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Designing a Sustainable Industrial Tourism Supply Chain Network Considering Destination Attractiveness: A Real Case Study

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Industrial Tourism (IT) can lead to economic prosperity, job creation, capital attraction, and greater interaction between industry and society. On the other hand, the Industrial Tourism Supply Chain (ITSC) comprises activities and stakeholders, including transportation, industrial units, accommodation centers, and facilitators, whose coordinated performance directly affects the quality of tourists' experience and the efficiency of this industry. Therefore, the present study examines ITSC considering sustainability aspects to address gaps in the field. Moreover, the important issue of destination attractiveness is considered in the proposed model. The proposed model is solved using the Revised Multiple-Choice Goal Program (RMCGP) method. To evaluate the proposed model, a case study in Mazandaran province, Iran, is considered, and a sensitivity analysis is conducted on some key parameters. The findings show that the activity in this industry and the provision of services are economically justified.

Keywords: *Industrial tourism; Supply chain; Sustainability; Destination attractiveness; Revised Multiple-Choice Goal Program (RMCGP) method.*

1. Introduction

Supply chain management is a fundamental requirement for coordinating and integrating diverse activities across any industry, playing a pivotal role in enhancing efficiency, reducing costs, improving service quality, and boosting customer satisfaction. In recent years, the expanding share of the service sector in the economy has drawn increased attention to service supply chain management (Shahzadi et al. 2024). As a key service industry, tourism comprises a chain of activities and stakeholders including accommodation facilities, service providers, transportation systems, tourist attractions, and the tourists themselves, whose coordinated performance directly impacts the quality of the tourist experience and the destination's success (Charati et al. 2024). Within this context, Industrial Tourism (IT) is an emerging niche that bridges industrial capabilities with tourism activities; beyond offering tourists educational, cultural, and recreational experiences, it fosters regional economic development and showcases local industrial potential (Frew 2008). Despite this potential, research into the design and management of the Industrial Tourism Supply Chain (ITSC) remains limited, and no coherent, integrated framework has yet been established for the field; consequently, examining the ITSC and designing a model tailored to its specific characteristics is of particular importance. Furthermore, sustainability has become a fundamental requirement for the long-term development of the tourism industry, as tourism growth that fails to simultaneously address economic, social, and environmental interests can lead to adverse consequences for the destination,

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the local community, and natural resources (Gruchmann et al. 2022). Similarly, within IT, activities such as tourist transportation, resource consumption, infrastructure utilization, and interaction with local communities can generate a range of economic, social, and environmental impacts (Otgaar 2012). Therefore, simultaneously addressing economic, social, and environmental dimensions when designing an industrial tourism supply chain can, while boosting efficiency and profitability, help conserve resources, benefit local communities, and mitigate negative environmental impacts, thereby paving the way for the sustainable development of this form of tourism. Moreover, destination attractiveness is a key factor in the success and development of tourism, playing a crucial role in tourists' destination choices and their satisfaction with the travel experience (Reitsamer et al. 2016). In industrial tourism, destination attractiveness is not limited merely to the presence of an industrial facility; rather, factors such as the diversity and quality of tourism products and services, innovation, the use of advanced technologies, accessibility and safety, environmental quality, staff behavior, destination reputation, and tourism infrastructure can all influence tourists' perceptions of an industrial destination's appeal. Consequently, incorporating destination attractiveness into the design of an ITSC can facilitate the identification and selection of more appealing industrial facilities, boost tourism demand, enhance the tourist experience and satisfaction, and ultimately improve supply chain performance (Jacobsen et al. 2019). Accordingly, aiming to bridge part of the existing research gap, this study presents a mathematical model for ITSC that accounts for both sustainability and destination attractiveness. To solve the proposed multi-objective model, a Revised Multi-Choice Goal Programming (RMCGP) method is employed to enable a balance among the model's various objectives. Additionally, to evaluate the model's applicability and validity, a real-world case study was conducted in Mazandaran Province; based on the findings, managerial and practical recommendations are offered to improve the design and management of ITSC. Thus, by integrating the ITSC with the two key concepts of sustainability and destination attractiveness, the present study not only advances existing literature but also provides a practical framework for decision-making by managers and policymakers in this field. In general, the notable points of the present study compared to other studies are as follows:

- ✓ Designing the ITSC by presenting a mathematical model.
- ✓ Considering sustainability and destination attractiveness in the proposed model.
- ✓ Using the Revised Multiple-Choice Goal Program (RMCGP) method to solve the model.
- ✓ Considering a real case study in Mazandaran province to evaluate and verify the proposed model.
- ✓ Providing management suggestions according to the output results.

Also, the overall framework of the present work is provided and shown in Figure 1.

The other parts of the present study are as follows: In the second part, the research background related to the field of study is reviewed. In the third part, the problem is clearly explained, and the proposed mathematical model is presented. In the fourth part, the Methodology is described. The case study, input data, and output results are presented in Section 5. Finally, in the last part, conclusions and suggestions for future research are presented.

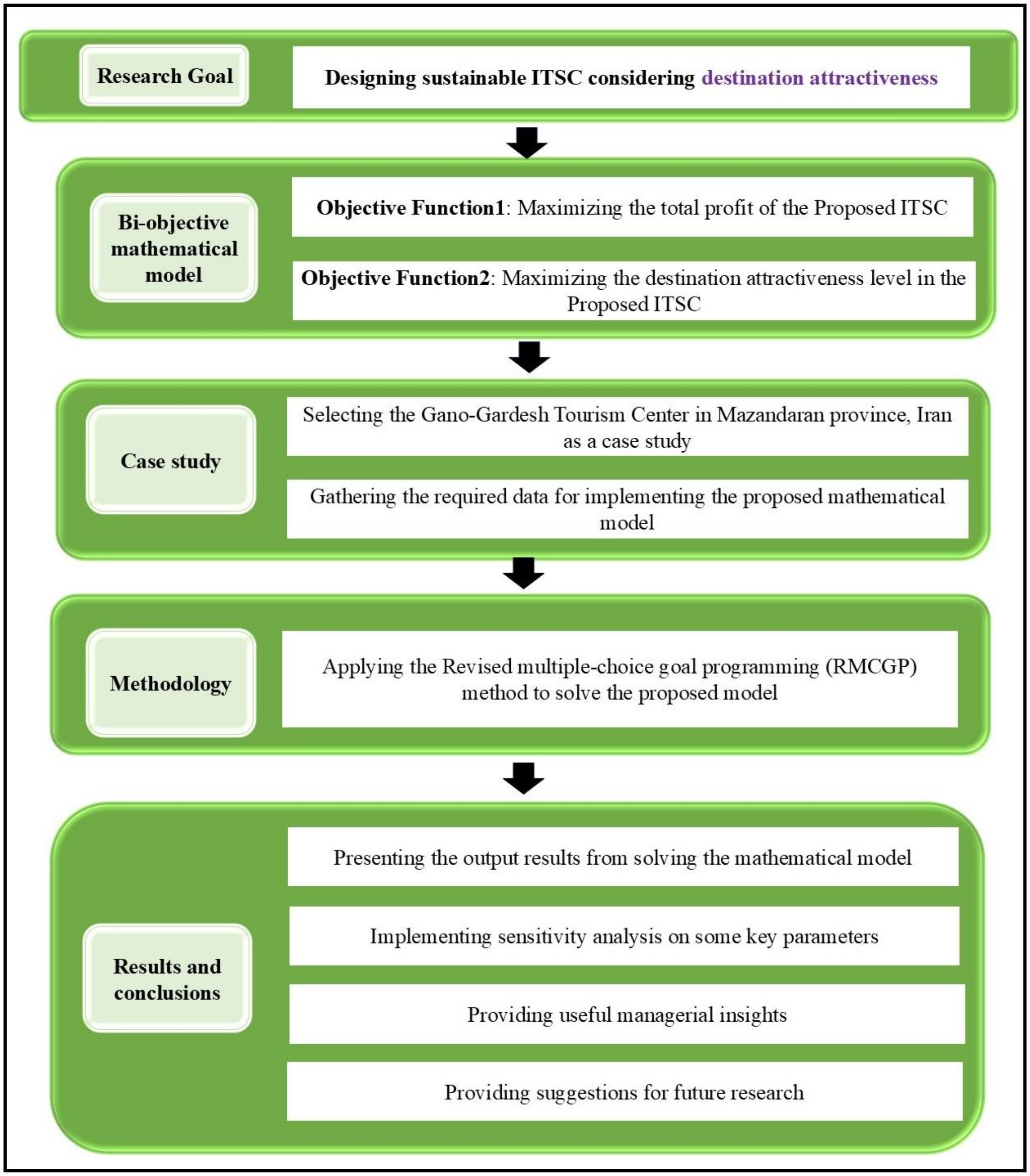

Figure 1: The overall framework of the present work.

2. Research Backgrounds

Jia (2010) first reviewed the current status of China's IT development, and did so by analyzing examples of the first national industrial and agricultural tourism sites. On this basis, suggestions for future development were put forward. In Jia's view, clarifying the relationship between industry and tourism, making full use of the unique resources of enterprises, and using the concept of tourism experience to develop differentiated products. Otgaar (2012) discussed and tested the empirical application of a joint agenda for the development of IT, drawing on case studies from four European regions. He analyzed the conditions under which visits to operating companies are aligned with the strategies of public and private institutions. Bujok et al. (2015) presented examples of successful regeneration of abandoned industrial facilities. These cases demonstrate the transformation of often dilapidated buildings and structures into facilities that play a useful and educational role in society. This approach can be applied not only in the Czech Republic but also in other parts of Europe. Lee (2016) conducted a study to examine the views of an expert group on the factors influencing the attractiveness of IT in general and factory tours in particular. 34 key factors were extracted from previous research on visits to active and inactive industrial sites. These factors were then categorized into a hierarchical structure with four levels of destination management practices, including attractions, access, amenities, and ancillary services. The relative importance of these factors was assessed by using the Analytic Hierarchy Process (AHP) method. Since 2003, the Taiwanese government has attempted to enhance the brand power of companies by supporting the conversion of traditional factories into tourism-oriented centers. These measures have led to significant growth in the IT sector in the country, and many manufacturers have sought to establish tourism factories. However, the relationship between providing IT services and creating strong brand equity remains largely unknown. To investigate this issue, Chow et al. (2017) assessed customers' perceptions of the value of a branded tourism factory, which was assessed through the concept of brand equity. Beer et al. (2018) comprehensively examined the relationship between tourism and renewable energy sources and analyzed their potential for the tourism industry and the attractiveness of selected areas. Renewable energies can be considered an attractive factor in the IT sector. In some cases, these resources lead to an increase in the number of visitors to an area due to their modern design, proportions, and the image they present of environmental protection; in other cases, their unique features play this role. The results of the analysis showed that geothermal power plants and wind farms attract the most visitors to the related centers, which can be attributed to their specific visual appeal. Andrade and Caamaño-Franco (2018) aimed to examine the role of IT in the local development of four regions that are part of this type of tourism in Spain and Portugal. Using a quantitative approach and a questionnaire for the local population, they obtained results that show that IT has positive effects on various aspects of local development, including symbolic, heritage, social, human, economic, and infrastructural capital. With the increase in people's income and the diversification of leisure demands, the preferences of Chinese travelers have gradually shifted from traditional tourism attractions to more distinctive and innovative forms. One of these forms that has attracted the attention of curious tourists is IT, which has rapidly expanded throughout the country. Wang and Fu (2019) selected the two cities of Shanghai and Huangshi as examples to investigate this issue and compared them, pointing out the differences in the development stages, growth types, and IT models in these two cities. Studies related to industrial heritage and IT development in Chinese cities are still limited and require further research. To this end, Yang (2019) conducted a website content analysis to examine the industrial components in urban and tourism images to determine whether old industrial cities are promoting industrial heritage tourism and reconstructing their post-industrial images. In this study, 20 traditional industrial cities were selected as samples, and their data were collected through content analysis of their official websites. Szromek et al. (2021) analyzed and categorized the main types of business models that can be observed in tourism heritage sites. These sites have either been converted from former industrial facilities to such models or have been specifically created with the aim of conveying cultural heritage values. they shows different types of business model transformation that have occurred in the sites studied. Kuzior et al. (2021) examined two main issues: (1) the impact of economic, environmental, and digital marketing dimensions on supporting the development of post-IT, and (2) examining the differences in attitudes towards post-IT with respect to gender, age, level of education, and the use of digital channels in the development of this type of tourism. Montenegro et al. (2022) conducted a systematic review related to IT. They aimed to show how IT can help promote sustainability and competitiveness among active industrial companies. To this end, they used bibliometric analysis based on data from 32 relevant specialized articles. They did not intend to generalize the results to all cases, but rather focused on identifying specific factors affecting sustainability and competitiveness, based on a set of scientific studies that met specific criteria. Fang et al. (2024) attempted to investigate the relationships between the built environment, tourist participation, and tourism satisfaction and compare the influence loadings of different paths to identify the main variable in the IT field. Also, they compared two key paths of "built environment - tourism satisfaction" and "tourist participation - tourism satisfaction" with each other. Badia et al. (2024) examined the opportunities and potential of IT in the agri-food sector in the post-pandemic context. They believe that IT can play an important role in promoting responsible behavior of companies and tourists and help address emerging post-pandemic challenges, including sustainable production and consumption and waste reduction. This exploratory study presents a case study of the IT pilot "Succeed in Puglia" in the Apulia region of Italy. Coruzzolo et al. (2025) surveyed 200 abandoned industrial sites in Italy and catalogued and analyzed them using the sustainable tourism criteria defined by the United Nations World Tourism Organization. The findings indicate that 67% of these sites are abandoned factories that were mainly renovated for tourism purposes in the 2000s. These sites generally offer exhibitions (74%) and guided tours (61%), and with the main focus on industry (80%). **Table 1** provides brief details of the reviewed articles in the IT field.

Table 1: Summary of papers reviewed in the IT field.

Author(s)	Year	Research type		SC?	Sus?	Des?	Case study
		Q*	Q**				
Jia	2010	×	✓	×	×	×	China
Otgaar	2012	×	✓	×	×	×	Germany, France, the Netherlands, and Italy
Bujok et al.	2015	×	✓	×	×	×	Czech Republic
Lee	2016	✓		×	×	✓	Taiwan
Chow et al.	2017	×	✓	×	×	✓	Taiwan
Beer et al.	2018	×	✓	×	×	×	Switzerland
Andrade and Caamaño-Franco	2018	×	✓	×	×	×	Spain and Portugal
Wang and Fu	2019	×	✓	×	×	×	China
Yang	2019	×	✓	×	×	×	China
Szromek et al.	2021	×	✓	×	✓	×	Poland
Kuzior et al.	2021	✓	×	×	×	×	Poland and Ukraine
Montenegro et al.	2022	×	✓	×	✓	×	-
Fang et al	2024	✓	×	×	×	✓	China
Badia et al.	2024	✓	×	×	✓	×	Italy
Coruzzolo et al.	2025	×	✓	×	✓	×	Italy
Present work	**2026**	✓	×	✓	✓	✓	**Iran**

Q*: Quantitative, Q**: Qualitative, SC: Supply Chain, Sus: Sustainability, Des: Destination attractiveness.

2.1. Research gaps and novelties

As can be seen in Table 1, no research has considered the ITSC network design. The issue of sustainability is one of the significant issues in the field of supply chain studies, especially in the field of tourism, considering the characteristics of this industry, but few of these works have considered this important issue. To consider the sustainability issue and its aspects (Economic, social, and environmental aspects), first, the economic aspect is considered through the first objective function presented in the proposed mathematical model. Also, the social aspect is considered by considering the destination attractiveness to maximize customer satisfaction. Finally, the environmental aspect is considered by considering the maximum allowable distance between members of the proposed chain (IUs and ACs) to allocate the customers to them. Also, considering the diversity of industries and the strong history of Iran in fields such as oil, mining, handicrafts, and sufficient potential for IT activities in the country, no in-depth research has been conducted in this field in Iran, but in the present work, an attempt has been made to implement the proposed mathematical model for the ITSC in Iran as a case study.

3. Problem statement and model presentation

3.1. Problem statement

In this research, the ITSC is studied, and its chain structure is designed. As can be seen in Figure 2, the ITSC includes three levels of ACs and IUs, the center providing the IT services (facilitator), and the IT applicants or customers. The IT service provider center provides the IT services in the form of Industrial Tourism Packages (ITP), including industrial services and tourism services. Industrial services include industrial tours, and tourism services include food (main meal) and accommodation. Also, services such as transportation, insurance, and tour guides, which are common to all the ITPs, are provided by the industrial tourism service provider center (facilitator). Applicants in the IT field refer to the facilitator, and this center, in cooperation with IUs and ACs, provides the industrial services and tourism services available in each ITP. A notable point in designing the ITSP is that after receiving industrial services (visiting IUs), customers should be allocated to the nearest available ACs according to the capacity of the ACs. This point emphasizes reducing the emission of environmental pollutants (The environmental aspect of sustainability). The most important assumptions of the proposed problem include:

- ✓ All services are provided in the form of the ITP, which includes two types of industrial services (industrial tour) and tourism (food, accommodation, and transportation).
- ✓ Industrial services (industrial tours) are provided by IUs and tourism services by ACs.
- ✓ After receiving an industrial tour, customers are assigned to the nearest ACs from IUs.
- ✓ Each group of customers is allocated to one AC to receive both accommodation and food services.

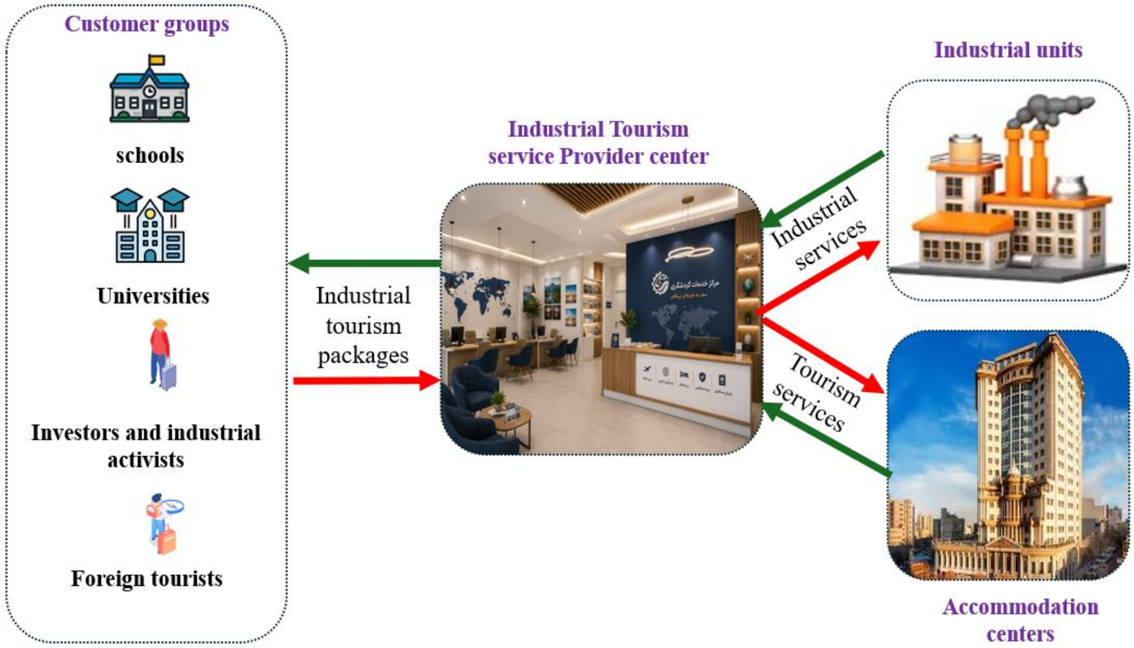

Figure 2: Proposed ITSC framework.

3.2. Proposed mathematical model

Indices:

S	Index of tourism services (1,...,S)
J	Index of Industrial units (1,..,J)
A	Index of accommodation centers (1,…A)
C	Index of industrial tourism applicant group (Customer Group) (1,…,C)
P	Index of ITP (1,...,P)
T	Index of period (1…T)

Parameters:

oc_p	Operating cost of providing an ITP *p* by the facilitating center
pc_{sa}	Cost of providing tourism service *s* by AC *a* per person
fp_{cp}	Price of providing an ITP *p* for customer group *c*
za_{sp}	1: If tourism service *s* is present in ITP *p,* otherwise 0
ea_{sat}	1: If tourism service s is provided by AC *a* in period *t*, otherwise 0
cap_{pt}	Capacity of the ITP *p* (per package) in period *t*
pr_c	Average coefficient for customer group c per person
$capi_{jt}$	Capacity of the IU *j* for industrial service in period *t*
$capa_{sat}$	Capacity of the AC *a* for tourism service *s* in period *t*
d_{cpt}	Demand of customer group c for the ITP *p* in period *t*

θ_c	Country currency exchange rate (the rate to convert dollars to Tomans) for customer group c
dis_{ja}	Distance of the IU j from the AC a
dd_j	Destination attractiveness degree for the IU j
λ	Maximum allowable distance
M	A large positive value

Decision Variables

IU_{cjt}	1: If a customer group c is allocated to the IU j to receive industrial service in period t, otherwise 0.
AC_{csat}	1: If a customer of group c is allocated to receive tourism service s that is allocated to the AC a in period t, otherwise 0.
Y_{cjt}	The number of customer group c that is allocated to industrial center j to receive industrial service in period t.
X_{csat}	The number of customer group c customers that receive service s to the AC a in period t
R_{cpt}	The satisfied amount of customer group c for each ITP p in period t

Objective Functions (OF)

$$\max Z_1 = \sum_c \sum_p \sum_t \theta_c \times pp_{cp} \times pr_c \times R_{cpt} - \sum_c \sum_p \sum_t oc_f \times pr_c \times R_{cpt} - \sum_c \sum_s \sum_a \sum_t tc_{sa} \times X_{csat} \qquad \text{(Eq.1)}$$

Equation 1 shows the equation for the first OF. The first OF seeks to maximize the profit of the facilitator center, which is obtained from the difference between the total revenues and costs.

$$\max Z_2 = \sum_c \sum_j \sum_t dd_j \times Y_{cjt} \qquad \text{(Eq.2)}$$

The second OF seeks to maximize the level of destination attractiveness of the chain for allocating the customers to each of the IUs.

Constraints:

$$\sum_j Y_{cjt} = \sum_p R_{cpt} \qquad \forall c,t \qquad \text{(Eq.3)}$$

Equation (3) represents the number of customers allocated to the IUs to receive industrial services.

$$\sum_a X_{csat} = \sum_p R_{cpt} \times pr_c \times za_{sp} \qquad \forall c,s,t \qquad \text{(Eq.4)}$$

Equation (4) represents the number of customers allocated to the ACs to receive tourism services.

$$Ac_{csat} \le ea_{sat} \qquad \forall c,s,a,t \qquad \text{(Eq.5)}$$

Equation (5) states that a customer group is assigned to an AC to receive the related service when the center in question provides that service.

$$Y_{cjt} \le M \times IU_{cjt} \qquad \forall c, j, t \qquad \text{(Eq.6)}$$

$$X_{csat} \le M \times AC_{csat} \times ea_{sat} \qquad \forall c, s, a, t \qquad \text{(Eq.7)}$$

Equations (6) and (7) state that a center can provide a service to a customer when the customer is assigned to that center.

$$\sum_c Y_{cjt} \le capi_{jt} \qquad \forall j, t \qquad \text{(Eq.8)}$$

$$\sum_c X_{csat} \le capa_{sat} \qquad \forall s, a, t \qquad \text{(Eq.9)}$$

Equations (8) and (9) are related to the capacity of each member involved in the proposed supply chain.

$$\sum_j IU_{cjt} = 1 \qquad \forall c, t \qquad \text{(Eq.10)}$$

Equation (10) ensures that the companions of a customer group in each ITP are assigned to only one IU to receive industrial services.

$$\sum_a Ac_{csat} = 1 \qquad \forall c, s, t \qquad \text{(Eq.11)}$$

Equation (11) ensures that the companions of a customer group in each ITP are assigned to only one AC to receive tourism services.

$$AC_{c2at} = AC_{c1at} \qquad \forall c, a, t \qquad \text{(Eq.12)}$$

Equation (12) states that a customer group can receive food service from an AC only if it is assigned to that AC to receive accommodation service.

$$\sum_c R_{cpt} \le cap_{pt} \qquad \forall p, t \qquad \text{(Eq.13)}$$

Equation (13) shows that the service provision by the center providing the ITP is at most equal to the final capacity of that center for each ITP.

$$R_{cpt} \le d_{cpt} \qquad \forall c, p, t \qquad \text{(Eq.14)}$$

Equation (14) shows that the center providing ITP provides services at most up to the center's demand.

$$\sum_s dis_{ja} \times IU_{cjt} \times AC_{csat} \le \lambda \qquad \forall c, j, a, t \qquad \text{(Eq.15)}$$

Equation (15) indicates the maximum allowable distance between IUs and ACs for assigning customers to them (this constraint emphasizes the environmental aspect of sustainability).

$$Y_{cjt}, X_{csat}, R_{cpt} \geq o, \text{int} \qquad \forall c,s,a,j,p,t \qquad \text{(Eq.16)}$$

$$XA_{at}, IU_{cjt}, AC_{csat} \in \{0,1\} \qquad \forall c,s,a,j,p,t \qquad \text{(Eq.17)}$$

Equations (16) and (17) determine the nature of the decision variable.

4. Methodology: Revised Multi-Choice Goal Programming (RMCGP) approach

The RMCGP approach is an extended method of classical goal programming that is used to solve multi-objective decision-making problems with flexible and multiple objectives. This method allows decision makers to optimize their preferences between conflicting objectives and allows for revision of the objectives (goals) based on new conditions. The basis of this method is that instead of using zero and one variables, we use a continuous variable for each objective, and, depending on the type of problem, we try to minimize deviations from the lower or upper bound of the expectation levels (Chang 2008). In general, the mathematical model of the RMCGP method is as follows:

$g_i^{\max}$	Upper limit of the expectation level of the i-th ideal
$g_i^{\min}$	Lower limit of the expectation level of the i-th ideal
y_i	A continuous variable
d_i^+	Positive deviation from $\lvert f_i(x) - y_i \rvert$
d_i^-	Negative deviation from $\lvert f_i(x) - y_i \rvert$
w_i	Weight or importance of positive and negative deviation from the i-th ideal
α_i	Weight or importance of the sum of positive and negative deviations of the variable from the expected levels

OF

$$\min = \sum_i w_i (d_i^+ + d_i^-) + \alpha_i (e_i^+ + e_i^-) \qquad \text{(Eq.18)}$$

Constraints

$$f_i(x) - d_i^+ + d_i^- = y_i \qquad \forall i \qquad \text{(Eq.19)}$$

$$y_i - e_i^+ + e_i^- = g_i^{\max} \qquad \forall i \qquad \text{(Eq.20)}$$

$$g_i^{\min} \leq y_i \leq g_i^{\max} \qquad \forall i \qquad \text{(Eq.21)}$$

$$d_i^+, d_i^-, e_i^+, e_i^- \geq 0 \qquad \forall i \qquad \text{(Eq.22)}$$

5. Implementations and findings

5.1. Case study: Gano-Gardesh Tourism Center

The Gano Gardesh Tourism Services Center is one of the centers that provides tourism services in various fields, especially in the IT field in Mazandaran province, Iran. This unit provides industrial tourism services to applicants in this industry in cooperation with IUs and ACs. The services provided by this unit are in the form of the ITP and include industrial services (industrial tour) and tourism services (accommodation and food), and transportation. The customers or applicants of this industry include four customer groups: local educational and research centers, domestic educational and research centers, domestic tourists interested in technology and industry, and international tourists interested in technology and industry.

5.2. Input data

- ✓ The planning horizon is four weeks (one month).
- ✓ The number of IUs and ACs with which the Ganoo Gardesh unit collaborates is 11 and 5, respectively.
- ✓ The average customer group companion coefficient is 25, 20, 10, and 3 people, respectively.
- ✓ The maximum distance allowed for allocating customers after visiting IUs to residential centers is considered to be 60 kilometers.
- ✓ Also, the country currency exchange rate of ITP per customer is considered to be 1, 1, 1, and 80 thousand tomans, respectively.
- ✓ The operating cost of each ITP is 150, 300, 400, 700, and 900 thousand tomans, respectively.
- ✓ The destination attractiveness scores for the eleven IUs are 0.710, 0.656, 0.529, 0.460, 0.699, 0.525, 0.363, 0.430, 0.733, 0.548, and 0.475, respectively.
- ✓ Other required data are provided in Tables 2 to 5.

Table 2: Capacity of each IU for industrial service in each period.

		Time periods			
		1	2	3	4
IUs	1	4	4	4	3
	2	3	3	3	3
	3	4	4	4	2
	4	2	2	2	2
	5	4	4	4	3
	6	3	3	3	3
	7	3	3	3	3
	8	4	4	4	3
	9	3	3	3	3
	10	2	2	2	3
	11	3	3	3	3

Table 3: Cost of providing each tourism service with different quality levels by each AC (in Tomans)

		ACs				
		1	**2**	**3**	**4**	**5**
Tourism services	**S1**	100000	100000	130000	100000	130000
	S2	180000	180000	150000	180000	150000

Table 4: Price of providing each ITP per customer group (in Tomans)

		ITP				
		1	2	3	4	5
Customer group	1	150000	280000	320000	600000	900000
	2	150000	280000	320000	600000	900000
	3	150000	280000	320000	600000	900000
	4	20 (dollar)	30 (dollar)	60 (dollar)	80 (dollar)	100 (dollar)

Table 5: Demand for each ITP by each customer group

		All periods				
		ITP				
		1	2	3	4	5
Customer group	1	4	2	1	0	0
	2	0	0	0	2	1
	3	0	0	2	0	2
	4	0	0	0	0	1
	4	0	0	0	0	1

5.3. Output results

The proposed model is solved using Lingo software version 17 and applying the RMCGP method. The optimal value of the OF1 (Maximizing the total profit) is obtained as 182,155,000 Tomans, and the OF2 (Maximizing the destination attractiveness level) is obtained as 9.744. These values are considered the upper expected solution for the RMCGP method. Table 6 shows the responsiveness of each ITP by the facilitator. Also, the lower limit of the expectation level for OF1 and OF2 is obtained as zero and 7.82, respectively. Also, the weight values are considered 0.6 and 0.4 for each objective function, respectively. After solving the model with the RMCGP, the output values are equal to y_1=182,155,000 Tomans, y_2=9.066, $d_1^+=d_1^-=d_2^+=0$, and $d_2^-=0.678$. Also, the service level of the chain in the optimal solution is 55 percent. Moreover, the output also shows that customers are allocated to IU1, IU2, and IU11, and only AC4 receives tourism service in each ITP. Also, Table 6 provides the status of responding to the demand of each customer group for each ITP in each period. Also, Figure 3 shows the demand of each customer group and the amount of demand responded to for each customer group. According to Figure 3, it can be seen that customers in groups 2 and 4 have all their demands responded to, and the lowest amount is for customers in group 3.

Table 6: Status of responding to the demand of each customer group for each ITP.

		Time period 1				
		ITP				
		1	**2**	**3**	**4**	**5**
Customer group	**1**	2	2	0	0	0
	2	0	0	0	2	1
	3	0	0	1	0	1
	4	0	0	0	0	1
		Time period 2				
	1	4	2	1	0	0
	2	0	0	0	2	1
	3	0	0	0	0	0
	4	0	0	0	0	1
		Time period 3				
	1	4	2	1	0	0
	2	0	0	0	2	1
	3	0	0	0	0	0
	4	0	0	0	0	1
		Time period 4				
	1	1	2	0	0	0
	2	0	0	0	2	1
	3	0	0	1	0	1
	4	0	0	0	0	1

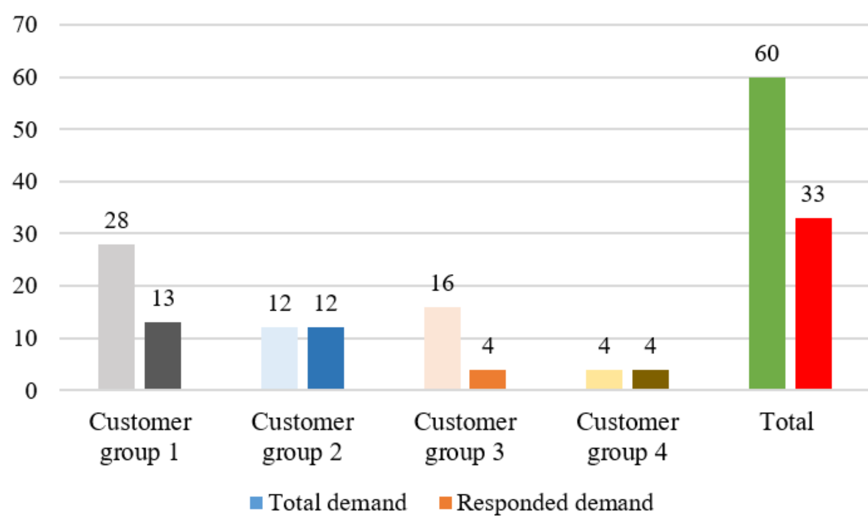

Figure 3: The demand number and responded demand number for each customer group.

5.4. Sensitivity analysis

5.4.1. Maximum allowable distance

The effect of changes in the maximum allowable distance on the value of each OF is shown in Figure 4. Based on Figure 4, it can be seen that the more freedom the facilitator has in terms of distance to allocate different groups of customers to IUs and ACs, the value of each of the functions increases.

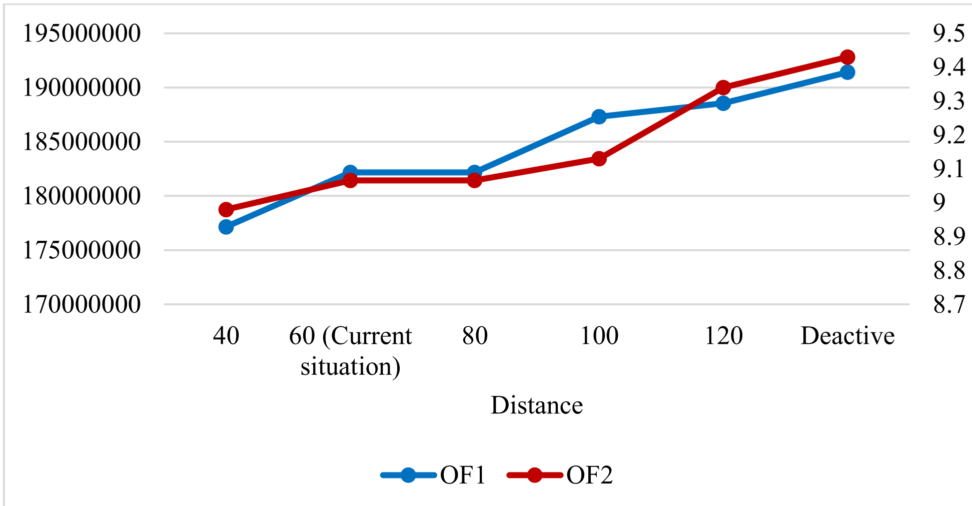

Figure 4: Trend of changes in each OF as the maximum allowable distance parameter varies.

5.4.2. The presence or absence of capacity constraints

In this section, the active or inactive status of each of the capacity constraints in the proposed model has been examined. As can be seen from Figure 5, the largest changes in each of the OFs are when the capacity of the IUs is inactive, which indicates the great influence of this parameter in the model. Also, in the case where the capacity constraint of the facilitator is inactive, it is observed that the value of each of the OFs is the same as the optimal solution of the model, which indicates that the current capacity of the facilitator is appropriate.

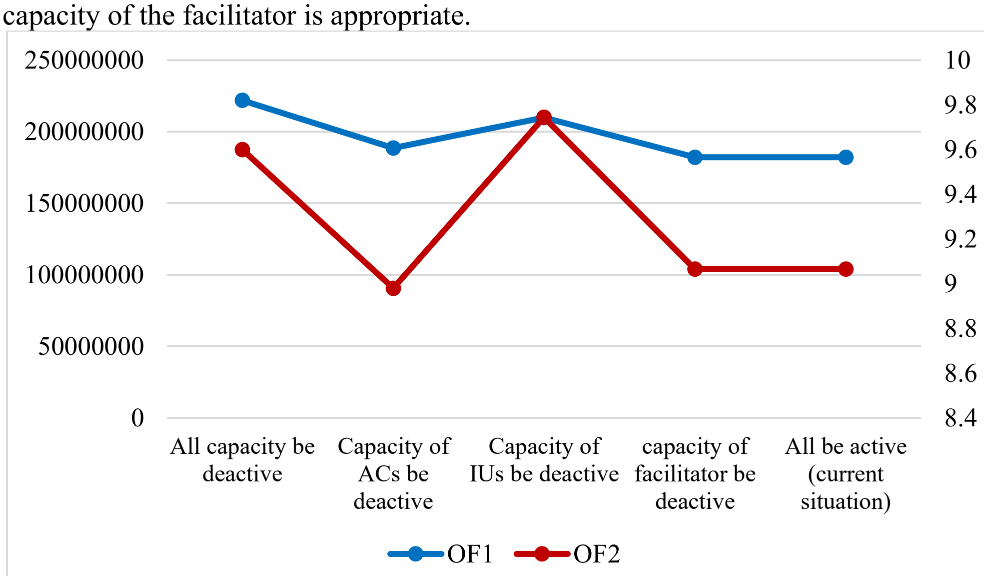

Figure 5: Trend in changes for each OF with and without capacity constraints.

5.4.3. Average coefficient for customer group

It can be seen from Figure 6 that the higher the average coefficient of the customer groups, the higher the value of OF1 increases, but the value of OF2 decreases. This is logical because the capacity of accommodation centers is defined per person, and with the increase of this parameter, the combination of assigning customer groups to the ACs and IUs changes according to the restrictions of the maximum allowed distance and the capacity of ACs, and the facilitator can no longer provide all customer groups with IUs that have the highest degree of destination attractiveness.

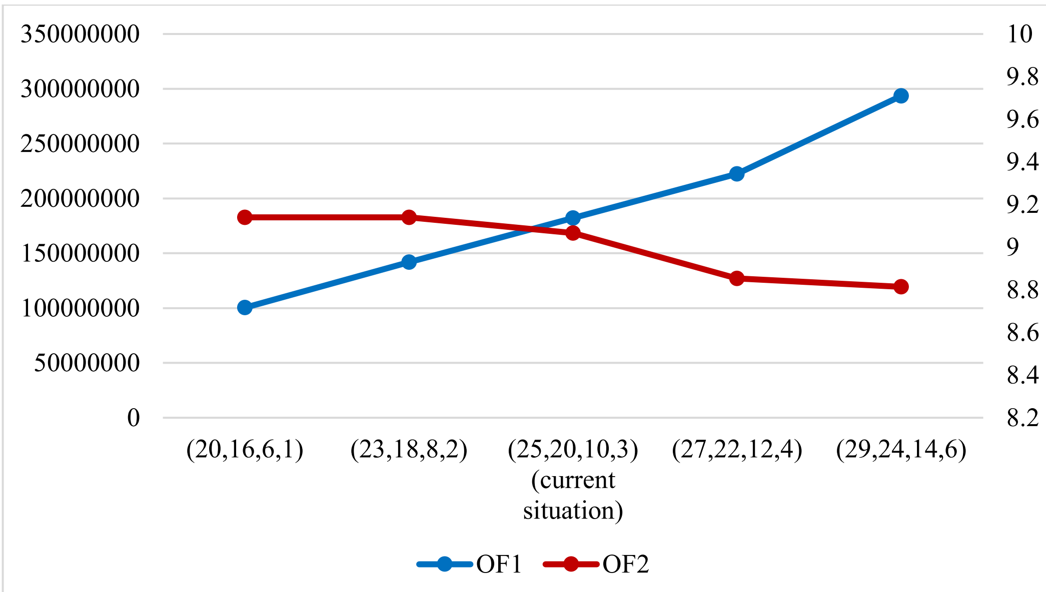

Figure 6: Trend of changes in each OF with changes in the average coefficient parameter.

5.4.3. Managerial discussions

As we know, this research presents a three-level ITSC that includes customer groups, a facilitator, ACs, and IUs. To evaluate the performance of the proposed chain, a bi-objective mathematical model is formulated to maximize the chain's profit and the degree of destination attraction. According to the output results and the sensitivity analysis, the following management suggestions are presented.

- ✓ The facilitator should cooperate with IUs that have a higher level of destination attractiveness. This practice has two benefits: first, it increases customer satisfaction and, as a result, increases demand. The second benefit is that IUs strive to enhance the criteria that make an IU attractive to customers.
- ✓ The facilitator should cooperate with the ACs and IUs that offer them higher capacity. This will allow the facilitator to respond to greater demands and increase profits.
- ✓ Considering the maximum acceptable distance for allocating different customer groups to ACs after visiting IUs, in addition to preventing environmental pollution, increases the satisfaction of customer groups by saving them time.
- ✓ Considering the exchange rate fluctuations in Iran, the model also shows well that since the exchange rate is very effective in responding to the demand of the international customer group, the facilitator tends to respond to the demand of this customer group 100% and considers this customer group as a higher priority.

6. Conclusions and Future Research Suggestions

In the present study, the ITSC has been studied and designed by presenting a bi-objective mathematical model. The chain includes the customer group, facilitators, IUs, and ACs. In this study, a bi-objective mathematical model includes maximizing the profit of the chain and maximizing the level of destination attractiveness in the chain when assigning different customer groups to IUs. The proposed mathematical model is based on a real case study in Mazandaran province and is solved using the RMCGP method. The output results show that the optimal value of the OF1 (profit maximization) is 182,155,000 Tomans, and the OF2 (maximization of the attractiveness level of the chain) is 9.744. The output results also show that the facilitator allocates different customer groups to IU1, IU2, and IU11, and only AC4. The results show that carrying out IT activities in Iran, especially Mazandaran province, not only leads to economic prosperity and improvement of social conditions (increasing employment generation) and cultural exchange, but also leads to the development of industries that cooperate with centers that operate in the IT field. Overall, future research suggestions can be expanded by focusing on development strategies, service diversification, resilience, and social development. Future studies could examine marketing strategies, specifically the impact of promotional activities and customer acquisition tactics to understand their effects on tourist loyalty and the dynamics of tourism industry networks. Furthermore, the distinct characteristics of various sectors such as oil and gas, automotive, food, handicrafts, mining, and technology should be considered when designing product packages tailored to the interests of diverse tourist groups. Finally, given the tourism industry's vulnerability to economic downturns, natural disasters, infrastructure constraints, and other disruptions, it is recommended that resilience be prioritized through measures such as backup transport options, alternative routes, and robust crisis response plans.

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