EPiC Series in Technology

Volume 2, 2024, Pages 44–52

Proceedings of the International Conference on
Maritime Autonomy and Remote Navigation 2023

Social Mindset Restructuring: A Critical Requirement for Implementing Maritime Autonomy

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Abstract

Industrial Revolution 4.0 is changing the interaction between humans and intelligence technology that carries systemic implications to distinctive elements of our social life. The paper discusses the implications of societal dimensions of expanding maritime autonomy by focusing on how the human mindset at social and individual levels allows the opportunity for change. In this paper, we introduce the theoretical framework of Social Mindset Restructuring, hereafter referred to as (SMR), as a critical requirement for understanding the societal dimension of implementation of maritime autonomy in the near future. This study is part of a larger research project examining the human element as a core in developing national maritime identity, in which collective mindset restructuring is essential. The SMR provides an effective tool to study how humans will interact with intelligent machines and systems and how society at the individual and collective level understands, embraces, takes part, and evolves with the change. The authors argue that MASS and maritime autonomy as part of Industry 4.0 is more than a mere technological development but a social evolution as it completely redefines the work and how human interact with technology. The successful implementation of maritime autonomy, as part of Industry 4.0, requires the restructuring of not only the maritime community but the society at large by adapting the social mindset the role of technology in the industry and how humans interact with smart machines. We develop the SMR as a theory within the socio-cultural and cultural-historical theoretical lens such as Cultural Historical Activity Theory (CHAT). SMR suggests that people are required to be enculturated through both formal and informal education to have the opportunity to be exposed to and experience relevant activities related to Maritime 4.0 and MASS. The careful design of infrastructure and social activities to provide opportunities for public exposure, involvement, and experience of people with maritime domain will lead to development of related social consciousness

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and mindset. At the individual level conscious people develop a maritime identity which is crucial in their understanding and involvement with the implementation of the evolving technological advancement in Maritime Autonomy.

Keywords: Industry 4.0, Maritime Autonomy, Maritime Autonomous Surface Ship (MASS), Socio- cultural Perspective, Cultural Historical Activity Theory (CHAT), Social Mindset Restructuring (SMR)

1 Introduction

Maritime autonomy 4.0 has undergone a change in society, and the development of automation technology of MASS encompasses the whole societal dimension. The noteworthy review for creating a better understanding in the context of shipping 4.0 are cognitive, communicative, and operational areas (Emad, Enshaei, & Ghosh, 2022), which points to the far-reaching of the salient human element in maritime. Nevertheless, this innovation is extensively discussed as the advancement of technology facing the fourth industrial revolution. In the case of prospectus MASS, the growing interest comes from sectors of industry, academia, and regulators. However, the involvement of broad societal stakeholders in the future vessel implementation seems to be disregarded (F. Goerlandt, 2020). Autonomous ships envisage safety, sustainability, and cost-efficiency (Burmeister, Bruhn, Rødseth, & Porathe, 2014; Floris Goerlandt & Pulsifer, 2022; Levander, 2017), although the stages of autonomy transition bring different implications (IMO, 2021) and require preparation. In terms of the seafarers, it deals with upcoming demands and alterations in education and training to meet the autonomous vessel requirements (Lušić, Bakota, Čorić, & Skoko, 2019). In addition, the autonomous system challenges the socio-technical system's complexity (Mallam, Nazir, & Sharma, 2020), the influence of automation technology on women seafarers (Kim, Sharma, Gausdal, & Chae, 2019), and the reduction in the number of ship crew (Kooij & Hekkenberg, 2021).

The disruptions mentioned above show that the role of digital technology has altered maritime operations. It leads to adaptation for the future Maritime Education and Training (MET) and seafarers' competencies (Sharma, Kim, & Nazir, 2021). The gap in readiness among agents and uncertain skills competencies have been identified in maritime autonomy implementation (Emad & Ghosh, 2023). Although the autonomy in the maritime industry has changed the roles and responsibilities of involved machine-human agents, human roles still play an essential factor (Relling, Lützhöft, Ostnes, & Hildre, 2018). Moreover, the socio- technical system in Industry 4.0 has extensive ramifications for society, technology, infrastructures, culture, procedures, and objectives (Sony & Naik, 2020).

This study further explores the concept of maritime dimension 4.0, which focuses on the crucial requirement of restructuring social mindsets to effectively implement maritime autonomy by proposing a novel theoretical framework of SMR. It is informed by the socio- cultural perspective of the CHAT. SMR is a part of the thorough investigation of the national maritime identity development dynamics, which discloses the human development in society regarding mind, awareness of consciousness, and identity establishment. SMR is essential to be developed as a theoretical framework because it encompasses looking even more prominent than the activity system, as CHAT focuses on one or two as minimal activities (Engeström, 2001). In contrast, SMR looks at society in the broader scope of a nation and how SMR works by enabling social consciousness development through the enculturation process that can be done in both formal and informal learning. Hence, society can expose, and experience relevant activities involved in a sustained process of mindset transformation toward the world of maritime autonomy. Considering that maritime autonomy in Industry 4.0 incorporates intelligent technology such as Artificial intelligence (AI) that requires learning stages to obtain flexible adaptation for performing tasks and goals (Kaplan & Haenlein, 2019). Hence, embodying the domain of human development is our distinctive approach to providing

SMR through amplifying social consciousness in maritime autonomy 4.0, leading to maritime identity development.

2 Literature Review

A fully integrated industry drives the main idea of industrial 4.0 toward the advent of intelligence technology, such as digitalisation, the Internet of Things, Services (IoT & IoS), Cyber-Physical Systems (CPS), Automation, Big Data, Could Computing (Emad, Khabir, & Shahbakhsh, 2020; Hofmann & Rüsch, 2017). The emergence of Industry 4.0 creates the "smart factories" in which the IoT plays a leading role (Hermann, Pentek, & Otto, 2015); the IoS navigates to factories, and CPS interconnects to the broad environment of humans, machines, and products in intelligent manners of decentralisation and autonomous (Brettel, Friederichsen, Keller, & Rosenberg, 2017). In the context of Maritime Autonomy, the role of Seafarers in autonomous shipping put on the rise in its discourse of interests (Shahbakhsh, Emad, & Cahoon, 2022). Likewise, reviewing Sefarer's future needs in maritime education and training towards the upcoming autonomous ship operation is significant (Emad et al., 2022). In conjunction with anticipated governance risks toward the future MASS implementation, it depends on its degree of autonomy advised as allowing participative social discourse (F. Goerlandt, 2020).

Considering that maritime autonomous operation is in the foreseeable future, this section attempts to argue in light of the literature by allowing the possibility of human-machine interaction to be well anticipated by the entire society. Additionally, the socio-cultural perspective is embodied as the foundation in developing frameworks for reviewing human mind development in theoretical and conceptual aspects. As this research advocates the opportunity to restructure the mindset of humans within the enormous societal scope, the notion of social cognitions influenced by language and socio-cognitive development and beliefs under the umbrella of Theory of Mind (ToM). As it is rooted in the ToM, the socio-cultural scholars are categorised as "interactivism", which supports the relationship between social cognition and cultural integration (Mirski & Bickhard, 2021) that manifests in activities.

Human activity is viewed as a cohesive system that includes the interaction between human consciousness and social practice or activity as a concept of internalisation (Wertsch & Stone, 1985). Vygotsky claims it refers to the social development situation (Rieber, 1998). An individual's consciousness is not restricted to their physical body but is dispersed throughout their surroundings, activities, and interactions with other participants (Eun, 2019). These ideas—the unification of behaviour and consciousness and the integration of social interaction and the mind—are the critical components of Vygotsky's theory of human development (Eun, Knotek, & Heining-Boynton, 2008; Shabani, 2016) as the fundamental elements of cognitive human development are socially guided, influenced and shaped through interactions (Berk, 2010).

Human cognitive development occurs through social interaction and involvement in learning, working and social engagement activities. Activity explains how cognition and development are placed and distributed across sociocultural environments. Scholars from cultural-historical traditions explain activity theory as CHAT. The first generation of CHAT refers to influential Vygotsky's idea of mediation as constructed in a triangular model consisting of subject, object, and mediating artefact (Cong-Lem, 2022; Vygotsky & Cole, 1978). The second generation was postulated by Leont'ev, who clarified the significant distinction between an individual action and a communal activity (Leont′ev, 1981). The third generation of CHAT, formulated as the fundamental model, is expanded to incorporate at least two interacting activity systems (Engeström, 2001).

The interaction of social consciousness, enculturation, and the individual is a dynamic, interconnected and co-constitutive process representing human beings' complex and adaptive.

Learning is an enculturation process (Gavelek & Kong, 2012), as it is lensed through the community of practices (Kong & Pearson, 2005). Enculturation is a cognitive practice of individuals interacting with knowledge resources, such as writing and numerical symbol systems, within a socioculturally influenced context (Menary, 2007). Learning from a socio- cultural perspective is studied as the earliest language acquisition in the case of infants (Bruner, 1985). Unschooled children and adults' formal and informal apprenticeships in various ancient and contemporary cultures (Rogoff, 1990). Children's peer connection and teamwork in and out of school contexts (Cole, 1998). Enlightened by previous research, we defined social enculturation in SMR as formal and informal schooling aimed at human cognitive development within a nation-state context.

3 Methods

Qualitative research is applied as part of the grand research of national maritime identity development analysis, which uncovers human development at the societal level as mind, consciousness-awareness and identity development. In this paper, we are developing an SMR theoretical framework to analyse a new phenomenon of maritime autonomy of MASS from a larger perspective as a social-intelligence machine interface. In addition, qualitative research supports the construction of theory based on creative empirical theory-data interplay rather than "the theory-data fit (Alvesson & Karreman, 2011). In the postmodern era of social constructionism, qualitative research can inform theory formation through reflection and interpretation of empirical data (Strong, 2012), such as the maritime automation in Industry 4.0.

4 Introduction of SMR Theoretical Framework

The triad pillars introduced by SMR are Social Mindset Restructuring as a goal, social Consciousness Development as a process and Identity development as an outcome (Figure 1). It was previously informed by the interlinkage of Socialisation, Enculturation and Identity Development (Poole, 1994). The SMR is formulated based on the unique need to lens the social phenomena guiding diverse social groups with different activities in pursuing specific national objectives through adaptation and current change.

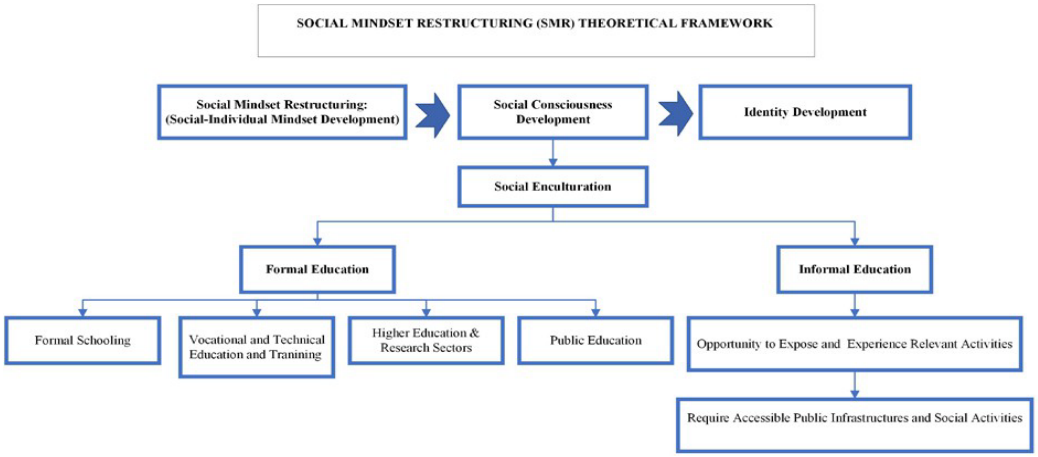

Figure 1: Social Mindset Restructuring (SMR) Theoretical Framework

The development of SMR is part of an in- depth critical analysis that reflects empirical data from extensive research on the development of national maritime identity. Another crucial factor to consider in SMR construction is that empirical data reveal the phenomenon as a nation is supposed to uphold its historical values and core identity rooted in its extensive history and culture, even while technology inexorably advances, becoming increasingly modernised and digital.

Figure 1 displays the development of social consciousness through social enculturation in formal and informal education. Typically, every country's educational system contains these streamlining. Where history is made, culture is internalised, and identity is shaped. The combination of formal education and the informal education sector provides diverse exposure and experience that can be accessed by preschool, school-aged and post-school social group ages. Provided that public infrastructure and social activities are made publicly accessible. The two streamlined social enculturations of formal and informal education allow spaces for advanced modern and sociocultural sources of learning that can be performed. Thus, we advised restructuring the social mindset. The term "social mindset restructuring" is defined in the light of sociocultural as allowing human ability to be adaptive to the culture in which humans live as individuals and social. In this context, the Industrial Revolution 4.0. The reason is that adaptive human cognitive development cannot be done individually since people's minds are socially guided and constructed. Therefore, society has to adapt to the new human-machine interface as a way of social mindset restructuring to utilise AI as a cultural tool of the new age of human civilisation. Vygotsky's Zone of Proximal Development theory profoundly informed this analogy, which examined two levels of actual and potential cognitive development through assistance from capable others (Tzuriel, 2021; Vygotsky & Cole, 1978).

Putting the context of the new age, the digitalisation of society touches all parts of human life, such as working, moving, and engaging with many facets of life; everything is becoming intelligent. Humans are not the only agents; AI is gaining agency roles due to human choices. AI is used to help people accomplish things more efficiently. Society is changing, moving from being a more human technology centre (human was the leading player) into technology having a larger share in human day-to-day existence. The difference between old and new technology is that new technology is intelligent, which occupies a more significant share of the intelligence tasks' performance. In contrast, the old technology relied on centered human intelligence. This remarkable shift in shared intelligence required a restructuring in the collective social mindset in which humans use their minds to do intelligent and decision-making tasks shared with intelligent machines, and it demands us to think differently about the tools and the job-task completion. Our point of view is based on the assertion that changes in cultural characteristics are inexorably linked to changes in human activity and cognition (Gauvain & Munroe, 2012).

5 SMR Application to Maritime 4.0 and MASS

The discourse of intelligence technology advancement in maritime overshadows the social sphere element; however, human-machine interaction is part of Industry 4.0 cores. How humans allow AI to share the decision-making process requires social consciousness and mindset-restructuring. The changes and revolution have significantly influenced the immediate maritime stakeholders and the community.

Implementing the Social Mindset Restructuring (SMR) in Maritime 4.0 of MASS commences by establishing the objective of incorporating the ocean into society's collective consciousness. Individuals are required to be conscious of the ocean's significance as a vital life source and as an integral component of their social, cultural, and historical domain, consistently engaged in the progression of future technology. The SMR facilitates the expansion of individuals' perspectives on the ocean through enculturation towards a comprehensive ocean component known as maritime

autonomy 4.0 of MASS. The advent of the Fourth Industrial Revolution has restructured the focus of human-machine sharing interaction towards managing oceans and maritime operations.

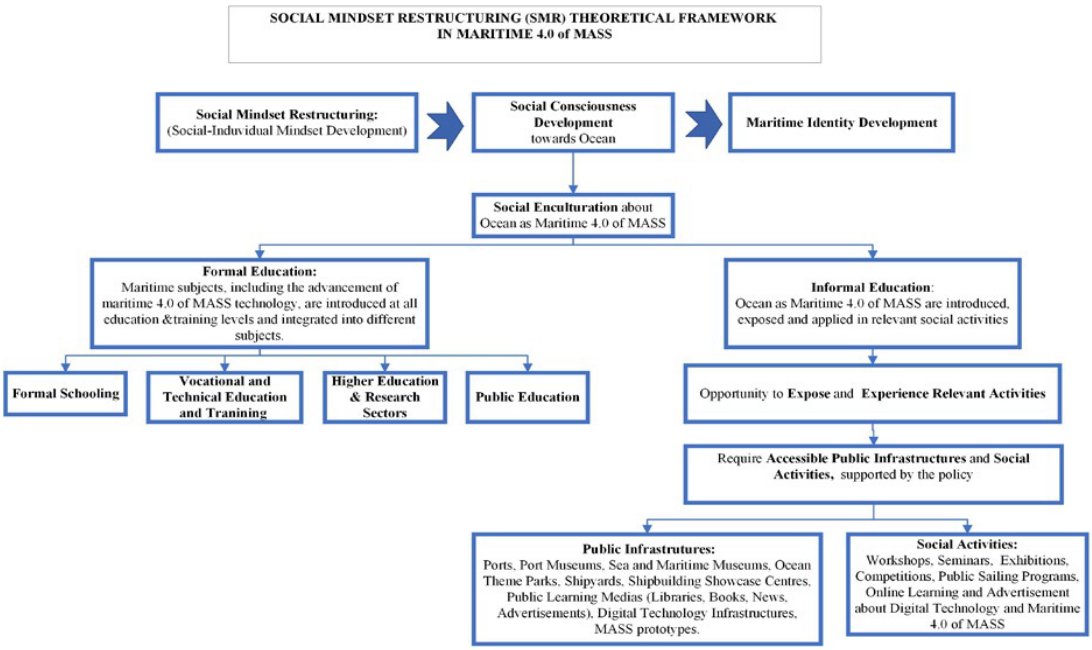

Figure 2: Social Mindset Restructuring (SMR) in Maritime Autonomy 4.0 of MASS

Figure 2 illustrates that social consciousness development can be done through social enculturation about the ocean, including the future of maritime 4.0 of MASS. Formal education at different levels and sectors requires introducing maritime subjects involving maritime autonomy 4.0 integrated into relevant subjects. Hence, the outcomes of formal education are ready and adaptable to the future of industrial maritime demands. Since the industrial chains are interrelated, the automation system also applies in the sectors of manufacturing (Brettel et al., 2017), railway transportation (Kans, Galar, & Thaduri, 2016) and logistics (Hofmann & Rüsch, 2017). Likewise, its intelligence transformation impacts the socio-technical systems in the context of autonomous shipping (Mallam et al., 2020).

As the maritime industry is moving towards autonomous operation, the entire community cannot be separated from the advancement of autonomous technology. In this case, informal education sectors complement the uncovered sectors by allowing people to be exposed to and experience maritime 4.0 as part of the future ocean operation. The advised practical SMR of Maritime Autonomy 4.0 from informal enculturation can be done by creating contexts for the community. In the maritime autonomy transformation context, the policy supports public infrastructures (learning infrastructures: Port, Museum, Prototypes, digital technology instalment and literacy tolls) and social activities (workshops, seminars, exhibitions, competitions and public sailing experience). These are required to be provided and made accessible to the public.

Moreover, MASS and prospectus-capable seafarers in the maritime 4.0 industry can be executed through context creation in social activities during the enculturation process of embracing pride rooted in the national maritime history and culture as prospective goals. It provides society and the younger generation with promising career opportunities to become the seafarers of the future in the era of maritime automation technology. Enculturation of maritime autonomy requires continuing exposure to socialisation and experience as internalisation at every level of education in formal and

informal sets. The more collective social consciousness of maritime autonomy is enculturated, it has the power to allow and restructure people's mindsets, which could ultimately lead to cognitive changes and identity development toward maritime autonomy 4.0 direction.

6 Conclusions

SMR is a critical requirement for maritime autonomy implementation since the Industrial Revolution 4.0 allows the human-machine interface to share roles intelligently. As the maritime industry embraces the benefits of autonomous operations, it is reasonable that the industrial mindset has shifted into digital transformation. Considering the multifaceted maritime industry, this research introduced SMR as the theoretical framework to encompass maritime autonomy by taking a broader perspective of societal facets. The suggested SMR cultivates a strategy to restructure social mindset by developing social consciousness in this context towards the ocean as maritime 4.0 of MASS. Thus, social enculturation is the SMR concept's medium to educate people in formal and informal settings. Formal education at all levels and sectors necessitates the inclusion of maritime subjects that incorporate digitalisation and MASS within applicable disciplines. Moreover, the informal education sectors supplement the uncovered sectors by allowing individuals to be exposed to and engage with maritime 4.0, an integral aspect of future ocean operations. It is necessary to ensure that public infrastructures and social activities are established and accessible to the general public. Our thorough analysis reveals the potential impact of SMR on identity development in maritime.

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