia et al, 2015; Seuring and Muller, 2008; Tseng et al, 2019). Green practices, such as GSCM have long been used to develop the “developed countries”; however, this green action still needs attention in developing countries (Jing et al, 2019). The cultural factors are one of the parameters influencing the implementation of GSCM (Golicic and Smith, 2013; Jing et al, 2019). As pointed out by Chavez et al., to attract potential consumers and client for whom green products and services matter and enjoy the competitive advantage of these markets, many companies around the world have used these environmentally friendly practices(Chavaz et al, 2015). GSCM's concerns in the construction industry include protecting the environment, gaining economic benefits and solving social problems, and ultimately minimizing the negative effects of the supply chain on the environment (Jing et al, 2019).

GSCM has important goals in relation to environmental performance. These goals include controlling risks, meeting market expectations, achieving good organizational performance, and complying with the rules (Jing et al, 2019). Since GSCM has an interdisciplinary and multi-objective nature, a systematic model is needed to evaluate its performance (Kazancoglu et al, 2018). Risk and uncertainty terms are used interchangeably, although they are not the same (Colicchia and Strozzi, 2012).Knight distinguishes between risk and uncertainty. He claimed that risk is often measurable, while uncertainty cannot be measured (Knight, 1921). Different definitions have yet been provided on the concept of risk in the supply chain. Supply chain risk management is defined as "identifying potential sources of risk and implementing appropriate strategies, through a coordinated approach among supply chain members, in order to reduce vulnerability of the supply chain” (Christopher et al, 2003). The main purpose of supply chain risk management is to protect the business from adverse events (Colicchia and Strozzi, 2012).

Inefficient supply chain risk management leads to higher costs, production delays, machinery failure, and ultimately cancellation of programs (Badea et al, 2014). In this regard, supply chain managers face a long list of green schemes that can be incorporated into the different stages of supply chain. However, the problem is that resource constraints hinder implementation of all of these initiatives (Porter and Kramer, 2006; Masoumik et al, 2015). Therefore, managers need to make strategic choices to gain more competitive advantages over green supply chain initiatives (Masoumik et al, 2015).

Accordingly, it is inevitable to identify and apply techniques that are able to compare and rank factors and ultimately select the best strategies. The DEMATEL method was first developed by the Battelle Memorial Institute in the Sciences and Humanities Program to study and solve complex and intertwined problems using hierarchical approaches (Lin et al. 2011; Shieh et al. 2010; Wang Et al. 2012; Wu et al. 2010). Traditional techniques are based on the assumption that the elements should be independent in terms of relationships, while DEMATEL method does not require such an assumption. In contrast, this method uses structural modeling techniques to identify possible interdependencies between the elements in a system by constructing differentials to show the causal relationships and the powers of influence among them (Liou et al. 2007; Shieh et al. 2014; Tzeng et al. 2007; Wu and Tsai, 2011).

The ANP method is a more general and extended form of the AHP (Analytical Hierarchy Process) that uses a network structure, consisting of clusters and elements within them, as well as the inter-element relationships for prioritization purposes. In this study, ANP and DEMATEL methods were used to rank and prioritize the factors (Chemweno et al. 2015; Masumic et al. 2015).

Delphi is defined as a method for discovering and correcting group judgments. The method is based on predictions. The method is recommended for solving subjective and group decision-makings or judgments. It can also be effective when group-formation is not possible for some reasons, such as temporal, spatial, and personality mismatches. Although it is costly to have a physical presence, holding face-to-face meetings would help efficient implementation of this method. In the present study, this method was used to identify and screen GSCM indicators (Crawford and Wright, 2016).

Vertical cylindrical vessels with floating roofs are often used for storing crude oil and petroleum products. In addition, these tanks can be effective in reducing vapor emissions, corrosion, and fire hazards. Modern floating roof tanks are usually of two types. The first type has one roof, while the second type has two floating roofs (Gallagher, 2003; Pan et al. 1986; Sun et al. 2007). Many studies have been conducted over the years on floating roof tanks, their computational methods, and their design (Mitchell,1973; Yoshida,1983).In general, welding and painting processes constitute the two main stages of tank construction that can be done either manually or automatically. Automatic welding systems are rapidly replacing manual systems. One of the benefits of this replacement is that work force will have more time to spend for more creative works. The largest number of automatic systems in industry serves the processes of welding, painting, and displacing equipment (Ryuh et al. 2006). Nowadays, it is well established in the industrialized countries that the use of automated equipment increases efficiency and quality in many aspects. Nowadays, automated systems are known as intermittent production techniques, which improve the performance of industries both quantitatively and qualitatively. Welding techniques are classified into manual, semi-automatic, mechanized, automatic, and robotic methods.

Manual welding is a kind of welding technique in which the torch or electrode is held manually by man, while the automatic welding is done by a robotic device. In robotic and automatic welding techniques, welder's performance is a guarantee of welding quality. Welding defects are detected by periodic inspections, and based on which, repair and maintenance programs are implemented (Lima and Bracarense, 2011).

Iran, as a rapidly developing country, whose economy is enriched by oil and gas exports, has to integrate Green Economy concept into its energy sector. Currently in Iran, welding and painting processes of the construction of condensate storage tanks are done using manual methods. If the attitude of the industry managers shifts over the use of automatic systems, increasing productivity and reducing the environmental impacts of this industry will be expected in the future. Hu and Hsu, through a variety of studies, have identified twenty-five key factors in GSCM, some of which include "Observing environmental requirements in purchasing items", "implementing the processes of green purchasing", "green design", "environmental policies for GSCM", and "establishing an environmental risk management system for GSC" (Hu and Hsu, 2006). Wu and Chang used DEMATEL technique to select GSCM factors. Their findings showed that environmental policy and senior management support are important factors in implementing GSM. These two factors should be given the highest priority for action (Wu and Chang, 2015). Masumik et al. developed a conceptual model for prioritizing GSCM strategies, which was based on the combination of ANP and SEM methods. They also suggested the use of conceptual models for future research (Masumik et al. 2015). Chemweno et al. used ANP technique to select a suitable risk assessment method among the three FTA, FMEA, and BN methods for equipment repair. Their results confirmed the usefulness of the proposed method to assist repair and maintenance operations (Chemweno et al. 2014). Kazancoglu et al. used Fuzzy DEMATEL method to evaluate GSCM performance in a cement industry. By specifying the causal relationships and the priorities of the relevant criteria, they developed a comprehensive model for performance evaluation, consisting of 6 criteria and 21 sub-criteria. The identified criteria in their model include environmental performance, economic and financial performance, executive performance, logistics performance, organization performance, and marketing performance (Kazancoglu et al. 2018).

GSCM provides a great opportunity for those concerned about sustainability issues and environmentally friendly business practices. Companies must rethink about the design and production technologies of their products and services to produce more environmentally friendly products. In this regard, GSCM is becoming increasingly important. Increased pollution and scarcity of available resources have forced Iranian industries to use less energy and resources, which can be offset by focusing on GSCM.

Increasing environmental awareness among product users has forced Iranian industries to adopt green supply chains to continue operating with confidence in market share and environmental protection. The presence of various obstacles has made the implementation of GSCM in Iranian industries more complicated. Business globalization, competitive advantages, outsourcing, shorter product life cycles, increased demand, cost pressures, and economic environment are all inevitable factors that increase uncertainty and risk in the supply chain. Designing and managing of supply chain effectiveness, in the global and competitive economic environment is increasingly complex and challenging. In order to maintain competitiveness, the supply chain must be efficient. In addition, the most important issues facing today's generation are resource scarcity and environmental pollution. A concerted strategy to achieve productivity growth with green management is green productivity, which has been identified as the key of sustainable development. Since the 1960s, activities have begun to evaluate suppliers to select a number of them or to control existing suppliers based on criteria, such as quality, delivery, and cost. The green supply chain is a type of supply chain in which environmental requirements are met and products are returned to the supply chain after a useful life. Adopting an investment strategy to improve the environmental performance of the supply chain offers many benefits such as saving energy, reducing pollutants, reducing waste generation, creating value for customers, and ultimately improving productivity for companies and organizations. Among various industries, construction industry is at greater risk than any other industries due to the prevalence of uncertain atmosphere in this type of activity. One of the high-risk fields in the construction industry is the oil and gas sector, which plays a strategic role for the economy of Iran.

Construction of storage tanks for crude oil, petroleum products, and petrochemicals in developed countries has been done for many years using mechanical (automatic /semi-automatic) methods. The importance of this issue to overseas builders is to the extent that specific standards for the design and construction of tanks in these new ways have been developed. Despite the effectiveness of the modern technologies, experts and managers in the country of Iran continue to emphasize the use of traditional and manual methods. They provide justifications, such as unemployment crisis due to the use of automated techniques and its social outcomes, as a reason to reject the effectiveness of these techniques. However, more job opportunities would be created by the "productive industries" that rely on the production of automatic welding and paining equipment, which do not require sophisticated technologies. This would not only alleviate the employment problem, but would also provide valuable prerequisites for entering the country into domestic production and consumption in this field, and even exporting such equipment as well as technical and engineering services to other countries.

Due to the importance of the subject, this study, by a combined use of DEMATEL and ANP methods, investigated the GSCM of welding and painting processes in the construction of condensate storage tanks in South Pars region of Iran. Reviewing the relevant literature showed that no research has yet been undertaken to consider simultaneously the risk and greenness (environmental aspects) components in the technology selection for the supply chain of oil reservoirs. This research is the first to combine the risk and greenness metrics of supply chain in the technology selection of these tanks. This study, for the first time, has succeeded in providing a suitable framework for similar research by preparing a comprehensive list of effective criteria and combining the capabilities of DIMATEL and ANP methods. The main hypotheses of this study were 1) by integrating DEMATEL & ANP methods it would be possible to provide a suitable model for GSCM of the construction technology for condensate storage tanks, 2) the indicators affecting the green supply chain of condensate storage tanks have intrinsic relationships, and 3) By combining DEMATEL & ANP methods, it would be possible to select the most suitable environmentally friendly methods for painting and welding of condensate storage tanks.

Material and methods

Study area

Iran's South Pars gas field is one of the largest independent gas resources in the world, located on the joint Iranian-Qatari borderline in the Persian Gulf (Figure 1).

The gas field is 3000 m beneath the seabed at a depth of 65 m. The amount of its reserves totaled 464 trillion standard cubic feet (13 trillion cubic meters) and 17,000 million barrels of condensate (equivalent to 8% of the total gas reserves in the world and about 50% in Iran). The area of the part in the water territory of Iran is 3700 km^2. The sour gas of this field is in 4 layers, with the H_2S amount of about 5000 ppm in different layers.

Figure 1. South Pars Gas Field of Iran

The purpose of the present study was to investigate the GSCM of the construction of condensate storage tanks. The study scope was restricted to the selection of raw materials, suppliers, pre-construction, construction, completion, and delivery to the operator, to select the most appropriate method of welding and painting as the main processes of the construction of the tanks.

Research procedure

This is an applied descriptive survey. Interviews and questionnaires were the main research tools and the method of data collection was field surveys. The case study was the construction of gas condensate storage tanks in the South Pars Gas Field region. The data were collected directly from the opinions of 20 experts working on the tank construction projects in the region. Due to the need for purposeful sampling, snowball sampling method was used. In this study, Delphi technique was used to screen questionnaires and localize factors. In the Delphi group, 16 experts were managers, engineers, and contractors working on the South Pars project. They had operational and executive experience on the construction processes of condensate storage tanks, and were familiar with GSCM. Four faculty members, who were well versed in the field of GSCM, attended in the team of experts. Among the participants, 70% were male (14 persons) and the rest (6 persons) were female. Moreover, 40% of them have more than 15 years of work experience, 35% between 10 and 15 years, 15% between 5 and 10 years, and 10% less than 5 years. The academic degree of majority of them (60%) was M.Sc. Those with Ph.D. degree constitute only 10% of the participants and 30% of them had B.Sc. or associate degree. Data computation and analysis at different stages were performed with the help of Super Decision and Excel software programs. The steps of the research process are depicted in Figure 2.

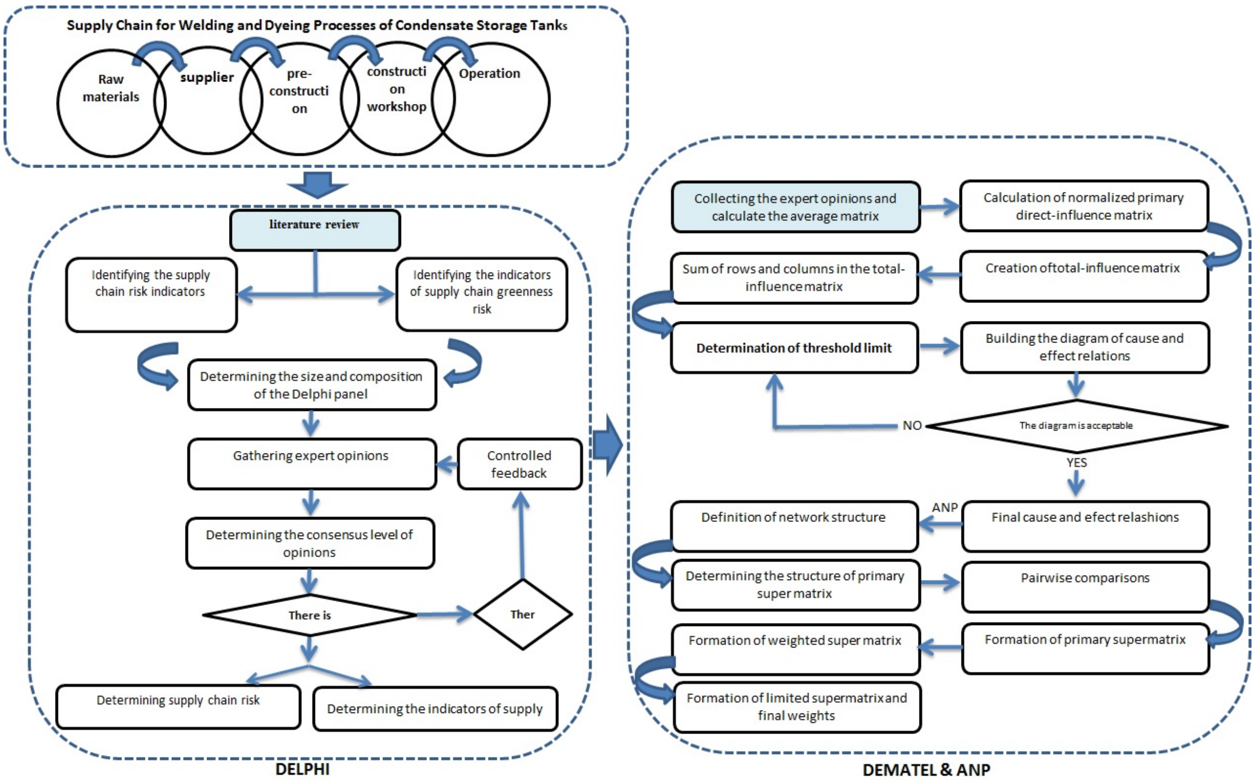

Figure 2. Executive process of the research

Here provides a description on the research steps.

Step 1: by literature reviews, a list of factors affecting the green supply chain was identified. An initial screening was then performed to remove the duplicate or synonymous indices.

Step 2: using snowball-sampling method, individuals with full knowledge of GSCM of the storage tanks in the gas phases of South Pars region were identified. At first, two experts were identified and then they were asked to introduce other experts in the field of the research. In total, 20 experts expressed their willingness to participate in the research.

Step 3: In order to develop the initial draft of Delphi questionnaire, all indicators or sub-indicators identified by the group members, were examined to use an appropriate and understandable equivalents for each of these indicators. After preparing a draft of the questionnaire, it was placed at disposal of some of the experts for initial examination. The results showed that the experts had a common understanding of the topic and questions, indicating the validity of the questionnaire construct. When designing the questions, attempts were made to review the research literature and articles related to GSCM. According to the experts' opinion, the initial screening of the questions was done. Then, the questions were designed based on the indicators endorsed by the experts. Accordingly, the questions received the experts' approval, which was an indication of the validity or reliability of the questionnaire content. Cronbach's alpha was used to assess the reliability of the questionnaire. The designed questionnaire was sent to the experts in the first round. After collecting the filled out questionnaires in the first round, the average of the expert opinion was calculated. Based on the average values, the data of the questionnaire were analyzed. According to the experts' opinion, those indicators (questions) with an average value of greater than the average limit (3) were considered as important indicator and those with the average of less that 3 was recognized as the minor effect indicators.

Step 4: Based on the results of the first draft, the second draft of the questionnaire was prepared. For the designing the second draft, those questions (two questions) that were recognized as "minor effect" in the first round were excluded from the questionnaire. Instead, three new questions were designed for the three indicators introduced by the experts, and added to the questionnaire. The redesigned questionnaire was sent to the experts. They also provided with the results of the first round polling.

Step 5: After holding the sessions and identifying effective indicators and sub-indices, the internal relationships of the components were investigated using DEMATEL. In this section, the DEMATEL method was only implemented for the criteria. For this purpose, the experts' opinions on the pairwise influence of the criteria on each other were collected and after calculating the arithmetic mean of the opinions, it was considered as a direct-influence matrix.

To normalize the direct-influence matrix, Equations 1 and 2 were used.

$$H_{ij} = \frac{z_{ij}}{r} \tag{1}$$

In which r is calculated by the following equation:

$$r = max_{1\leq i\leq n}\left(\sum_{j=1}^{n} z_{ij}\right) \tag{2}$$

Then, the total-influence matrix was obtained according to Equation 3.

$$T = \lim_{k\to+\infty}(H^1 + H^2 + \cdots + H^k) = H \times (I - H)^{-1} \tag{3}$$

In this equation I is the identity matrix.

The threshold value must be calculated to determine the Network Relation Map (NRM) between the indices. This way, partial relationships can be ignored and the network of meaningful relationships can be plotted. Only those relationships, whose values in the T matrix are greater than the threshold value, will be displayed in the NRM. To calculate the threshold value of the relations, it is enough to calculate the average of the matrix T values. For this purpose, the algebraic sum of the values in the rows and columns of the T matrix was calculated by Equations 4 and 5.

$$(D)_{[di]_{n\times1}} = \left[\sum_{j=1}^{n} T_{ij}\right]_{n\times1} \tag{4}$$
$$(R)_{[rj]_{1\times n}} = \left[\sum_{i=1}^{n} T_{ij}\right]_{1\times n} \tag{5}$$

Where;

D and R are respectively $n \times 1$ and $1 \times n$ matrices.

The column D is obtained from the sum of T matrix rows and the row R from the sum of the columns of the matrix. If $D_i - R_i > 0$, the relevant criterion will be influential and categorize as a cause group, otherwise ($D_i - R_i < 0$), it will be impressionable and classify as an effect group. After setting the threshold level, all values of the matrix T that are less than the threshold limit will become zero, meaning that its causal relation is not considered.

Step 6: At this step, the criteria that are most effective in making the final decision were identified. The criteria, options, and network structure were created according to the expertise opinion, literature reviews, and interviews with the relevant experts. After identifying the network elements, they were linked together based on the type of connection with the internal elements.

Step 7: In order to rank the model, the indicators were ranked relative to the model to determine the weight of the main indicators. For this purpose, a pairwise comparison matrix was created for all indicators, sub- indicators, and options by taking into account the internal relationships and the experts' opinion. Then, the pairwise comparison matrices were entered into the Super Decision software. The software outputs showed that the consistency coefficient of all the pairwise comparison matrices was less than 0.1. Therefore, the system consistency was approved.

Step 8: In order to evaluate the weights of the elements in the ANP structure, the eigenvector principles of pairwise comparison matrices were applied. Next, the criteria for GSCM and supply chain risks of tank construction were ranked using the normal weights of the Super Matrix in Super Decision software.

Result and discussion

The list of the identified indicators for the green supply chain is presented in Table 1. A total number of 20 experts, who expressed their willingness to participate in the research, were identified by snowball method.

The average value of the research questions in the first round of Delphi showed that out of the 35 questions (sub-indicators) in the first-draft questionnaire, three questions gained an average value of less than the average limit (i.e. the value of 3). These questions were about the "errors caused by inappropriate management policies", "production of new products from recycled materials", and "level of green technology".

Therefore, these questions were recognized as "low-importance "and excluded. The experts also introduced two new indicators in the first-draft questionnaire, including "applying the principles of comprehensive quality management" and "disruptions in the supply of clean raw materials". According to the second round of Delphi, the mean of all sub-indicators (questions) was higher than the average limit (3). In the second round, no new sub-indicators were suggested and none of the indicators and sub-indicators in the second draft of the questionnaire was excluded. In better words, all of the indicators and sub-indicators in the second round polling were considered as the indicators and sub-indicators of assessing the greenness and risk of the supply chain management of condensate storage tanks in the South Pars gas phases. Based on these results, one of the objectives of the study, namely identifying the indicators of greenness and risk of the supply chain, was achieved.

However, the "condition of consensus or agreement" should also be examined in order to determine if a consensus has been reached on all of the questions (indicators and sub-indicators). To do this, at least 70% of the experts should have given the same answer to the each question. Examining the questionnaires revealed that the consensus level of the experts' opinion, in all the questions, was more than 0.7.

According to the internal relationships of the main indicators, the financial risk was recognized as the most effective indicator and reverse logistics as the least importance indicator. The environmental management indicator was engaged in the most interaction with other factors. The approval of the relationship between the main indicators was very helpful in choosing the correct method for calculation of weights, which was the ANP. Figure 3 shows the influence of the factors on each other.

Table 1. Indicators and sub-indicators for the risk and greenness of supply chain of tank construction adopted from relevant literature

Indicator	Sub-indicator
Environmental indicator	Improper fuel consumption (Masoumik et al. 2015) Using materials incompatible with the environment (Mangla et al. 2015) Environmental pollution (Kafa et al. 2015) Climate change (Badea et al. 2013)
Green design and packaging indicator	Designing and packaging products in a way that reduces material and energy consumption (Masoumik et al. 2015) Designing products and packs so that they can be reused or recycled (Masoumik et al. 2015) Designing the products and packs in a way to avoid the use of toxic and hazardous materials (Masoumik et al. 2015) Use of labels to show the recyclability of products and packs (Masoumik et al. 2015) use of eco-friendly materials in the packaging of products (Masoumik et al. 2015)
Environmental management indicator	Supporting the green supply chain by senior and middle managers (Hu and Hsu, 2006) Obtaining Certificates of ISO 14000 Series and Environmental Management System (EMS) (Kafa et al. 2015) Existence of a policy and strategy in the field of environment and social responsibility of the organization (Hu and Hsu, 2006) Management revisions in environmental plans of the organization (Kafa et al. 2015) Errors caused by inappropriate management policies (Mangla et al. 2015) Setting criteria for reduced energy consumption and the use of clean energy (Kafa et al. 2015)
Reverse logistic indicator	Collection, transportation, and separation of "used products and packs" for recycling (Chopra and Sodhi, 2004) Returning the packs to suppliers for reusing and recycling (Waters, 2007) Obligating the suppliers to collect their packaging materials (Chopra and Sodhi, 2004) Returning the products to suppliers for recycling (Mangla et al. 2015) Implementation of the network and central wastewater treatment plant for industrial and sanitary wastewater (Chopra and Sodhi, 2004) Implementation of the waste management system (Chopra and Sodhi, 2004; Waters, 2007) Preparing new products from recycled materials (Masoumik et al. 2015)
Operational risk indicator	Failure of machinery, equipment, or facilities (Yang and Li, 2010; Wang et al. 2012) Design hazards (Qianlei, 2012; Ruimin et al. 2012) skilled worker shortage (Yang and Li, 2010; Ruimin et al. 2012) level of green technologies (Mangla et al. 2015)
Supply risk indicator	Risk of logistics costs (Qianlei, 2012) Negligence of the key supplier (Wang et al. 2012) Supplier quality (Mangla et al. 2015; Kafa et al. 2015)
Financial risk indicator	Budget resources (Mangla et al. 2015) Inflation and currency exchange rates (Yang and Li, 2010) Financial constraints (Yang and Li, 2010)
Demand risk indicator	Risk of bullwhip effect (Qianlei, 2012) Market volatility (Ruimin et al. 2012) Risk of competition (Mangla et al. 2015)

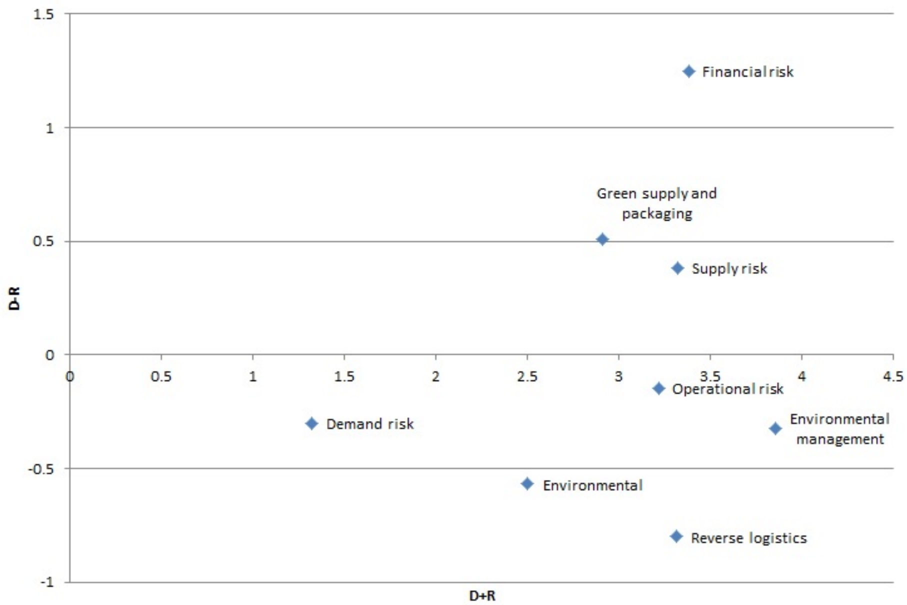

Figure 3. Influence of the key indicators for the greenness and risk of the supply chain, derived from DEMATEL method

Ranking the indicators and sub-indicators and selecting the options using ANP

At this stage, based on the relationship between the indicators and sub-indicators, goal, and options of the research, the decision tree was plotted according to Figure 4. The outputs of Super Decision software showed that the consistency coefficient of all pairwise comparisons was lower than 0.1, so the system consistency was approved. Then, the criteria for the greenness and risk of the supply chain were ranked based on the normalized weights of the super matrix (Figure 5). According to the pariwise comparisons of the main indicators of GSCM, the environmental management indicator, with a weight of 0.35, was recognized as the most influential factor. The indicator of operational risk, with a weight of 0.22, was ranked second. The supply risk indicator , with a weight of 0.003, was recognized as the lowest important factor. In the next step, the sub-criteria of GSCM were ranked based on the normalized weights of the super matrix (Table 2).

According to the table, failure of machinery and equipment, with a relative weight of 15% was recognized as the most important sub-criterion and support from senior managers, with a relative weight of 10%, was ranked second. Return of the packs to the supplier for reuse, with a relative weight of 8%, was placed in the third rank.

Table 2. Ranking the greenness and risk sub-criteria of the tank construction supply chain

Sub-criterion	Normalized weight based on cluster	Normalized weight based on the whole model	Final rank
Failure of machinery and equipment	0.63683	0.033266	1
Support of senior managers from GSCM	0.26076	0.021444	2
Return of the packs to suppliers for reuse	0.40691	0.016454	3

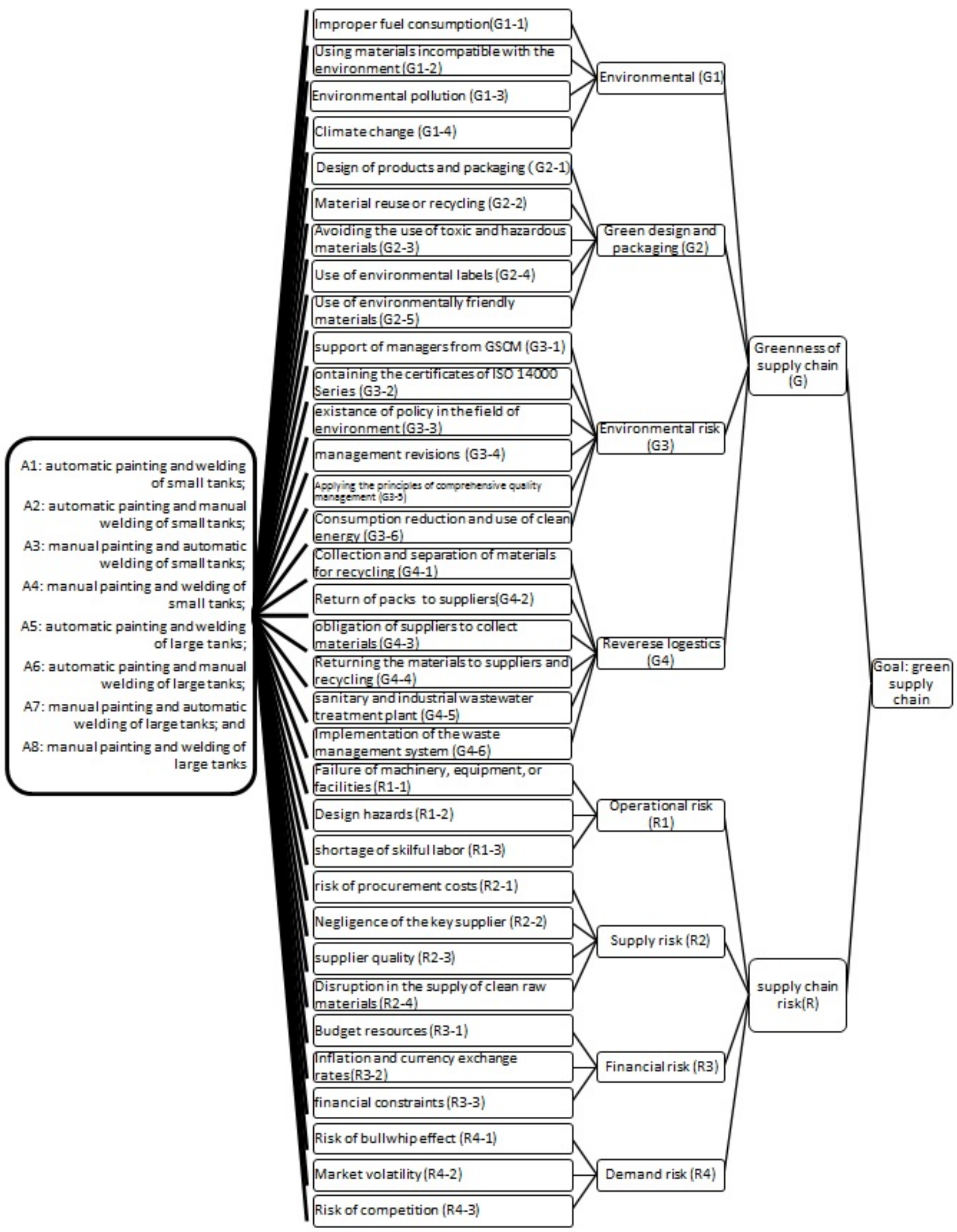

Figure 4. Mapping the relationship of the goal with indicators, sub-indicators, and options

Finally, the options for the tank construction methods were ranked based on the normal weights in the super matrix (Figure 6). According to the results, the automatic methods of painting and welding, with a relative weight of 0.21, was recognized as the best construction method of the large storage tanks. The manual method of painting and welding, which is currently used in majority of the projects in Iran, with a weight of 0.08, was found as the worse method.

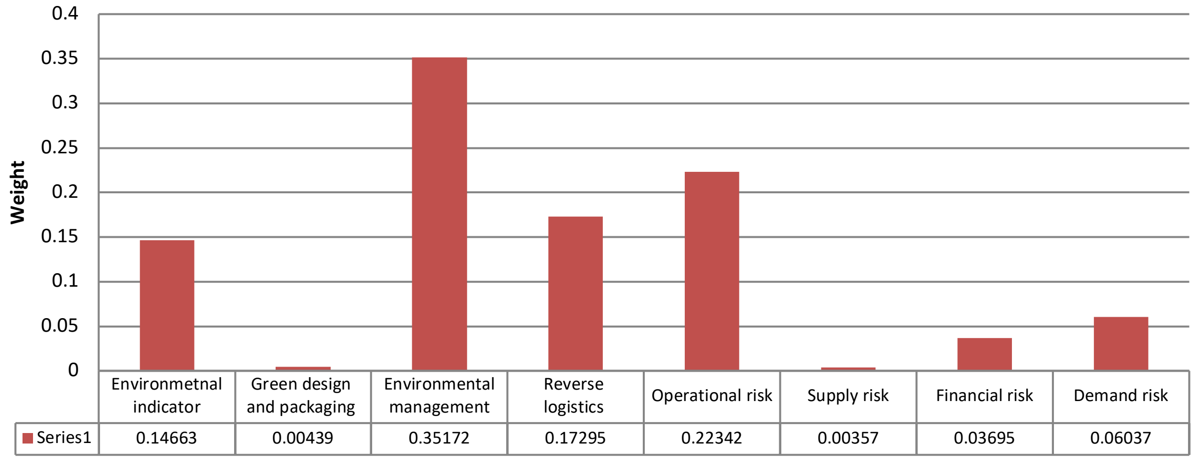

Figure 5. Ranking the GSCM criteria of condensate storage tank construction

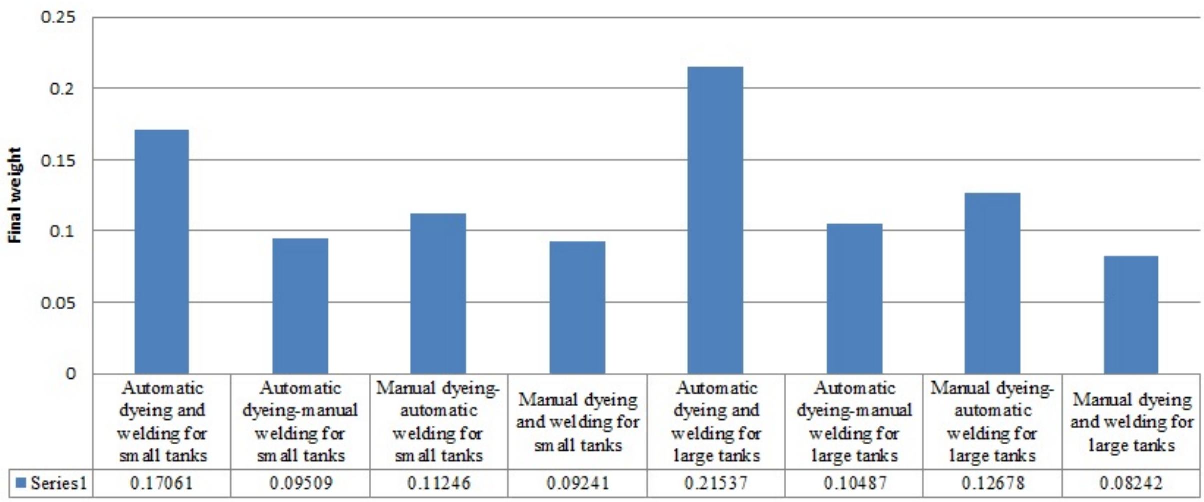

Figure 6. Final weight of the options for welding and dyeing of condensate storage tanks

Sensitivity analysis in the Super Design software showed that even with the uniform increase in the weight of the criteria, the priority of the options will not change significantly. In better words, with increasing the weight of criteria and sub-criteria across the supply chain, the choice of automatic painting and welding methods for large tanks will remain at the forefront of the decisions.

Jannat Tumpa et al. (2019) studied the barriers towards establishing the GSCM practices in the textile industry in Bangladeshi. They introduced “financial constraint” among the most important barriers of establishing the GSCM in the industry, which is in line with the findings of the current study. According to the present study, the financial risk was recognized as the most influential indicator in GSCM of condensate storage tanks. The role of financial constraints on the establishment of GSCM has also been emphasized by Yang et al. (209) and Wu et al. (2019). Masoumik studied the applicability of an ANP-based conceptual model in GSCM. They proposed three green strategies, including prevention of pollution, the use of green technology, and supervision on production. In the present study, green strategies, including environmental index, green packaging and design index, environmental management index, and reverse logistics index were proposed (Masoumik et al 2018). The study by Wu and Chang, which identified key factors of green supply management by DEMATEL method in, recognized “observing the environmental requirements when purchasing items” and “green purchasing” as two important factors in GSCM. However, the present study identified the “environmental management index” and “operational risk index” as two important factors in GSCM (Wu and Chang, 2015).

Conclusion

Given the increasing importance of environmental issues and attention of clients to this issue, as well as the rules that obligate the industries for observing environmental considerations, it would be useful to consider the proposed GSCM in selecting the best method for the construction of condensate storage tanks. The purpose of this study was to identify and prioritize the factors influencing GSCM. According to the research findings, among 8 main indicators and 35 sub-indicators of GSCM, financial risk was recognized as the most influential indicator and reverse logistics as the lowest important factor. Environmental management indicator was in the most interaction with other factors. Overall, the environmental management indicator, with a weight of 0.35172, was ranked first and the “supply risk” indicator, with a weight of 0.00357, was recognized as the least important indicator. The strategy of “automatic dyeing and welding of large tanks”, with a weight of 0.21537, was selected as the best construction method of the tanks. In better words, the overall preference was with automatic welding and painting. It is anticipated that a more scientific approach than today, namely the replacement of automated methods with the manual methods, would have a significant impact on the "time and resource management" and "cost savings" of the respective organizations. The results also showed that by integrated use of DEMATEL and ANP methods, more accurate ranking can be achieved for strategy selection. Incorporating realistic costs and timing of each project and issues related to uncertainties can play an important role in decision-makings. Therefore, in order to improve future studies, it is recommended to use fuzzy decision techniques and mathematical models to answer the questions about the real cost and time of projects.

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