Designing and Testing the Supply Chain Agility Model in Oil and Gas Industry with a Mixed Approach

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Abstract
Today, environmental change has become an integral part of businesses. One of the best ways to respond to these changes is supply chain agility. Therefore, the purpose of this study is to design and test the supply chain agility model in oil and gas industry. This research is conducted with a mixed approach. The statistical population was experts in the oil and gas industry. In the qualitative phase, a sample consisting of 8 experts are selected to extract the drivers, components and consequences of supply chain agility model and using the content analysis approach. In the quantitative phase, a sample of 64 experts are selected and the collected data are analyzed using a questionnaire tool through the structural equation modeling approach with Smart PLS software version 2. Qualitative findings represent that environmental drivers act as prerequisites and requirements of supply chain agility. Supply chain agility consists of the general categories of agile sensitivity, planning and production, which ultimately leads to the consequences of supply chain agility. Quantitative phase findings show that supply chain agility drivers have a significant and positive effect on agility sensitivity, agile planning and agile production. Also, agile planning and agile production have a significant and positive effect on the consequences of supply chain agility, but agile sensitivity has no significant effect on the consequences of supply chain agility. The results of fitting the research model also showed that this model has a good fit.

keywords: Agility, Supply Chain, Mixed Approach, Oil and Gas Industry.

1. Introduction

Complexities and uncertainty along with high environmental fluctuations have made the supply chain vulnerable to various disruptions. Organizations operate in a changing and unpredictable environment, so there is no escape from disruptions in their supply chain. Therefore, this chain must be designed in such a way that it has the necessary ability to respond efficiently and effectively to unexpected events and be able to fix the disruptions and with better competitiveness, cost reduction, good quality, reduction of order time and better services can be achieved (Rahimi et al, 2018). Supply chain disruptions refer to a situation where the flow of goods or services is interrupted, leading to financial consequences, a decrease in market share, and numerous problems in the company's operational performance. According to various researches, almost 80% of companies are facing disruptions in the supply chain and looking for a solution to face these disruptions (Alikhani et al., 2019). Various approaches to reduce and deal with these disruptions in the supply chain, such as supply chain management, flexibility, etc., have been presented by the researchers.

In general, the traditional approaches in the supply chain sought to reduce uncertainty and make it possible to correctly predict market demand. But, nowadays, researchers have come to the conclusion that it is not possible to eliminate and ignore uncertainty. On the other hand, companies have faced rapid changes in technology, increasing uncertainty, markets dynamic, reduced product life cycles, and major changes in customer needs and

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demands. In such a situation, the organization's ability to adapt and quickly respond to environmental changes and market conditions has become a key issue in the minds of management scientists (Salehi Sadaghiani& Ghasem Zadeh, 2018). Another change in the current environment is that the supply chain in many companies faces many challenges and threats such as economic crises or natural disasters such as floods, earthquakes, fires, storms, disruptions in the supply, production and distribution system. They are faced with the fact that it can cause failure and interruption in the supply chain, reducing the level of competitiveness and reducing the level of customer satisfaction and ultimately reducing the level of profitability, which has required various organizations to provide appropriate answers (Ghorbanpour & Rasuli, 2018).

Such changes have weakened the traditional approaches in the face of environmental changes and turbulences and created the need for newer approaches. So, the researchers have made different solutions for the problem of how to face environmental changes and uncertainty. Organizations can face these conditions by using several paradigms such as "adaptive organization", "flexible organization" and "agile organization". Most research on determining the means by which companies can face environmental changes emphasizes the role of the "adaptive organization". Flexible organization is defined as the ability to adapt internal resources and activities and capabilities to deal with business changes. The adaptive organization emphasizes the role of the organization to adapt to environmental changes and is mostly reactive to these changes. Therefore, the question of how organizations succeed in a dynamic and unpredictable environment is one of the most important challenges in today's world. In such an environment, agility has become an important capability that has many effects on the organization's performance (Soltani et al., 2019; Walter, 2021). To overcome this weakness, in 1990s, a new approach was introduced to respond to business environmental changes as "agility" which includes the ability to "adapt". Since the late 1990s, agility has received increasing attention in the business world as well as in the field of academic research. Therefore, the concept of agility is introduced for the first time to be used in the production function. In this regard, the origin of agile production was first introduced by a group of researchers in 1991 (El-Tawy & Gallear, 2012). Supply chain agility is defined as the ability of the organization and its supply chain to quickly adapt to changing and unpredictable environmental conditions. Therefore, companies must be quick and flexible in their operations and supply chain partners to manage these disruptions and ensure the smooth flow of goods and services to end customers (Khan and Wisner, 2019). Based on this reasoning, it is stated that agility and responsiveness in supply chains is crucial to the profitability of any organization operating in the supply chain process. Therefore, in order to overcome vulnerabilities and uncertainties, knowledge of suppliers, products, new resources and development of appropriate standards to ensure new product development, manufacturing and delivery to the target market, agility is a vital element (Naughton et al., 2020).

Many researchers believe that supply chain agility was widely considered as a critical success factor in the competitive market. Because, agile supply chain gives companies the ability to recognize environmental changes (agile sensitivity), respond appropriately to these changes, and improve the service cycle. Supply chain agility refers to the ability of the supply chain to respond quickly to market changes and also as the ability of the supply chain and its members to achieve group speed and re-adjust its operations to meet the very dynamic needs of the customer (Chan et al., 2017; Swafford et al., 2006). By the help of supply chain agility, the organization gains the ability to learn about long-term changes, such as political and social changes, economic progress and delivery time for suppliers (Alkrait & Almaktoom, 2021). Supply chain agility is recognized by researchers and managers as one of the most important current supply chain management issues. Various disturbances such as political changes, accidents, natural disasters, and supplier inefficiencies can affect the revenue and cost of the entire supply chain. The agility and adaptability of the supply chain increases sustainability in procurement (Jindal et al., 2021).

The oil and gas industry is one of the industries that play a key role in the economy of many countries. In this industry, many costs are spent to provide raw materials, equipment and support services. In this condition, manufacturing companies are looking for an approach that can improve their performance. One of the approaches that helps companies in the oil and gas industry to adapt to environmental changes, especially international conditions, is supply chain agility approach. On the other hand, Iran is one of the countries where has the most oil and gas resources (Berkashli, 2013). Unfortunately, reliable and stable financial resources are not available to producing companies in oil and gas industry. Such a situation will seriously damage the country's sustainable energy security in the coming years (Report of the Special Commission for the Protection of National Production and Supervision of the Implementation of Article 44 of the Constitution, 2021). Therefore, by considering Iran's heavy and special responsibility in providing sustainable energy to the country and carrying out the activities in the field of exporting these strategic products, it seems that the designing and testing the supply chain agility model in oil and gas industry is extremely important and necessary. In this regard, the problem that this research is facing is, what levels and components does the supply chain agility model (drivers, components and consequences) consist of, and what is the relationship between the different levels and components of this model? The main goal of this research is to design and test the supply chain agility model in oil and gas industry.

2.Theoretical Foundations

In order to gain a competitive advantage in the highly variable business environment, companies must cooperate

Table1: Definitions of supply chain agility

Authors	Definition
Prater et al., 2001	The degree of agility of a company's supply chain is determined by how its physical components (such as resourcing, manufacturing, and delivery) are configured to combine speed and flexibility. As the levels of speed and, more importantly, flexibility increase, the level of supply chain agility increases
Swafford et al., 2006	Supply chain agility represents a fast, flexible and robust business. Able to adapt quickly in response to unexpected and unforeseen changes and events, market opportunities and customer needs. Such a business is based on processes and structures that facilitate speed, adaptability and robustness and provide a coordinated enterprise capable of achieving competitive performance in a highly dynamic and unpredictable business environment that is not suited to current organizational practices.
Collin & Lorenzin, 2006	An agile supply chain means being fast and flexible, and specifies that the main objectives of supply chain agility are to respond quickly to short-term changes in demand or supply and to handle external disturbances.
Didehkhani, 2010	Supply chain agility as a whole and its components refers to the speed of alignment and networking and its activities to meet dynamic and fluctuating customer needs.
Lenort & Wicher, 2012	Supply chain agility is the ability to cope with unexpected changes, survive unprecedented threats in the business environment, and use changes as opportunities.
Moniruzzaman et al., 2016	Agility supply chain is the organization's ability to reconfigure, adjust, and change resources for the key processes of planning, sourcing, manufacturing, delivering, and returning to meet the demands of a changing environment.
Fayezi et al., 2017	Supply chain agility is a strategic capability that helps organizations respond quickly to internal and external uncertainties through the effective integration of supply chain relationships.
Tayyaran et al., 2019	Supply chain agility refers to the ability to respond and react quickly and successfully to environmental changes.
Tamtam & Tourabi, 2021	Supply chain agility was defined as the ability of the supply chain to quickly align its operations with the dynamic environment. The agility of the supply chain to respond and the readiness of the supply chain to change demand in terms of quality, quantity and variety. Also, It refers to the supply chain's ability to be alert to changes and respond (proactively/reactively) to these changes using resources.
Escamilla et al., 2021	Supply chain agility refers to the speed of responding to sudden changes in demand or supply, adapting over time to the evolution of market structures and strategies, aligning the interests of all companies in the supply network. Only supply chains that are agile, adaptive and aligned provide companies with a sustainable competitive advantage.

with the suppliers and customers for a better operational efficiency, and cooperate with each other to obtain an acceptable level of agility. In this case, an agile supply chain is created (Ali Akbari et al., 2019). Supply chain agility is the ability of the organization and its supply chain to quickly adapt to changing and unpredictable environmental conditions. Therefore, companies must be quick and flexible in their operations and supply chain to manage these disruptions. In this part of the research, the theoretical foundations of supply chain agility have been proposed.

2.1.Supply chain agility

In order to be able to achieve market share and survival in the field of competition, it is necessary for the companies to pay attention to their supply chain. Because, gaining a competitive advantage is not only achieved by paying attention to the inside, but also requires the analysis and use of an external condition. Based on this point of view, the supply chain and the partners of the companies are vital. When a company's supply chain functions successfully, business partners and the company itself can benefit from a competitive advantage. So, an integrated supply chain is necessary to deal with the uncertainty in demand. In addition, non-integrated manufacturing processes, non-integrated distribution processes and poor supplier - customer relationships will lead to failure (Barhmi, 2019).

To solve supply chain problems and face environmental changes, supply chain agility was created as a research field in 1999. So, agility has been suggested as a tool through which the supply chain is able to adapt to the changing needs of the market (Al Humdan et al., 2020). Perhaps, at the beginning, supply chain agility and its impact on the product and supply of goods was unknown but after knowing this concept for almost two decades, much attention was paid to supply chain agility. It has become a driver of success and a sign of a company's competitive advantage. While agility is considered one of the essential characteristics of successful supply chains in today's turbulent and competitive environment, especially in global markets. Since, companies with agile supply chains due to their ability to synchronize supply with demand better than their competitors, they can respond competitively to unforeseen changes in the business environment. Despite the popularity of supply chain agility, the concept seems supply chain agility is vaguely

Table2: Background of the research

Researcher and Year	Title	Found
Wu and Angelis, 2007	Achieving agility of supply chain management through information technology applications	The integration of IT infrastructures, consisting of data compatibility and cross-application integration, is crucial to achieving agility, as various integration processes in agile supply chains can be enabled by IT infrastructures that enable information flow and coordination activities across functional units and network partners. It makes it difficult. Also, the integration of information technology infrastructure affects agility in various operational dimensions, such as speed, flexibility throughout the supply chain
El-Tawy and Gallear, 2012	Exploring the supply chain agility attributes in fast moving consumer goods industry: a case study in the middle east	The studied supply chain that works in this type of industry must be agile and the characteristics required achieving agility in the supply chain. It includes the following: accountability; customer services; flexibility ; Innovation; Speed; Quality; productivity ; and the thinking of responsible people
Karami et al., 2016	Impacts of success key factors of supply chain agility on the strategic performance of the electronics companies in Iran	Key factors of agility have a direct and positive effect on organizational performance and competitive advantage
Talarposhti et al., 2016	Factors affecting supply chain agility at hospitals in Iran	Employee skills, application of information technology, integration processes, sensitivity and responsiveness to the market, appropriate planning, introduction new service, cost reduction, patient satisfaction and service quality on agility Iran's public hospitals are affected and the introduction of a new service the highest rank and skill development of employees got the lowest rank did
Jamali, and Fallah, 2017	Agility of the supply chain in the businesses that technically support the Iranian oil and petrochemical industries	Senior management perspective, employee competencies integrity, flexibility, speed of response, cost, culture of learning and innovation, culture of continuous improvement, integration of strategies, recognition of customer needs, sensitivity to the market and customer, providing customer satisfaction, information infrastructure, amount Access to information and technological innovations have a significant impact on supply chain agility
Chan et al., 2017	The effects of strategic and manufacturing flexibilities and supply chain agility on firm performance in the fashion industry	Strategic flexibility and production flexibility positively affect supply chain agility. However, strategic flexibility has a direct and significant effect on firm performance, while production flexibility does not. In addition, supply chain agility plays an important role in mediating the effects of strategic and manufacturing flexibility on firm performance
Dubey et al., 2018	Supply chain agility, adaptability and alignment: empirical evidence from the Indian auto components industry	Sharing and supply chain connectivity resources affect supply chain visibility , which is influenced by the moderator top management commitment increases supply chain agility, adaptability, and alignment

Table2: Background of the research (continued)

Researcher and Year	Title	Found
Rahimi et al., 2019	Providing a model for supply chain agility of ground-based military products and its impact on supply chain performance	There are 41 effective methods in the agility of the supply chain of military products in 8 groups, including communication with the supplier, management of the workshop, improvement of the organizational structure, improvement of human resources, product design, integration and improvement of the process, use of information technology and communication with the customer. The final model of this research shows that the use of such methods in the form of hierarchical relationships leads to the appropriate response of the supply chain of military products to its customers
Akbarzadeh et al., 2019	Explaining the role of market sensing, supply chain agility and supply adaptability on supply chain ambidexterity automotive industry of Iran (case study: Irankhodro industrial group)	The ability to measure the market has an effect on the agility of the supply chain and the ability to adapt, and the ability to adapt and the agility of the supply chain have an effect on the duality of the supply chain
Ali and Siddiqui, 2019	Influence of supply chain agility on profitability: evidence from Pakistan	There was a negative and significant relationship between speed and profitability. This means that fast processes actually reduce profitability. In addition, this study showed a positive and moderate effect of flexibility on profitability. It seems that the other two items, competence and responsiveness, do not have a significant effect on profitability
Ehtesham Rasi et al., 2019	The effect of supply chain agility based on supplier innovation and environmental uncertainty	The set of factors that have influenced supply chain agility in this model can explain 98% of supply chain agility changes.
Khan and Wisner, 2019	Supply chain integration, learning, and agility: effects on performance	Integration has a significant impact on external and internal learning. In addition, supply chain integration has a negligible impact on firm performance and supply chain agility. Finally, it was found that internal learning has an insignificant effect on supply chain agility, but a significant direct effect on firm performance, while external learning has an insignificant effect on firm performance both directly and indirectly
Alikhani and Torabi, 2019	Retail supply chain network redesign based on multiple resilience capabilities	Reversibility strategies has an effect on reducing the total cost in the design of the retail supply chain network
Nozari and Ghahremani-Nahr, 2021	Provide a framework for implementing agile big data-based supply chain (case study: FMCG companies)	The proposed system intelligently recognizes the agility needs of the organization and tries to achieve it, and ultimately creates a competitive advantage for the company and increases customer satisfaction and expands the organization's market share
Jamalpour, 2022	Investigation and analysis of effective factors on improving lean supply chain agility by AHP method	Customer satisfaction, administrative assistant and support, marketing assistant, financial assistant, and customer retention are among the most important factors affecting lean supply chain agility

Table3: Reliability and validity of the research tool

Variable	Variable Type	Final Index Number	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
Environmental Drivers	Independent	15	0.90	0.91	0.43
Agile Sensitivity	Mediator	4	0.88	0.92	0.75
Agile Planning	Mediator	7	0.92	0.93	0.68
Agile Manufacturing	Mediator	5	0.90	0.92	0.72
Consequences Of Agility	Dependent	13	0.96	0.96	0.68

Figure1: Initial conceptual model of the research (created by the researcher)

defined and poorly structured. Some authors have defined it operationally, some as a management philosophy and others in terms of strategy. In addition, the special concept supply chain agility has been developed in the literature due to the use of different perspectives of "agility" developed in different disciplines to the broad concept of agility related. In fact, some researchers on the multidisciplinary nature supply chain agility have commented (Al Humdan et al., 2020). In this regard, different researchers have defined supply chain agility through different perspectives, and each of these definitions pay attention to a specific aspect of this concept. Table 1 shows some definitions of supply chain agility.

Based on the above definitions, although each of the definitions refers to certain aspects of agility, a comprehensive definition that considers all dimensions of agility has not yet been provided by researchers. In these definitions, the authors have raised various issues of supply chain agility. Four issues in the definitions of agility are significant and they help to reduce the ambiguity surrounding the concept supply chain agility: (1) speed, (2) agility scope, (3) agility mode and (4) agility consequences (Al Humdan et al., 2020). In this research, supply chain agility is defined as the ability to identify environmental changes, sensitivity and appropriate response to the supply chain to these changes. However, in previous literature, agility refers to the effective and flexible adaptation of unique demands. The main purpose of creating an agile response is flexibility throughout the supply chain. In modern manufacturing, this can require the ability to produce and deliver in large or small batches, which reduces the vulnerability associated with machine downtime and product change over, that often identified as a critical component of agile manufacturing. Agility should also require a flexible workforce with members who are cross-trained or able to perform a variety of jobs on demand. The development and design of the product is also reduced in the assembly, which allows the rapid transformation of materials from raw material to the final product (Tonday et al., 2021). Therefore, it is necessary for an agile organization to have flexibility in order to be able to act flexibly to introduce new products and new options which are based on customer needs and demands (Little, 2014). Designing a comprehensive supply chain agility model requires identifying the supply chain agility drivers, supply chain agility components and consequences of supply chain agility.

2.2. Supply chain agility components

In order for an organization to be able to operate in an agile manner, the speed of production and distribution activities must be its supply chain and constantly seek to improve their activities. Supply chain agility involves (1) reducing product development cycle time and production and delivery time; (2) increasing the level of product customization in production; (3) improve customer service; (4) delivery reliability and (5) Responding to market needs (Um, 2017). In addition, different researchers have listed different components and factors for agility.

Moniruzzaman et al., (2016) stated four key elements of supply chain agility including flexibility, responsiveness, competence and speed. Flexibility is the ability of one supply chain to deal with changes. These researchers identified flexibility as an important attribute of agility needed to meet uncertain market demand. Responding to ability supply chain refers to a dynamic market.

Unexpected demand requires a rapid assessment of the organization's capabilities to determine whether the demand can be met and to provide feedback to consumers in short time. Competence is the ability of supply chain to achieve its goals. Competency component includes "integrity and flexibility of information technology", "operational competence" and "management competence". It must constantly adjust and restructure its processes and relevant strategies to respond quickly to market changes. Increasing complexity in customer preferences means that

Table4: Descriptive statistics of demographic variables

Variable	Categories	Frequency	Percentage
Age	Less Than 35 Years	7	10.9
	35-40 Years	15	23.4
	40-45 Years	32	50
	45 Years And Older	10	15.6
Gender	Female	5	7.8
	Male	59	92.2
Marital Status	Single	11	2/17
	Married	53	82.8
Level Of Education	Bachelor's Degree And Below	27	42.2
	Master's Degree	26	40.6
	Doctorate	11	17.2
Work Experience	Less Than 10 Years	9	14.1
	10-15 Years	14	21.9
	15-20 Years	27	42.2
	20 Years And Above	14	21.9

highly customized products are often required. In this regard, Macclever et al. (2017) stated that the agility of the supply chain consists of the components of vigilance, speed, response, flexibility, pro-activeness, quality/accuracy, profitability/cost, communication, adaptation /adaptation, changes/lack of Certainty, and competitiveness is formed. Tamtam and Tourabi (2021) also stated that supply chain agility consists of four characteristics: perfectness, reliability, productivity, cost minimization and new product development. Agile supply chain lies in the integration of five capabilities: customer (market) sensitivity, virtual organization, processes, networks and information systems.

Tonday et al. (2021) stated that supply chain agility can be examined from four points of view: Agile planning: Areas such as processes, control and monitoring, information and data sharing, development, delivery and distribution are the primary elements of agile manufacturing and supply chain systems architecture.

Systems: The combination of a designed route, schedule, control, monitoring and feedback system Real-time monitoring of production to supply of essential goods from production to final use is an important criterion for the rapid development and implementation of an agile supply chain.

Technology optimization: Using modern technologies such as Internet, robots, automation in material handling, drones, artificial intelligence and machine learning, Internet of Things, etc.

Planning: Human resources are a critical factor in achieving agility in the supply chain and logistics for loading, unloading and distribution of products. It is difficult to organize and guide people towards flexibility in the supply chain and logistics. Manpower planning significantly affects the determination and ideas of achieving agile supply chain systems.

2.3. Supply chain agility drivers

Drivers were actually used to justify the need for agility and to describe the economic and manufacturing environment that drives supply chains to achieve agile capabilities. Agile drivers are used as a starting point to identify agile components or enablers. Among the motivators of supply chain agility, we can mention the change in the market place, competition, customer needs, technology and social factors. Also, few researches on the motivators of Supply chain agility and its impact on supply chain agility components have been done. Tamtam and Tourabi (2021) conducted a research titled "Analysis of the agility of the supply chain of the automotive industry" during the time of Covid-19. The findings of this case study show that three factors require maximum attention: process compliance, logistics and distribution capabilities, supporting information technology. So, improving supply chain agility, should be based on these enablers.

Barve (2011) stated that environmental drivers indicate the requirement of organizations to respond more to the needs of customers, changing conditions of competition and increasing levels of environmental turbulence has aroused interest in the concept of "agility".

Shamsi Gooshki et al. (2021) expressed that environmental stimuli are actually caused by changes in the environment that create the need for strategic agility within the organization. These drivers include the presence of domestic competitors at the industry level, the obligation to comply with domestic standards, drastic changes in prices, the entry of strong foreign competitors into the domestic markets the existence of intense international competition to achieve the right quality and price, and the presence of external pressures on the domestic industry such as Sanctions are divided into two categories of internal and external driver.

2.4. Consequences of supply chain agility

Researchers have claimed that agility as an attribute is related to supply chain management. Therefore, the supply chain agility has different consequences for the organization and can be related to the effectiveness of the customer. It means the degree of fulfillment of customer-related goals and can also be related to cost efficiency (Gligor et al., 2015).

Table5: Environmental drivers of supply chain agility

Subcategory	Source
There are many competitors in the domestic industry	Shamsi Gooshki et al, 2021
The possibility of dissatisfaction of the surrounding community in terms of the services provided by companies	experts
Requirement of regulatory and inspection organizations to increase speed and accuracy	experts
Obligation to create laws to facilitate operation and productivity	experts
The process of globalization and the introduction of virtual software	experts
The lack of raw materials inside and the criticality of some required items	Shamsi Gooshki et al, 2021
Requirements of organizations related to the company	experts
The desire to grow and develop the capabilities of companies	experts
Computer-based technology agents	experts
The existence of collaborative relationships and pressure from partners	experts
Pressure from customers	Shamsi Gooshki et al, 2021
Efforts to reduce domestic dependence on foreign raw materials and equipment	experts
Trying to prevent currency from leaving the country	experts
There is a strong need for technical knowledge in fields such as mechanics, instruments, chemicals, etc.	experts
Existence of sanctions and barriers to the entry of required equipment into the country	Shamsi Gooshki et al, 2021
The existence of intense international competition to achieve quality and reasonable price	Shamsi Gooshki et al, 2021

Table6: Supply chain agility components

Main categories	Subcategory	Reference
Agile sensitivity	Monitor customer status	Shamsi Gooshki et al, 2021
	Identify resources of raw material suppliers	experts
	Agile support services	experts
	Analyzing and forecasting fluctuating conditions in the market and preparing to face it	Shamsi Gooshki et al, 2021
Agile planning	Using specialized software	experts
	Standardization of rules and processes	experts
	strong regulatory guidelines	experts
	Selection and use of first-tier suppliers	experts
	Exploiting the port location of the province to supply foreign items	experts
	Regional planning for the use of local capabilities	experts
	Using the capabilities of knowledge-based companies in the oil and gas industry	experts
Agile manufacturing	Ability to fulfill the production plan	Shamsi Gooshki et al, 2021
	Fast supply of parts and equipment needed for the production line	Shamsi Gooshki et al, 2021
	Speed in producing products	Shamsi Gooshki et al, 2021
	Flexibility in implementing production plans	Shamsi Gooshki et al, 2021
	Inefficient equipment replacement speed	Shamsi Gooshki et al, 2021

Shamsi Gooshki et al. (2021) believed that the companies cannot be agile to respond to environmental changes and stimuli may lose their market share and and exploit market opportunities and customer needs well, and they can actually achieve a competitive advantage.
Agility can also be considered for supply chain survival and growth in an environment of turbulent and volatile markets. Considering that the current conditions of the competitive advantage, in contrast to agile. Companies have the ability to recognize and respond quickly. They are sensitive to unexpected changes and events, they identify markets are conditions in which we see a reduction in the product life cycle, an increase in the demand for customized products and services, a decrease in the visibility of demand and continuous change, so many managers of organizations have acknowledged that agility

is critical for their endurance and competitiveness. Agility has been considered as a fast and effective organizational enabler that enables the company to create a competitive advantage (Macclever et al., 2017).
Based on this, companies with agility both at the strategic level and the supply chain level can achieve customer effectiveness, market share, cost efficiency, and a sustainable competitive advantage.

3. Background

Various researches have been conducted inside and outside of Iran regarding supply chain agility. In this section, some of these researches are mentioned in the table 2. The study of previous research shows that in some researches, the needs of supply chain agility (environmental factors that create the need for agility) such as Shamsi Gooshki et al (2021), Wu and Angelis (2007) and Akbarzadeh et al. (2019) has been addressed.
In some others, attention has been paid to the analysis of supply chain agility components, such as the research of Rahimi et al. (2019), and finally, some other previous researches have focused on the performance results (results) of the supply chain, such as Khan and Wisner (2019), Chan et al. (2017) have been investigated.
Based on this, the investigation and analysis of the environmental drivers of supply chain agility, the components of supply chain agility and the results and consequences of supply chain agility, especially in oil and gas industry considered as one of the key industries of any economy, and also the relationship between these levels are of special importance and examining the drivers, agility components and its consequences in the form of a native system model is one of the innovation of the research conducted in this study. In this regard, for the first time, this research has examined all three levels and the relationship between these levels, at the supply chain level. These relationships are shown in the form of the initial conceptual model of the research in figure 1.

4. Material and methods

The present research, in terms of purpose, is practical and of a mixed approach. This research has been done in two parts, qualitative and quantitative. Mixed methods provide a better understanding of social and behavioral phenomenon and a better explanation. In the mixed approach, researchers use both quantitative and qualitative data to get a better understanding of the phenomenon under study. Statistical population of this research in the qualitative and quantitative phase is considered to be the experts of oil and gas industry. In the qualitative part, by reviewing the literature and background of the research, and then using the tool of open questionnaire and snowball sampling strategy, an interview is conducted with 8 experts of oil and gas industry and specifically petrochemical companies, and using the analysis method, components of the research model are extracted. First, the sub-categories or the measures related to the measurement of the variables of environmental drivers, the components of supply chain agility and then the consequences of supply chain agility are extracted and at last, categorized in the form of main categories. At this stage of the research, the saturated model has been extracted and the indicators of supply chain agility drivers, supply chain agility components and supply chain agility consequences have been finalized. In the quantitative part, the final research questionnaire, based on the indicators and the final model of the research that was obtained in the qualitative phase, is analyzed using the structural equation modeling approach and using Smart PLS software version 2. In the quantitative phase, using a questionnaire (five-point Likert scale from 1 very low to 5 very high) from 64 managers, experts and specialists in petrochemical companies active in oil and gas industry data were collected. Therefore, first, the model indicators are distributed among the sample members in the form of a questionnaire, operational and after validating it by 8 experts.
At this stage, the statistical sample is selected using available sampling method. In order to measure the validity, the composite validity index is also used, and to measure the reliability of the quantitative phase It should be noted that in this research, structural equation modeling of reflective type has been used. In this model, each marker represents a measurement with error of the underlying variable. In the reflective model, the direction of causality is from the structure to the indicators. In other words, it is assumed that the observed measurements reflect the change in the underlying variable.The reliability and validity results of the final research tool in the quantitative phase are shown in table 3. In Table 3 indicates that composite validity of all the research categories is at a very high level and the Cronbach's alpha of all the research categories is also very high, and Average Variance Extracted of the research categories is also higher than the standard value.

5. Results

In this part of the research, qualitative findings and quantitative findings are stated. Table 4, firstly, presents the descriptive statistics of demographic variables.
Demographic findings represented that most of the participants were more than 40 years old, male and married, most of them had a bachelor degree and below by more than 15 years of work experience.

5.1. Qualitative findings

In this part of the research, environmental drivers, components and consequences of supply chain agility, as well as the final model of the quality phase, are presented. Drivers of supply chain agility are presented in table 5.
In this research, the environmental drivers of supply chain agility are in line with the definition of Shamsi Gooshki et al. (2021). Environmental factors create the need and requirement for supply chain agility, include the factors such as the presence of numerous competitors in the industry, the possibility of community dissatisfaction and the requirement of organizations. Supply chain agility components are presented in table 6. In this research, the supply chain agility consists of the components of agile sensitivity, agile planning and agile production, and each

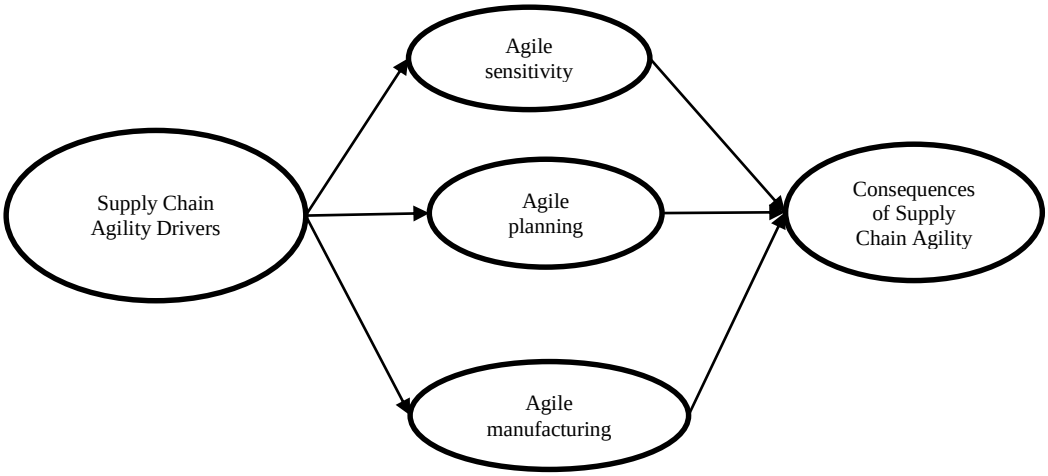

Figure2: The final conceptual model of the research

Table7: Consequences Of Supply Chain Agility

Subcategory	Reference
Speed in product delivery	Shamsi Gooshki et al, 2021
Product reliability	Shamsi Gooshki et al, 2021
Quality stability	Shamsi Gooshki et al, 2021
Reduce costs	Shamsi Gooshki et al, 2021
Customer satisfaction	experts
Empowerment in the field of fulfilling obligations	experts
Non-disruption and stability in production	experts
Ease of supplying the equipment needed by the sites	experts
Price advantage compared to competitors	Shamsi Gooshki et al, 2021
Increase the level of employment	experts
Improve native capabilities	experts
Reducing damages caused by international sanctions in the supply of parts and equipment	experts
Improving cooperation between companies with similar production	experts

of these components consists of subcategories according to table 6. The consequences of supply chain agility are presented in table 7.

The consequences of supply chain agility are the benefits that the companies can have. These consequences include the factors such as the speed in product delivery, product reliability, quality stability, etc. Based on the content stated and a qualitative study, the final model of drivers, components and consequences of supply chain agility in oil and gas industry is presented in figure 2.

5.2. Quantitative findings

In this section of the research, the descriptive findings and the test of the research model are presented using Smart PLS version 2 software and the structural equation modeling approach. In the modeling of structural equations, the numbers placed on the path between structures are called path coefficients. These numbers have shown the standard regression Beta or correlation coefficient of two constructs. The numbers placed on the path between the structures and the questions indicate the factor loading of the questions in forming the desired structure. The numbers inside the circle of endogenous variables of the model represent the coefficient of determination (R2) of the main construct. The larger these numbers are, the more explanatory the model is. As a general rule, the questions that failed to explain more than 0.40 (40 percent) of their corresponding structural changes are removed from the set of questions. As the results of table 3, the values of composite reliability and Cronbach's alpha for all constructs are greater than 0.7 and the extracted average variance values are greater than 0.5. Therefore, the reliability and validity of the research tool at the level of constructs is at an acceptable level.

In the following, to evaluate the convergent validity, factor loading values and their significance were referred to. Also, to determine the face validity of the questionnaire, the prepared content was first approved by expert professors in the research subject. Figure 3 shows the factor loading values and their path coefficient.

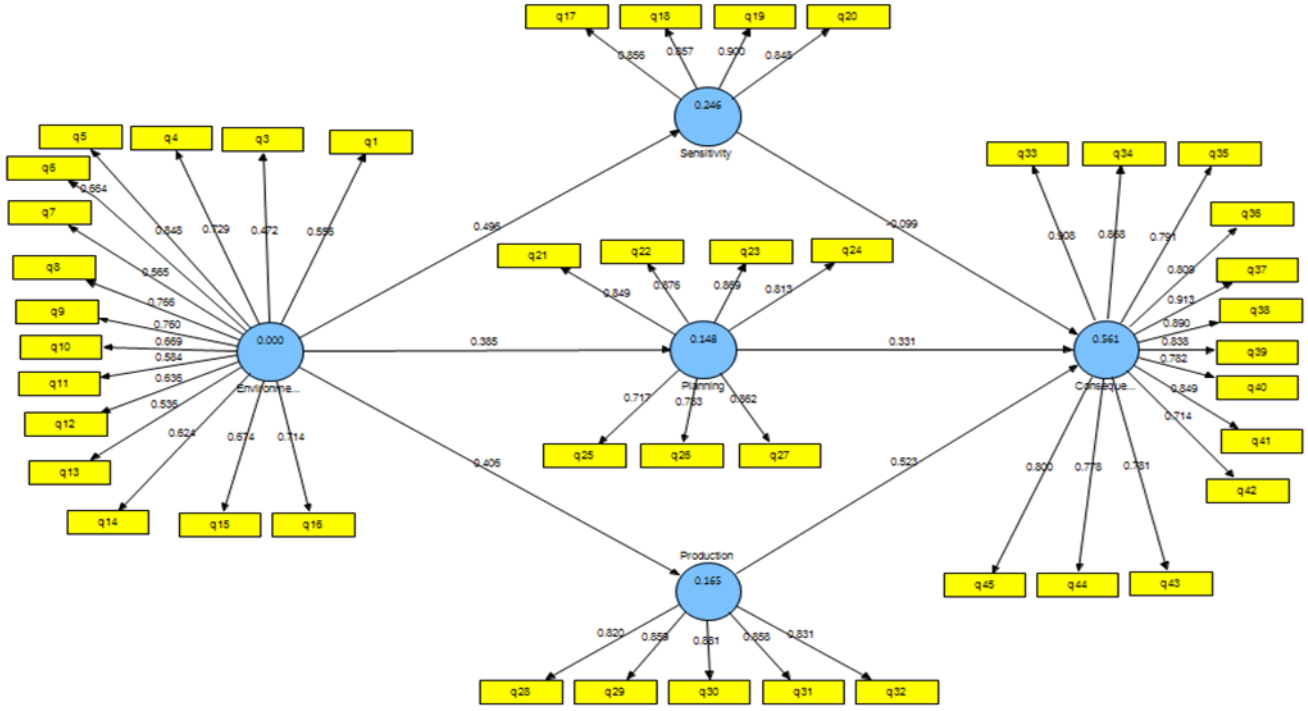

Figure3: Path coefficient test of research variables

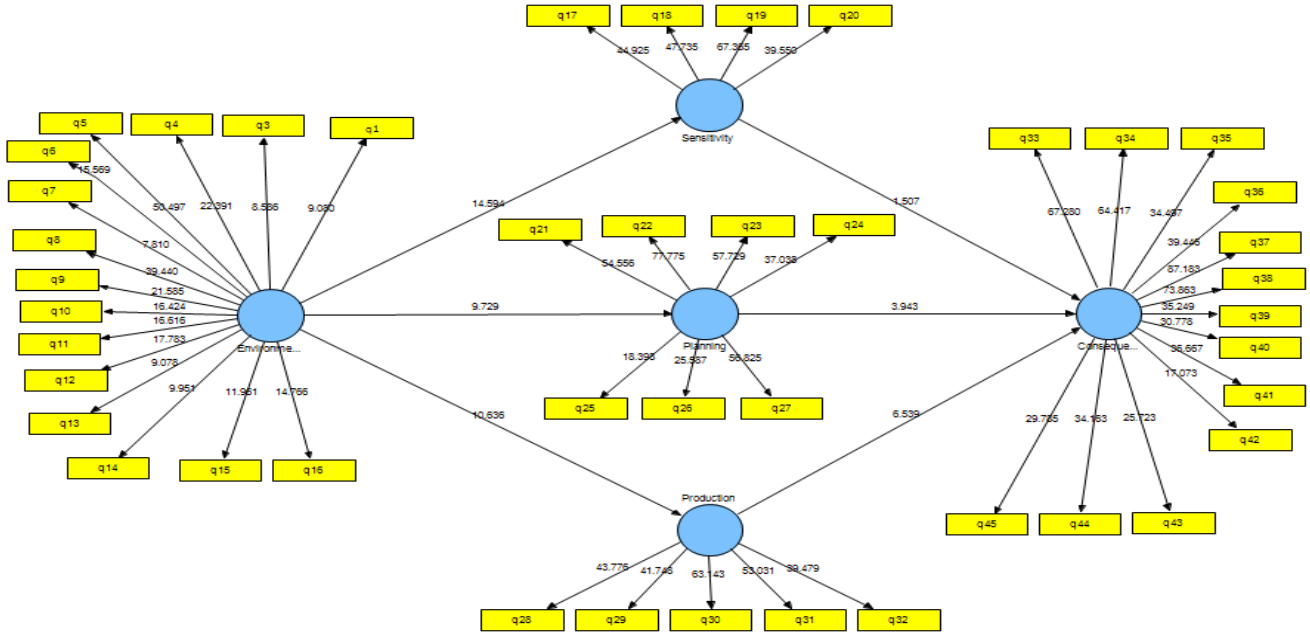

Figure4: T statistic test of research variables

According to the figure 3, the factor loading of all the factors in the 5 components of the research model, except index 2 which was removed earlier, is greater than 0.5, a factor loading above 0.5 means convergent validity of the indicator, and there is a positive relationship between these variables, except agile sensitivity and consequences of supply chain agility.

T test results are shown in Figure 4. The results showed that the relationship between drivers, components and consequences of supply chain agility are significantis at the 5% error level (t> 1.96).

In the following, the structural model is evaluated. At this stage, based on the model proposed, co-linearity evaluation, significance evaluation and suitability of structural relationships, R2 level evaluation and finally the importance-performance matrix analysis will be performed. Table 8 shows the results of co-linearity assessment (VIF), relationship assessment and R2.

Findings of table 8 show that the environmental drivers of supply chain agility have a significant and positive relationship with agile sensitivity, agile planning and agile production. The relationship between agile planning and

Table8. Structural model evaluation

Independent Variable	Dependent Variable	Coefficient Standard Route	T Statistic	P-Value	Coefficient Of Determination
Driver	Agility	0.496	14.59	0.00	0.24
Driver	Planning	0.385	9.72	0.00	0.48
Driver	Production	0.406	10.63	0.00	0.16
Agility	Consequences	0.099	1.50	0.00	
Planning	Consequences	0.331	3.94	0.00	0.56
Production	Consequences	0.523	6.53	0.00	

Table9. Fit indices of the final research model

	Average Model Index	Consequences Of Agility	Agile Manufacturing	Agile Planning	Agile Sensitivity	Environmental Drivers
Communality Index	0.65	0.68	0.72	0.68	0.75	0.43
Redundancy Index	0.15	0.24	0.11	0.09	0.17	-
Good Of Fitness Index	0.42					

agile production with consequences of supply chain agility is also significant and positive, but there is no significant relationship between agile sensitivity and consequences of supply chain agility.

Also, structural equation modeling with Smart PLS approach lacks a general optimization criterion. In path modeling with this approach, the measurement model, structural model and also the whole model should be optimized. In path modeling, three general indices of communality index, redundancy index and overall model good of fitness (GOF) index are presented for model fitting.

The communality index (positive values), the quality of the reflective measurement models for each block, the redundancy index (positive values), the structural model quality measurement criterion for each endogenous block, and the good of fitness index of the entire model of both measurement and structural models are considered. Findings of the modified model fit indices are presented in table 9.

Findings of table 9 show that the communality index of all research variables is positive and acceptable. Also, the redundancy index of endogenous variables of the model is also positive and acceptable. On the other hand, the good of fitness index of the entire research model has been evaluated as 0.42 and good.

6.Discussion and Conclusion

The purpose of this research is to design and test the supply chain agility model in oil and gas industry. This research was conducted with a mixed approach. The findings of the qualitative phase showed that the environmental drivers of supply chain agility include the presence of many competitors in the industry, the possibility of dissatisfaction of the surrounding community in terms of the services provided by the companies, the requirement of regulatory and inspection organizations to increase speed and accuracy, the requirement to create laws in facilitating function and productivity, the process of globalization and the introduction of virtual software, the lack of raw materials inside and the criticality of some required items, the need of organizations related to the company, the desire to grow and develop the capabilities of companies, computer-based technology factors, the existence collaborative relationships and pressure from partners, pressure from customers, efforts to reduce internal dependence on raw materials and foreign equipment, efforts to prevent foreign exchange from leaving the country, great need for technical knowledge in fields such as mechanics, precision instruments, chemicals, etc., the existence of sanctions and barriers to the entry of the required equipment into the country and the existence of intense international competition to achieve the right quality and price.

These findings are in line with Tamtam and Tourabi (2021), Barve (2011) and Shamsi Gooshki et al. (2021). The findings of the qualitative phase showed that the agility of the supply chain is one of the general categories of agile sensitivity, monitoring the situation of customers, identifying sources of raw material suppliers, making support services agile and analyzing and predicting fluctuating conditions in the market and preparing to face it, agile planning using specialized software, standardizing rules and processes, creating strong regulatory guidelines, selecting and using first-class suppliers, exploiting the port location of the province to supply foreign items, regional planning to use local capabilities and Using the capabilities of knowledge-based companies in the oil and gas industry, and agile production, the ability to realize the production plan, fast supply of parts and equipment needed for the production line, speed in the production of products, flexibility in the implementation of production plans and the speed of replacing inefficient equipment. These findings are in line with Moniruzzaman et al., (2016), Macclever et al. (2017), Tamtam and Tourabi (2021) and Tonday et al. (2021). The findings of the qualitative phase also showed that the consequences of the supply chain agility are from the categories of speed in product delivery, product reliability, quality stability, cost reduction, increase in customer satisfaction, empowerment in

fulfilling obligations, non-disruption and stability in production, the ease of supplying the equipment needed by the sites, the price advantage compared to the competitors, the increase in the level of employment, the improvement of local capabilities, the reduction of damage caused by international sanctions in the supply of parts and equipment, and the improvement of cooperation between companies with similar production. These findings are in line with Shamsi Gooshki et al. (2021) and Macclever et al. (2017).

Finding of the quantitative phase showed that supply chain agility drivers in oil and gas industry have a significant and positive effect on agile sensitivity, agile planning and agile production. Agile planning and agile production also have a significant and positive impact on supply chain agility consequences, but agile sensitivity does not have a significant impact on supply chain agility consequences. These findings are in line with Jamalpour (2022), Akbarzadeh et al. (2019), Rahimi et al., (2019), Chan et al. (2017) and Karami et al. (2016).

Also, some findings indicated that among the indicators of supply chain agility drivers of the trend of globalization, rules to facilitate operation and productivity, strong need for technical knowledge, the need for related organizations, the desire for growth and development, technology and the existence of collaborative relationships have the most importance. The findings showed that among the sensitivity indicators of agile supply chain, making support services agile, identifying sources of raw material suppliers, analyzing and forecasting market conditions, and monitoring the status of customers have importance.

The findings showed that among the indicators of agile supply chain planning, the creation of strong regulatory guidelines, the selection and use of first-class suppliers, the use of specialized software, the standardization of rules and processes, and the use of the capabilities of knowledge-based companies have the greatest importance. The findings showed that among the indicators of agile production in the supply chain, the speed of product production, fast supply of production line parts and equipment, the speed of replacing inefficient equipment, the flexibility of production plans and the ability to realize the production plan have the most weight. Among the indicators of the consequences of supply chain agility, the speed of product delivery, empowerment to fulfill obligations, no interruption in production, price advantage, improvement of cooperation with similar companies, and increase in customer satisfaction have the most weight and importance.

Based on the research findings, it is suggested:

- In order to improve the level of agility of the supply chain in oil and gas industry, the most attention should be paid to the motivators of agility in this industry, especially globalization, laws facilitating operation and productivity, the strong need for technical knowledge, the need for related organizations, and the desire for growth and development.
- In order to improve agile sensitivity in oil and gas industry, it is suggested to focus on making support services agile, identifying raw material supply sources, and analyzing and predicting market conditions.
- In order to improve the agile planning of the supply chain in oil and gas industry, it is suggested to pay attention to the creation of strong regulatory guidelines, the selection and use of first-class suppliers, the use of specialized software, and the standardization of rules and processes.
- In order to improve the agile production of the supply chain in oil and gas industry, it is suggested to pay the most attention to the speed of product production, fast supply of production line parts and equipment, and the speed of replacement of inefficient equipment.

It is also suggested for the future researchers to investigate with other approaches such as grounded theory, causal conditions, main phenomenon, contextual conditions, strategies and consequences of supply chain agility. It is also suggested to identify and prioritize the supply chain agility components in other industries as well, so that the comparison between different industries is possible.

In this research, the researcher faced some limitations. In oil and gas industry, the number of people who have expertise in the field of supply chain agility is limited. Also, this limited number of people is hardly available and only a few of these people had both the knowledge and expertise and the interest to cooperate with the researcher. On the other hand, less attention has been paid to the supply chain agility in the oil and gas industry, which has made the researcher face the problem of accessing related resources.

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