Blockchain: Transformation of NATO Logistics Capabilities

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ABSTRACT

Smart contracts, smart cities, and cryptocurrencies are the most renowned applications of blockchain technology. As such those applications break so much with traditional practices and show the emerging and disruptive character of blockchain technology, that some describe these new applications being the result of the 'blockchain revolution'. A significant number of research projects have been conducted in this area and begs the question on how to adopt blockchain technology in the military domain. This paper focuses on a common understanding what blockchain technology encompasses, the potential opportunities for application in the logistics domain, and discusses a necessary NATO transformation in policies, procedures, doctrine and systems to adopt blockchain technology.

1.0 INTRODUCTION

In an age of data predominance, maintaining strategic advantage relies on data. The way of collecting, sharing, exchanging, filtering, analysing, and using data can increase efficiency and effectiveness to support the warfighter in the operational theatre. Advances in technology offer different software tools making possible this effort. Multiple tools, though, are available, sustainability and resilience in the defence world requires identifying, understanding, and implementing the most effective ones.

Throughout history, new ideas, new applications, and technological revolutions have changed the world in most profound ways. Although a revolution "blockchain" occurred very silently in 1992, the arrival of Bitcoin[1] network and the digital currency in 2009 Blockchain affected significantly the definition of governance of finance services. However, its specific features are reshaping the thought, behaviour, perception, and the way of doing business in non-financial areas as well. They are unfolding across the digital defence world, and increasing the experimentation and adoption in the military logistics areas-movement and transportation, supply chain, asset tracking, and data sharing.

To understand the blockchain technology, to explore existing use cases and to consider relevant, unaddressed problems, Logistics and Sustainment Branch conducted a webinar on blockchain technology in March 2022. The webinar, "Putting Blockchain to Use in NATO [1]", hosted industry professionals - technology users, providers, developers and consulters - and built up a blockchain technology community of interest, expanded knowledge on defence and civilian blockchain technology applications, and identified opportunities for NATO to capitalize on. The webinar was followed by a quick survey aiming to find the answer of "*How can we transform and develop NATO logistics capabilities by using blockchain?*"

This paper builds upon the webinar and provides a link to the webinar recordings, our survey results, articles, white papers, and reports. In section 2, a common understanding of what blockchain technology encompasses is given followed by a description of its applications and its main actors in the blockchain

[1] Bitcoin and blockchain, though, two names are often used interchangeably; the latter is the technology which was developed for Bitcoin.

environment. Subsequently, we will focus on the current problems and the transformative role of blockchain in NATO logistics. After that survey results and users' comments are given, followed by conclusions.

2.0 BLOCKCHAIN TECHNOLOGY AWARENESS

2.1 Understanding the Blockchain Technology

Blockchain is commonly described as *distributed digital ledger*, like an Excel spreadsheet shared across a numbers of computers. However, it is possible to find a number of different definitions depending on the particular aspects, such as technical, legal, business. For instance, Joseph Holbrook's definition approaches blockchain from business perspective:

> "*A business network that is used between peers to exchange value. Value can be currencies, tracking information, or anything that interested parties require to be maintained on the blockchain ledger* [2, p.5]. "

Holbrook suggests that tailoring the definition for the target audiences according to their role and circumstances can facilitate their understanding. A defence logistics definition could be considered as follows:

> "*A distributed digital military ledger that is used between nations of alliances to exchange defence logistics value. Defence logistics value can be recognized logistics picture, asset tracking information, cross border paper-based documents, or anything that interested military units require to be maintained on the blockchain ledger to improve digital backbone of sustainability*[2]. "

The well-known features of this technology are decentralization, immutability and transparency. Decentralization simply defines that the blockchain network is responsible for the assets [3, p.78]. In traditional systems, a central authority-third party controls the data flow and database. In doing so, this authority ensures the security and the trust between the parties in the centralized system environment. In a decentralized system, the responsibility does not belong to an individual, entity, or government because the blockchain technology takes the 'trust' element from the hands of a central structures and gives it to a decentralized structure, where the network itself develops the trust [22, p.11]. As shown below in the Figure 1, same data is distributed to every single user in the blockchain network and that data is stored in each computer in the network.

[2] When relevant conditions take place in defence domain adding the terms of '*currencies'* to this definition might be considered. There is not a "blockchain definition" in the official NATO Terminology Database at this writing.

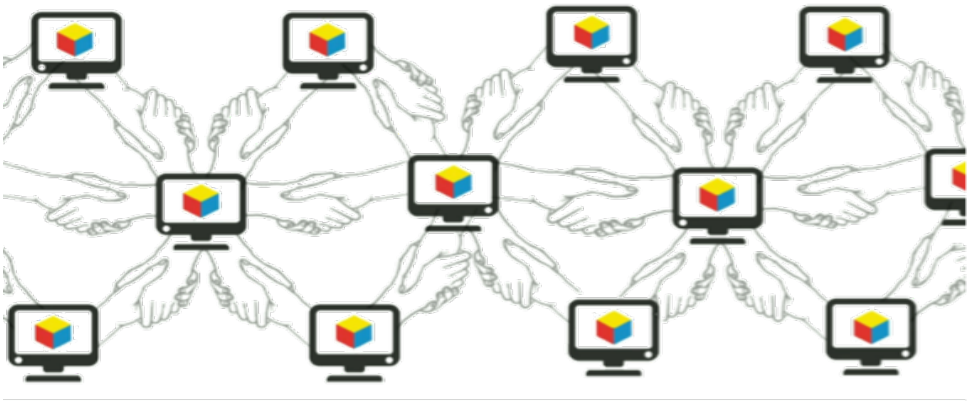

Figure 1: Trust protocol [5]

Its immutable and irreversible record infrastructure addresses the main characteristic of blockchain. Data is time-stamped and stored permanently on this digital ledger. Unauthorized users cannot alter or modify the permanently stored records. These timestamped, authorized and incorruptible properties ensure accountability of the data [4, p.155]. In other words, it is authentic. Additionally, to provide transparency in the network, it gives everyone the equal right to see the data.

In addition to these features, blockchain has limitless append-only characteristic. This allows the users to add new information to the existing records endlessly and see them chronologically [3, p.21]. It also enables individual users, organizations and ledgers to interact individually, easily and securely with greater speed and without requiring any third party approval.

Blockchain's noteworthy 'emerging technology' character relies on these significant features. They multiply the blockchain popularity especially in finance sector. Besides, US Department of Defence stated that it is also reshaping counterterrorism, cyber-intrusion, defence, intelligence, global monetary policy, currency valuation and manipulation as a 'disruptive technology' [13, p.7]. In recognition of its emerging and disruptive character, numbers of entities in both private and public sector are gradually adopting this technological opportunity in their business environment.

2.2 Blockchain Technology Applications and Opportunities

Currently the main user for blockchain applications are the finance and banking areas, however, its usage is not limited in only the financial world. As seen below, business, government, education, and health fields are implementing this technology in their different services.

Blockchain usage in different industries [6, p.17]:

- Finance: Cryptocurrencies, Contracting, Clearing, Settling, Record-keeping;
- Business: Market exchange, Insurance, Resource management, Supply chain, Rights management;
- Government: Smart cities, Transportations, e-Passports, Digital IDs;
- Healthcare: Health records, Managing supply chain and prescriptions;
- Education: Managing content, Certificates, Learning outcomes evaluation;

In traditional systems for finance and business, the large volume of cross-border transmittals is responsible for the movement of money between different entities. This multi-player process takes up to a few days to process and in which some transfer fees are applied. In contrast, Blockchain technology allows communicating peer-to-peer (P2P) and eliminating intermediaries in this process. Removing central authorities from the process also removes transfer fees and allows distributing very tiny payments between

peers. For instance, the Deutsche Bank project, theoretically, showed that parties could exchange a contract without an intermediary and reduce the operational risk [7, p.8]. This P2P technology also allows file sharing by using the distributed data storage. Thus, users can access data, which is stored in other user's computer connected to the same P2P network [23, p.86].

Traditional contracts set the rules and terms within a defined context. Even in large organizations, the traditional contract lifecycle is mostly based on paper records and manual processes. Plus, it still relies on personal connections, emails, and phone calls to confirm the truthiness of visible data, which is critical to initiate the next contractual step. On the other hand, smart contracts break down the work into a written code automating the terms in a computer program. Doing so, it digitalize the contract lifecycle and reduces the paper-based contracts and manual process in enterprise environment. Additionally, they can conduct a collaborative business process among multiple parties [23, p.8]. They simply do the described work when all conditions are satisfied. Thus, it improves timely-access to single source of truth, and inefficiencies with paper-based and manual processes.

Global supply chains are long and contains multi-players on the operational side and therefore, supply chain management highly depends on interoperability. For example [8], Walmart Canada identified a supply chain problem as: *The use of multiple information systems between Walmart Canada and its carriers that could not talk to each other*. To resolve this problem, a blockchain network automating the process was suggested. That network reduced the number of disputed invoice rate from over 70% to less than 1%. The original goal of the network, though, was to eliminate disputes and wasted resources. This solution provided Walmart and its supply chain players with insights that have led to major operational improvements.

To maintain strategic advantage, the defence sector is exploring the opportunities applying this technology. Survey data and recent studies show that military forces are working in the logistics arena on movement and transportation, 3D printing, supply chain, asset tracking, data record-access-sharing, and certification related blockchain applications. One of these defence-related applications is 3D printing. The Defence Department is looking to this technology in order to maintain maximum security in the 3D printing process where "corrupting both the downloaded 3D print-file and the blockchain channel is nearly impossible [9]."

In these different applications, blockchain comes in various types, such as private (permissioned) and public (permissionless), and hybrid (federated) architectures. The main difference between permissioned and permissionless architecture is the transparency level of the network. In a public network, anyone can access the stored data and make transactions. Whereas the private (permissioned) blockchain network allows the users having certain rights to reach the data and proceed the process. The comparison of private and public distributed ledgers is shown in Table I [10, p.668]. Actors in blockchain environment can choose the most appropriate structure type to fulfil their own requirements.

Table 1-1: Comparison of Public and Private Distributed Ledgers.

Feature	Public(permissionless)	Private(permissioned)
Access to data	Everyone	Only specific users
Decentralization	High	Low
Trust users	No	Yes
Anonymity	Yes	No
Survivability	Low	Medium
Transaction verification	Restricted	Everyone
Transaction confirmation	Slow	Fast
Management of privileges	Yes	No

These different applications and opportunities attract new actors in different sectors. As the technology

continues to improve, developing in-house blockchain technology requires skilled work force. That increases new job opportunities, however, demand for blockchain skills is likely to grow rapidly. A recently held event, Blockchain Skills Conference[3] stated that *approximately 50% of companies experience recruitment difficulties*. Moreover, *global blockchain market is predicted to grow from 7 billion to over 160 billion by 2029*, 23 times more than its current value. The conclusion reached from this numbers is that numbers of actors seeking new blockchain opportunities will grow and diversify in blockchain environment in the upcoming seven-year period.

2.3 Key Actors in Blockchain Environment

Growing interest and increasing investment in blockchain technology bring new actors into the ecosystem, most notably cyber security professionals and IT experts. This expertise is needed because the permissionless structure allows each individual having a personal electronic device to join a public blockchain network. This highly accessibility is mostly described as one of the blockchain technology vulnerabilities. To prevent similar vulnerabilities and to deploy blockchain securely, experts conduct operational analyses, researches, and studies as well as introduce new tools and technological advances such as quantum computing. These efforts gradually increase the involvement of academia, global consulting companies, and think tanks in the environment.

Blockchain is a relatively new technology and its standards are still under development. The broad approach in setting standards is very important specially to establish global interoperability. International Standards Organization (ISO) is one of the key players in this process. ISO published eight standards, and 10 standards are currently under development. There are 42 participating members and 20 observing members in this working area. Additionally, legal authorities are also working on regulatory developments.

The blockchain technology can transform a city to a smart one. In a city transformation process, the abovementioned features can *optimize and enhance maintenance of urban infrastructure, transportation systems, education, healthcare, security, and connectivity through access to information* [11]. The city of The Hague, the Netherlands, for instance, evaluates these features and conducts smart city infrastructure innovation projects. As the blockchain enabled solutions spread across the governments, demanding policymakers' involvement in the process will very likely increase.

From governmental perspective, Russian and Chinese governments are also key players of blockchain environment. Understanding their capabilities can amplify the blockchain awareness. China, for example [12], plans to use of blockchain applications in supply chain, e-governance and financial technologies, and conducts research and development on smart contracts, asymmetric encryption, and consensus algorithms. Furthermore, Chinese military evaluates blockchain technology as a game changer for intelligence, weapons lifecycle, personnel management, information warfare, data integrity throughout military supply chains.

Russia also an active player in blockchain. Russian government has invested in research and development (R&D) into the technology. For example [13], the Russian Ministry of Defence commenced a research to analyse *how blockchain technology can be used to mitigate cybersecurity attacks and to support military operations*. Development of an intelligent system to detect and prevent cyber-attacks on important databases and weapon systems is stated as the priority of this research.

Different advanced technologies can be considered among the key players as well. According to recent research, blockchain technology can complement artificial intelligence technology. To assure the truthfulness of the stored data by Unmanned Aerial Vehicles (UAVs), blockchain can be used as well. Blockchain can *empower the UAVs and make them safer, more accurate and easy to control* [24, p.2].

[3] The conference was held virtually by Economic and Social Research Institute on June 1st, 2022.

Quantum is another key technology that blockchain will soon have a strong relationship to create new cybersecurity systems for protecting digital value [3, p.150].

In short, blockchain technology will require actors to be familiar working across public and private sector as the technology gradually spreads across both areas. Considering the efforts of key players, developing military capabilities is as important as developing non-military capabilities in the blockchain environment, which can play a leading role in improving interoperability across all stakeholders.

3.0 TRANSFORMATION IN NATO LOGISTICS

3.1 Digital Transformation in NATO

Digital transformation of the Alliance becomes a necessity in order for NATO to embrace multi-domain operations and to maintain strategic advantage. Supreme Allied Commander Transformation, General Philippe Lavigne highlights *the existence of operational necessity for digital transformation to achieve cross-domain operations, optimize effects and to conserve Command and Control superiority* [14]. Lieutenant General David Julazadeh, the Deputy Chief of Staff for Capability Development at NATO's Allied Command Transformation, describes the revolutionary digital transformation as to be *transforming the Alliances from a platform centric organization to a secure data centric organization* [15].

Digital transformation can support and enable commanders to make the right decisions. However, its outcomes are highly dependent on availability of the right data, at the right time, in a secure data environment. Besides, they highly rely on current capabilities of leadership, people, processes, organization, and technology.

The pathway for a NATO digital transformation begins with NATO's "Foster and Protect" strategy for Emerging and Disruptive Technologies (EDTs). This strategy currently focuses on nine priority areas of innovation. To support these key areas, Blockchain is an identified EDT project that will compliment these priorities. EDT areas collectively can allow sustainable digital transformation delivered across the Organization.

3.2 Is the Problem still 'Interoperability'?

Interoperability can be described simply as the ability to work with other capabilities. It includes all issues related to the interaction of the capability with other capabilities, partners, and nations, and the connectivity of information systems and security domains. Some of the member nations transform their capabilities faster. However, any advanced national capability can become nearly useless in a coalition. The key for success in a diverse organisation is to be able to work together. Lt. Gen. Julazadeh highlights [15], *interoperability still remains essential for success but it is not an obstacle.*

Advances in technology offer an environment of collaboration, cooperation and eventually integration of individual capabilities establishing full interoperability. Central in reaching interoperability goals is the digital transformation of NATO and the nations enabling the vast amount of data throughout the Alliance, made available within a trusted and secure network environment able to collect, store, access, record, exchange and share the data.

3.3 Where Are We in NATO Logistics Chain?

Logistics is described as the science of planning and carrying out the movement and maintenance of forces. [16, p.1-1.]. It includes plan, design, development, acquisition, storage, movement, transportation, distribution, maintenance, evacuation and disposition, medical and health service support. Complementing

national efforts, NATO has been developing various capabilities, concepts and software tools to address capability gaps and Alliance-wide requirements: e.g. NATO Operations Logistics Chain Management (OLCM) capability, Logistics Functional Area Services (LOGFAS), and Enablement Support Services, which is currently under development process. They all compliment NATO's forward-looking logistics concept.

The software capabilities developed over the years aim to provide an interoperable logistics environment to military staffs. Military logistics stakeholder community is not, however, limited to only military entities. A permanent bridge between military and non-military entities is required in this ecosystem. Presently data exchange among different sectors has greatly increased in the multi-actor logistics environment. Simply, 30 different nation's military units, their non-military entities, and their private sectors, as well as NATO bodies must be able to work collaboratively with various software capabilities.

Thus, NATO logistics relies on advanced, interoperable and trustable software systems populated by all players with all available, necessary and required data in order to conduct logistics services in a timely, secure and efficient manner. It is critical that the data is shared amongst all players and a broad agreement on sharing and exchange of data is necessary for the effective execution of NATO logistics.

The amount of data circulating in NATO's digital space is huge and valuable for the adversaries, too. From this point of view, secure data platforms are highly important. In this condition, 'trust' gains the importance. Especially, security concerns trigger the trust issue between peers and non-peers in the digital world.

The interest most of the time focuses on data collection rather than establishing data sharing incentive. Since the value of data increases, clearly, willing to share that value needs incentive. Today's technology solutions offer to be able to work in the same and trustable environment with military and non-military partners and talk common data language.

3.4 Where to Next? Decentralized and Trustable Ledger in NATO Logistics Chain

In these days, people have to deal with overabundance of data, different regulations, terminology, standards, and cyber concerns. An organizational effort can facilitate overcoming these issues. For example, Eugene Laney, head of international government affairs for DHL Express, underlines the collective effort in the supply chain management: "*Blockchain, however, is a team sport; no one company today completes customer supply chain shipments by itself*. [17]" Across NATO, can any member nation accomplish her operations logistics responsibilities by herself, for instance, without moving across borders, without any integration with different nations software tools, and so on? If not, where to next?

Blockchain technology can be used to control and register the goods and services across the NATO logistics ecosystem [18], thus it can increase the volume of visible data. Recalling the first Genesis Block written to the Bitcoin blockchain ledger is just a text [19], which is not financial, shows that blockchain technology can serve as a repository of data [3, p.43]. Some nations have already commenced to use data repositories.

Logistics in defence environment requires coordinated, collaborated and synchronized joint and multi-domain military and non-military, international and intergovernmental actions. Subsequently, interoperability to share data between platforms and to move it both horizontally and vertically in all levels becomes highly critical to support future's warfighter. By developing a data exchange chain able to provide right data on the right time, to the right people at the right level could increase the success level in the operations. For instance, data can flow among the users of the blockchain network by a single and distributed ledger across NATO. The users can be both military and non-military actors across public and private domains.

It is clear that large organizations having confidential and huge digital data sources would never prefer

completely transparent records in a public blockchain domain. An integrated permissioned-blockchain capability for NATO can create a combined effect greater than the sum of the nations' separate parts. A permissioned blockchain can provide organizational-level security [2, p.7] and maintain the trust element in the ecosystem. Thus, logistics data may spread through a secure environment rather quickly than its flow in the current systems. It can ensure the interoperability to share data across domains, which is critical to future's warfighter in order to act together coherently, effectively and efficiently to achieve Allied tactical, operational and strategic objectives. In theory, mentioned efforts can also contribute to develop a non-paper logistics environment.

Some industry actors suggest that *the blockchain technology itself functions like a regulation* [20, p.155]. In other words, the technology facilitates the processes by reducing the involvement of humans, a known source of introduction of data errors into the system, and thus decreasing the likelihood of erroneous data. In NATO, standard agreements (STANAGs) are a way to regulate the interactions between nations and they are a major tool for interoperability. For instance, in NATO logistics environment, there are 50 STANAGs endorsed by Logistics Committee. Having considered the need to use the other STANAGs' to manage logistic in the theatre, a logistician should build knowledge about more than 50 STANAGs.

Smart contracts promise to automate some of the previously written regulations. In other words, they can be described as a digital regulation. NATO's regulations could be digitalized and transformed into smart contracts. Doing so would convey many documents to digital environment and enable them to function without any human effort. Produced data during this process can be stored as immutable and time-stamped. It can allow the blockchain network users to know what is true- at least with regard to structured recorded information [20, p.6].

4.0 SUMMARY OF THE SURVEY RESULTS

4.1 Respondents

A quick survey was conducted between May 2 and 13, 2022 in the form of a questionnaire to find the answer of *"How can we transform and develop NATO logistics capabilities by using blockchain?"* question. This was sent to all blockchain webinar attendees, Capable Logistician 2023 Initial Planning Conference participants, and NATO Industrial Advisory Group (NIAG) Logistics Community of Interest members. The survey aimed to collect inputs from blockchain and logistics related communities.

The questionnaire was answered by 53 persons, from fifteen nations and NATO bodies. The respondents reported that they fill manager, director, section head, consultant, legal advisor, staff officer, engineer positions across NATO Command Structure, military, and non-military entities. Almost half of the respondents undertake strategy and planning roles in their workspace. 54% of respondents became aware of blockchain technology by NATO technology related activities (e.g. conferences, webinars, articles, reports).

4.2 The Role of Blockchain Technology

Analysis of the questionnaire questions on the role of blockchain technology is presented under three questions.

The respondents' nations are Albania, Belgium, Czech Republic, France, Germany, Italy, Lithuania, Netherland, Norway, Poland, Portugal, Romania, Spain, Türkiye, and United Kingdom (UK). Almost 47% of respondents think their nation or their military forces can lead in or undertake activities to achieve blockchain transformation of NATO logistics capabilities.

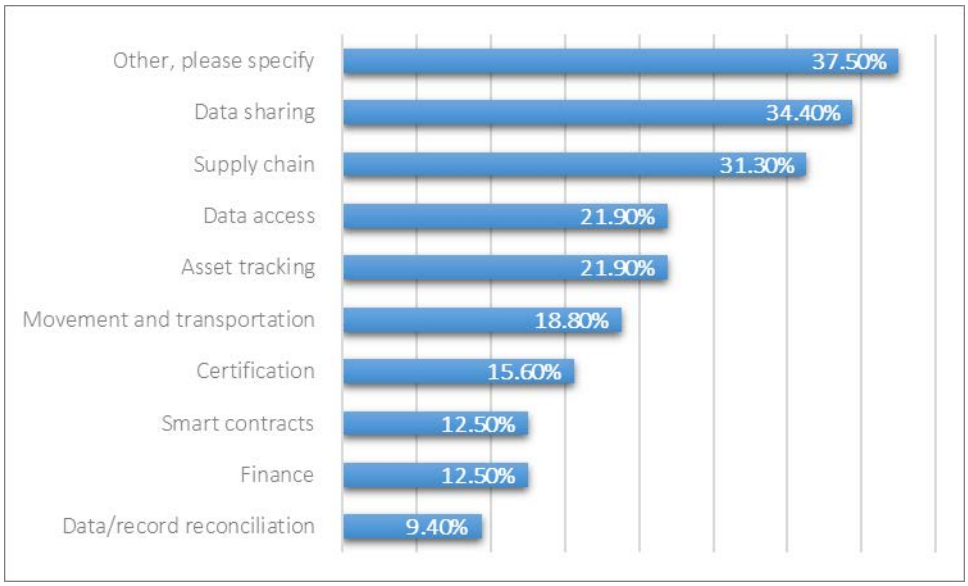

Figure-2 Q. There are countries whose organizations have deployed blockchain solutions into their core business activities. On which of the blockchain areas are your military forces working?

Based on these responses, top two blockchain technology solutions are deployed into data sharing and supply chain military activities. Following military-level blockchain technology efforts largely appear to consist of data access, asset tracking, and movement and transportation. However, almost 37% of respondents are unaware of current blockchain efforts in their military environment.

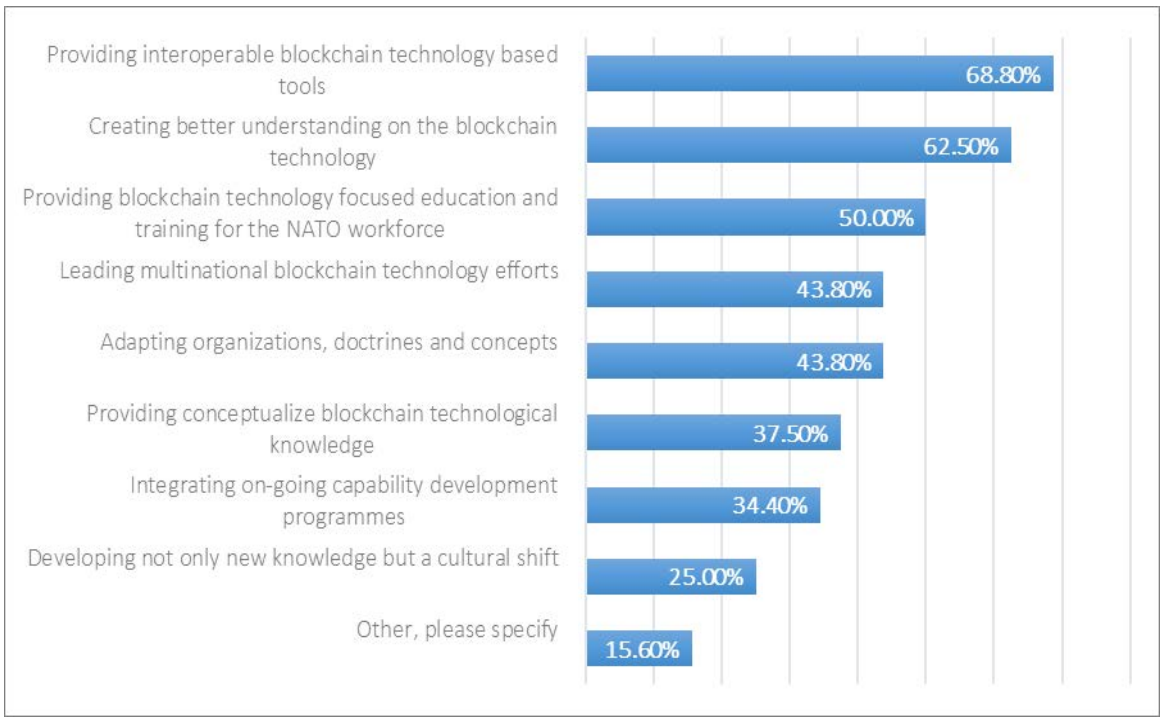

Figure-3 Q. In which areas should NATO play the leverage role in the blockchain transformation of NATO Logistics Capabilities?

These answers support the blockchain technology can improve interoperability capabilities. Specifically, 69% of survey respondents say that NATO should play the leverage role in the blockchain transformation of NATO Logistics Capabilities in providing interoperable blockchain technology based tools. Besides, creating better understating on the technology, focusing on education and training, leading multinational efforts, and adapting organizations, doctrines and concepts are specified as the other areas in which NATO should undertake leverage role.

4.3 The Leading Concerns to Blockchain Transformation

According to survey responses, 75% of the respondents think that cybersecurity concerns are among the issues that should be taken into consideration to adopt blockchain technology based solutions.

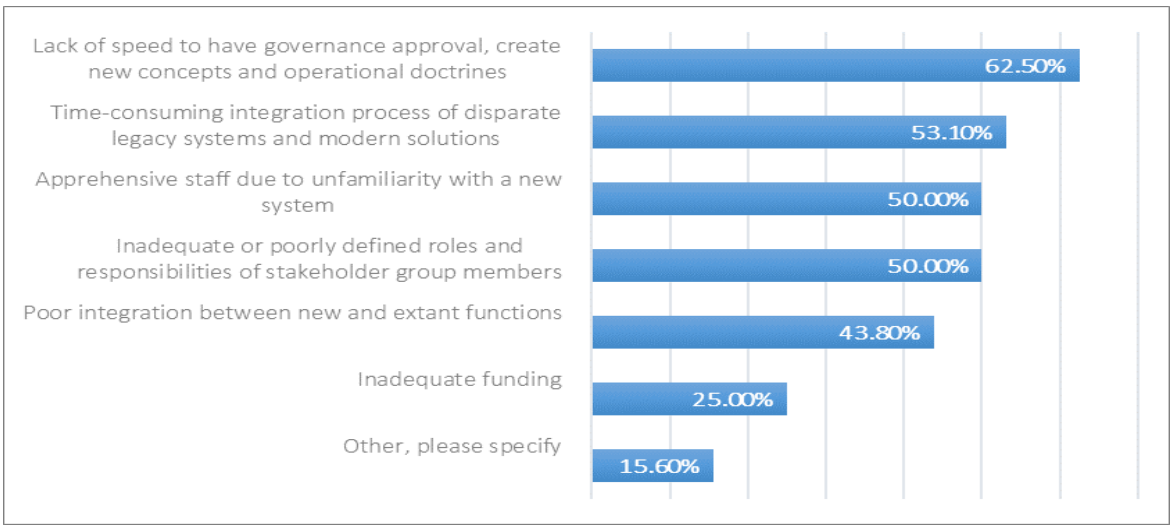

Figure-4 Q. Which of the below challenges could have impact on adopting blockchain technology based solutions in NATO logistics environment?

Major challenges of adopting blockchain technology to overcome are slow governance approval speed and long integration processes between legacy and new systems. One of the specific answers is "*NATO needs to prevent establishing another "Concept", "Procedural Approach" or "Technological Possibility" which looks good on paper, but, as proven in the current RUS/UKR situation "far off real world" requirements to warfighting."* This shows that adopting blockchain technology efforts can be challenged by the organizational inertia and the mind-set based on continuing the current trajectory. As Tsedal Neeley and Paul Leonardi stated in their "Developing a Digital Mindset" article in Harvard Business Review, "*Like any other change initiative, digital transformation often encounters resistance, and early missteps are inevitable.* [21, p.51]."

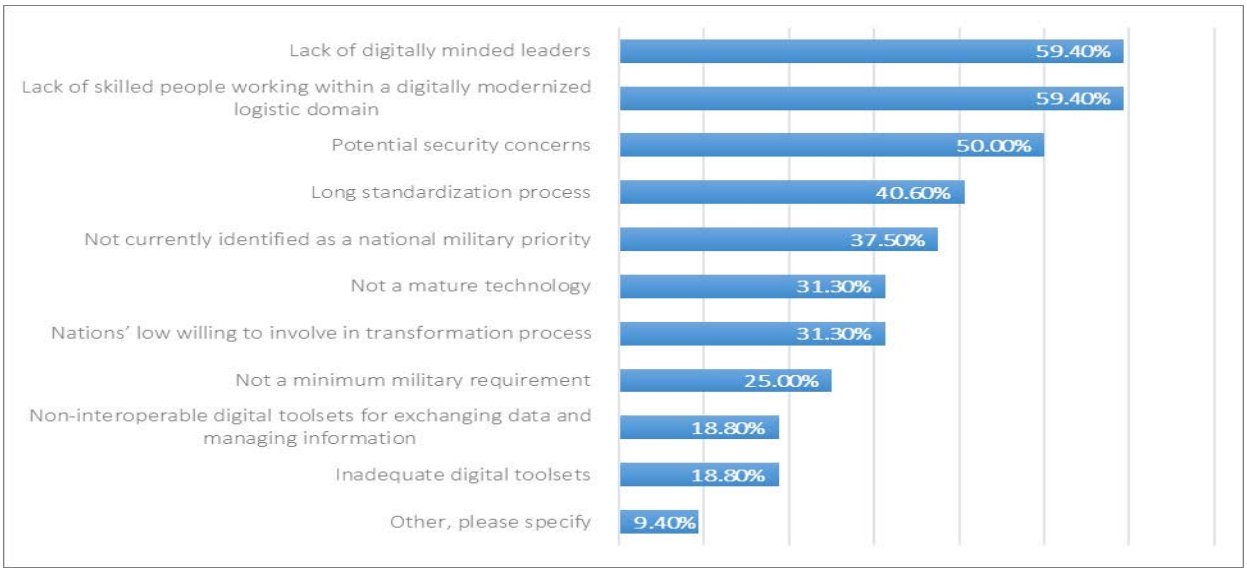

Figure-5 Q. Which of the below obstacles can apply to have greater adoption in blockchain technology?

Lack of digitally minded leaders and lack of skilled people are the top two responses regarding the obstacles of the greater adoption of blockchain technology. It is, however, interesting to see that only 25% of the respondents think this is *not a minimum military requirement.* The other interesting observation is less than 19% thinks the digital toolsets are inadequate.

In the last question, the survey focused on the specific comments made by respondents. In summary, they advise the below points:

- Considering blockchain technology's relevance;
- Re-focusing on "operating";
- We/NATO needs to cut down on "administering";
- Approaching blockchain technology from a conceptual perspective and process;
- Taking into account differences among the national efforts and implementation of this technology.

5.0 CONCLUSION

In the digital age, maintaining strategic advantage relies on various technological capabilities. Instead of choosing one of the advanced technologies and investing in it, identifying and understanding different technologies and bringing them into digital transformation portfolio can increase the digital value of the organization.

Any advanced technology is ever perfect, each has its own advantages and disadvantages. Blockchain technology is also not different and involves its own pros and cons. Successful digital transformation is only possible if the right capabilities are in the right places to integrate with others. In a digital transformational journey, new possibilities, if not exploited, could become new issues.

A better understanding on this technology can be achieved by embarking on a conceptual approach followed by experimentation. Giving the answer whether or not a *humble decentralized and trustable ledger* may be the solution for working together in a digitally regulated sustainable logistics ecosystem.

To ensure standardization of blockchain terminology in NATO, establishing standards and defining the terminology gains importance in the digital transformational process. This effort can potentially contribute to interoperability. To enhance interoperability and the effectiveness of blockchain technology solutions, collaborations with non-military partners play the key role.

To step up the blockchain awareness and allow the alliances to become more proactive requires collective effort. "Humble Ledger in NATO Logistics Chain" will be the subject of NATO Logistics Blockchain Technology Concept in 2023. NATO stakeholders' attendance and contribution to develop this concept will be highly appreciated in this journey.

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