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The effect of supply chain management challenges on research and development projects using Fuzzy DEMATEL and TOPSIS approach

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Abstract
Purpose: This paper aimed to identify, classify and prioritize supply chain management challenges for research-development projects in the R&D organization.
Research Methodology: Based on previous literature and interview with related experts, the initial challenges of SCM for research-development projects in Iran organization were extracted. Thereafter, the identified challenges were finalized, classified, and prioritized. For this purpose, a semi-interview and questionnaire were designed, applied, and then analyzed using some statistical methods. Validation of the results was done through several interviews. Finally, the necessary modifications were made to the factors of environmental sustainability associated with the COVID-19 crisis.
Results: In this study, the challenges of SCM for research-development projects in Iran organization were divided into six categories: cultural, motivational, contextual, process, infrastructural, and capabilities. Thereafter, suggested solutions were presented which describe how the challenges of SCM in research-development projects may be removed progressively.
Limitations: This research is only described in project-based organizations. The study was limited to construction projects in different cities of Iran.
Contribution: The prioritized challenges of SCM are a guideline for managers or decision-makers of R&D projects which will enable them, resolve challenges or improve on decision making. It also serves as a useful base for researchers to expand further research concerning the challenges of SCM in other research-development organizations. This study may present high value for researchers in the SCM field for research-development projects. Also, this study presents several solutions for the improvement of challenges considering the level of their importance to SCM.
Keywords: project supply chain management, research-development project, fuzzy DEMATEL, fuzzy TOPSI
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1. Introduction

The temporary-unique nature of the project's uncertainty with regard to chain flexibility involved in the research phase and sustainability in the production phase, cause project organizations to pay more attention to the concurrent engineering process. Project in these organizations is faced with serious challenges due to their scant knowledge of the importance of these issues. Therefore, they need to focus on network interaction, optimal participation with layers involved in the project, and reduction of time and costs in the project research cycle and product research outcomes by considering the benefit of all layers in the project. These requirements led to the emergence of a new concept of project supply chain management[1] that was first introduced by Asbjrnslett in 1980 but was less emphasized (Asbjrnslett, 1998). Project supply chain management (PSCM) creates opportunities for organizations and influence project successfully. Although its deficiency could cause an increase in costs, time, and delay in projects, and could also decrease quality and waste of financial resources.

Studies have shown that during the 1990s, numerous public and private organizations accepted and used the techniques of SCM, such as efficient response to the customer, continuous procurement, and inventory and vendor management systems, to gain sufficient competitive advantage in the market. Evidence has shown that organizations manage effectively their entire supply chain, successfully reduce logistics costs and related inventory, cycle time, and improve customer service. For example, the use of the supply chain in Procter Company led to annual savings of about $ 65 million. According to its management reports, a principle approach that is based on both production and works with suppliers was used to eliminate the additional activity and resources in the entire supply chain. But several project-based organizations have neglected the acceptance and use of supply chain techniques. This type of organization, in the construction industry, is usually associated with low quality, low-profit margins, high time, and cost (Yeo & Ning, 2002). In a study, it was estimated that about 40% of the work in the construction industry is non-value-added activities, such as time spent waiting for the approval or achievement of material at the project site (Mohamed, 1996). Although there are proven advantages of applying supply chain in projects,research-development project supply chains are faced with numerous challenges in its application and integration such as intercultural problems, lack of necessary skills, operational problems, lack of resources, and external problems (Ritchie & Brindley, 2007).

Therefore, the purpose of this study was to identify, classify and prioritize SCM challenges in Iran's R&D Organization. The novelty of this research article was to consider two concepts include supply chain management and project management together for the project-based organizations. In addition, this study considers SCM challenges in the whole project life cycle including planning, implementing, control and monitoring. The study covers both single project management and megaproject management.

1. Theoretical background and literature review

Iran R&D Organization is focused on the field of research-development projects. These projects can include any scientific research, technology, and systems and all levels of the organization (Young, 2003). Their life cycle includes need assessment, conceptual design, preliminary design, detail design (development phase), construction, utilization, and disposal (operation phase). Project supply chain management, which seeks value enhancement in projects through logistics', focuses on demand (in development phase) and supply (in operations phase) alignment. However, value enhancement can be achieved through engineering and supply chains contribution in developing the demand for the project object, and by creating value through cost efficiency in the operations supply chains (Hetland, 1999).

There are several different challenges associated with research-development PSCM. Thus these challenges have been divided into six categories: capabilities, process, contextual, infrastructural, motivational, and cultural. They may be related from three perspectives: macro, inter-organizational and micro perspective. Challenges from the macro perspective are related in such a way that they can be exploited and resources in the development and operation phase from several sources can be obtained from different locations and procurement processes among operators, contractors, and suppliers. However, challenges from the inter-organizational perspective are related to collaboration in inter-organizational arenas. While challenges from the micro perspective are related to each actor in being attractive as a supply chain actor (Cousins & Spekman, 2003).

[1] Project supply chain management= PSCM

Capability challenges are the scientific and technological capabilities associated with industry and external partners which are the minimum requirement necessary for cooperation partnership. In fact, there are different types of actors with different roles, responsibilities, and capabilities in a project supply chain that cause challenges in the project. These increase the complexity of project management and the rate of change (Young, 2003). The major challenge in this field is to find a way to utilize the capacities and capability of local-external organizations in order to maximize their benefits (Morris & pinto, 2007). Also, some challenges and obstacles are associated with collaborative innovation and property intellectual. However, several researchers have identified the different necessary factors for effective collaboration in PSCM, which include cognitive differences, organizational, cultural, and institutional differences between parties (Parrod, et al., 2007), (Vrijhoef & Koskela, 2000). Collaboration may draw up a single contract with a prime contractor or alliance group of contractors. Prime contractors announce that they seek to reduce the number of subcontractors and develop long-term relationships with a smaller number of partners. When industries are becoming mature, they tend to focus more on cost efficiency and value enhancements through a rich set of suppliers with technology development capabilities. The relationship that existed between the Operators and the technology-based companies permits close integration of their operations and R&D (Lainez & Kopanos, 2008).

Process challenges refer to specific steps, a certain sequence of activities, and specific mechanisms for doing things. The demand definition and specification process in project development is directly related to the value positioning of the project. This demanding process will establish and commit the supply chain when the defined demand is supplied through the contract execution model (Kerzner, 2006). PSCM needs to establish mechanisms to create integration. The major challenge in this field is the selection process of the operator or contractor in the development or operation phase of the projects. The selection process can cause an optimal network through a life cycle (Tam, et al., 2011). Also, alternatives selection in conceptual design, technologies alternative and supply chains alternative, due to new supply chains, can establish new opportunities or challenges that are uncovered through uncertainty management of the project and are able to change cost and execution time (Yeo & Ning, 2006).

Contextual challenges refer to the industry's background and context. and regulation of behaviors in the institutional framework and interaction forms. The major challenge in this field is related to project life cycle, project stages, and nature. The supply chain should be involved in a project life cycle in order for it to be part of project definition and project object specification (Kim, et al., 1992), (Young, 2003).

Infrastructural challenges refer to the structure and equipment necessary to facilitate and expedite matters such as communication, ICT infrastructure. Project-based organizations require integrated information systems. Moreover, Motivational Challenges refer to situations in which the individual and group are motivated to interact and exchange ideas and to obtain cooperation and participation. Cultural challenges refer to situations of trust culture, honesty, teamwork, data and information sharing, cooperation and interaction culture, and collective learning during the project life cycle (Lainez & Kopanos, 2008).

Several researchers have identified four key actions that must be carried out for the successful implementation of PSCM: building a network within the different enterprise, change in organizational structure, establishing assessment processes, and cooperation and coordination design (Edum, et al., 2001). Other researchers have introduced five necessary activities for the implementation of PSCM in order to select appropriate mechanisms for integration and trade-off between different organizations (Gattorna, 2005), (Vrijhoef & Koskela, 2000). Forozandeh et al. reported the right suppliers, right project executors, and network design of layers as the key success factors involved in project-based organization's implementation of PSCM (Forozandeh, 2015). Moreover, Miguel believes that many potential problems and challenges may be due to inadequate knowledge, cultural differences, motivational factors, different organizational styles and bureaucracy (Lainez & Kopanos, 2008). Among other obstacles lack of resources and problems in contracts can be singled out.

2. Research methodology

In this study, the method of data collection was descriptive because it included a set of methods that describe the conditions necessary to make better decisions. Also, it was a survey because it examined an existing situation, the relationship between variables, and the challenges faced by the R&D projects. At first, 20 research-development projects were selected for examination in the R&D Organization. They were obtained from different fields such as electronics, mechanics, etc. Many of them were related to non-integration between supply, production, and construction, and as such, can cause problems and challenges.

Based on previous literature, the challenges of PSCM in R&D industries were extracted. In the next stage, the different challenges of PSCM were classified by reviewing the related literature and thereafter, conducting a semi-structured interview with 12 experts that were asked to either verify or reject the existence of each challenge. Accordingly, 42 challenges were identified and extracted from the interview, and after the elimination of duplicated challenges and integration/removal of some with the same themes, 25 key challenges were obtained. In order to categorize the identified key challenges, 10 experts were selected using the Delphi technique; however, the majority opinion of the experts was considered. Subsequently, the PSCM challenges were classified into six categories. The sources of the extraction of these challenges have been mentioned previously. Then each of the PSCM identified challenges was put into one of these groups.

Table 1. Important PSCM challenges in R&D projects -contextual

Code	Challenge	Class	source
Co1	Lack of understanding and comprehension of concepts and principles of PSCM and its importance for research-development projects	Contextual	(Asbjrnslett, 1998), (Simchi-Levi, et al., 2000)
Co2	Lack of necessary development in the field of process design and layers interaction procedure		(Morris & pinto, 2007)
Co3	Lack of consistency of project approach with its supply chain type		(Young, 2003), (Shapiro, 2004)

Table 2. Important PSCM challenges in R&D projects -process

Code	Challenge	Class	source
Pr1	Weaknesses in the needed mechanisms for the establishment of PSCM	Process	(Young, 2003)
P22	Weakness in the definition, standardization, frameworks and rules and transparency of collaboration and cooperation between layers involved in the project		(Basu & Wright, 2008), (Morris & pinto, 2007), (Nassimbeni, 1998)
Pr3	Lack of transparency in tasks and role of each layer in research cycle process		(Shapiro, 2004)
Pr4	Lack of audit processes in research PSC and preventive and corrective actions		(Morris & pinto, 2007), (Simchi-Levi, et al., 2000)

Table 3. Important PSCM challenges in R&D projects -capabilitical

Code	Challenge	Class	source
Ca1	Non-forming and lack of optimal participation in the entire life cycle and in key bottlenecks	Capabilitical	(Schultzel & Unruh, 1996), (Xuea, et al., 2005),(Forozandeh,2018).
Ca2	Lack of optimized network design for optimal management of the research-development project life cycle in Iranian industry		(Silver, 1988), (Risku & Karkkainen, 2006), (Forozandeh, et al, 2019)

Ca3	Lack of integration of research and development, production and supply in all project life cycle phase		(Kim, et al., 1992), (Zailani & Rajagopal, 2005), (Palaneeswaran, et al., 2003), , (Madadi, 2008)
Ca4	Lack of mature industry and full control overcome the design and integration of systems and products		(Morris & pinto, 2007), (Schmidt & Glen, 2011), (Caron, et al., 1998),
Ca5	Lack of understanding and identification of knowledgeable and proficient partners to manage, execute, and better control network partners		(Basu & Wright, 2008) , (Dainty, et al., 2001)
Ca6	Lack of information and full awareness of the capabilities of the suppliers and sub-contractors by the industry		(Basu & Wright, 2008)

Table 4. Important PSCM challenges in R&D projects -motivational

Code	Challenge	Class	source
Mo1	Unmotivated and indifferent of staff due to lack of attention to training and motivational issues	Motivational	(Shapiro, 2004)
Mo2	Lack of financial commitments by some layers and reduced cooperation incentive among them		(Basu & Wright, 2008)
Mo3	Decrease in External partners incentives (motivation)due to legal issues and financial-intellectual property		(Schultzel & Unruh, 1996), (Basu & Wright, 2008), (Seneviratne,2020)

Table 5. Important PSCM challenges in R&D projects -cultural

Code	Challenge	Class	source
Cu1	Lack of cultural definition of long-term cooperation, strategic win-win	Cultural	(Basu & Wright, 2008), (Moradi,2020)
Cu2	Reduced Attention to cultural issues such as trust, dishonesty, teamwork, and collaborative learning among layers		(Basu & Wright, 2008), (Kanji & Wong, 1998)
Cu3	Existence of competition environment between the layers, instead of collaboration and cooperation among them		(Forozandeh, 2015), (Shapiro, 2004)

Table 6. Important challenges in PSCM in R&D projects -infrastructural

Code	Challenge	Class	source
St1	Lack of necessary development in the field of ICT-IT infrastructure	infrastructural	(Morris & pinto, 2007), (Shapiro, 2004), (Edum, et al., 2001), (Ghorbani ,2020)
St2	Lack of consistency between the product nature and selected supply chain type		(Vollmann, et al., 1995)
St3	Lack of integration between quality management activities and PSC members		(Morris & pinto, 2007), (Young, 2003), (Basu & Wright, 2008)
St4	Standardization of processes between PSC partners		(Basu & Wright, 2008) , (Khalfan, et al., 2001)
St5	Lack of examination of qualified layers in terms of quality and capability through related certificates		(Young, 2003), (Khalfan, et al., 2001)
St6	The lack of precise and systematic identification and application of technology through the agile supply chain and leaning in different phases of the project life cycle, as well as to resolve the project key bottlenecks		(Burton & Lanciault, 1999), (Khalfan, et al., 2001), (Borodako, et al ,2019)

Subsequently, a questionnaire was prepared to confirm the results of the interview and to prioritize the identified challenges. The questionnaire consisted of six parts, in which each part included one class of PSCM identified challenges. In each part, the related challenges were listed (25 identified challenges), and the importance of each of them was scored from 1 to 5 according to the Likert scale (5 being the most important, 1 being the least important). Thereafter, the questionnaires were distributed among 50 experts that comprised topics of different areas such as electronics, mechanics, etc. Thus 42 questionnaires were answered and returned. In this study, questionnaires validity was conducted using the content validity method. Thus the quantity and quality of the questions and index were examined and evaluated by ten experts, and any ambiguity and shortcomings of the questionnaire were resolved. Finally, suggested solutions were presented for minimizing the identified challenges of PSCM. The research process is shown in Figure 1.

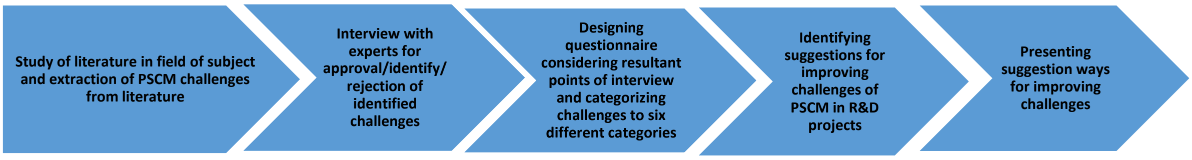

Figure1**.** Process and method of research

The statistical population of this research is composed of different responsibilities in the three sectors of the contractor, executor, and consultor in R&D projects. These industries fulfilled the following three criteria: Being project-based; Functioning in the research-development projects of different areas, and having an SCM sector within the organization. The population information is given in the table below.

Table 7. Demographic information of statistical sam

Age	**fi**	**Gender**	**fi**	**Session**	**fi**
20-30	4	Male	30	Bachelor	6
30-40	17	Female	12	M sc	32
40-50	17			Phd	3
50-60	4				
Total	42	Total	42	Total	42

The main hypotheses to be tested are H0: All challenges identified are of the same priority, H1: At least a challenge has different priorities from other challenges.
The collected data were analyzed using two methods: descriptive and deductive. A single sample *t*-test and Friedman test were used for the deductive analysis of the data. The single sample *t*-test was applied for the approval or rejection of the 42 identified challenges. The identified challenges were prioritized using the Friedman test (nonparametric test). SPSS software was used for data analysis.

The Cronbach's alpha coefficient of the questionnaire was equal to 0.919. The reliability coefficient was 0.7 and as such, it can be concluded that the applied questionnaire required research reliability. On the other hand, evaluation of the conditions for each variable indicated that omission of each variable does not lead to a significant increase or decrease in the reliability coefficient of the questionnaire.

3. Results and discussions

According to the results of the SPSS, the number of valid statistical samples was 42 (100%), excluded was 0, and total cases were 42 (100%). Based on the results of the Friedman test, the total number of samples was 42, the chi-square value was 65.003, the DF value was 24, and the significant amount (sig) was 0. Due to the fact that the significant amount was less than 5%, the null hypothesis is rejected. Therefore, it can be concluded that the rank means and challenges priority is not the same. Also, the Friedman test was used to calculate the rank mean for each variable. The larger rank mean had higher priority. The challenges and rank mean are given in Table 8.

Table 8. Challenges and rank mea

Code	Ranks Mean	Rank	Code	Ranks Mean	Rank	Code	Ranks Mean	Rank
Pr1	16.04	1	Ca3	13.4	11	St1	11.95	21
Co1	15.45	2	Ca1	13.39	12	Cu2	11.92	22
Ca6	14.69	3	Ca4	13.31	13	Mo1	10.44	23
Cu3	14.57	4	Pr4	13.27	14	St6	10.26	24
Co3	14.11	5	Ca5	13.06	15	St3	8.04	25
St5	14.11	6	Mo2	12.98	16			
Co2	13.96	7	Mo3	12.64	17			
Pr3	13.79	8	Cu1	12.32	18			
Pr2	13.55	9	St4	12.23	19			
Ca2	13.48	10	St2	12.05	20			

Subsequently, the rank means of challenges for each category were averaged. Thus, this is the criteria for the determination of the priority of each category of challenges (Table 9).

Table 9. Prioritize classified challenges

	category	challenges	Average of ranks mean
C1	Contextual	Co1,Co2,Co3	14.5
C2	Process	Pr1 ,Pr2,Pr3,Pr4	14.16
C3	Capabilitical	Ca1,Ca2,Ca3,Ca4,Ca5,Ca6	13.55
C4	Cultural	Cu1,Cu2,Cu3	12.93
C5	Motivational	Mo1,Mo2,Mo3	12.02
C6	Infrastructural	St1,St2,St3,St4,St5,St6	11.44

In the next step, a questionnaire was designed to determine and evaluate the intensity of the relationship between the challenges and was provided to a number of experts active in the field of scope. They were asked to assign a number between 0 and 4 according to Table 2, according to the effect of each index on the other indices. Due to the limited values, the data were analyzed in a fuzzy environment to be more accurate. According to the collected data, the initial decision matrix was formed according to Table 10.

Table 10. Fuzzy decision-making matrix base on experts active

C8	C7	C6	C5	C4	C3	C2	C1	Z
(0.75,0.75,1)	(0.75,0.75,1)	(0.75,0.75,1)	(0.75,0.75,1)	(0.5,0.75,1)	(0.75,0.75,1)	(0,0.25,0.5)	(0,0,0)	C1

(0.75,0.75,1)	(0.5,0.75,1)	(0.5,0.75,1)	(0.25,0.5,0.75)	(0.5,0.75,1)	(0.75,0.75,1)	(0,0,0)	(0.5,0.75,1)	C2
(0.25,0.5,0.75)	(0.75,0.75,1)	(0.5,0.75,1)	(0.75,0.75,1)	(0.5,0.75,1)	(0,0,0)	(0,0.25,0.5)	(0.75,0.75,1)	C3
(0.5,0.75,1)	(0.25,0.5,0.75)	(0.5,0.75,1)	(0.25,0.5,0.75)	(0,0,0)	(0,0.25,0.5)	(0,0,0)	(0,0,0)	C4
(0.5,0.75,1)	(0.75,0.75,1)	(0.5,0.75,1)	(0,0,0)	(0,0,0)	(0.5,0.75,1)	(0.25,0.5,0.75)	(0.25,0.5,0.75)	C5
(0.75,0.75,1)	(0.5,0.75,1)	(0,0,0)	(0,0.25,0.5)	(0,0,0)	(0,0.25,0.5)	(0,0.25,0.5)	(0.25,0.5,0.75)	C6

By performing the mentioned steps, the total relations matrix was obtained as follows (Table 11):

Table 11. The relations matrix

Definitive	D-R	Definitive	D+R	R	D	Indicator
0.15	(0.24, 0.16, 0.01)	-2	(-1.89, -2.03, -1.97)	(-1.06, -1.09, -0.98)	(-0.82, -0.93, -0.98)	C1
0.16	(065, 0.067, 0.034)	-1.79	(-1.12, -1.91, -1.99)	(-0.88, -0.99, -1.01)	(-0.23, -0.92, -0.97)	C2
0.19	(0.39, 0.15, 0.066)	-1.99	(-1.96, -1.99, -2)	(-1.17, -1.07, -1.03)	(-0.78, -0.92, -0.96)	C3
-0.21	(-0.53, -0.16, -0.07)	-1.94	(-1.95, -1.94, -1.96)	(-0.71, -0.88, -0.94)	(-1.24, -1.05, -1.01)	C4
0.22	(0.65, 0.15, 0.05)	-1.92	(-1.81, -1.93, -1.98)	(-1.22, -1.04, -1.01)	(-0.58, -0.88, -0.96)	C5
-0.1	(-0.52, -0.02, 0.013)	-2.03	(-2, -2..03, -2.02)	(-0.74, -1.01, -1.01)	(-1.26, -1.03, -1.00)	C6

According to the calculations and the results, it was found that indices C2 and C5 have the most interaction with other indices because they have the highest amount of D + R. Is effective, so the most important among the indicators is C2. On the other hand, index C6 has the least interaction with other indices (D + R = -2.03).

It was also found that indices C1, C2, C3, and C5 are causal variables and affect other indices. In contrast, indices C4, C6 are disabled variables and are influenced by other indices. In addition, we have:

- C1 is an indicator that affects all other indicators. C1 is one of the key problem-solving indicators and should be given priority.
- C2, like C1, is an indicator that affects all other indicators. This index is also one of the main problem solvers.
- C3 is affected by the C4 index and other indicators are affected. This indicator, like the other two indicators, should be a priority.
- C4 is affected by all other indicators and does not affect any criteria.
- C5 is an indicator that affects all other indicators. This index is also one of the effective indicators.
- C6 affects the C4 index. Thus C6 is an independent indicator that affects quantitative indicators.

The weight of the indicators was calculated in Table 12.

Table 12. The weight of the indicators based on the Dematel method

Definite weight	Normalized weight	Weight		Indicator	Definite weight	Normalized weight	Weight		Indicator
0.03008	2.765688	L	0.03008	C4	0.047	0.04362	4.01021	L	C1
0.037293	3.428512	M	0.037293			0.04848	4.45718	M	
0.04045	3.71907	U	0.04045			0.04239	3.89742	U	

0.044	0.04839	4.4483	L	C5	0.038	0.02153	1.97959	L	C2
	0.04358	4.00605	M			0.04128	3.79505	M	
	0.04385	4.03132	U			0.04374	4.02133	U	
0.042	0.03232	2.97116	L	C6		0.05024	4.61834	L	C3
	0.04456	4.0966	M			0.04646	4.2714	M	
	0.04451	4.09157	U			0.04491	4.12899	U	

In the last stage, the challenges were ranked with TOPSIS technique. TOPSIS technique is one of the multidisciplinary decision-making methods, from the compensatory group and the subgroup of adaptation techniques. The strength of this technique is in solving multiple-choice problems due to the overlap of indicators in strengths and weaknesses (Kohansal and Rafiei, 2008). Using this technique and the weights obtained in the previous step, the challenges are ranked to form a challenges basket. The initial matrix is formed after data collection. Table 13 is used to convert verbal variables to fuzzy numbers.

Table 13. Fuzzy verbal variables

Fuzzy values	Verbal expressions
(0.9,1,1)	Very much
(0.7,0.9,1)	Much
(0.5,0.7,0.9)	Medium
(0.3,0.5,0.7)	Few
(0.1,0.3,0.5)	Very few

After forming the initial matrix and scaling it, the weightless scaling matrix was obtained by multiplying the weights (Table 12) obtained in the scaled matrix (Table 14).

Table 14. The fuzzy weightless scaling matrix

	C1	C2	C3	C4	C5	C6
P1	(0.01,0.02,0.03)	(0.02,0.04,0.04)	(0.04,0.04,0.04)	(0.01,0.02,0.03)	(0.01,0.02,0.03)	(0.02,0.03,0.04)
P2	(0,0.01,0.02)	(0.01,0.03,0.04)	(0.04,0.04,0.04)	(0.02,0.03,0.04)	(0.04,0.04,0.04)	(0.03,0.04,0.04)
P3	(0.04,0.05,0.04)	(0.1,0.02,0.03)	(0.02.0.02,0.03)	(0,0.01,0.02)	(0.01,0.02,0.03)	(0.03,0.04,.04)
P4	(0.04,0.05,0.04)	(0,0.01,0.02)	(0.02,0.02,0.03)	(0.02,0.03,0.04)	(0.01,0.02,0.03)	(0.02,0.03,0.04)
P5	(0,0.01,0.02)	(0.01,0.02,0.03)	(0.02,0.02,0.03)	(0.02,0.03,0.04)	(0.01,0.02,0.03)	(0.02,0.04,0.04)

According to the mentioned steps, we calculate the distance of each point from the positive and anti-ideal ideal points. We use the results in the final ranking of challenges. Challenges that are closest to the positive ideal and farthest away from the counter-ideal are preferred. However, due to the availability of opportunities to modify constraints or set new constraints for decision-makers, the project selection composition may change, meaning that decision-makers remove or add specific challenges

(Alinejad and Farahabadi Victims, 2015). Table 15 shows the results of challenges evaluation and ranking.

Table 15. The results of challenges evaluation and ranking using fuzzy TOPSIS

Rank	Similarity rate	Project
6	0.308295	C1
1	0.70959	C2
5	0.442117	C3
3	0.649088	C4
4	0.641494	C5
2	0.657088	C6

According to the collected data of the initial matrix, the decision matrix for analyzing the sub-criteria was formed using the FUZZY DEMATEL technique. By performing different steps of this technique, the following information was obtained (Table 16).

Table 16. Results of FUZZY DEMATEL technique for sub-criteria

code	D+R certain	D+R fuzzy		D-R certain	D-R fuzzy		Weight	
Co1	-1.9766	L	-1.99	-0.0201	L	-0.049	0.01259	C1
		M	-1.975		M	-0.015	0.01255	
		U	-1.963		U	-0.016	0.01238	
Co2	-2.659	L	-2.056	0.63830	L	0.017	0.01381	
		M	-2.971		M	0.951	0.03774	
		U	-2.016		U	0.009	0.01324	
Co3	-2.629	L	-2.077	-0.63898	L	-0.032	0.01376	
		M	-2.93		M	-0.95	0.0188	
		U	-0.95		U	-0.003	0.01269	
Pr1	-1.9857	L	-2.045	-0.0165	L	-0.006	0.0135	C2
		M	-1.973		M	-0.02	0.01248	
		U	-1.979		U	-0.014	0.01259	
Pr2	-2.02194	L	-2.05	-0.000434	L	0.016	0.01373	
		M	-2.018		M	-0.007	0.01314	
		U	-2.011		U	-0.012	0.01302	
Pr3	-2.040198	L	-2.043	0.020979	L	0.088	0.0141	
		M	-20.41		M	0.009	0.01355	
		U	-2.035		U	0.003	0.01344	

Pr4	-2.040507	L	-2.072	-0.007744	L	-0.034	0.01368	
		M	-2.042		M	-0.006	0.01346	
		U	-2.005		U	0.012	0.0131	
Ca1	-2.02399	L	-2.15	-0.0074395	L	-0.162	0.01385	C3
		M	-1.999		M	0.023	0.01309	
		U	-1.999		U	0.024	0.0131	
Ca2	-2.017749	L	-2.02	0.0031009	L	0.023	0.01337	
		M	-2.018		M	-0.0008	0.01319	
		U	2.015		U	-0.0014	0.01314	
Ca3	-1.99243	L	-1.969	0.0481739	L	0.0739	0.01303	
		M	-1.996		M	0.045	0.0132	
		U	-2		U	0.0353	0.01319	
Ca4	-2.033236	L	-2.082	0.012591	L	-0.016	0.01393	
		M	-2.025		M	0.0182	0.01384	
		U	-2.018		U	0.0189	0.01331	
Ca5	-1.966311	L	-1.945	-0.034922	L	0.0356	0.01248	
		M	-1.973		M	-0.051	0.01229	
		U	-1.96		U	-0.042	0.01219	
Ca6	-2.0253206	L	-1.951	-0.0449238	L	-0.025	0.01217	
		M	-2.038		M	-0.054	0.01311	
		U	-2.047		U	-0.029	0.01338	
Mo1	-1.994364	L	-1.959	-0.025764	L	0.0791	0.01293	C4
		M	-2.006		M	-0.048	0.01273	
		U	-1.983		U	-0.042	0.01247	
Mo2	-2.04727	L	-2.013	-0.0102339	L	0.0087	0.01318	
		M	-2.054		M	-0.017	0.01355	
		U	-2.056		U	-0.004	0.01367	
Mo3	-2.027992	L	-1.998	0.0101486	L	0.066	0.01335	
		M	-2.034		M	0.002	0.01342	
		U	-2.032		U	-0.013	0.01329	
Cu1	-1.984739	L	-1.98	0.0176652	L	-0.008	0.01265	C5
		M	-1.984		M	0.021	0.01288	
		U	-1.994		U	0.031	0.01308	
Cu2	-2.0001847	L	-1.978	-0.002869	L	0.0089	0.01308	

		M	-2.005		M	-0.004	0.01274	
		U	-2.004		U	-0.009	0.01299	
Cu3	-1.975995	L	-1.959	0.016435	L	-0.016	0.01296	
		M	-1.981		M	0.0236	0.01233	
		U	-1.974		U	0.0201	0.01286	
St1	-2.038999	L	-2.06	0.0607153	L	0.0403	0.01275	C6
		M	-2.036		M	0.0657	0.01401	
		U	-2.028		U	0.061	0.01387	
St2	-1.995795	L	-1.987	0.0042266	L	-0.041	0.01253	
		M	-1.992		M	0.014	0.01294	
		U	-2.019		U	0.012	0.01329	
St3	-1.961168	L	-1.992	-0.002064	L	-0.018	0.01274	
		M	-1.954		M	0.003	0.01238	
		U	-1.958		U	-0.002	0.01241	
St4	-1.650963	L	-2.068	-0.0073387	L	0.002	0.01386	
		M	-1.965		M	-0.008	0.01246	
		U	0.023		U	-0.013	0.000002	
St5	-2.0161479	L	-1.997	-0.0051920	L	-0.012	0.01284	
		M	-2.024		M	-0.005	0.01324	
		U	-2.003		U	-0.0022	0.01302	
St6	-2.0369102	L	-2.023	0.0014737	L	-0.038	0.0131	
		M	-2.039		M	0.0118	0.01354	
		U	-2.037		U	-0.0004	0.1344	

Examining the relationships between challenges will help us achieve better results. According to the results of Demetel technique, it was found that co2 challenge has the least interaction and the st4 challenge has the most interaction among other challenges. This shows the great importance of the st4 challenge. The challenges were ranked using the fuzzy TOPSIS technique and the weights obtained in the previous step, the results of which can be seen in Table 17.

Table 17. Results of fuzzy TOPSIS technique and ranking of challenges for sub-criteria

challenges	D_i^+	D_i^-	Cl_i	rank	challenges	D_i^+	D_i^-	Cl_i	rank
Co1	0.0697	0.026	0.2714	17	Mo1	0.0625	0.0369	0.3711	4
Co2	0.0619	0.0388	0.3852	1	Mo2	0.0703	0.0237	0.2516	20
Co3	0.0662	0.0401	0.377	2	Mo3	0.0711	0.0227	0.2418	22
Pr1	0.0723	0.0183	0.2025	25	Cu1	0.0625	0.0369	0.371	5
Pr2	0.065	0.0293	0.311	15	Cu2	0.0683	0.0304	0.3081	16

Pr3	0.0673	0.0326	0.3263	12	Cu3	0.0719	0.0199	0.2167	23
Pr4	0.0729	0.0185	0.2026	24	St1	0.0638	0.032	0.3339	9
Ca1	0.0648	0.0305	0.3198	13	St2	0.0672	0.0341	0.3365	8
Ca2	0.068	0.0318	0.3186	14	St3	0.0714	0.0242	0.2532	19
Ca3	0.0716	0.0243	0.2536	18	St4	0.0629	0.0376	0.374	3
Ca4	0.0658	0.0327	0.3319	10	St5	0.0673	0.0363	0.3502	6
Ca5	0.0671	0.0347	0.3408	7	St6	0.0688	0.0338	0.3291	11
Ca6	0.0711	0.0228	0.243	21					

4. Conclusion

In project-based organizations with high uncertainty levels, it is important to predict challenges in supply and project management together. Many instances of events and impacts affect project supply chain operations. Due to the nature of project-oriented organizations' activities, this organization is always faced with the possibility of consistent challenges in the external environment. Therefore, this article, by reviewing previous research in the field of project supply chain, first examines the important indicators and parameters of this chain; Then, according to these organizations' nature, it tried to integrate project parameters in this supply chain. Therefore, according to studies conducted in this field, key challenges were extracted, and finally, challenges of project supply chain in project-based organizations were given. Many researchers consider only supply chain and project management separately. In addition, in the present work PSCM, challenges of different stages of the life cycle are considered and their performance is studied. The research results from the opinions of managers and supply chain experts of project-oriented organizations.

Iran R&D organization with research-development projects context require the implementation of PSCM in order to take advantage of the knowledge and technological potentials and reduce the cost and time of access to products and systems. The successful implementation of SCM depends on the existence of different factors, and their utilization can resulting in better performance. However, the lack or inefficiency of the factors can pose difficult challenges and obstacles to an organization. This research was carried out to identify, categorize and prioritize the most important challenges of this issue.

As shown in Table 11, the contextual challenges with scores 2, 5, and 7 and a rank mean of 14.50 are very important in the implementation of SCM. This means that R&D projects need to work hard on soft issues such as culture, customs, and norms governing ratio to systems, processes, and procedures. However, process, capabilities, cultural, motivational, and infrastructure challenges can be considered as important, moderate to high importance, moderate to low importance, little importance, and least important sequence in the next priorities. The results of this research are in agreement with the logic and existing status of the Iranian R&D organization.

The major reason is that there are no proper contextual conditions for the implementation of PSCM, the existing environment of R&D projects influenced the past cultural and contextual factors. Therefore, to change this condition requires enough time and cost. Also, the necessary process cannot identify and optimize the real condition. PSCM in R&D projects requires integrated information systems from different capabilities in different industries. They should use the different capabilities to save cost and time.

Based on the research findings, the following conclusions regarding managers, decision-makers, and future researchers were drawn:

- Although most contextual challenges originated from Iran's R&D organization nature of industries, but revision, perspective change, and updated rules and regulations reduced the size of these challenges. Industries have tried to review and update the rules of intellectual property. Some opinions and attention must be reformed based on the fact that the R&D Industries are missional and as such, should not have economical view. They should consider the economic aspects, beside the accepted mission and follow business perspective.
- Iran R&D organization should establish and implement processes and relevant mechanisms needed for the exchange of ideas and technology. They should create proper mechanisms to cooperation definition, cooperation implementation and the exchange of ideas, and exploit the capacities of the party's process and resolve existing barriers that can cause decreasing research speed.
- The use of human resources and technical knowledge can promote industry capabilities and partnership. Some capability challenges consider centers that are formed within the organisation and have necessary ability to manage external partner's network. On the other hand, some challenges are caused by low level of technological competence and capacity to absorb external partners. Therefore, to proffer solution to address the challenges, industries should promote internal technological capacity and capability through engagement to research- development activity and establish the context of cooperation and interactive learning.
- PSCM requires education and culture in particular to provide mental and cultural context for the implementation of research-development projects supply chain. Through this, they can promote a culture of trust, collaboration, knowledge sharing, learning and collaboration, and synergies. This can be achieved by the existence of cooperation and synergy between industries, promotion of culture, information-knowledge sharing, the institutionalization of a culture of long-term cooperation, and win-win strategy through the design and implementation of desirable business models. To overcome cultural challenges in Iran, efforts should be geared towards improving values, customs, and habits; norms are formed and institutionalized in Iran R&D organizations which of course are difficult and dedicated tasks.
- Iranian R&D organizations should pay special attention to motivational issues at personal or organizational levels, should consider organization benefits in the decision-making process, and increase organization motivation for PSCM in research-development projects. To achieve these, they should have a special plan for inter-organization promotion of individuals and external cooperation motivation. To establish motivation by inter-organization promotion, the individuals should be informed that the use of external capacity does not indicate low benefit and that its application benefits all layers. Besides, colleagues and external actors should establish different attractions such as financial, learning, etc that act as an effective factor.
- Iranian R&D organizations act to create the necessary infrastructure in order to facilitate the project supply chain according to the specific requirements. They should try to develop and maximize the application of information technology, communication and creatable platforms, and the creation and use of moderators/facilitators. Also, they should create technology intelligence procedures with appropriate methods, tools, structures, processes, and actors. The Internet and related e-commerce technologies can be exploited to overcome major systemic constraints. The challenge is to create and build a boundary-spanning information infrastructure that enables quick and efficient information sharing and communication.

Limitation and study forward

To further accurately classify challenges, related studies need to be accessed via exploratory factor analysis. In this study, the importance of each category was calculated based on the average rate of challenges. However, structural equation modeling can be used to determine the effectiveness or the importance of each category of challenges. Identification of causal relationships and interactions between challenges can be done through Interpretive Structural Modeling, demattel, and CM cognitive map. The relationships between these challenges Were examined and the weight of each index was determined. Challenges were evaluated and prioritized using the fuzzy TOPSIS technique, which is an efficient way of deciding on complex issues. Using the above model in a project company, the proposed challenges were evaluated and prioritized based on 6 effective indicators that were extracted with the help of literature according to which were approved by experts. Finally, it was found that challenges c2, c4, and c5, respectively, have the highest priority for placement in the basket. In future research, in addition to the relationships between indicators, the interaction of challenges can also be considered.

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