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Developing an appropriate model for establishing an integrated management system for the Caspian coastal strip through the application of urban social capacities (capitals)

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Abstract

Integrated coastal zone management, as an approach to sustainable governance, requires an understanding of the interactions among social, managerial, environmental, and economic dimensions. Despite the strategic importance of the Caspian Sea coastal zone, empirical evidence on the structural relationships between social capital and the factors affecting the establishment of integrated management remains limited. This study aimed to explain the role of social capital in establishing an integrated management system for the Caspian Sea coastal zone by examining perceptual-semantic, managerial-policy, physical-ecological, and economic infrastructure dimensions. The study is applied in purpose and employed a descriptive-survey method. The statistical population consisted of stakeholders and users of the coastal zones of Guilan, Mazandaran, and Golestan provinces. Of the 310 questionnaires distributed, 300 valid questionnaires were analyzed using partial least squares structural equation modeling (PLS-SEM). The findings indicated that all research hypotheses were supported at the 0.05 significance level. The strongest path was observed from the perceptual-semantic dimension to the managerial-policy dimension, with a path coefficient of 0.790 and a t-statistic of 20.789. Furthermore, the physical-ecological dimension significantly influenced economic infrastructure, and social capital significantly influenced the physical-ecological dimension, with path coefficients of 0.785 and 0.757, respectively. Among the direct effects on integrated management, the perceptual-semantic dimension had the strongest effect, with a coefficient of 0.298. The coefficient of determination for the dependent variable was 0.857. Overall, establishing integrated management of the Caspian Sea coastal zone requires strengthening social capital, managerial capacity, ecological conservation, and economic infrastructure within a coordinated and participatory governance framework.

Keywords

Caspian Sea coastal zone
coastal management
integrated coastal zone management (ICZM)
integrated management system
social capital

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1. Introduction

Coastal zones are among the most valuable yet environmentally sensitive territorial areas, playing a crucial role in sustainable development of countries. As interfaces between terrestrial and marine systems, these areas possess considerable environmental, economic, social, and cultural capacities and have consequently become major centers of human activity, population settlement, infrastructure development, trade, maritime transportation, tourism, and large-scale investment (MAOTDR, 2007). At the same time, the concentration of such activities has intensified pressure on natural resources, increased conflicts between resource exploitation and conservation, aggravated environmental pollution, contributed to the degradation of coastal ecosystems, and made decision-making processes in coastal areas increasingly complex. Therefore, coastal management can no longer be regarded solely as an environmental or physical planning issue; rather, it has become a multidimensional challenge in which social, economic, institutional, and managerial dimensions are equally important.

International policy frameworks also explicitly emphasize coordinated coastal management. Agenda 21, adopted at the Rio Earth Summit, called upon governments to establish coherent management systems, protect coastal ecosystems, promote the sustainable use of resources, and strengthen coordination among responsible institutions (EEA, 2006). This approach is based on the principle that effective coastal management can be achieved only through coordinated decision-making, stakeholder participation, policy synergy, and integrated implementation measures. Within this context, integrated coastal zone management (ICZM) has emerged in recent decades as one of the most important approaches to territorial management. By emphasizing coordination across environmental, economic, social, and institutional dimensions, ICZM seeks to balance the conservation of natural resources and the fulfillment of development needs.

Numerous studies show that the success of integrated management systems does not depend solely on formulating regulations or establishing administrative structures. Rather, the quality of interorganizational interactions, the degree of policy coordination, stakeholder participation, institutional capacity, and the nature of relationships among different actors play decisive roles in the effectiveness of such systems (Gallagher, 2010; Sanò et al., 2010; Batista et al., 2020). Researchers have further emphasized that integrated management can contribute to sustainable development only when it addresses ecological considerations alongside social, institutional, and economic dimensions and balances the interests of different stakeholder groups (Persada et al., 2019). Accordingly, coordination among executive agencies, policy coherence, citizen participation, and effective use of existing societal capacities are major prerequisites for successfully establishing integrated coastal zone management (Niavis et al., 2019).

Within this framework, social capital has gained prominence in the ICZM literature as one of the most important capacities underpinning development and governance. By strengthening public trust, expanding collaborative networks, increasing social participation, facilitating interactions among institutions, and enhancing collective responsibility, social capital creates favorable conditions for improving decision-making quality and implementing management policies (Arefipour et al., 2022). Under such circumstances, a sufficient level of social capital can reduce conflicts among stakeholders, strengthen coordination between executive institutions and local communities, and provide the necessary foundation for participatory governance. Consequently, numerous studies have identified social capital as a key component in the success of integrated management policies and have emphasized its contribution to greater trust, cooperation, and effectiveness in coastal development programs (Ahadnejad et al., 2014).

Despite the growing body of research on integrated coastal zone management, a considerable proportion of previous studies have focused separately on managerial, environmental, economic, or social dimensions, while relatively limited attention has been devoted to simultaneously examining the relationships among these dimensions within a coherent analytical framework. In many studies, social capital has been identified as a factor contributing to improved governance, increased public participation, or enhanced management quality. Nevertheless, the effects of its various dimensions on the establishment of ICZM, particularly under the specific conditions of the Caspian Sea coastal zone, have rarely been empirically assessed. Furthermore, differences in the ecological, social, economic, and institutional characteristics of coastal regions limit the direct generalizability of findings obtained from other

countries or regions to the Caspian Sea coast, thereby reinforcing the need for context-specific studies that reflect local conditions.

The Caspian Sea coastal zone, characterized by valuable ecosystems, concentrations of urban and rural settlements, expanding economic activities, tourism, fisheries, transportation, and the simultaneous involvement of numerous executive institutions, constitutes one of the most complex management arenas in the country. These characteristics not only increase the importance of integrated planning and management but also make coordination among responsible organizations, stakeholder participation, policy coherence, and the effective utilization of social capacities essential requirements for managing this coastal zone. Under such circumstances, identifying the relationships between social capital and the dimensions affecting the establishment of an integrated management system can provide valuable scientific evidence for strengthening policymaking, improving management processes, and enhancing the effectiveness of executive decisions.

Despite advances in the ICZM literature, a considerable gap remains between theoretical discussions and empirical evidence of the factors affecting the establishment of such management systems. Most previous studies have addressed managerial, environmental, economic, or social dimensions separately, with relatively few simultaneously examining these factors within an integrated framework. Moreover, many of these findings have been obtained in different geographical, institutional, and social contexts; therefore, their direct application to the Caspian Sea coastal zone is subject to important limitations. This issue becomes particularly significant because, in addition to its ecological and economic values, the Caspian Sea coastal zone faces challenges associated with the multiplicity of decision-making institutions, diverse stakeholder interests, development pressures, increasing exploitation of coastal resources, and the need to maintain a balance between development and conservation. Effective decision-making under such conditions requires scientific evidence tailored to the specific characteristics of this coastal zone and a comprehensive understanding of the factors influencing the establishment of an integrated management system.

Accordingly, the present study aims to empirically assess the factors affecting the establishment of an ICZM system along the Caspian Sea coast. Drawing on a theoretical framework derived from the literature and testing the relationships among the theoretical constructs, the study seeks to provide empirical evidence regarding the magnitude of the effects exerted by these factors. The findings may strengthen the scientific basis of decision-making while contributing to improved policymaking, greater coordination among responsible institutions, and enhanced effectiveness in coastal zone management.

On this basis, the main research question is formulated as follows:

To what extent do the factors affecting the establishment of an integrated coastal zone management (ICZM) system along the Caspian Sea coast contribute to explaining the establishment of this management system?

Answering this question enables an empirical assessment of the proposed theoretical framework and may contribute both to the advancement of existing knowledge on ICZM and to the provision of practical evidence for managers and policymakers in this field

2. Theoretical foundations of the study

Over recent decades, coastal zone management has evolved from a sectoral approach focused primarily on physical protection and the isolated management of individual resources toward an integrated, participatory, and governance-oriented perspective. This transition has become increasingly important because coastal zones are not merely geographical territories; rather, they constitute social–ecological systems in which natural processes, economic activities, institutional structures, social relations, and cultural values interact with and influence one another simultaneously. Managing such systems therefore requires an approach that extends beyond organizational and sectoral boundaries and can balance the conservation of natural capital, economic utilization, social justice, and sustainable development (EEA, 2006).

Within this framework, integrated coastal zone management (ICZM) has emerged as one of the most important approaches to spatial governance, aiming to coordinate all activities, policies, and stakeholders affecting coastal areas. This approach emphasizes long-term planning, policy coherence, institutional coordination, public participation, conflict management, and evidence-based decision-making. It aims to move beyond fragmented and sector-specific approaches by managing coastal areas as integrated

systems (Gallagher, 2010). The realization of this approach requires continuous interaction among governments, local communities, the private sector, non-governmental organizations, and other stakeholders, as none of these actors alone can sustainably manage such complex systems (Sanò et al., 2010).

The cross-sectoral nature of integrated management means that its success depends not merely on the existence of laws or administrative structures, but also on the quality of interorganizational relationships, institutional coordination capacity, the extent of stakeholder participation, and the ability of governance systems to manage conflicts. From this perspective, integrated management can be regarded as a form of adaptive governance capable of learning, reviewing, and adjusting policies in response to changing environmental, economic, and social conditions (Yuan & Chang, 2021). In recent years, this perspective has gained increasing attention in coastal management programs worldwide and has facilitated greater convergence among environmental conservation, economic development, and social well-being (Caviedes et al., 2022). The historical evolution of integrated management in countries such as China further demonstrates that this approach's success depends on simultaneously strengthening institutional capacity, social participation, and the coherence of national and local policies (Li et al., 2026).

Among the factors influencing coastal governance, social capital represents one of the most important endogenous societal capacities for fostering cooperation, trust, and collective action. Social capital encompasses mutual trust, norms of cooperation, communication networks, social participation, collective responsibility, and interactions among individuals and organizations, which facilitate coordination among different actors (Bourdieu, 1986). Unlike economic or physical capital, social capital is intangible; nevertheless, it plays a decisive role in reducing coordination costs, enhancing decisions legitimacy, and improving the quality of governance (Coleman, 1988). Within integrated management systems, social capital provides the foundation for building trust between communities and management institutions and enhances the capacity for effective stakeholder participation. Higher levels of public trust, collaborative networks, and social cohesion increase the likelihood of acceptance of management policies, implementation of conservation programs, and reduction of conflicts among resource users (Putnam, 2000). Moreover, social capital facilitates the exchange of local knowledge, promotes collective learning, and strengthens responsibility toward common resources, all of which are particularly important in coastal resource management (Ostrom, 1990).

In coastal areas, diverse stakeholders, competition over resources, and complexity of institutional relationships further amplify the importance of social capital. Trust among resource users, cooperation among responsible organizations, participation of local communities, and interaction between the public and private sectors provide the capacity required to coordinate decisions and implement joint policies (Miković et al., 2020). Strengthening this social capacity not only improves governance quality but also enhances conflict management, natural resource conservation, and sustainable development (Katikiro et al., 2024). Social capital can therefore be seen as the starting point of a chain of interactions that gradually shapes stakeholder attitudes, influences governance quality, and ultimately contributes to the establishment of ICZM (Mahajan et al., 2024; Andrachuk et al., 2026). In the theoretical framework of the present study, social capital is considered an exogenous variable because it is expected, on the one hand, to affect the establishment of ICZM directly and, on the other hand, to facilitate integrated governance by strengthening the perceptual–cognitive and management–policy dimensions. Accordingly, the relationships between social capital and the perceptual–cognitive dimension, the physical–ecological dimension, and the establishment of ICZM provide the basis for the study's first, second, and fifth hypotheses.

The establishment of ICZM is not determined solely by the presence of social capital; stakeholders' perceptions and interpretations of coastal areas, the quality of the governance system, and environmental and economic conditions also play decisive roles in its realization. From this perspective, the perceptual–cognitive dimension encompasses the perceptions, values, attitudes, and interpretations that individuals and groups develop regarding coastal resources, environmental hazards, place identity, social responsibility, and the performance of management institutions. These perceptions influence how individuals respond to management policies, how much they accept conservation programs, and their level of participation in collective decision-making.

When coastal areas are perceived as social, ecological, and intergenerational assets, favorable conditions emerge for pro-environmental behavior, greater public

trust, and voluntary participation. Conversely, a predominantly exploitative perception of coastal resources may increase the likelihood of conflict, unsustainable resource use, and resistance to conservation policies (Small & Nicholls, 2003; Persada et al., 2019). Furthermore, greater awareness of environmental hazards and improved public understanding of the consequences of human interventions can strengthen societal capacity to embrace integrated management approaches (Mohsin et al., 2025). Accordingly, the present study assumes that social capital improves the management system by strengthening the perceptual–cognitive dimension and that this construct, in turn, directly influences the management–policy dimension. The study's first and third hypotheses examine these relationships.

The management–policy dimension represents the institutional manifestation of social capital and shared perceptions in public decision-making and policy implementation processes. This dimension draws on interorganizational coordination, regulatory integration, transparency, accountability, stakeholder participation, decentralization, implementation capacity, and conflict management, thereby providing a mechanism through which social capacities can be translated into practical actions (Niavis et al., 2019). Within this framework, effective governance is achieved when mechanisms for cooperation and joint decision-making are established among responsible institutions, the private sector, local communities, and other actors (Batista et al., 2020). In addition, flexible, learning-oriented management structures enhance the capacity to adapt policies to environmental and social changes while reducing fragmented, sector-specific decision-making (Holian et al., 2026).

Accordingly, the proposed model assumes that strengthening the management–policy dimension directly contributes to establishing ICZM while simultaneously improving the physical and economic dimensions through enhanced institutional coordination. These relationships provide the theoretical basis for the study's fourth and sixth hypotheses.

Alongside social and institutional dimensions, physical–ecological characteristics also play a decisive role in the success of integrated management. Coastal environmental quality, pollution levels, natural capacity, shoreline changes, ecological vulnerability, habitat quality, and environmental resilience collectively shape the conditions under which management policies are implemented (Gallagher, 2010). The greater the environmental fragility, the stronger the need for cross-sectoral coordination and preventive policies. Under such conditions, coastal ecosystem conservation cannot be achieved solely through technical interventions; rather, it requires convergence among environmental, economic, and social policies (Li et al., 2026). For this reason, the physical–ecological dimension in the present study is considered not merely a contextual factor but also a component influencing both the establishment of ICZM and the development of economic infrastructure. It therefore provides the theoretical basis for the second, seventh, and eighth hypotheses.

Similarly, sustainable coastal zone management cannot be achieved without adequate economic infrastructure. Transportation, tourism and service infrastructure, public and private investment, employment opportunities, and the sustainability of local livelihoods provide the capacity necessary to align conservation with development (Mann et al., 2018). Where such infrastructure is inadequate, pressure on natural resources may increase, and implementing conservation policies becomes more difficult. Conversely, developing sustainable economic infrastructure can reduce dependence on excessive resource exploitation while strengthening stakeholders' incentives to participate in long-term coastal management programs (Trialfhianty et al., 2025; van der Ploeg et al., 2024). Moreover, the economic resilience of coastal communities enhances their adaptive capacity in the face of environmental change and natural hazards, thereby contributing to the realization of sustainable governance (Wang et al., 2025).

Taken together, these theoretical foundations indicate that establishing an ICZM system is not the outcome of any single variable; rather, it results from dynamic interactions among social capital, stakeholder perceptions and interpretations, management and policymaking capacities, physical–ecological conditions, and economic infrastructure. Based on this theoretical rationale, the conceptual model of the present study positions social capital as an exogenous variable that influences the establishment of ICZM through the strengthening of perceptual–cognitive and management dimensions, improvements in physical–ecological conditions, and the enhancement of economic infrastructure. These relationships are formulated as nine research hypotheses and are empirically tested using partial least squares structural equation modeling (PLS-SEM).

Table 1. Research variables and indicators

Construct	Indicator code	Indicator	Role in the model	Source
Social capital	S1	Level of social trust among residents	Main independent variable	Ahadnejad Roshti et al., 2014; Arefipour et al., 2022
	S2	Trust in management institutions		Ahadnejad Roshti et al., 2014; Shams Pouya & Tavakolinia, 2015
	S3	Level of voluntary public participation		Arefipour et al., 2022; Miković et al., 2020
	S4	Participation in urban–coastal decision-making		Ahadnejad Roshti et al., 2014; Niavis et al., 2019
	S5	Strength of relationships among social groups		Miković et al., 2020
	S6	Level of cooperation among local institutions		Arefipour et al., 2022; Niavis et al., 2019
	S7	Informal networks within the community		Ognibene, 2010
	S8	Social cohesion and solidarity		Ahadnejad Roshti et al., 2014; Miković et al., 2020
	S9	Social responsibility		Shams Pouya & Tavakolinia, 2015; Arefipour et al., 2022
	S10	Exchange of local knowledge among individuals		Miković et al., 2020; Arefipour et al., 2022
	S11	Capacity for participation by non-governmental organizations		Batista et al., 2020; Niavis et al., 2019
	S12	Interorganizational trust		Miković et al., 2020
	S13	Level of public–private sector interaction		Arefipour et al., 2022; Batista et al., 2020
	S14	Cultural capital and social awareness		Basile, 2006; Niavis et al., 2019
Perceptual–cognitive dimension	P1	Subjective perception of the value of coastal areas	Mediating variable	Persada et al., 2019; Small & Nicholls, 2003
	P2	Attitude toward environmental conservation		Batista et al., 2020; Persada et al., 2019
	P3	Awareness of coastal hazards and threats		Gallagher, 2010
	P4	Cultural meaning and identity of the coast		Persada et al., 2019; Small & Nicholls, 2003
	P5	Sensitivity to environmental changes		Gallagher, 2010; Sanò et al., 2010
	P6	Awareness of citizens' rights		Niavis et al., 2019; Batista et al., 2020
	P7	Perception of the quality of current management		Niavis et al., 2019; Farahani & Ahmadian, 2022
Management–policy dimension	M1	Interorganizational coordination in coastal management		Niavis et al., 2019; Persada et al., 2019
	M2	Integration of coastal laws and regulations		EEA, 2006; Farahani & Ahmadian, 2022
	M3	Institutional transparency and managerial accountability		Batista et al., 2020; Ahadnejad Roshti et al., 2014
	M4	Stakeholder participation in policymaking		Niavis et al., 2019; Arefipour et al., 2022

Construct	Indicator code	Indicator	Role in the model	Source
Management–policy dimension	M5	Decentralization and delegation of authority to the local level	Mediating variable	Persada et al., 2019; Shams Pouya & Tavakolinia, 2015
	M6	Existence of long-term and integrated plans		EEA, 2006; Niavis et al., 2019
	M7	Implementation capacity of responsible institutions		Farahani & Ahmadian, 2022; Batista et al., 2020
	M8	Conflict management among coastal actors		Sanò et al., 2010; Persada et al., 2021
Physical–ecological dimension	K1	Coastal environmental quality	Contextual variable	Gallagher, 2010
	K2	Existing pollution levels (water, soil, and coastal substrate)		Farahani & Ahmadian, 2022; Sanò et al., 2010
	K3	Ecological vulnerability of the area		Gallagher, 2010
	K4	Shoreline changes		Farahani & Ahmadian, 2022; Persada et al., 2019
	K5	Natural environmental capacity		Sanò et al., 2010
	K6	Ecological resilience capacity		Gallagher, 2010; Persada et al., 2019
	K7	Quality of coastal habitats		Sanò et al., 2010; Farahani & Ahmadian, 2022
Economic infrastructure dimension	E1	Level of tourism infrastructure		Karimipour & Mohammadi, 2010; Persada et al., 2021
	E2	Transportation infrastructure		Karimipour & Mohammadi, 2010
	E3	Access to economic services		Mann et al., 2018; Persada et al., 2019
	E4	Coastal employment opportunities		Karimipour & Mohammadi, 2010; Mann et al., 2018
	E5	Public investment		Sanò et al., 2010; Farahani & Ahmadian, 2022
	E6	Private-sector participation in coastal development		Batista et al., 2020; Arefipour et al., 2022
	E7	Sustainability of local livelihoods		Persada et al., 2019; Mann et al., 2018
Establishment of the caspian sea integrated coastal zone management system	C1	Coordination among responsible coastal institutions	Dependent variable	EEA, 2006; Niavis et al., 2019
	C2	Effective stakeholder participation in coastal management		Batista et al., 2020; Arefipour et al., 2022
	C3	Integration of coastal decisions and policies		Niavis et al., 2019; Persada et al., 2019
	C4	Improvement in the quality of coastal environmental protection		Gallagher, 2010
	C5	Reduction of institutional and functional conflicts		Sanò et al., 2010; Farahani & Ahmadian, 2022
	C6	Enhancement of coastal social–ecological sustainability		Persada et al., 2019; Miković et al., 2020
	C7	Increased effectiveness of the coastal management system		EEA, 2006; Batista et al., 2020

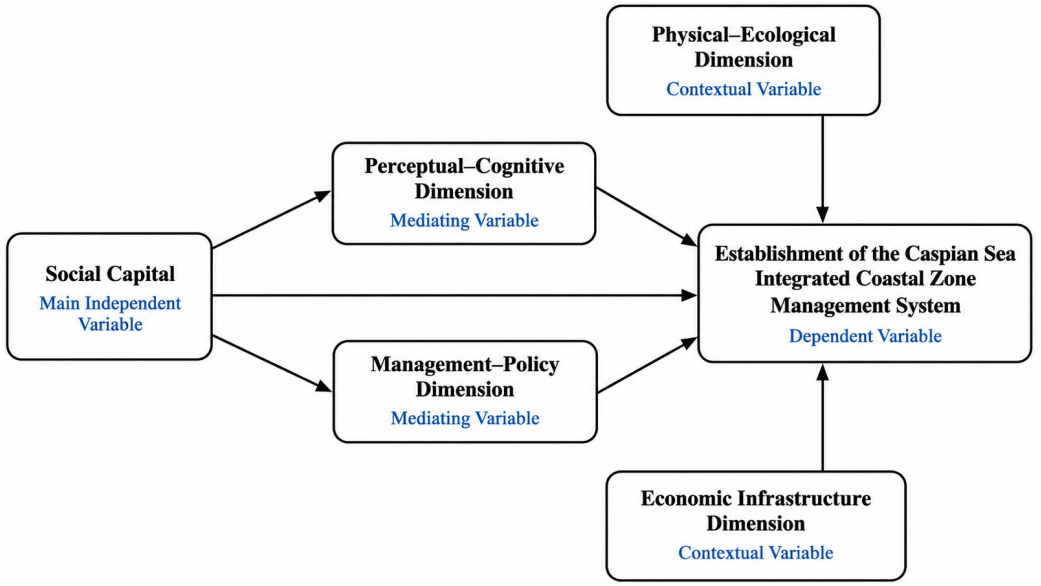

Figure 1. Conceptual model of the study

Accordingly, the conceptual model of the study is based on the premise that social capital, as the principal foundation of cooperation, trust, and participation, provides the basis for influencing the establishment of integrated management. On the one hand, this effect is reinforced through the perceptual–cognitive dimension, since the way coastal areas are understood and valued influences society's willingness to engage with management programs. On the other hand, the management–policy dimension translates this social capacity into implementation, institutional, and decision-making mechanisms. Meanwhile, the physical–ecological and the economic infrastructure dimensions, as influential contextual factors, shape the conditions under which integrated management can or cannot be realized. From this perspective, the research model is not based on a simple linear relationship; rather, it represents an interactive system in which the quality of social relations, collective perceptions, institutional arrangements, and the objective contexts of development and the environment simultaneously contribute to the formation of integrated coastal governance.

3. Research background

A literature review indicates that over the past three decades, studies on Integrated Coastal Zone Management (ICZM) have gradually moved beyond an exclusive focus on physical and environmental dimensions and have increasingly emphasized the roles of social capital, participatory governance, institutional capacities, and stakeholder interactions. Although the concept of social capital was initially developed within sociology and political science, seminal studies'findings demonstrated that it can play a decisive role in the success of public policies, common-pool resource management, and local governance.

In this regard, Bourdieu (1986) conceptualized social capital as a capacity arising from durable networks of social relationships that enhance individuals' and groups' access to collective resources. Coleman (1988), emphasizing trust, shared norms, and social relationships, likewise identified social capital as an important factor facilitating cooperation and strengthening the capacity for collective action. Subsequently, Putnam (1993) and Putnam (2000), through their examination of local institutions' performance, demonstrated that social trust, civic participation, and communication networks are directly associated with governance effectiveness and successful management of public resources. Woolcock (1998) further extended these perspectives by explaining the relationship among social capital, economic development, and the effectiveness of public policies, demonstrating that the quality of social and institutional relationships can enhance the capacity of management systems to address complex problems. These studies provided an important foundation for subsequent research on participatory management, environmental governance, and ICZM.

With the expansion of the ICZM literature, researchers

sought to assess the role of social capital alongside other managerial, institutional, and environmental factors. Early studies of coastal management demonstrated that the success of integrated management programs depends not merely on the existence of laws and administrative structures but also on coordination among responsible institutions, stakeholder participation, mutual trust, and cooperation among different actors. Recent studies have further reinforced this perspective.

For example, Zhang et al. (2025), examining fishers' participation in a rights-based fisheries resource management system, found that social networks, trust, and social norms directly increase stakeholders' willingness to participate in management systems and that social capital enhances the effectiveness of resource management policies by strengthening perceived value. Wang et al. (2025), using structural equation modeling (SEM) and fsQCA, demonstrated that social capital and institutional capacities are among the principal factors enhancing the livelihood resilience of coastal communities and facilitating their transition toward sustainable development pathways. Similarly, Mohsin et al. (2025), using SEM, found that risk perception, trust, and stakeholder participation significantly influence the fisheries management systems' performance. Satumanatpan et al. (2026), examining the role of ethical values and pro-environmental behaviors among fishing communities, also emphasized the importance of interactions among social values, local participation, and coastal resource conservation. Collectively, these studies indicate that recent literature no longer regards social capital merely as a social variable; rather, it recognizes it as a fundamental component of governance, stakeholder participation, institutional capacity enhancement, and the successful implementation of ICZM.

Alongside international studies, research conducted in Iran has also emphasized the importance of social capital and participatory mechanisms in coastal zone management, although individual studies have generally addressed only certain dimensions of the issue. Ahadnejad Roshti et al. (2014) examined the social factors affecting coastal zone management and found that social trust, local cohesion, citizen participation, and cooperation among local institutions constitute some of the most important prerequisites for participatory management. Arefipour et al. (2022), focusing on the relationship among social participation, institutional capacity, and sustainable coastal development, reported that interaction among the public sector, private sector, and non-governmental organizations provides a basis for enhancing the effectiveness of management policies. A comparison of these two studies indicates that although both emphasize the role of social capital, the former focuses primarily on social dimensions, whereas the latter places greater emphasis on institutional and governance capacities. Consequently, the simultaneous relationships among these dimensions within a unified framework have received relatively limited attention.

With regard to governance and policymaking, numerous studies have also emphasized the necessity of institutional coordination in coastal zone management. Shams and Tavakolinia (2015) demonstrated that trust in management institutions, decentralization of decision-making, social responsibility, and strengthening local management play important roles in enhancing the effectiveness of coastal policies. At the international level, Niavis et al. (2019) identified coordination among organizations, stakeholder participation, and the integration of decisions as essential elements of integrated management. Batista et al. (2020) likewise argued that effective governance can be achieved when institutional transparency, accountability, participation of local actors, and environmental protection are addressed simultaneously.

In the same vein, Xue et al. (2025), examining the reciprocal relationship between integrated coastal management (ICM) and marine spatial planning (MSP), demonstrated that synergy between these two approaches enhances coastal governance capacity and facilitates the establishment of integrated management by strengthening institutional coordination, policy coherence, and stakeholder participation. These findings suggest that successful coastal zone management depends less on administrative structures than on the quality of governance, cross-sectoral cooperation, and continuous interaction among institutions and stakeholders.

Another group of studies has emphasized the role of perceptual, value-based, and social factors in the acceptance and success of coastal management policies. Persada et al. (2021) found that residents' attitudes toward environmental conservation, their perceptions of coastal values, and their assessments of the performance of management institutions influence their level of participation and acceptance of

management policies. Satumanatpan et al. (2026), in their study of fishing communities in the Gulf of Thailand, also confirmed the importance of ethical values, environmental responsibility, and social participation in coastal resource conservation. These findings indicate that social capital and governance alone cannot guarantee the effectiveness of integrated management in the absence of positive attitudes, public trust, and social acceptance. Simultaneous attention to social, perceptual, and institutional dimensions is therefore essential to the success of coastal policies. Overall, the review of both seminal and recent studies indicates that social capital, institutional capacities, participatory governance, interorganizational coordination, and social perceptions have each been identified as influential factors in ICZM. However, most previous studies have examined these factors independently or through a limited set of relationships, and there is little empirical evidence about their simultaneous relationship within the framework of a coherent model tailored to the institutional, social, and managerial conditions of the Caspian Sea coastal zone. Furthermore, a substantial proportion of international studies have been conducted in different geographical and institutional contexts, limiting the direct generalizability of their findings to the Caspian Sea coast. Accordingly, a study that empirically evaluates the relationships among these factors in the Caspian Sea coastal zone, drawing on a theoretical framework informed by both seminal literature and recent findings, can help address this research gap and provide scientific evidence for improving policymaking and facilitating the establishment of ICZM.

4. Materials and methods

The present study was applied in terms of purpose and adopted a quantitative, explanatory research approach using a cross-sectional survey design. The study aimed to empirically evaluate the theoretical model for establishing an integrated coastal zone management (ICZM) system along the Caspian Sea coast, with particular emphasis on social capacities, and to examine the predefined structural relationships among the model constructs. Given the cross-sectional nature of the study, the relationships identified by the model were interpreted as estimated structural relationships and effects, and no claims of definitive causality among the variables were made. The study was not exploratory, and no new constructs or factors were extracted from the survey data.

In the first stage, theoretical foundations, previous studies, and specialized documents related to social capital and ICZM were reviewed. Based on this review, the constructs, interconstruct relationships, and conceptual model were specified before data collection. The questionnaire items were subsequently developed in accordance with the conceptual and operational definitions of each construct and adapted to the specific context of the Caspian Sea coastal zone. The statistical population consisted of stakeholders and users of the Caspian Sea coastal zone in the three provinces of Gilan, Mazandaran, and Golestan. Given the multifunctional nature of coastal areas, this population was heterogeneous in terms of its relationship with the coast, interests, user experience, level of expertise, and degree of interaction with institutional and management structures. Accordingly, five groups were included in the sample: local coastal residents, fishers, coast-related economic and service-sector actors, tourists and recreational users, and experts and professionals involved in coastal planning, management, and environmental affairs.

Residents and fishers had more direct experience of social, livelihood, and ecological changes because of their continuous interaction with the coastal environment and resources. Economic and service-sector actors were primarily connected to the coast through employment, investment, tourism, and economic utilization. Tourists and recreational users directly experienced environmental quality, accessibility, and coastal services, whereas experts and professionals represented specialized and institutional perspectives on coastal planning, policymaking, and management. Including these groups was intended to capture a range of perspectives concerning the conservation, utilization, and management of the coastal zone.

Given the geographical extent of the statistical population, the absence of a comprehensive sampling frame covering all stakeholders, and the difficulty of accessing all members of the population, non-probability convenience sampling was employed. Data were collected from selected coastal areas across the three provinces. In Gilan Province, Astara, Bandar Anzali, and Rudsar were selected; in Mazandaran Province, Ramsar, Nowshahr, Mahmudabad, and Babolsar; and in Golestan Province, Bandar Torkaman and Gomishan. The selection of these areas enabled coverage of parts of the western, central, and eastern sections of the southern Caspian Sea coast and facilitated the inclusion of respondents with diverse

social, economic, tourism-related, livelihood, and ecological backgrounds. The final sample consisted of 300 respondents. To ensure balanced geographical coverage, 100 respondents were selected from each of the three provinces of Gilan, Mazandaran, and Golestan. Within each province, the sample comprised 20 residents, 20 fishers, 20 economic and service-sector actors, 20 tourists and recreational users, and 20 experts and professionals associated with coastal affairs. Consequently, each of the five respondent groups consisted of 60 participants in the overall sample. This distribution was designed to ensure balanced representation of different perspectives within the sample and should not be interpreted as proportional allocation based on the actual population size of each group across the three provinces.

Table 2. Distribution of respondents by province and stakeholder group

Respondent group	Gilan	Mazandaran	Golestan	Total
Local residents	20	20	20	60
Fishers	20	20	20	60
Economic and service-sector actors	20	20	20	60
Tourists and recreational users	20	20	20	60
Experts and professionals	20	20	20	60
Total	100	100	100	300

Given the use of non-probability convenience sampling, the findings primarily represent the estimated structural relationships within the sample. Therefore, generalization of the results to all stakeholders along the coastal zones of Gilan, Mazandaran, and Golestan provinces should be made with caution. Furthermore, the study was not intended to statistically compare provinces, cities, or stakeholder groups; rather, the structural model was estimated using the entire sample of 300 respondents. Accordingly, the balanced sample distribution was intended to enhance geographical coverage and diversity of perspectives. It should not be regarded as a basis for inferring statistical differences among provinces or stakeholder groups. In assessing sample-size adequacy, the ratio of respondents to questionnaire items was considered only one preliminary criterion, alongside the number of constructs, structural paths, and overall model complexity. The questionnaire comprised 50 items, and an approximate ratio of 5–10 respondents per item was adopted as an initial criterion for determining sample size (Hair et al., 2019; Sarstedt et al., 2022; Kline, 2023), suggesting 250–500 respondents. Moreover, given the number of latent constructs, the presence of both direct and indirect paths, and the need to obtain stable estimates in PLS-SEM, we set a minimum target of 300 valid questionnaires. Accordingly, allowing for the possibility of incomplete or unusable responses, 310 questionnaires were distributed. Following screening and data cleaning, 300 complete and valid questionnaires were retained for the final analysis. This sample size was also consistent with methodological considerations for PLS-SEM studies (Memon et al., 2020). The data collection instrument was a 50-item questionnaire. The items were derived from the theoretical foundations, previous studies, and indicators related to social capital and ICZM and were adapted to the specific conditions of the Caspian Sea coastal zone. The questionnaire covered six constructs: social capital, the perceptual–cognitive dimension, the management–policy dimension, the physical–ecological dimension, the economic infrastructure dimension, and the establishment of an ICZM system. The theoretical origins of the items for each construct and the sources used in their development are presented in the table of research indicators and items. Before the final administration of the questionnaire, its face validity was assessed by experts in coastal zone planning and management, environmental studies, and social capital. The items were reviewed in terms of clarity, comprehensibility, relevance to the construct being measured, and absence of ambiguity. Following data collection, construct validity was evaluated through assessment of the measurement model, including factor loadings, convergent validity, and discriminant validity. Because data for all study constructs were collected from the same respondents using a single instrument at one

point in time, the possibility of common method bias (CMB) was also examined. Harman's single-factor test was therefore conducted by simultaneously entering all 50 items. The results indicated that the first factor accounted for 43% of the total variance. Since this value was below the 50% threshold, no evidence was found that a single general factor dominated the responses; thus, no dominant common method bias was observed.

Table 3. Results of Harman's single-factor test for common method bias

Test	Result	Evaluation criterion	Variance explained by the first factor
Harman's single-factor test	No dominant common method bias	< 50%	43%

Data analysis was performed using partial least squares structural equation modeling (PLS-SEM) in SmartPLS. First, the measurement model was evaluated using a confirmatory approach by examining factor loadings, Cronbach's alpha, composite reliability (CR), average variance extracted (AVE), and discriminant validity. After establishing the adequacy of the measurement model, the structural model was assessed by examining path coefficients and their significance through bootstrapping, along with the coefficient of determination (R^2), effect size (f^2), predictive relevance (Q^2), and variance inflation factor (VIF). Thus, the adequacy of the measures for the predefined constructs was first established; then, the estimated structural relationships among the constructs were tested.

4.1. Study area

The study area encompasses the Caspian Sea coastal zone within the three provinces of Gilan, Mazandaran, and Golestan. The Caspian Sea, the world's largest inland body of water, is approximately 1,030–1,200 km long and 208–480 km wide, with an average width of approximately 344 km. Its water surface lies approximately 27 m below mean sea level, and its total area is estimated at approximately 378,000 km². The three northern provinces of Gilan, Mazandaran, and Golestan have a combined area of approximately 61,465 km², equivalent to 3.83% of the country's total area (Ramezani & Taleghani, 2013).

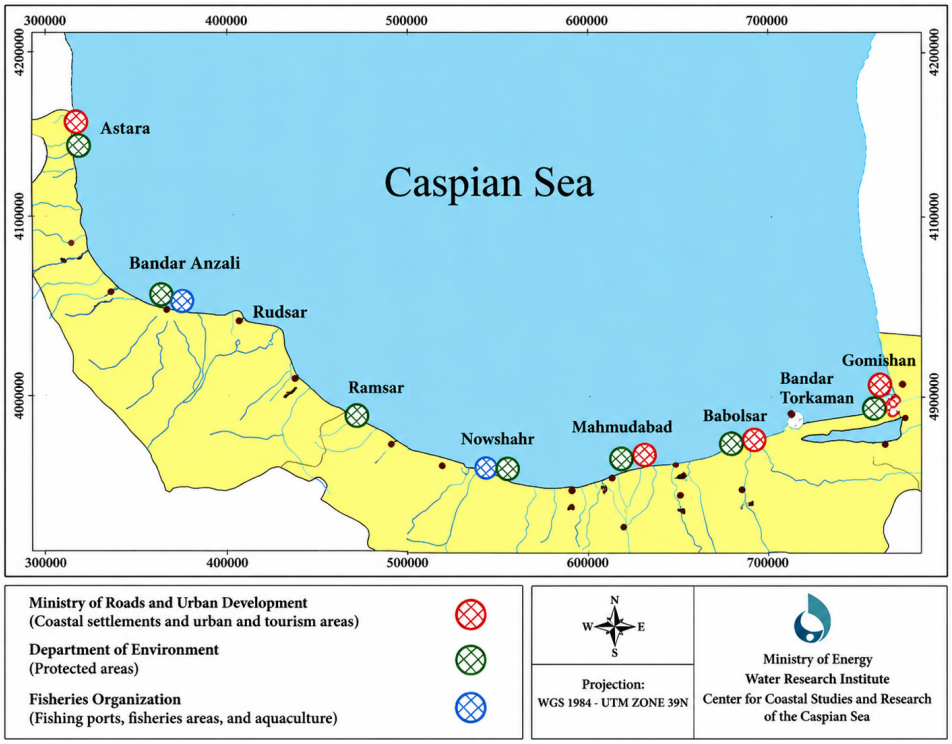

Figure 2. Caspian Sea coastal study area

5. Findings

The findings of the study are presented in two sections: descriptive and inferential. The first section reports the demographic characteristics of the respondents to provide a clear picture of the sample composition and the social context of the analysis. This stage facilitates a better understanding of potential differences in respondents' perceptions and attitudes. The second section presents the inferential analysis based on modeling and the relationships among the study constructs.

5.1. Descriptive analysis of respondents

The descriptive findings indicate that the respondents represented diverse groups in terms of gender, age, and educational attainment, thereby providing a broader basis for analyzing their perspectives.

Table 4. Distribution of respondents' demographic characteristics

Variable	Category	Percentage/description
Gender	Female	24.6%
Gender	Male	75.4%
Age	18–25 years	Highest frequency
Age	36–45 years	High frequency
Education	Bachelor's degree	44.2%
Education	Other educational levels	Lower percentages

The results show that 75.4% of respondents were male and 24.6% were female. In terms of age, the highest frequencies were observed among respondents aged 18–25 and 36–45 years. Regarding educational attainment, bachelor's degree holders constituted the largest group, accounting for 44.2% of the sample. This distribution indicates that the research data were obtained through the participation of respondents from diverse social groups.

Table 5. Descriptive statistics of the research variables

Variable	Mean	Standard deviation	Minimum	Maximum
Social capital	3.74	0.65	2.10	4.90
Perceptual–cognitive dimension	3.52	0.61	1.90	4.80
Physical–ecological dimension	3.21	0.73	1.60	4.60
Economic infrastructure dimension	3.35	0.70	1.80	4.80
Management–policy dimension	3.19	0.66	1.80	4.70
Integrated coastal management	3.45	0.69	1.70	4.80

As shown in Table 5, "Social capital" had the highest mean (3.74), whereas the "Management–policy" dimension had the lowest mean (3.19). The range between the minimum and maximum scores indicates considerable variation in respondents' perceptions across the different dimensions. Overall, the mean values of all variables exceeded the theoretical midpoint of 3, indicating relatively favorable conditions across the dimensions from the respondents' perspective. Nevertheless, the "Physical–ecological" and "Management–policy" dimensions require greater attention.

5.2. Inferential analysis of the findings

Measurement model: Reliability and convergent validity

Table 6. Assessment of the measurement model, reliability, and convergent validity

Construct	Indicator	Factor Loading	Cronbach's alpha	CR	AVE
Social capital	S1	0.847	0.956	0.961	0.634
	S2	0.803			
	S3	0.798			
	S4	0.812			
	S5	0.841			
	S6	0.825			
	S7	0.791			
	S8	0.863			
	S9	0.818			
	S10	0.826			
	S11	0.778			
	S12	0.806			
	S13	0.789			
	S14	0.842			
Perceptual–cognitive dimension	P1	0.838	0.927	0.938	0.682
	P2	0.856			
	P3	0.802			
	P4	0.831			
	P5	0.814			
	P6	0.797			
	P7	0.774			
Management–policy dimension	M1	0.806	0.933	0.941	0.675
	M2	0.791			
	M3	0.822			
	M4	0.844			
	M5	0.785			
	M6	0.812			
	M7	0.801			
	M8	0.776			
Physical–ecological dimension	K1	0.804	0.918	0.930	0.654
	K2	0.782			
	K3	0.796			
	K4	0.771			
	K5	0.826			
	K6	0.808			
	K7	0.792			

Construct	Indicator	Factor Loading	Cronbach's alpha	CR	AVE
Economic infrastructure dimension	E1	0.817	0.924	0.935	0.668
	E2	0.798			
	E3	0.829			
	E4	0.807			
	E5	0.784			
	E6	0.833			
	E7	0.801			
Establishment of the Caspian Sea ICZM system	C1	0.828	0.931	0.942	0.691
	C2	0.846			
	C3	0.814			
	C4	0.853			
	C5	0.805			
	C6	0.837			
	C7	0.821			

The measurement model results in Table 6 indicate that all constructs and indicators demonstrate satisfactory measurement quality and meet the requirements for proceeding to structural model assessment. First, all indicator loadings exceed the 0.70 threshold, indicating adequate associations between the individual items and their corresponding constructs and demonstrating their ability to represent the concepts being measured. Accordingly, none of the questionnaire indicators required removal or revision, and all items made acceptable contributions to measuring their respective latent variables. Among the constructs, social capital demonstrated Cronbach's alpha of 0.956, CR of 0.961, and an AVE of 0.634. Within this construct, S8 (social cohesion and solidarity) had the highest factor loading (0.863), followed by S1 (level of social trust among residents) at 0.847 and S14 (cultural capital and social awareness) at 0.842. Conversely, S11 (capacity for participation by non-governmental organizations) had the lowest loading (0.778), although it remained above the accepted threshold and therefore did not require removal. The perceptual–cognitive dimension also exhibited satisfactory reliability and convergent validity, with Cronbach's alpha, CR, and AVE values of 0.927, 0.938, and 0.682, respectively. P2 (attitude toward environmental conservation) had the highest factor loading (0.856), whereas P7 (perception of the quality of current management) had the lowest loading (0.774). For the management–policy dimension, Cronbach's alpha was 0.933, CR was 0.941, and AVE was 0.675, indicating satisfactory internal consistency and convergence. M4 (stakeholder participation in policymaking) recorded the highest factor loading (0.844), whereas M8 (conflict management among coastal actors) had the lowest loading (0.776). This pattern highlights the significant role of stakeholder participation in policymaking for measuring this construct. For the physical–ecological dimension, reliability and convergent validity indices were also satisfactory. K5 (natural environmental capacity) had the highest factor loading (0.826), whereas K4 (shoreline changes) had the lowest loading (0.771). Both values nevertheless exceeded the accepted threshold. The economic infrastructure dimension demonstrated adequate measurement quality, with Cronbach's alpha of 0.924, CR of 0.935, and AVE of 0.668. E6 (private-sector participation in coastal development) had the highest factor loading (0.833), whereas E5 (public investment) recorded the lowest value (0.784). Finally, the establishment of the Caspian Sea ICZM system demonstrated Cronbach's alpha of 0.931, CR of 0.942, and AVE of 0.691. C4 (improvement in the quality of coastal environmental protection) had the highest factor loading (0.853), whereas C5 (reduction of institutional and functional conflicts) had the lowest loading (0.805). Overall, Cronbach's alpha and CR values for all constructs were well above the minimum accepted threshold of 0.70, all AVE values exceeded 0.50, and all factor loadings

were greater than 0.70. These findings confirm satisfactory reliability and convergent validity of the measurement model and support proceeding to structural model assessment and hypothesis testing.

Table 7. Discriminant validity of the research constructs based on the Heterotrait–Monotrait Ratio (HTMT)

Construct	SC	PM	MP	KE	EI	ICZM
SC	—					
PM	0.762	—				
MP	0.735	0.748	—			
KE	0.684	0.719	0.726	—		
EI	0.701	0.712	0.753	0.738	—	
ICZM	0.781	0.774	0.812	0.746	0.768	—

Table 7 indicates that the HTMT values among the research constructs range from 0.684 to 0.812. All coefficients are below the conservative threshold of 0.85; therefore, the measurement model's discriminant validity is confirmed. In other words, each construct measures an empirically distinct concept, with no undesirable overlap among the latent variables. The highest HTMT value (0.812) was observed between the management–policy dimension (MP) and the establishment of the Caspian Sea ICZM System. This relatively strong relationship indicates a close association between the quality of policymaking, institutional coordination, implementation capacity, and the establishment of an integrated management system. Nevertheless, the value remains below the critical threshold, confirming that the two constructs retain their conceptual distinctiveness. The lowest HTMT value (0.684) was observed between social capital (SC) and the physical–ecological dimension (KE), reflecting greater empirical distinctiveness between these two constructs

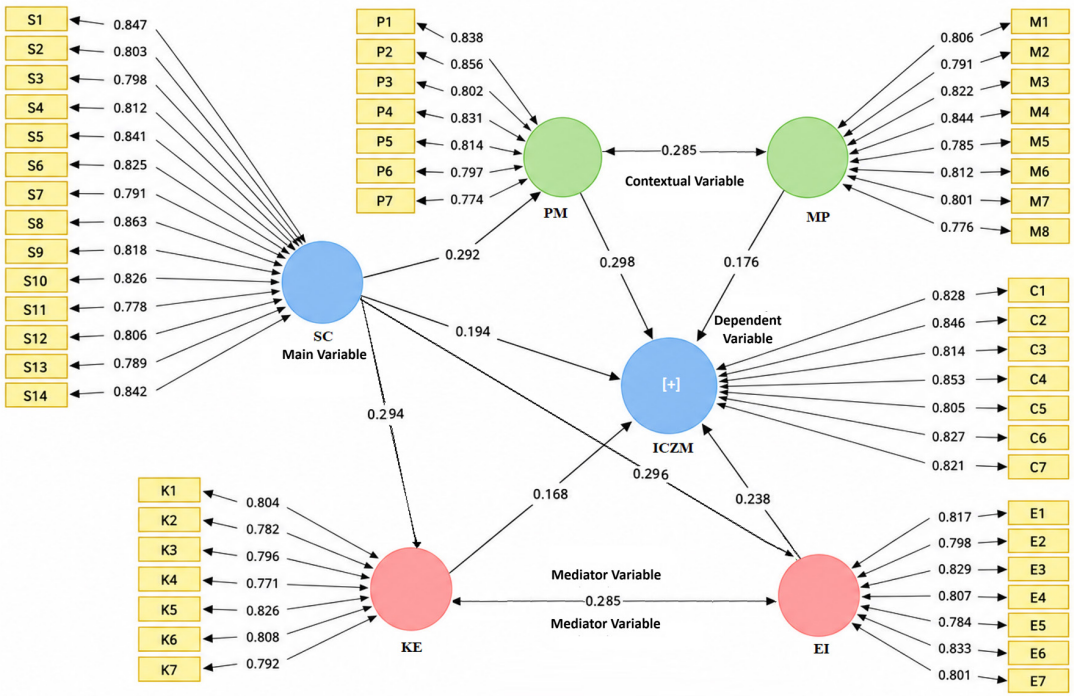

Figure 3. Structural model of the study in SmartPLS, including the relationships among social capital, mediating dimensions, contextual variables, and the establishment of the Caspian Sea ICZM system

After confirming the adequacy of the measurement model, the structural model was assessed to evaluate the quality of the relationships among the constructs, the explanatory power of the endogenous variables,

and the predictive capability of the model. At this stage, collinearity among the predictor constructs, coefficients of determination, predictive relevance, and the effect size of each path were examined. In addition, overall model fit indices were considered to determine how consistent the proposed structure is with the data collected from the coastal areas of the Caspian Sea.

Table 8. Structural model assessment indices

Construct	Code	VIF	R^2	Q^2	f^2	Assessment
Social capital	SC	1.89	—	—	0.36	Strong effect and acceptable collinearity
Perceptual–cognitive dimension	PM	2.07	0.541	0.362	0.28	Moderate-to-strong explanatory and predictive power
Management–policy dimension	MP	2.23	0.624	0.408	0.32	Relatively strong explanatory power and effect
Physical–ecological dimension	KE	1.96	0.573	0.384	0.24	Moderate explanatory power and acceptable effect
Economic infrastructure dimension	EI	2.11	0.617	0.425	0.27	Adequate predictive power and effect
Establishment of the Caspian Sea integrated coastal zone management system	ICZM	2.48	0.857	0.589	—	Very strong explanatory and predictive power

The variance inflation factor (VIF) assessment in Table 8 indicates that the VIF values of the research constructs range from 1.89 to 2.48. These values are substantially below the critical threshold of 5 and even below the more conservative criterion of 3.3; therefore, no severe collinearity exists among the predictor variables. This finding is important because it indicates that social capital, the perceptual–cognitive, management–policy, physical–ecological, and economic infrastructure dimensions, although interrelated, are not identical concepts and each contributes distinctly to explaining the establishment of ICZM in the Caspian Sea coastal zone. The coefficient of determination (R^2) for the dependent construct, ICZM, was 0.857. Accordingly, the variables included in the model explained 85.7% of the variance in the establishment of the Caspian Sea ICZM system. This value indicates the model's very high explanatory power. Nevertheless, we should not interpret it as a mere indication of a complete solution to coastal management issues. The remaining variance may be attributable to factors such as national legislation, political changes, implementation constraints, organizational conflicts of interest, climatic conditions, and unpredictable environmental events that were not directly measured in the present model. The coefficients of determination for the mediating and contextual variables were also substantial. The management–policy dimension had an R^2 of 0.624, representing the highest level of explained variance after the dependent variable. This finding suggests that coordinated policymaking in the Caspian Sea coastal zone is substantially associated with the quality of social capital, trust among actors, and genuine stakeholder participation. The economic infrastructure dimension also exhibited a substantial R^2 of 0.617, indicating that coastal economic capacities cannot be strengthened independently of social networks, coordinated investment, and public–private participation. In contrast, the perceptual–cognitive dimension had the lowest R^2 among the endogenous constructs (0.541), although this value still represents moderate-to-strong explanatory power. Public perceptions of coastal values, place identity, and the need for environmental conservation are shaped not only by management interventions but also by lived experience, local culture, and the history of interactions between communities and their environment. The Q^2 values were positive and greater than zero for all endogenous constructs, confirming the model's predictive relevance. The highest Q^2 value was observed for the establishment of the ICZM system (0.589), indicating considerable predictive capability. This was followed by the economic infrastructure and management–policy dimensions. This pattern suggests that management decisions along the Caspian Sea coast are more likely to produce tangible outcomes when accompanied by infrastructure provision, livelihood sustainability, and the participation of economic actors. The assessment of f^2 further indicated that social capital, with a value of 0.36, had a stronger effect than the other constructs. This finding

positions social capital as a central driving force within the model, implying that trust, cooperation, cohesion, and communication networks are not merely supporting factors but can influence the quality of policymaking, public perceptions, and the capacity to implement integrated management. The management–policy dimension ranked next with an f^2 value of 0.32. The Perceptual–cognitive, economic infrastructure, and physical–ecological dimensions also demonstrated moderate and meaningful effects, suggesting that the exclusion of any of these dimensions could reduce the model's explanatory power

Table 9. Overall model fit indices

Index	obtained value	Acceptance criterion	Status
SRMR	0.051	< 0.08	Acceptable
NFI	0.918	> 0.90	Acceptable
RMS_theta	0.108	< 0.12	Acceptable
d_ULS	1.038	Below the upper bound of the bootstrap confidence interval	Confirmed
d_G	0.841	Below the upper bound of the bootstrap confidence interval	Confirmed

The results indicate that the SRMR value was 0.051, below the 0.08 threshold. Therefore, the discrepancy between the observed and estimated correlation matrices is within an acceptable range. This finding suggests that the proposed model adequately represents the relationships among social capital, the perceptual–cognitive, management–policy, physical–ecological, and economic infrastructure dimensions, and the establishment of the Caspian Sea ICZM system, with limited residual error. The NFI value was 0.918, exceeding the accepted criterion of 0.90. This index indicates that the research model adequately improves over the baseline model in explaining the structure of relationships among the variables. In other words, simultaneously incorporating social capacities, managerial factors, public perceptions, ecological conditions, and economic infrastructure provides a more accurate representation of the mechanism underlying the establishment of integrated management along the Caspian Sea coast than a model that disregards these relationships. The RMS_ theta value was 0.108, below the 0.12 threshold. This result confirms the satisfactory quality of the reflective measurement model and the relatively low discrepancy among the residual covariances of the indicators. From this perspective, the selected items adequately measure the latent constructs, and no substantial weakness is evident in the model's reflective structure. The d_ULS and d_G values were 1.038 and 0.841, respectively. The final evaluation of these two criteria should be conducted against the confidence interval bounds obtained through bootstrapping in SmartPLS. Values below the upper bound of the confidence interval indicate no significant discrepancy between the empirical and model-implied matrices. Based on the reported results, both indices fall within acceptable ranges and support the model fit.

Taken together, the SRMR, NFI, RMS_theta, d_ULS, and d_G indices indicate an acceptable fit between the model and the research data. However, satisfactory statistical fit alone does not imply the complete adequacy of coastal management policies. The model's practical value becomes evident when the confirmed relationships are translated into implementation mechanisms, including strengthening trust between local communities and responsible institutions, establishing sustainable channels for stakeholder participation, reducing organizational conflicts, protecting sensitive habitats, and aligning economic investment with the ecological capacity of the Caspian Sea coastal zone.

5.3.Hypothesis testing and path coefficients

Table 10. Results of hypothesis testing and structural model path coefficients

Hypothesis	Path	Path coefficient (β)	STDEV	t-value	p-value	CI 2.5%	CI 97.5%	Result
H1	SC → PM	0.736	0.048	15.331	0.000	0.643	0.824	Supported
H2	SC → KE	0.757	0.043	17.605	0.000	0.671	0.839	Supported
H3	PM → MP	0.790	0.038	20.789	0.000	0.712	0.859	Supported

Hypothesis	Path	Path coefficient (β)	STDEV	t-value	p-value	CI 2.5%	CI 97.5%	Result
H4	KE → EI	0.785	0.040	19.625	0.000	0.703	0.862	Supported
H5	SC → ICZM	0.194	0.058	3.345	0.001	0.082	0.307	Supported
H6	PM → ICZM	0.298	0.052	5.731	0.000	0.196	0.399	Supported
H7	MP → ICZM	0.176	0.056	3.143	0.002	0.067	0.286	Supported
H8	KE → ICZM	0.168	0.057	2.947	0.003	0.056	0.279	Supported
H9	EI → ICZM	0.238	0.054	4.407	0.000	0.132	0.344	Supported

Table 10 indicates that all relationships hypothesized in the research model were statistically significant. The t-values for all paths exceeded the critical value of 1.96, while the p-values for all hypotheses were below 0.05. Furthermore, none of the bootstrap confidence intervals included zero, confirming the stability and reliability of the estimated path coefficients. Accordingly, all nine research hypotheses were supported, providing adequate statistical support for the proposed model in explaining the establishment of the Caspian Sea ICZM system. Among the relationships examined, the strongest path coefficient was observed for the effect of the perceptual–cognitive dimension on the management–policy dimension (β = 0.790). This finding indicates that stronger stakeholder attitudes, awareness, cultural identity, and perceptions regarding the values of the coastal environment provide a more favorable basis for coordinated, participatory, and effective policymaking. In other words, successful coastal management is influenced not only by administrative structures but also by stakeholders' shared understanding and perceptions of the importance of conservation and sustainable use of coastal areas. This finding highlights the need to prioritize public awareness, environmental education, and the enhancement of social awareness in management programs. The second strongest relationship was the effect of the Physical–Ecological Dimension on Economic Infrastructure (β = 0.785). This result indicates that economic infrastructure development, tourism, and investment in coastal areas can achieve the required level of sustainability when planned in accordance with environmental quality conservation, ecological capacity, and the resilience of coastal ecosystems. Therefore, economic development along the Caspian Sea coast should be aligned with natural resource conservation, pollution control, and the prevention of coastal ecosystem degradation. The findings also demonstrate the fundamental role of Social Capital within the model structure. The path coefficient from Social capital to the physical–ecological dimension was 0.757, while the coefficient from social capital to the perceptual–cognitive Dimension was 0.736, both representing strong relationships. These findings indicate that increased social trust, citizen participation, interinstitutional cooperation, social networks, and social cohesion not only enhance individuals' perceptions of the coastal environment but also play an important role in environmental conservation and enhancing ecological capacity. Social Capital can therefore be regarded as a major driving force underlying changes in the other dimensions of the model. Among the paths leading directly to the dependent variable, the perceptual–cognitive dimension had the strongest direct effect, with a path coefficient of 0.298. This finding suggests that successful ICZM is strongly associated with stakeholders' attitudes, beliefs, sense of responsibility, and positive perceptions of coastal values. Even when appropriate laws and management structures are in place, achieving management objectives may remain difficult without local communities' support and a shared understanding of the need for conservation and integrated management. Economic infrastructure had the next strongest direct effect on ICZM establishment (β = 0.238). This result indicates that tourism and transportation infrastructure, investment, and employment opportunities improve the effectiveness of coastal management. In other words, integrated management is more likely to succeed when sustainable economic opportunities for local communities are developed alongside environmental conservation. The direct effect of social capital on the establishment of ICZM was also statistically significant (β = 0.194), although its magnitude was smaller than its indirect effects. This finding indicates that social capital exerts most of its influence through strengthening perceptual–cognitive and management–policy dimensions. Thus, social trust and public

participation are more likely to produce desirable outcomes when translated into appropriate policymaking, institutional coordination, and participatory decision-making. The smallest direct path coefficients were observed for the effects of the management–policy dimension (β = 0.176) and the physical–ecological dimension (β = 0.168) on ICZM establishment. However, these smaller coefficients should not be interpreted as indicating that these dimensions are unimportant. Rather, their roles are more strongly manifested through interactions with other constructs and through the creation of favorable conditions for integrated management. In other words, appropriate management structures or favorable environmental quality alone cannot guarantee the establishment of ICZM without strengthening social capital, enhancing public awareness, and developing economic infrastructure. Overall, the results indicate that social capital is the starting point of the transformation chain in Caspian Sea coastal management and contributes to establishing integrated management by strengthening perceptual, managerial, physical–ecological, and economic dimensions. Based on the magnitude of the path coefficients, policy priorities for the Caspian Sea coastal zone should focus on enhancing public awareness and perceptions, strengthening social capital and trust among stakeholders, protecting ecological capacities, developing sustainable economic infrastructure, and improving management and policy coordination. These priorities are directly derived from the structural model results and can provide a basis for developing implementation strategies for the integrated and sustainable management of the Caspian Sea coastal zone.

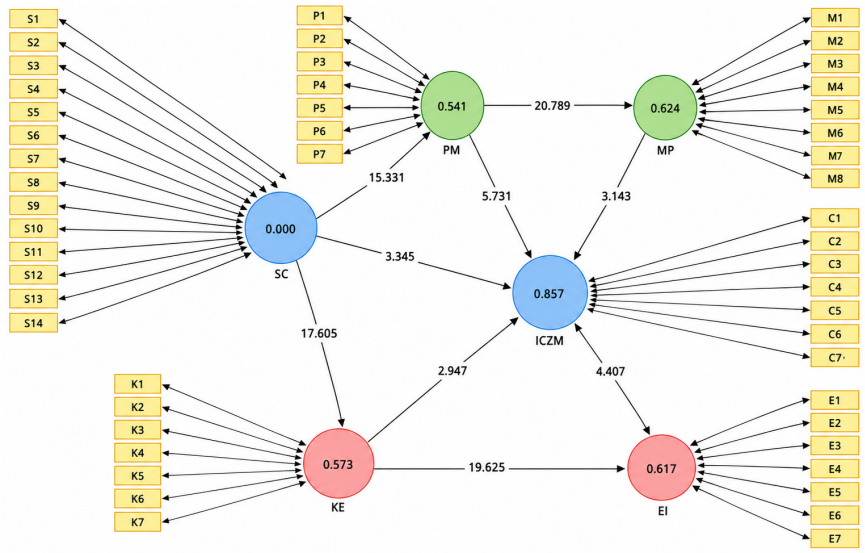

Figure 4. Hypothesis-testing model based on bootstrapping results in SmartPLS

Figure 4 presents the results of hypothesis testing based on the bootstrapping procedure in SmartPLS. In this figure, the t-statistics for all direct paths among the research constructs are displayed on the arrows, while the coefficients of determination (R^2) are shown within the endogenous constructs. Since the purpose of this figure is to assess the statistical significance of the structural relationships, only the direct relationships among the variables are presented, and indirect effects are not displayed. In addition, only the R^2 values are reported within the constructs to indicate the proportion of variance explained in each endogenous variable. Examination of the t-statistics shows that all structural paths have values greater than the critical threshold of 1.96. Therefore, all relationships specified in the model are statistically significant at the 95% confidence level. The highest t-statistic was observed for the path from the perceptual–cognitive dimension to the management–policy dimension, indicating the particularly strong statistical robustness of this relationship in the research model. This was followed by the path from the physical–ecological dimension to economic infrastructure and the path from social capital to the physical–ecological dimension, which also exhibited high t-statistics. These findings further confirm the

important role of social capital in shaping the managerial, environmental, and economic dimensions of integrated coastal zone management in the Caspian Sea coastal zone. In contrast, although the paths from social capital to the establishment of ICZM, from the management–policy dimension to the establishment of ICZM, and from the physical–ecological dimension to the establishment of ICZM had lower t-statistics than the other relationships, their values remained above the critical threshold and were therefore statistically significant. These results indicate that the establishment of an ICZM system along the Caspian Sea coast is shaped by the simultaneous effects of a combination of social, perceptual, managerial, physical–ecological, and economic factors, and none of these dimensions alone can fully explain the dependent variable. Overall, Figure 4 confirms that the statistical results adequately support the theoretical model, and all hypotheses formulated in the study were supported.

Table 9. Direct, indirect, and total effects among the research constructs

Path	Direct effect	Indirect effect	Total effect
SC → PM	0.736	—	0.736
SC → KE	0.757	—	0.757
PM → MP	0.790	—	0.790
KE → EI	0.785	—	0.785
SC → ICZM	0.194	0.220	0.414
PM → ICZM	0.298	0.051	0.349
MP → ICZM	0.176	—	0.176
KE → ICZM	0.168	0.128	0.296
EI → ICZM	0.238	0.133	0.371
SC → EI	—	0.192	0.192
KE → PM	—	0.187	0.187

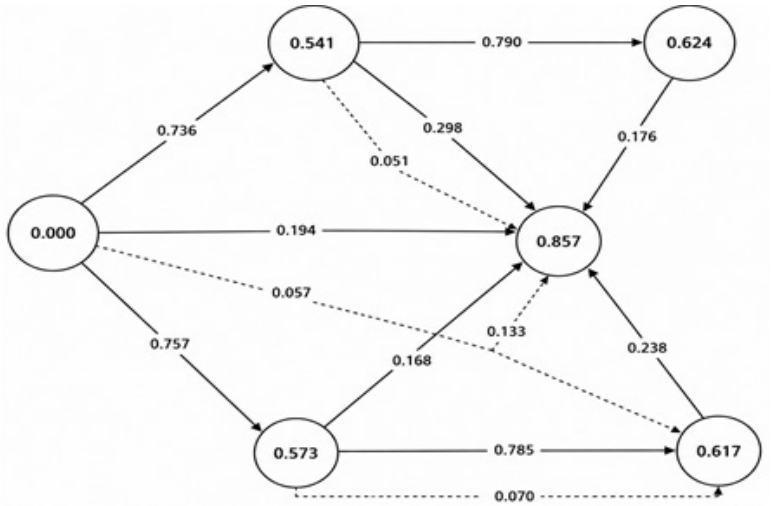

Figure 5. Final model of the direct and indirect relationships among the research constructs in the establishment of the Caspian Sea ICZM system

Figure 5 presents the final structure of the relationships among the research constructs based on the results of partial least squares structural equation modeling (PLS-SEM). In this model, in addition to the direct relationships among the variables, indirect effects are represented by dashed lines to provide a comprehensive illustration of the mechanisms through which effects are transmitted among the constructs.

Standardized path coefficients are also reported for all direct and indirect paths, while the coefficients of determination (R^2) are displayed within the endogenous constructs to indicate the proportion of variance explained in each construct.

As illustrated in the figure, social capital, as the model's starting point, directly affects the perceptual–cognitive dimension, the physical–ecological dimension, and the establishment of ICZM. The perceptual–cognitive dimension subsequently contributes to strengthening the management–policy dimension and also directly affects integrated coastal zone management, thereby playing an important mediating role in transmitting the effects of social capital. Similarly, the physical–ecological dimension not only directly affects the establishment of ICZM but also provides the basis for the development of economic infrastructure, thereby transmitting part of its influence indirectly to the dependent variable. Finally, economic infrastructure, as the final link in this chain, plays an important role in strengthening the establishment of the Caspian Sea ICZM system.

The path coefficients indicate that the strength of the relationships among the constructs is not uniform and certain paths play more strategic roles than others. The simultaneous presence of direct and indirect relationships also demonstrates that establishing ICZM is not the result of a single factor but rather emerges from the interaction among social capital, stakeholders' perceptions and attitudes, policymaking and governance, physical–ecological conditions, and economic infrastructure. The R^2 values further indicate that the model has substantial explanatory power and that a large proportion of the variance in the endogenous constructs, particularly the establishment of the Caspian Sea ICZM system, is explained by the relationships incorporated into the model. Accordingly, Figure 5 provides an integrated representation of the direct and indirect effects of the research variables and indicates that achieving sustainable management of the Caspian Sea coastal zone requires simultaneous attention to social, managerial, ecological, and economic dimensions within a coordinated and integrated system.

6. Discussion and conclusion

The findings showed that establishing an ICZM system along the Caspian Sea coast results from the interaction of social, perceptual, managerial, physical–ecological, and economic factors, and none of these dimensions alone can explain the success of the coastal management system. The structural model results indicated that all research hypotheses were supported and the direct and indirect relationships among the constructs were statistically significant. Among the direct paths, the physical–ecological dimension exerted the strongest effect on the establishment of ICZM, followed by economic infrastructure, social capital, the management–policy dimension, and the perceptual–cognitive dimension. This finding indicates that conserving natural and ecological capacities, together with strengthening development infrastructure and social capital, constitutes a prerequisite for achieving sustainable management of the Caspian Sea coastal zone.

The findings of the present study are consistent with the classical perspectives of Bourdieu (1986), Coleman (1988), Putnam et al. (1993), and Putnam (2000), who identified social capital as a foundation for building trust, collective cooperation, and more effective governance. The present findings similarly demonstrated that social capital not only directly affects the establishment of ICZM but also plays an important role through enhancing the perceptual dimension, strengthening management capacities, and improving physical–ecological conditions. This result also consists with the findings of Zhang et al. (2025), Wang et al. (2025), and Mohsin et al. (2025), who identified social trust, stakeholder participation, and institutional capacities as major determinants of successful coastal resource management and sustainable development. The findings also consists with those of Niavis et al. (2019), Batista et al. (2020), and Xue et al. (2025) regarding the roles of institutional coordination, stakeholder participation, and the integration of management policies. However, the principal distinction between the present study and previous research lies in the fact that most earlier studies examined only selected factors affecting coastal management, whereas the present study tested these factors simultaneously within an integrated structural model and demonstrated that social capital influences the other dimensions of the model through both direct and indirect pathways. Furthermore, domestic studies by Ahadnejad Roshti et al. (2014), Shams-Pouya and Tavakolinia (2015), and Arefipour et al. (2022) primarily emphasized social trust, local participation, and institutional capacities; however, they did not simultaneously examine the structural relationships among these components and the mediating roles of the perceptual, managerial, and physical dimensions. The present study therefore

addresses part of this research gap. Nevertheless, the findings should be interpreted in light of spatial differences within the study area, despite an overall pattern across the Caspian Sea coastal zone. The investigated coastal areas differ in terms of tourism intensity, land-use patterns, livelihood structures, pressures from physical development, and ecological sensitivity. In western Mazandaran, particularly Ramsar and Nowshahr, the predominance of tourism and service activities, increasing demand for coastal land, and pressure from physical development highlight the challenge of balancing economic interests, public access, and environmental conservation. In Mahmudabad and Babolsar, the simultaneous presence of residential, tourism, service, and economic functions increases stakeholder diversity and complicates coordination among users and responsible institutions. Similarly, in Gilan, areas such as Bandar Anzali, Astara, and Rudsar face diverse coastal interests and demands because of different combinations of port, tourism, residential, and local utilization activities. In contrast, in the eastern part of the study area, particularly Bandar Torkaman and Gomishan, the greater dependence of certain local and livelihood activities on natural resources, together with the ecological sensitivity of coastal and wetland environments, creates a different context for establishing integrated management. From this perspective, social capital, trust, and stakeholder participation are important across all zones; however, the mechanisms through which these social capacities translate into policymaking, ecological conservation, and economic infrastructure development may vary according to each zone's characteristics. The findings therefore support a coordinated regional framework for managing the Caspian Sea coastal zone, while implementation should remain sensitive to the social, economic, physical, and ecological characteristics of each area rather than applying a uniform implementation model to all coastal zones. However, because the structural model was estimated using the entire sample and no independent multi-group analysis was conducted to compare the cities, the spatial differences described above should be interpreted as contextual considerations rather than evidence of statistically significant differences among the study areas. Future research could comparatively examine these differences and test variations in model coefficients across different coastal zones using

The results further indicated that although social capital is the starting point in developing integrated management, the strongest direct effect on the dependent variable was exerted by the physical–ecological dimension. This finding suggests that along the Caspian Sea coast, the quality of coastal ecosystems, pollution reduction, conservation of natural habitats, and enhancement of environmental resilience play particularly important roles in the success of integrated management. Social capital, in turn, provides the foundation for increasing participation, trust, interorganizational cooperation, and acceptance of management policies, thereby indirectly enhancing the effectiveness of the management system. Integrated management can therefore achieve desirable outcomes when social, managerial, environmental, and economic policies are implemented simultaneously and in a coordinated manner.

Overall, the principal scientific contribution of this study is the development and validation of a comprehensive model for explaining the establishment of the Caspian Sea ICZM system. The model simultaneously explains the relationships among social capital, the perceptual–cognitive, management–policy, physical–ecological, and economic infrastructure dimensions and can serve as an applied framework for coastal planners and managers in developing integrated policies.

Nevertheless, the use of cross-sectional data, the restriction of the statistical population to stakeholders in the three coastal provinces, and reliance on perceptual data constitute important limitations of the study. Future studies should therefore examine variables such as climate change, smart governance, coastal monitoring technologies, geographic information systems (GIS), and digital stakeholder participation alongside the dimensions investigated in the present study. From an applied perspective, strengthening social capital, enhancing coordination among executive agencies, conserving ecological capacities, and developing sustainable economic infrastructure should be regarded as major policy priorities for establishing an ICZM system along the Caspian Sea coast. Despite the study's valuable findings, several limitations should be considered when interpreting the results. First, the research data were collected through questionnaires and were based on respondents' perceptions; therefore, subjective judgments and individual response biases may have influenced the findings. Second, the statistical population was limited to stakeholders and users of the coastal zones of Gilan, Mazandaran, and

Golestan provinces; consequently, generalizing the findings to other coastal regions of the country or other management systems should be undertaken with caution. In addition, the study's cross-sectional nature did not allow examination of temporal changes or dynamic relationships among variables, while potentially influential factors such as legal dimensions, climate change, national-level policies, and broader economic developments remained outside the scope of the research model.

Based on the findings, coastal policymakers and managers are advised to prioritize strengthening social capital, enhancing public trust, expanding stakeholder participation, and improving coordination among responsible organizations as fundamental requirements for establishing ICZM along the Caspian Sea coast. At the same time, coastal management programs should address conservation of physical–ecological capacities, reduction of coastal pollution, enhancement of ecosystem resilience, and development of sustainable economic infrastructure simultaneously, as the findings demonstrate the important roles of these dimensions in the success of integrated management. Future research should also employ longitudinal data, compare other coastal regions of the country, adopt mixed-methods approaches, and incorporate variables such as smart governance, climate change, geographic information systems, remote sensing, and digital technologies to develop a more comprehensive ICZM model. Such an approach could enhance the generalizability of the findings and contribute to the formulation of evidence-based policies for the sustainable development of the country's coastal areas.

Authors' Contributions

The first author contributed 35%, the second author 35%, and the third author 30%.

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Conflict of Interest

The authors report no conflicts of interest. They fully adhered to publication ethics in the preparation and publication of this article.

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