PREPARING MARITIME PROFESSIONALS FOR THEIR FUTURE ROLES IN A DIGITALIZED ERA: BRIDGING THE BLOCKCHAIN SKILLS GAP IN MARITIME EDUCATION AND TRAINING

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ABSTRACT. Blockchain technology has made headway into the global maritime industry. Touted as a disruptive technology, blockchains have the potential to drastically change business models leading to risks of job displacements given obsolete skills and talent for blockchain adoption. Our research shows that the global maritime industry is facing challenges with the leap in blockchain development and implementation, thus emphasizing the increasing need for appropriate qualification and upskilling through revamped MET regimes. Implications of digitalization on conventional MET is mostly preliminary in academic research, especially with regard to the blockchain phenomena. For this purpose, this paper aims to shed light on the implications of blockchain disruption in the maritime industry accelerating required changes in conventional MET approaches - mainly utilizing a case study methodology alongside semi-structured in-depth interviews as key elements of this exploratory qualitative research study. Our findings show the transformative potential of blockchains in the maritime landscape alongside technical barriers indicating complexities inherent with adoption. Lastly, we propose an infographic design framework to facilitate changes in MET methodologies among higher education institutions.

Keywords: Maritime Education and Training (MET), Blockchain Technology, Skills Gap, Supply Chain Management

1. INTRODUCTION

The global maritime industry is one of the key sectors of digital transformation due to advances in globalization prompting growth in containerized trade [1]. To date, maritime players have begun to realize the importance of leveraging of key emerging technologies as an urgent imperative to raise supply chain (SC)-performance to new levels in a volatile operating environment. Beyond the plethora of advanced technologies is the advent of blockchain technology that promises to transform existing legacy systems heavily rooted in traditional maritime commercial practices [2].

Nonetheless, the adoption of blockchains signifies a significant departure from traditional norms in the industry. Our research shows that the global maritime industry is already facing challenges with implementing blockchain technology – considering technical complexities posed by the technology alongside the resistance to change by organizations. This in turn necessitates the bridging of blockchain skills gap through revamped maritime education and training (MET) regimes in light of preparing maritime professionals for their future roles in a digitalized era.

Blockchain as a novel distributed ledger technology (DLT), promises transparency, immutability, and security, where transactions are validated cryptographically in a decentralized fashion (in the absence of a centralized intermediary) [3]. Amidst the blockchain hype, organizations seek to integrate such a novel platform into their businesses to streamline operational processes, ultimately causing organizations to rethink their strategies to effectively manage the adoption of this new emerging technology [4]. However, managers in the maritime landscape seem to lack knowledge about blockchains – especially with how blockchain-based applications are set to transform their industries [5]. Hence, the leap in blockchain development in the industry requires appropriate consequently compelling changes to teaching and learning curricula in conventional MET [7].

Despite the International Maritime Organization's (IMO's) Convention on *Standards of Training, Certification and Watchkeeping for Seafarers* (STCW) stipulating standards for training mariners, graduates seem to lack technological literacy to meet future professional standards and requirements in the maritime landscape [7]. Although block chain courses are offered in many industries however, offering this type of courses are still not compulsory under STCW and rather uncommon in the other parts of the industry.

Given the proliferation of blockchain initiatives in the marketplace, the investigation of the blockchain diffusion and its impact on existing MET methodologies is deemed timely. Changing educational paradigms in MET is therefore crucial to meet requirements for graduates in the maritime transportation and logistics (T&L) field. This inevitably challenges the status quo in terms of academic approaches to existing MET regimes. For this purpose, we have undertaken a research design that is exploratory in nature and grounded in in-depth literature review alongside a case study research methodology to facilitate better understanding of the blockchain phenomena.

2. DIGITALIZATION OF GLOBAL SUPPLY CHAIN NETWORKS: BLOCKCHAINS AND SMART CONTRACTS DEPLOYMENT

2.1.1 Introduction to Blockchain

Blockchain is a database of transactions that occurs in a "trustless" multiple stakeholder network environment, where each transaction is independently validated and digitally signed utilizing cryptographic keys to ensure secured transactions [8]. The technology is capable of recording transactions between parties in a secured and immutable manner without the reliance on any trusted intermediaries [9].

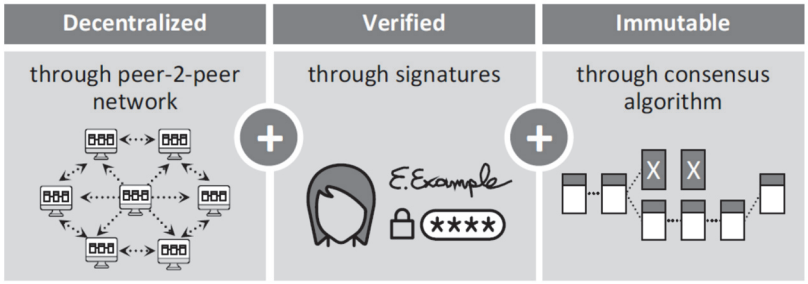

Figure 1: Blockchain Basics [10]

Descriptions of both public and private blockchains are outlined as follows [11]:

- ***Private blockchains (permissioned)*** *- ideal for stakeholders who prefer a controlled, regulated environment, and desire high throughput.*
- ***Public blockchains (permission-less)*** *- open networks where anyone can participate. To achieve consensus is costly, and is underpinned by economic incentives (mining cryptocurrencies – i.e Bitcoin and Ethereum) are required.*

2.1.2 Smart contracts

Developed by Nick Szabo in 1994, smart contracts are defined as "a computerized transaction protocol that executes the terms of a contract" to automate processes [11]. In other words, smart contracts are "self-executing" (without any human intervention) once pre-specified and pre-agreed upon conditions are fulfilled [9].

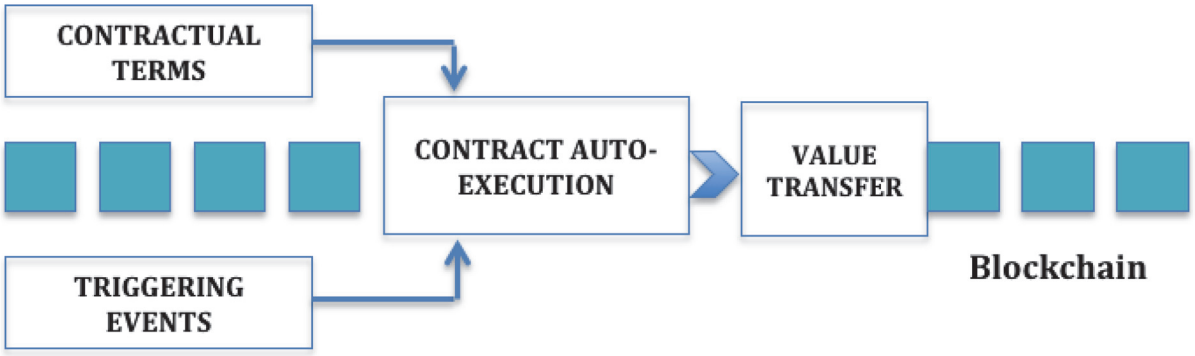

Figure 2. Smart Contract [12]

2.1.3 Navigating a paradigm shift with Blockchains

Traditional methods for handling and processing shipping documentation requirements are inefficient backed by standardized EDIFACT messages (Electronic Data Interchange) between data silos [13]. A significant breakthrough in the sector would be the digitization of paper-trail documents through blockchains to empower visibility and transparency to ocean freight. Blockchain seeks to leverage digital certification from paper-based certificate management and improve access to validated safety and seafarers' training certifications [14]. Additionally, blockchains' traceability features could potentially reduce fraudulent B/Ls through digitization in and trade [15].

2.1.4 Challenges facing conventional MET regimes: rising demand for Blockchain talent development

Blockchain applications and diverse use cases have led industry players to face complex and a wide-array of controversial issues. Despite IMO's STCW being the cornerstone of MET regimes, there seems to be the lack of highly qualified seafarers in the global maritime industry, i.e. incompetent information technology (IT) skills among seafarers when dealing with the safe use of automation on board ships [16].

Moreover, only a handful of small and medium-sized companies possess little knowledge about blockchains backed by the lack of convincing use cases not clearly distinguishing the technology's beneficial attributes over existing ICT solutions [10]. Liner

shipping players are also resistant to radical technological changes and are bewildered with the emergence of the different blockchain types in the blockchain space [17].

Notwithstanding the vast interest in academia regarding blockchains, there seems to be the lack of multifaceted insights regarding blockchain–based implications on future workforce requirements in the global maritime landscape. For this purpose, this paper aims to shed light on the implications of blockchain disruption in the global maritime industry accelerating required changes in conventional MET approaches. We further will provide recommendations to facilitate with blockchain talent development among maritime universities in line with narrowing the blockchain skills gap in MET.

To this end, we seek to address the following research questions:

i) *What is blockchain technology's transformative potential and its limitations in the global maritime domain?*

ii) *What are key recommendations to bridge the blockchain skills gap in MET in light of preparing maritime professionals for their future roles in a digitalized era?*

3. METHODOLOGY

The topic on blockchain technology is fairly new and complex within the scope of academic literature. In this essence, an exploratory study could facilitate with a new or vague area of investigation, thus allowing for the examination of a new emerging phenomenon to overcome difficulties facing organizations [18]. Thus, a case study was utilized as the main methodology to facilitate thorough discussion of findings alongside semi-structured in-depth qualitative interviews. A qualitative content analysis and thematic analysis approach were undertaken enabling the generation of meaning across data sets and the identification of significant themes [19].

3.2 Data collection & assessment

An empirical approach was applied by conducting semi-structured in-depth interviews (comprising both maritime and blockchain experts); wherein interview responses obtained acts as a testing factor for the chosen relevant case study. An interview guide was prepared allowing for open-ended responses and the generation of several codes concurrently. Main themes and sub-themes drawn from overall interview responses are based on proposed patterns relevant to blockchains in the maritime context. Additionally, a constructivist strategy was undertaken to ensure credibility and dependability of [20].

4. FINDINGS AND DISCUSSION

Interview responses have acknowledged the true transformative potential of public blockchains but were concerned with transparency, privacy and security features posed by the technology. Contrarily, responses were more inclined to the rolling-out of private blockchains in the maritime domain due to privacy, security and transparency (openness) concerns posed by public blockchains. These concerns indicate complexities inherent with blockchain implementation, which requires maritime players to thoroughly understand the technology's core principles and its application to use cases prior to adoption (as seen in *Figure 3* below):

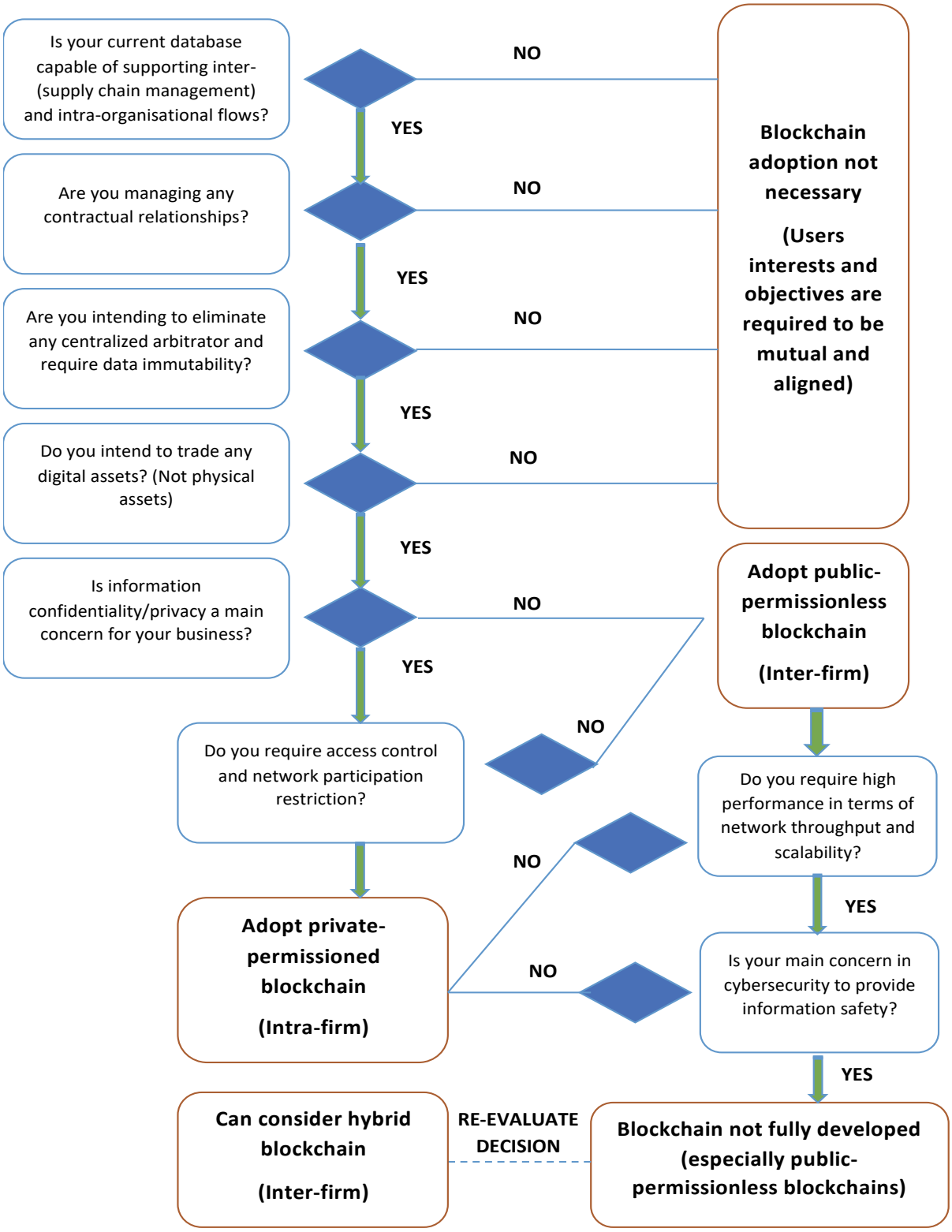

Figure 3. Decision Tree – Blockchain adoption

4.1 Digital Collaboration through Blockchains

Our data shows, to remain competitive, players have been urged to enhance integrated SC information models and the development of collaborative relationships through the deployment of blockchains to streamline operations. Further qualitative data analyses drawn have underlined equal participation by network participants in a decentralized blockchain ecosystem. Similarly, with responses from interviewees, McKinsey & Company stressed that *decentralization* is one of blockchain's unique attributes facilitating with the exchange of value and information without a trusted intermediary [21].

Data recorded on blockchains is decentralized (no longer stored centrally) and distributed across the network stored in individual nodes (computers) locally [22]. Further analysis of data responses have demonstrated that blockchains could offer equal opportunities in terms of data accessibility in real-time in a secured fashion – full control and ownership over data.

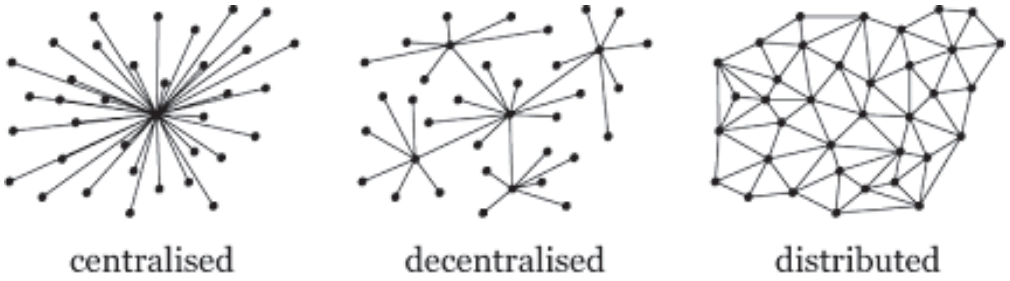

Figure 3: Decentralization and distributed networks [23]

Analyses of data have exhibited blockchain's potential of establishing new types of collaborative trusted relationships in line with enhanced integration between multiple parties along maritime SCs based on mutual trust and commitment. With blockchains, trust can be established and fostered in an entirely new manner wherein the disintermediation of trust is often embedded in settings with highly institutionalized values [24].

4.2 Blockchain Security and Privacy

The underpinnings of blockchains are based on cryptographic mechanisms through public and private keys - building the foundation for desired levels of security and trust in a network. Yet, the debate over conflicting privacy rights and security needs with blockchains continues to be distinctively evident based on the contradictory responses obtained. Such concerns include challenges with pseudonymous transactions and vulnerability to cybersecurity threats associated with blockchains.

Interviewees have unanimously agreed with the reasoning of blockchain's decentralization capable of operating with *no single point of failure* (trust distributed away from centralized authority). Hence, users are entitled to full control of trusted, immutable, and time-stamped data in chronological order rather than having data stored in centralized legacy databases with no cryptographic capabilities.

Many of our research participants have referred to blockchains as a secured technology against the backdrop of rising concerns regarding cyber security threats and

fraudulent transactions in a volatile environment. That said, being in development stages, blockchains are prone to points of vulnerability - as seen with recent malicious attacks on public-permissionless blockchains. A renowned case of blockchain hacking is Mt. Gox, where bitcoins were stolen from the exchange in February 2014 [26].

Another technical challenge facing users with public blockchains is privacy data protection and confidentiality despite the use of public-private keys to enhance security measures. Recent studies have also showed that users face risks of identity exposure through Bitcoin transactions i.e. public blockchains are not capable of securing transactional privacy and the protection of user identities [24]. Besides, confusion remains over pseudonymous transactions on Bitcoin blockchain ledgers, as most still assume that user transactions are somewhat anonymous despite identities addressed under a false name [25].

4.3 Blockchain Transparency & Openness

Interviewees have demonstrated a unified view on the growing demand for transparency integral to end-to-end integration in maritime SCs, hence favoring blockchain deployment to bring full transparency to processes along maritime SCs. Further probing of data demonstrated rising concerns regarding inadequate transparency in maritime SCs. Rising demand for transparent and trusted information across SCs acts as an impetus for blockchain adoption in the maritime domain to meet customer expectations in a rapidly changing environment.

Obtained responses demonstrated that blockchain-based solutions are ideal for the provenance of key-trade related trade documents e.g. the management of fraudulent B/Ls in international trade remains a concern given that traditional systems lack similar track-and-trace capabilities offered by blockchains [27].

Interview responses varied in terms of priority toward privacy at the expense of blockchain's transparency feature and its applicability to certain use case requirements. Academicians have also noted the intrinsic conflict between blockchain transparency and privacy – i.e. public-permissionless Bitcoin blockchain systems, where maintaining an ideal degree of anonymity could potentially deter privacy aspects [28]. Generally, interview responses indicated that both innovators and maritime experts were largely in favor of private blockchains due to less technological constraints when compared to public blockchains.

4.4 Fundamental Understanding & Technical Knowledge

Academicians have underlined the importance of having skilled and qualified professionals to accelerate blockchain development and adoption going forward [29]. Likewise, a source investigating blockchain implications in markets had also claimed that *'one of the challenges is skill set. There are not enough developers and engineers who can build what is necessary to make this transition.'*

5. CONCLUSION AND RECOMMENDATIONS

Despite the aforementioned advantages of blockchains, future maritime professionals are faced with trade-offs when implementing either private or public blockchains. Challenges with regard to the reconciliation of *transparency*, *privacy*, and *security* conceptualization

among users indicate complexities and implementation risks - in line with contradictory statements exhibited by interviewees - addressing RQ1.

5.1 Blockchain complexities and trade-offs

Given the complexities of blockchains, maritime professionals are expected to systematically re-evaluate trade-offs between the degree of transparency (openness) and privacy desired offered by blockchains, while taking into account which blockchain solution best fits their organization's scope of operations within the maritime field. Desired transparency differs on an individual preference basis, indicating that not every participant requires access to every piece of information [30].

Security and scalability limitations are also considered barriers facing public blockchain adoption. On the contrary, private blockchains are capable of offering data confidentiality the expense of transparency [30]. The case presented regarding IBM and Maersk *TradeLens* seeks to protect sensitive corporate information and consumer data through the deployment of a private blockchain enterprise solution governed by a centralized arbitrator that is ideal for B2B environments [25]. Altogether, technological constraints posed by blockchains largely demonstrates the inherent challenges faced by future maritime professionals when implementing the novel platform.

5.2 Bridging the Blockchain Skills Gap in MET

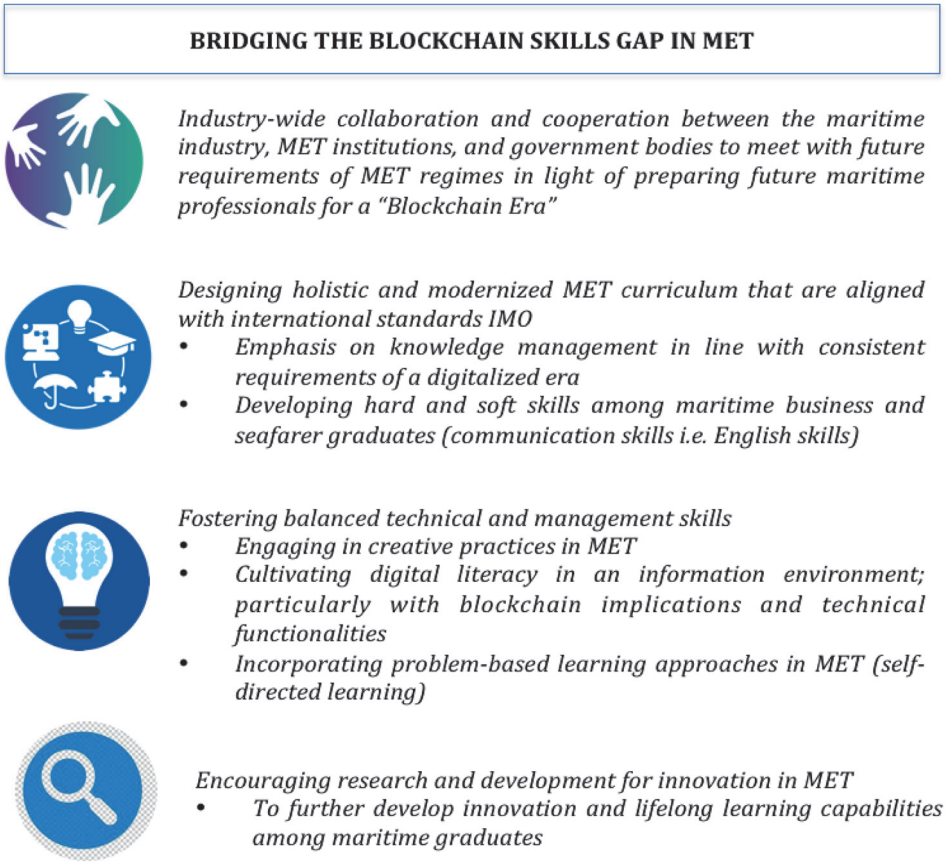

Figure 4. Bridging the blockchain skills gap in MET [31]

Essentially, education practitioners and researchers stemming from maritime communities are expected to play a major role to drive changes in conventional MET methodologies through revamped training curriculum in MET. Understanding the novel platform also demands the familiarity of an entirely new vocabulary, thus emphasizing the importance of improving English skills among future maritime professionals [32].

The magnitude of this qualitative exploratory study is limited in scope owing to time constraints, restricting the incorporation of more detailed discussion pertaining to blockchain-based smart contracts and cryptocurrencies.

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