

Human-Centered Leadership Readiness in Industry 5.0 Maritime Environments: An Exploratory Study of Emotional, Social, Intercultural and Digital Competencies

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ABSTRACT

This exploratory study examines Human-Centric Leadership Readiness (HCLR) within maritime Industry 5.0 environments, focusing on how emotional, social, intercultural, and digital competencies interact to shape leadership preparedness among future maritime professionals. Drawing on a cross-sectional survey of 60 maritime students and trainees from Bulgaria and Spain, the study introduces and pilot-tests the Human-Centric Leadership Readiness for Industry 5.0 (HCLR-I5) instrument, comprising five scales: HCLR, Emotional Self-Regulation (ESR), Social Attunement and Strength-Based Leadership (SA-SBL), Intercultural Communication Effectiveness (ICE), and AI/Digital Self-Efficacy (AI-SE). Correlation and multiple regression analyses reveal that HCLR is most strongly predicted by SA-SBL ($\beta = .52, p < .001$), followed by ICE ($\beta = .29, p < .01$) and ESR ($\beta = .21, p < .05$), with the overall model explaining a substantial proportion of variance ($R^2 = .74$). Unexpectedly, AI-SE shows a significant negative association with HCLR ($\beta = -.34, p < .01$), suggesting that self-reported digital confidence and human-centered leadership orientation may not develop in tandem. Mean scores were highly consistent across the Bulgarian and Spanish subsamples, indicating that shared professional maritime culture may shape leadership attitudes more than national context. The findings support a conceptual model positioning relational and human-centered capacities at the core of leadership readiness in increasingly digitalized maritime settings, while framing digital competence as a contextual rather than central driver. As a pilot study, the results offer preliminary evidence to inform future instrument refinement and leadership development initiatives within Industry 5.0 maritime education.

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1. Introduction.

At the heart of Industry 5.0 lies a fundamental recognition: technology alone does not create organizational effectiveness. While artificial intelligence, automation, and advanced digital systems continue to transform workplaces, organizational success ultimately depends on people—their capacity to collaborate, communicate, adapt, make ethical decisions, and exercise judgment in complex situations. Industry 5.0 therefore represents not merely a technological evolution, but a renewed commitment to placing human beings at the center of organizational development.

The transition from Industry 4.0 to Industry 5.0 marks a significant shift from technology - driven efficiency toward a more

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human - centric paradigm that emphasizes the role of people within increasingly complex and dynamic socio-technical systems. In this context, leadership is no longer defined solely by operational effectiveness or technological competence, but by the ability to balance efficiency with ethical awareness, social responsibility, and human well-being.

The maritime sector provides a particularly relevant setting for examining this transformation. Maritime operations are characterized by high-risk environments, strict hierarchical structures, and a growing reliance on digital and automated systems. At the same time, maritime work is inherently multicultural, involving diverse crews and complex communication dynamics. These conditions require leadership approaches that integrate social awareness, emotional regulation, intercultural competence, and responsible use of technology.

Despite the growing emphasis on human-centricity within Industry 5.0, important gaps remain in our understanding of how leadership readiness develops in increasingly digitalized and socio-technical environments. Existing research has devoted considerable attention to emotional intelligence, intercultural competence, leadership development, and digital literacy; however, these domains are most often examined independently. Consequently, limited empirical evidence exists regarding how emotional, social, intercultural, and digital capacities interact to shape leadership readiness in complex maritime contexts.

This gap is particularly evident within maritime education and professional development, where leadership preparation frequently remains fragmented across technical and non-technical training domains. While future maritime professionals are expected to operate advanced technological systems and collaborate within multicultural environments, relatively little is known about the combination of competencies that support human-centered leadership in Industry 5.0 settings.

From a theoretical perspective, this study contributes to the emerging discourse on human-centric leadership by conceptualizing leadership readiness as a multidimensional construct that emerges from the interaction between emotional, social, intercultural, and digital capacities. Rather than treating these competencies as isolated attributes, the study adopts an integrative perspective that reflects the complexity of contemporary maritime socio-technical systems, where effective leadership depends simultaneously on human judgment, interpersonal awareness, adaptability, and technological engagement.

The maritime sector provides a particularly valuable context for examining these relationships. Maritime operations combine advanced technological infrastructures, multinational crews, strict safety requirements, and high levels of operational uncertainty. As a result, maritime professionals must continuously balance technological competence with communication, collaboration, ethical decision-making, and human-centered coordination. These characteristics make maritime environments especially relevant for exploring leadership readiness within the broader Industry 5.0 paradigm.

To address this gap, the present study introduces the Human-Centric Leadership Readiness for Industry 5.0 (HCLR-I5) instrument as an exploratory framework for assessing leadership

readiness across four key dimensions: Emotional Self - Regulation (ESR), Social Attunement and Strength-Based Leadership (SA-SBL), Intercultural Communication Effectiveness (ICE), and AI / Digital Self-Efficacy (AI-SE). Human - Centric Leadership Readiness (HCLR) is conceptualized as an integrative outcome reflecting the extent to which individuals are prepared to lead effectively within technologically advanced and human - centered environments.

The purpose of this study is to explore how these dimensions relate to Human-Centric Leadership Readiness within maritime education and professional contexts. Drawing on data collected from maritime participants in Bulgaria and Spain, the study examines the relative contribution of emotional, social, intercultural, and digital capacities to leadership readiness and identifies patterns that may inform future leadership development initiatives.

Unlike many studies that examine leadership among experienced maritime professionals, the present research focuses on future maritime professionals preparing to enter Industry 5.0 environments, thereby providing insight into the human capacities that may shape the next generation of maritime leadership.

By combining instrument development with empirical investigation, the study provides initial evidence regarding the structure and predictors of human-centric leadership readiness in maritime Industry 5.0 environments. Furthermore, it offers a preliminary conceptual foundation for future research on leadership development within increasingly digitalized, multicultural, and socio-technical maritime systems.

2. Theoretical Background / Literature Review.

2.1. Industry 5.0 and Human-Centric Organizations.

A central feature of Industry 5.0 is the renewed emphasis on the human factor.

Rather than viewing employees primarily as operators of increasingly sophisticated technologies, Industry 5.0 highlights their role as creators of knowledge, innovators, and decision-makers. Human judgment, creativity, ethical reasoning, and social interaction are considered resources that cannot be fully replicated by intelligent systems and therefore remain essential for organizational effectiveness (Xu et al., 2021; Nahavandi, 2019).

This shift is particularly visible in the growing discussion of human-centric organizations. Such organizations seek not only to implement advanced technologies but also to create environments in which people can develop their capabilities, participate in decision-making processes, and contribute meaningfully to organizational goals. Consequently, organizational success is increasingly linked to the ability to balance technological innovation with employee well-being, social responsibility, and long-term sustainability (European Commission, 2021).

The European Commission identifies resilience and sustainability as two additional pillars of Industry 5.0. These concepts extend the traditional understanding of organizational performance beyond productivity and efficiency. Resilience refers to

the capacity of organizations to respond effectively to disruption, uncertainty, and rapid change, while sustainability emphasizes the long-term consequences of organizational decisions for people, communities, and the environment. Together, these principles encourage organizations to adopt a more adaptive and responsible approach to development (European Commission, 2021).

Another important aspect of Industry 5.0 is the changing relationship between humans and technology. Earlier technological narratives often focused on substitution, assuming that automation would gradually replace human labor. In contrast, Industry 5.0 promotes a logic of complementarity. Artificial intelligence, advanced analytics, simulation technologies, and autonomous systems are increasingly understood as tools that support human performance rather than eliminate the need for human involvement. The objective is not to replace human expertise but to strengthen it through intelligent technological assistance (Xu et al., 2021; Nahavandi, 2019).

As a result, contemporary organizations face a challenge that is not purely technological but also social and managerial. The successful implementation of Industry 5.0 depends on the ability to integrate digital capabilities with human competencies such as communication, adaptability, emotional intelligence, ethical awareness, and collaborative problem-solving. This observation is particularly relevant for sectors characterized by technological complexity and intensive human interaction, where organizational outcomes depend simultaneously on advanced systems and human decision-making (Schein, 2017; Robbins & Judge, 2019).

From this perspective, Industry 5.0 should not be understood simply as the next stage of technological evolution. Rather, it represents an attempt to redefine the relationship between technology and humanity by placing people, values, and social responsibility at the core of organizational development. This human-centered orientation provides an important foundation for examining leadership and leadership readiness in contemporary maritime environments.

2.2. Leadership in Industry 5.0 Maritime Contexts.

The emergence of Industry 5.0 has expanded the understanding of leadership beyond traditional concerns with efficiency, productivity, and technological optimization. Contemporary organizations increasingly operate in environments where technological advancement must be aligned with human well-being, ethical responsibility, and sustainable development. Consequently, leadership is evolving from a predominantly managerial function toward a human-centered process focused on enabling people, fostering collaboration, and supporting organizational adaptability (European Commission, 2021).

This transformation is especially relevant in the maritime sector, where professionals operate in technologically sophisticated, multicultural, and safety-critical environments. Maritime leaders are expected not only to manage operations and ensure compliance with procedures but also to coordinate diverse teams, facilitate communication, and support effective decision-making under conditions of uncertainty. As digitalization and automation become more deeply embedded in mar-

itime systems, leadership increasingly involves balancing technological capabilities with human needs and social considerations (Kotter, 2012; Carayannis & Morawska-Jancelewicz, 2022).

Within the Industry 5.0 paradigm, leadership is closely connected to adaptability, collaboration, and human development. Rather than relying primarily on formal authority, effective leaders create conditions that encourage trust, participation, learning, and psychological safety. Such environments allow individuals and teams to respond more effectively to technological change and organizational complexity while maintaining a strong focus on human interaction and collective responsibility (Schein, 2017; Robbins & Judge, 2019; Gibson et al., 2012; Senge, 2006). According to Pham and Li (2025), effective leadership in the digital age depends on balancing technological advancement with human-centered organizational practices that foster adaptability, collaboration, and sustainable organizational change. EFMD (2020) emphasizes that future leaders must combine digital awareness with human-centered capabilities such as emotional intelligence, adaptability, collaboration, and continuous learning in order to navigate the increasing complexity of the future workplace.

Recent developments in organizational theory further suggest that leadership effectiveness depends on the ability to integrate technological and human dimensions. Intelligent systems can support information processing, monitoring, and operational decision-making; however, leadership itself remains rooted in human judgment, ethical reasoning, interpersonal awareness, and the capacity to navigate complex social situations. Industry 5.0 therefore promotes a complementary relationship between people and technology, where digital tools enhance rather than replace human leadership capabilities (Xu et al., 2021; Nahavandi, 2019).

The changing nature of maritime work also requires organizations to adopt more collaborative and learning-oriented approaches. Leadership plays a central role in supporting organizational learning, facilitating knowledge sharing, and encouraging continuous adaptation. In this context, leaders act as connectors between people, knowledge, and technology, helping organizations develop resilience and respond effectively to emerging challenges (Senge, 1990; Garvin, 1993; Argyris & Schön, 1996).

A growing body of research indicates that successful leadership in Industry 5.0 environments is increasingly associated with emotional intelligence, social awareness, intercultural competence, and responsible engagement with technology. These capabilities are particularly important in maritime settings, where operational effectiveness depends heavily on teamwork, trust, communication, and coordination across cultural boundaries. As a result, leadership readiness may be viewed as a multidimensional construct emerging from the interaction between human-centered competencies and technologically enabled work environments. Such a perspective reflects the broader goals of Industry 5.0, which emphasize the integration of technological innovation with human values and social responsibility (European Commission, 2021; Carayannis & Morawska-Jancelewicz, 2022).

2.3. Human-Centric Leadership Readiness as a Multidimensional Construct.

The growing emphasis on human-centricity within Industry 5.0 has stimulated interest in the competencies required for effective leadership in increasingly digitalized and socio-technical environments. While leadership has traditionally been examined through behavioral styles, personality traits, or managerial competencies, recent perspectives suggest that future leadership effectiveness depends on a broader combination of emotional, social, intercultural, and technological capacities (European Commission, 2021; Carayannis & Morawska-Jancelewicz, 2022).

Within this context, leadership readiness can be understood as an individual's preparedness to assume leadership responsibilities in environments characterized by technological complexity, continuous change, multicultural interaction, and heightened demands for collaboration. Rather than representing a single skill or personality attribute, leadership readiness reflects the integration of multiple competencies that enable individuals to influence others, make responsible decisions, and adapt to dynamic organizational conditions.

One of the foundational dimensions of leadership readiness is Emotional Self-Regulation (ESR). Emotional self-regulation refers to the ability to recognize, manage, and appropriately express emotions, particularly under conditions of stress, uncertainty, or pressure. Research on emotional intelligence consistently demonstrates that leaders who can regulate their emotional responses are more likely to maintain effective judgment, foster trust, and create psychologically safe environments (Goleman, 1998; Senge, 2006). In high-risk sectors such as maritime transport, where operational decisions often occur under demanding conditions, emotional regulation contributes to both individual effectiveness and team stability.

A second dimension is Social Attunement and Strength-Based Leadership (SA-SBL). This construct reflects a leader's ability to understand the needs, perspectives, and strengths of others while fostering collaboration and engagement. Contemporary leadership theories increasingly emphasize the relational nature of leadership, highlighting the importance of empathy, active listening, trust-building, and the development of individual strengths within teams (Kotter, 2012; Carayannis & Morawska-Jancelewicz, 2022). In Industry 5.0 environments, where teamwork and human collaboration remain central despite technological advancement, leadership effectiveness depends heavily on social awareness and the capacity to mobilize collective potential.

Intercultural Communication Effectiveness (ICE) represents a third critical component of leadership readiness. Globalized industries increasingly require professionals to work across cultural, linguistic, and national boundaries. Effective leadership therefore depends not only on communication skills in general, but also on the ability to adapt communication styles, interpret cultural differences, and facilitate cooperation among diverse groups. This requirement is particularly evident in maritime environments, where multicultural crews and international operational contexts represent a defining characteristic of everyday

professional practice. Leaders who demonstrate intercultural competence are better equipped to manage misunderstandings, build cohesion, and support inclusive collaboration (Schein, 2017; Gibson et al., 2012).

The fourth dimension, AI/Digital Self-Efficacy (AI-SE), reflects an individual's confidence in using digital technologies, artificial intelligence, and technology-supported systems. As organizations increasingly integrate advanced technologies into operational processes, leaders are expected to understand, utilize, and interact effectively with digital tools. Digital self-efficacy contributes to adaptability and technological readiness by increasing confidence in engaging with innovation and supporting technology-assisted decision-making (Nahavandi, 2019; Xu et al., 2021). Sivkov (2020) argues that the rapid digitalization of the maritime industry requires continuous development of digital skills among maritime professionals, as technological competence is becoming an essential prerequisite for effective performance, adaptability, and participation in increasingly technology-driven operational environments.

However, within a human-centric framework, digital competence is viewed as a complementary capability that supports rather than replaces human judgment and interpersonal leadership processes.

The selection of these four dimensions reflects the core challenges associated with leadership in Industry 5.0 environments. Emotional regulation supports responsible decision-making under pressure; social attunement facilitates collaboration and trust; intercultural communication enables effective interaction across diverse contexts; and digital self-efficacy supports engagement with increasingly sophisticated technological systems. Together, these dimensions capture both the human and technological demands placed upon future leaders operating within complex socio-technical systems.

Based on the reviewed literature, Human-Centric Leadership Readiness (HCLR) is conceptualized as a multidimensional construct emerging from the interaction between emotional, social, intercultural, and digital capacities in Industry 5.0 environments.

2.4. Human-Centric Leadership Readiness in Maritime Contexts.

The growing emphasis on human-centricity within Industry 5.0 is particularly relevant to the maritime sector, where organizational performance depends on the interaction between advanced technological systems and human decision-making. Although maritime operations increasingly rely on digitalization, automation, artificial intelligence, and data-driven technologies, the human element remains central to safety, operational effectiveness, and organizational resilience.

Maritime organizations represent complex socio-technical systems in which technological reliability alone cannot guarantee successful outcomes. Research in maritime human factors consistently demonstrates that accidents, incidents, and operational failures are frequently associated with communication breakdowns, ineffective teamwork, leadership deficiencies, cultural misunderstandings, and human decision-making under pressure rather than purely technical failures (Grech et al.,

2008; Hetherington et al., 2006). Consequently, the development of human-centered competencies has become an increasingly important priority within maritime education and training.

The International Maritime Organization (IMO) has formally recognized the importance of leadership, teamwork, and interpersonal skills through the Human Element, Leadership and Management (HELM) framework. HELM emphasizes that effective maritime performance depends not only on technical competence but also on communication, situational awareness, teamwork, decision-making, and leadership capabilities. These competencies are particularly important in safety-critical environments where individuals must coordinate actions, manage uncertainty, and respond effectively to rapidly changing operational conditions (IMO, 2023).

Contemporary maritime research further highlights the importance of non-technical skills in leadership development. Pazar & Kitada (2025) argue that future maritime professionals must be prepared to operate within increasingly multicultural and globally interconnected work environments, where leadership effectiveness depends heavily on intercultural understanding, communication, and inclusive collaboration. Similarly, studies conducted within the World Maritime University (WMU) research community emphasize that leadership in maritime organizations is becoming progressively more people-oriented, requiring greater attention to diversity, human development, well-being, and organizational culture.

Research on maritime human factors also stresses the importance of emotional and social competencies. Mallam and colleagues have demonstrated that effective maritime performance is closely linked to behavioral, cognitive, and interpersonal factors, particularly in environments characterized by complexity, high workload, and operational risk. Leadership effectiveness in such contexts depends not only on procedural knowledge but also on emotional regulation, social awareness, and the ability to foster trust and cooperation among crew members.

Another important characteristic of maritime organizations is their multicultural nature. International crews frequently consist of seafarers from diverse linguistic, cultural, and professional backgrounds. Studies by Chauvin, Kitada, and other maritime scholars indicate that intercultural competence plays a critical role in reducing misunderstandings, strengthening teamwork, and enhancing safety performance. Effective leaders must therefore possess the capacity to adapt communication styles, manage cultural differences, and promote inclusive working environments that support collaboration and mutual respect.

Recent discussions surrounding digital transformation in shipping further reinforce the need for a balanced approach to leadership development. While digital technologies, artificial intelligence, autonomous systems, and smart shipping solutions are transforming maritime operations, scholars increasingly argue that technological competence alone is insufficient for effective leadership. Instead, the future of maritime leadership requires the integration of digital capabilities with emotional intelligence, intercultural awareness, ethical responsibility, and human-centered decision-making. According to Atanasova (2023), the effective transformation of maritime education de-

pends on the adoption of digital technologies and industry-oriented learning tools that bridge the gap between academic training and the digitalized maritime workplace. Furthermore, Sotirov, Petrova, and Tsvetkov (2025) demonstrate that the integration of artificial intelligence into gamified learning objects can significantly enhance learner engagement, critical thinking, and practical skill development, highlighting the potential of innovative educational technologies for preparing future professionals to operate in increasingly digitalized environments.

From this perspective, human-centered leadership readiness may be understood as a multidimensional capacity that enables individuals to navigate the intersection of technological complexity and human interaction. This perspective aligns closely with the principles of Industry 5.0, which position human well-being, resilience, and meaningful human involvement as essential components of sustainable organizational development. The present study builds upon this emerging body of maritime scholarship by examining how emotional, social, intercultural, and digital competencies interact in shaping leadership readiness among current and future maritime professionals.

Recent developments in maritime education further suggest that the competencies required for future maritime professionals extend beyond traditional technical expertise. The ongoing review of the STCW Convention increasingly emphasizes twenty-first century skills, including communication, adaptability, interpersonal competence, and digital literacy. Emerging evidence indicates that successful maritime professionals will require an integrated portfolio of technical and non-technical competencies to navigate the challenges associated with digitalization, automation, sustainability transitions, and multicultural collaboration. Consequently, leadership development in maritime contexts is increasingly viewed as a process of cultivating human-centered capabilities that enable professionals to work effectively alongside advanced technological systems rather than relying on technological competence alone.

3. Methodology.

3.1. Research Design and Sample.

The study employed a cross-sectional survey design to explore Human-Centric Leadership Readiness among future maritime professionals. Data were collected from maritime students and trainees enrolled in maritime education institutions in Bulgaria and Spain, representing two established maritime education environments within the Black Sea and Western Mediterranean regions.

The sample consisted of 60 participants drawn from Nikola Vaptsarov Naval Academy (NVNA) in Bulgaria and maritime-affiliated educational institutions in Barcelona, Spain. The selection of these educational settings was guided by their active engagement in contemporary maritime education initiatives and their participation in international collaboration networks focused on future maritime skills and competence development.

The focus on maritime students is consistent with the objectives of the study. Rather than examining established leadership practices, the research seeks to explore leadership readi-

ness among individuals preparing to enter increasingly digitalized, multicultural, and technologically complex maritime environments. As future maritime professionals, this generation is expected to play a significant role in shaping how Industry 5.0 principles are translated into maritime practice.

This focus distinguishes the present study from much of the existing maritime leadership literature, which primarily examines leadership among active maritime professionals, officers, and managers. Rather than investigating established leadership practices, the study explores leadership readiness among the future maritime workforce that will enter and shape Industry 5.0 environments. As digitalization, automation, and AI-supported systems continue to transform maritime operations, understanding how future professionals perceive leadership may provide valuable insight into the human capabilities that will influence the next generation of maritime organizations.

Participants represented a variety of maritime specializations and educational backgrounds and reported varying levels of practical exposure to maritime operations and multicultural working environments. Participation was voluntary, and all respondents successfully completed the attention-check procedure included in the survey.

Given the exploratory objectives of the research and the initial stage of instrument development, the study should be regarded as a pilot investigation intended to provide preliminary evidence regarding the structure and potential predictors of Human-Centric Leadership Readiness in maritime education contexts.

The study was further informed by the broader educational context of European maritime collaboration initiatives aimed at developing future-oriented maritime competencies, leadership capabilities, and human-centered approaches to professional development. These initiatives have contributed to ongoing discussions regarding the balance between technological advancement and human capacity development in maritime education.

3.2. Instrument.

Data were collected using the Human-Centric Leadership Readiness for Industry 5.0 (HCLR-I5) instrument, developed for the purposes of this study. The instrument adopts an anti-bias design and uses a five-point Likert-type response scale ranging from 1 (“Never”) to 5 (“Almost always”).

The instrument consists of five scales:

- Human-Centric Leadership Readiness (HCLR) - 8 items.
- Emotional Self-Regulation (ESR) - 5 items.
- Social Attunement and Strength-Based Leadership (SA-SBL) - 6 items.
- Intercultural Communication Effectiveness (ICE) - 5 items.
- AI/Digital Self-Efficacy (AI-SE) - 5 items.

The selection of these dimensions was informed by the literature on Industry 5.0, maritime leadership, human factors, and socio-technical systems. Together, they capture complementary aspects of leadership readiness by addressing emotional regulation, social interaction, intercultural collaboration, and engagement with digital technologies. The framework reflects the assumption that effective leadership in Industry 5.0 environments

emerges from the integration of human-centered and technological capabilities rather than from any single competency domain.

HCLR was operationalized as a theoretically grounded composite index reflecting multiple dimensions of human-centric leadership, including ethical awareness, emotional regulation under pressure, participative decision-making, and learning-oriented responses to failure. Given its multidimensional and formative nature, HCLR was not treated as a unidimensional reflective construct. The index score was calculated as the mean of the eight items.

The remaining four scales were treated as reflective constructs. Reverse-coded items (ESR5, SA6, ICE5, AI5) were recoded prior to analysis.

3.3. Data Analysis.

Data analysis was conducted using descriptive statistics, reliability analysis, correlation analysis, and multiple regression. Bryman (2015) emphasizes that correlation and regression analyses are valuable statistical techniques for exploring relationships between variables and identifying potential predictors - within social science research.

Internal consistency of the reflective scales was assessed using Cronbach’s alpha. Given the pilot and exploratory nature of the instrument, reliability estimates were interpreted with caution.

Pearson correlation analysis was used to examine the relationships between HCLR and the predictor variables. Multiple regression analysis was conducted to assess the relative contribution of Emotional Self-Regulation (ESR), Social Attunement and Strength-Based Leadership (SA-SBL), Intercultural Communication Effectiveness (ICE), and AI/Digital Self-Efficacy (AI-SE) in predicting Human-Centric Leadership Readiness.

Because the study is exploratory and the instrument is at an early stage of development, the statistical analyses were intended primarily to identify patterns of association and potential predictors of leadership readiness rather than establish definitive causal relationships.

4. Results.

4.1. Descriptive Statistics and Reliability.

Descriptive statistics and internal consistency coefficients for the reflective scales are presented in Table 1. Given the pilot nature of the study, reliability estimates are interpreted with caution.

Human-Centric Leadership Readiness (HCLR) was operationalized as a composite index; therefore, internal consistency coefficients were not computed for this measure. Among the reflective scales, Intercultural Communication Effectiveness (ICE) demonstrated acceptable reliability, while Social Attunement and Strength-Based Leadership (SA-SBL) showed marginal internal consistency. Emotional Self-Regulation (ESR) and AI/Digital Self-Efficacy (AI-SE) yielded lower reliability coefficients, consistent with the exploratory nature of the instrument and potential restrictions in response variability.

Table 1: Descriptive Statistics and Internal Consistency of Scales.

Scale	Mean	SD	Cronbach's α
HCLR	4.18	0.56	—
ESR	2.86	0.54	.53
SA-SBL	3.64	0.52	.62
ICE	3.68	0.49	.67
AI-SE	4.58	0.43	.38

Source: Authors.

The observed similarity between the Bulgarian and Spanish subsamples may represent an important finding rather than a limitation of the data. Maritime education and training are strongly influenced by internationally standardized frameworks, shared professional norms, and common operational requirements. Consequently, participants from different geographical contexts may develop comparable perceptions regarding leadership, teamwork, communication, and professional responsibility. This pattern supports the view that professional maritime culture may exert a stronger influence on leadership-related attitudes than national cultural differences.

Table 2: Comparison of Mean Scores by Location.

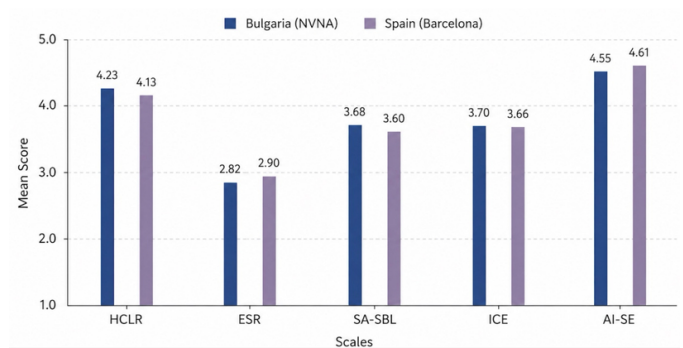
Scale	Bulgaria (NVNA)	Spain (Barcelona)
HCLR	4.23	4.13
ESR	2.82	2.90
SA-SBL	3.68	3.60
ICE	3.70	3.66
AI-SE	4.55	4.61

Source: Authors.

To provide additional context, mean scores were compared across the two subsamples (Bulgaria and Spain). As shown in Table 2, the results indicate relatively similar patterns across the two contexts. Human-Centric Leadership Readiness (HCLR) is slightly higher in the Bulgarian sample, while AI/Digital Self-Efficacy (AI-SE) shows marginally higher values in the Spanish sample. Differences across Emotional Self-Regulation (ESR), Social Attunement and Strength-Based Leadership (SA-SBL), and Intercultural Communication Effectiveness (ICE) are minimal, suggesting a consistent pattern of relationships across both maritime contexts.

Figure 1 further illustrates the similarity of mean scores across all five constructs between the Bulgarian and Spanish subsamples, indicating consistent patterns of human-centric leadership readiness across both contexts.

Figure 1: Comparison of Mean Scores by Location (Bulgaria vs Spain).



Source: Authors.

4.2. Correlation Analysis.

Pearson correlation analysis was conducted to examine the relationships between Human-Centric Leadership Readiness - (HCLR) and the predictor variables. The results are presented in Table 3.

Table 3: Correlation Matrix.

Variable	HCLR	ESR	SA-SBL	ICE	AI-SE
HCLR	1				
ESR	.47**	1			
SA-SBL	.72**	.49**	1		
ICE	.60**	.46**	.61**	1	
AI-SE	-.53**	-.35**	-.41**	-.38**	1

Note: $p < .01$

Source: Authors.

The results indicate that HCLR is positively and significantly associated with Emotional Self-Regulation ($r = .47$), Social Attunement and Strength-Based Leadership ($r = .72$), and Intercultural Communication Effectiveness ($r = .60$). Among these, SA-SBL demonstrates the strongest relationship with - HCLR.

This finding is consistent with the human-centric orientation of Industry 5.0, suggesting that leadership readiness may be more strongly associated with relational and collaborative capacities than with purely individual or technical attributes.

In contrast, AI / Digital Self-Efficacy (AI-SE) shows a significant negative correlation with HCLR ($r = -.53$), suggesting a potential inverse relationship between perceived digital confidence and human-centric leadership orientation.

While the result should be interpreted cautiously given the exploratory nature of the study, it suggests that technological confidence and human-centered leadership orientation may not always develop in parallel.

4.3. Multiple Regression Analysis.

A multiple regression analysis was conducted to assess the relative contribution of Emotional Self-Regulation (ESR), So-

cial Attunement and Strength-Based Leadership (SA-SBL), Intercultural Communication Effectiveness (ICE), and AI/Digital Self-Efficacy (AI-SE) in predicting Human-Centric Leadership Readiness (HCLR). The results are presented in Table 4.

Table 4: Multiple Regression Predicting HCLR.

Predictor	β	p
ESR	.21	< .05
SA-SBL	.52	< .001
ICE	.29	< .01
AI-SE	-.34	< .01

Model fit: $R^2 = .74$

Source: Authors.

The regression model explains a substantial proportion of variance in Human-Centric Leadership Readiness ($R^2 = .74$), indicating a strong overall model fit for a pilot study.

Social Attunement and Strength-Based Leadership (SA-SBL) emerges as the strongest positive predictor of HCLR ($\beta = .52$, $p < .001$), followed by Intercultural Communication Effectiveness (ICE) ($\beta = .29$, $p < .01$) and Emotional Self-Regulation (ESR) ($\beta = .21$, $p < .05$).

The relative strength of SA-SBL within the model further emphasizes the importance of relational capacities in contemporary maritime leadership. Within Industry 5.0 environments, the ability to understand, support, and engage others may represent a more critical component of leadership readiness than technological confidence alone.

In contrast, AI/Digital Self-Efficacy (AI-SE) demonstrates a significant negative effect ($\beta = -.34$, $p < .01$), indicating that higher levels of self-reported digital confidence are associated with lower levels of human-centric leadership readiness within this sample.

Overall, the findings provide partial support for the proposed relationships, confirming the positive role of emotional, social, and intercultural capacities, while revealing a contrasting pattern for digital self-efficacy. Although no formal statistical comparison was conducted, the similarity in mean scores suggests consistent patterns across both contexts.

Taken together, the findings provide preliminary support for the view that leadership readiness in Industry 5.0 maritime environments is primarily rooted in human-centered capacities, while digital competence functions within a broader socio-technical context.

5. A Preliminary Conceptual Model of Human - Centric Leadership Readiness in Industry 5.0 Maritime Environments.

Based on the empirical findings and the theoretical foundations presented in the literature review, a preliminary concep-

tual model of Human-Centric Leadership Readiness in Industry 5.0 maritime environments is proposed (Figure 2). Rather than representing a validated causal structure, the model serves as an integrative framework for understanding how human and digital capacities may interact in shaping leadership readiness within complex maritime socio-technical systems.

The model adopts a layered structure, positioning Human-Centric Leadership Readiness (HCLR) at the core as an emergent outcome of multiple human-centered capabilities. Emotional Self-Regulation (ESR), Social Attunement and Strength-Based Leadership (SA-SBL), and Intercultural Communication Effectiveness (ICE) are conceptualized as core human capacities that contribute positively to leadership readiness. These dimensions reflect the relational, emotional, and socially adaptive foundations of leadership in complex socio-technical environments.

A central assumption of the model is that leadership readiness originates primarily from human capacities rather than technological capabilities. Emotional regulation, social awareness, and intercultural effectiveness are conceptualized as foundational dimensions because they enable individuals to exercise judgment, build trust, coordinate collective action, and respond adaptively to uncertainty. Within this perspective, technology may support leadership processes, but it does not replace the human capabilities through which leadership is enacted.

The positioning of AI/Digital Self-Efficacy (AI-SE) within the outer layer of the model does not imply that digital competence is less important. Rather, it reflects the view that technological confidence functions within a broader human-centered leadership system. Digital capabilities may enhance performance, decision support, and operational effectiveness; however, their contribution to leadership depends on how they are integrated with emotional, social, and intercultural capacities.

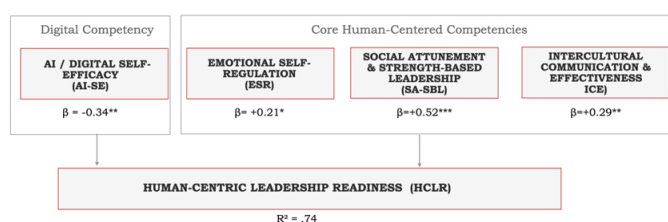
The model reflects an emergent and non-linear understanding of leadership readiness, consistent with the human-centric principles of Industry 5.0. It suggests that effective leadership in maritime contexts is not solely dependent on technical or digital competence, but on the ability to integrate technological capabilities within a broader framework of ethical awareness, social responsibility, and interpersonal sensitivity.

From this perspective, the model proposes that the future of maritime leadership in Industry 5.0 will depend not on the replacement of human capabilities by technology, but on the ability of future maritime professionals to integrate technological resources within fundamentally human systems of communication, collaboration, responsibility, and decision-making.

6. Discussion.

The present study aimed to explore the predictors of Human-Centric Leadership Readiness (HCLR) in maritime Industry 5.0 contexts and to pilot-test an integrative measurement instrument. The findings provide initial empirical insights into the relative role of emotional, social, intercultural, and digital capacities in shaping leadership readiness within complex socio-technical environments.

Figure 2: Predictors of Human-Centric Leadership Readiness (HCLR).



Note * $p < .05$; ** $p < .01$; *** $p < .001$.

For visual clarity, ESR, SA-SBL, and ICE are presented as a cluster of core human-centered competencies; however, all four predictors were entered independently into the regression model.

Source: Authors.

More broadly, the findings support a central assumption underlying Industry 5.0: technological advancement alone is insufficient to ensure effective organizational performance. While digital systems increasingly shape maritime operations, leadership readiness appears to be rooted primarily in human capacities that enable individuals to communicate, collaborate, build trust, exercise judgment, and respond adaptively to uncertainty. This observation reinforces the view that the human factor remains a critical determinant of effectiveness within contemporary maritime socio-technical systems.

The results highlight the central role of human - centered capacities in leadership development. Social Attunement and Strength-Based Leadership (SA-SBL) emerged as the strongest predictor of HCLR, followed by Intercultural Communication Effectiveness (ICE) and Emotional Self-Regulation (ESR). These findings suggest that leadership readiness in maritime contexts is primarily grounded in relational awareness, communication, and the ability to navigate complex social dynamics. This is particularly relevant in high-risk and multicultural maritime environments, where coordination, trust, adaptability, and collective decision-making are essential for effective performance.

The prominence of Social Attunement and Strength-Based Leadership is particularly noteworthy. Within increasingly digitalized environments, leadership might be expected to depend primarily on technological expertise and operational competence. However, the present findings suggest a different pattern. The strongest predictor of leadership readiness was not technological confidence, but the ability to understand, support, and engage other people. This result highlights the fundamentally relational nature of leadership and aligns closely with human-centric perspectives that place people, rather than technology, at the center of organizational effectiveness.

A particularly noteworthy finding is the negative association between AI/Digital Self-Efficacy (AI-SE) and Human-Centric Leadership Readiness. Importantly, this result should not be interpreted as evidence that digital competence is detrimental to leadership. Rather, it suggests that technological confidence does not automatically translate into human-centered leadership orientations. One possible explanation is that individuals who

perceive themselves as highly competent in technology-related domains may place greater emphasis on efficiency, automation, and system performance while assigning less importance to relational, emotional, and interpersonal dimensions of leadership.

This finding may be interpreted as an early manifestation of what could be described as a Digital Leadership Paradox. Although digital competence is becoming increasingly essential for maritime operations, technological confidence and human-centered leadership readiness may not always develop in parallel. While this interpretation remains tentative and requires further investigation, it highlights a potentially important challenge for leadership development in Industry 5.0 environments: ensuring that technological advancement is accompanied by the development of emotional, social, and intercultural capabilities that enable responsible and effective leadership.

The similarity of patterns observed across the Bulgarian and Spanish subsamples further strengthens the interpretation of the findings. This consistency can be explained by the strongly transnational nature of professional culture in the maritime sector. Maritime education and practice are shaped by globally standardized frameworks, shared training requirements, and - common operational procedures, which contribute to the development of aligned norms, values, and behavioral patterns across national contexts. As a result, professional maritime culture may exert a stronger influence on leadership-related attitudes than national cultural differences. Rather than reflecting differences between countries, the findings suggest convergence within a shared professional environment.

An additional contribution of the study stems from its focus on future maritime professionals rather than established leaders. Most maritime leadership research examines leadership practices among experienced officers, managers, or organizational leaders. In contrast, the present findings provide insight into how leadership readiness is emerging among the next generation of maritime professionals who will operate within increasingly digitalized Industry 5.0 environments. Consequently, the results may offer an early indication of the competencies and leadership orientations that could shape the future maritime workforce.

Taken together, these findings informed the development of a preliminary regression-based conceptual model of Human-Centric Leadership Readiness, in which emotional, social, and intercultural capacities form the core, while digital competence functions as a contextual capability within a broader socio - technical system. The model reflects the view that leadership readiness emerges from the integration of multiple competencies rather than from technological expertise alone. However, the proposed framework should be understood as a preliminary conceptual model derived from pilot data rather than a fully validated structure. Its primary purpose is to guide future theoretical development and empirical investigation.

Overall, the findings suggest that leadership readiness in Industry 5.0 maritime environments is best understood as a human-centered phenomenon emerging from the interaction between emotional, social, intercultural, and technological capacities. Although digital competence remains essential for future maritime operations, the present results indicate that human-centered

capabilities constitute the foundation upon which effective leadership readiness is built.

7. Limitations and Future Research.

Several limitations should be acknowledged when interpreting the findings of the present study.

First, the study was conducted using a relatively small sample of maritime students and trainees from two maritime education environments. Although the sample was appropriate for the exploratory objectives of the research, the findings should be regarded as preliminary and should not be generalized to the broader maritime population without further validation.

Second, the HCLR–I5 instrument is in an early stage of development. While the results provide initial support for the proposed framework, some scales demonstrated relatively low levels of internal consistency, particularly AI/Digital Self-Efficacy (AI-SE). These findings suggest that further refinement of individual items and additional psychometric testing are necessary before the instrument can be considered fully validated.

Third, the study employed a cross-sectional design, which limits the ability to examine how leadership readiness develops over time. Human-Centric Leadership Readiness is likely to evolve through education, professional experience, exposure to multicultural environments, and interaction with emerging technologies. Longitudinal studies would therefore provide valuable insight into the developmental dynamics of leadership readiness across different career stages.

Another limitation relates to the composition of the sample. The study focused on future maritime professionals rather than experienced maritime leaders. While this focus represents a distinctive contribution by providing insight into the next generation of maritime professionals entering Industry 5.0 environments, future research should compare students, cadets, officers, and maritime managers in order to examine how leadership readiness changes across professional trajectories.

The relatively low reliability of AI-SE suggests that the construct should be interpreted as preliminary and requires further scale refinement and validation in larger samples. Future research should seek to validate the HCLR–I5 framework using larger and more diverse international samples drawn from different maritime education institutions and professional settings. Further studies may also explore potential moderating variables such as professional experience, cultural background, gender, leadership exposure, and technology acceptance. In addition, future investigations should examine the relationship between human-centered leadership readiness and emerging maritime challenges associated with artificial intelligence, automation, autonomous systems, and digital transformation.

Despite these limitations, the present study provides an initial empirical foundation for understanding Human - Centric Leadership Readiness in Industry 5.0 maritime environments and offers a basis for further theoretical development and empirical validation.

8. Conclusion.

This study contributes to the growing body of research on human-centric leadership in Industry 5.0 by introducing and pilot-testing the Human-Centric Leadership Readiness for Industry 5.0 (HCLR–I5) framework within a maritime context. Drawing on data collected from future maritime professionals in Bulgaria and Spain, the study provides initial empirical evidence regarding the relationship between emotional, social, intercultural, and digital competencies and their contribution to leadership readiness.

The findings indicate that Human-Centric Leadership Readiness is primarily associated with human-centered capacities, particularly Social Attunement and Strength-Based Leadership, Intercultural Communication Effectiveness, and Emotional Self-Regulation. These results reinforce the view that effective leadership in increasingly digitalized environments continues to depend fundamentally on the ability to understand, engage, and collaborate with other people.

At the same time, the negative association between AI / Digital Self-Efficacy and Human-Centric Leadership Readiness highlights the complexity of leadership development in Industry 5.0 environments. While digital competence remains an essential requirement for future maritime professionals, the findings suggest that technological confidence alone does not guarantee the development of human-centered leadership orientations. This observation points to the need for a more balanced approach to leadership development in which technological capabilities are integrated with emotional, social, and intercultural competencies.

The study further suggests that professional maritime culture may exert a stronger influence on leadership-related attitudes than national cultural differences. The consistency of patterns observed across the Bulgarian and Spanish subsamples supports the notion that internationally shared maritime education frameworks and professional norms contribute to common understandings of leadership readiness.

Beyond its empirical findings, the study offers a preliminary conceptual model that positions human capabilities at the core of leadership readiness while recognizing digital competence as an important contextual capability within broader socio - technical systems. This perspective is consistent with the principles of Industry 5.0, which emphasize that technological progress should enhance rather than diminish the role of human judgment, responsibility, collaboration, and well-being.

Ultimately, the findings suggest that the future of maritime leadership will depend not only on how effectively professionals use advanced technologies, but on how successfully they integrate those technologies within fundamentally human systems of communication, collaboration, ethical responsibility, and collective decision-making. As maritime organizations continue to navigate digital transformation, developing these human-centered capacities may prove to be one of the most important leadership challenges-and opportunities-of the Industry 5.0 era.

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