Introduction, objectives and the implementation process

CHAPTER 01

A Introduction

Trade revenue still constitutes a significant source of income for many developing country Governments.

The streamlining, simplification and general improvement of trade processes has long been acknowledged as a significant driver of efficiency at national borders. These processes, and the use of modern technology within them, are considered key factors in the reduction of the time and cost of trading in most countries. However, developing countries – and sometimes their developed counterparts – face many challenges in streamlining trade processes using emerging technologies. While this is sometimes due to technical and regulatory difficulties, challenges can also arise from the sheer speed of change within the global trade landscape, lack of technical expertise and resource constraints. Many trade procedures still lack the required simplicity, transparency, compliance and quality assurance that could support traders, sustain Government revenue, broadly reduce the time and cost of trading, and improve the overall trader experience.

Furthermore, trade revenue still constitutes a significant source of income for many developing country Governments. But new developments, such as the proliferation of cross-border e-commerce, have presented new challenges on compliance, quality controls and revenue collection. At the same time, new technologies such as blockchain could assist Governments to improve their overall trade processes, while helping to specifically deal with emerging challenges arising from high-volume, low-value trades driven by e-commerce. This could improve overall trade compliance and prevent potential revenue leakages.

Cross border trade is becoming a mix of bulk containerized shipments and high-frequency e-commerce – individual items that cross borders at ever higher volumes— making the current trade landscape complex and trade compliance assurance difficult for Governments. Consequently, new technologies are required for Governments to successfully ensure quality controls, manage trade risks and sustain trade revenue. Digital technology – in the form of trade portals, trade reform trackers and single windows – already helps many Governments in significant ways, and blockchain has powerful capabilities that could further empower Governments to build infrastructure resilience, secure their paperless trade endeavours and smoothly process all forms of trade flows, whether bulk containerized trade or e-commerce.

The primary technical features of blockchain – such as hash functions, timestamps, smart contracts and default encryption – are well-suited to various trade processes, including risk management, post clearance audits, data protection and process automation. More on the critical features of blockchain and how they can support Governments' trade facilitation efforts is elaborated in the Global Report on Blockchain and its Implications on Trade Facilitation Performance, published by the United Nations Conference on Trade and Development in 2023.

Blockchain is a relatively nascent technology that is considered complex. But there is already prevailing scepticism around the potential returns on investment, and this is coupled with a lack of insight into the proper implementation procedures. There are also general resource

constraints around the expertise and funding needed to undertake these implementation processes. Thus, several Governments are not yet investing in building the technology, the technical expertise required, the regulatory environment or stakeholder preparedness to be able to implement it in their trade processes. Leveraging the technology's capabilities to facilitate trade will require most Governments to put in place a number of regulatory, technical and policy measures for successful implementation and sustainable use. The potential of blockchain for the new age of cross-border trade, however, remains compelling, albeit with some challenges. Challenges exist around the legal and regulatory frameworks, technical incompatibilities with legacy infrastructure, scalability limitations of the technology, data privacy and security concerns, shortage of appropriate talent and expertise, user acceptance difficulties, resource constraints and cost concerns. Both developed and developing countries need to resolve these policy and technical challenges in order to achieve success in the implementation process as well as optimal use of the technology.

According to a joint survey by the World Customs Organization (WCO) and the World Trade Organization (WTO) in 2022, blockchain technology has already drawn the attention of several Governments, with 19 per cent of customs authorities exploring the technology's potential through a proof of concept, 14 per cent testing solutions through pilot projects, and 24 per cent planning to explore its potential within the next three years.

B Objectives

Existing guides about blockchain implementation are generally broad in scope and lack specificity and depth in terms of practical steps for implementing the technology. Thus, the present guide aims to:

Give Governments a framework for the successful and sustainable implementation of blockchain-supported trade facilitation ecosystems.

Present implementation steps, a stakeholder engagement approach, and technical and regulatory requirements for the implementation of blockchain for trade facilitation.

Outline the development, deployment and adoption process of blockchain for trade facilitation.

Outline areas where blockchain can bring potential value and efficiency gains in trade in terms of quality, controls, compliance, security and infrastructure resilience.

Provide technical details on complementary workflows that can accompany the implementation of blockchain for optimal utility of the technology.

Outline the technical implementation options available to Governments as well as the technical and regulatory trade-offs of all implementation considerations.

Provide use-case scenarios and implementation considerations in accordance with international standards.

Provide measures for ensuring backward and forward integration with existing and future trade infrastructure.

Delve into the processes and requirements of undertaking blockchain needs and readiness assessments for trade facilitation.

C
Understanding blockchain

Blockchain is a digital database that holds information in a secure and distributed manner with numerous copies saved on many machines. While this creates redundancy, it also increases the resilience of applications built using the technology. The functional security, resilience and reliability of the applications deployed on blockchain are ensured by the strength and dependability of the blockchain itself. They are generally considered shared, immutable databases that facilitate the process of keeping records and tracking these records in real-time and in a shared environment, and thus they can build a trustworthy service in a not necessarily trustworthy environment (Clavin and others, 2020). Stakeholders in a blockchain keep servers/nodes and use them to validate and store data in the form of block-type data structures while inter-stakeholder coordination generates and updates the data through consensus algorithms and the security and integrity of the data is ensured through encryption (Lu, 2019). The code that runs and establishes a blockchain between the many different stakeholder computers ensures security by making unauthorized entries on the ledger very difficult and tampering nearly impossible (Green, 2022). These technical features and functionalities of the technology make blockchain particularly useful for certain Government and industry use-cases, such as supply chain management, trade processing, automation, record keeping, quality assurance, compliance and data protection.

Key features of blockchain that can add value and yield efficiency gains in terms of trade facilitation are summarized in table 1.

Table 1. Key features of blockchain and their use-case suitability in trade facilitation

Blockchain features	Use-case suitability within trade
Data encryption	Data exchange among key stakeholders. User data and identity protection. Compliance and audits of key authorizations. Fraud detection, forgery prevention and counterfeit elimination. Prevention of unauthorized stakeholder activities.
Timestamps and hash functions	Creation, verification and acceptance of originals and electronic copies of trade documents. Detection of intellectual property theft and substandard goods. Preservation of data integrity. Detection of damaged or expired goods. Tracking and tracing of supply chains and goods' life cycle.
Multiple storage of data and records	Resilience of digital trade infrastructure. Preservation of critical trade data in extreme cases, such as natural disasters. Business continuity during system outages, cyberattacks or data breaches.

Source: Compiled by ESCWA.

The Trade Facilitation Agreement and blockchain technology

The Trade Facilitation Agreement (TFA) of the WTO not only sets out obligations for countries to undertake necessary trade reforms but also serves as a key global technical and legal structure that provides significant guidance to countries looking to reduce the cost and time to trade, enhance their competitiveness and reach trade revenue targets. Digital technologies such as trade portals, single windows and reform trackers are generally implemented in the context of TFA provisions and have helped many countries meet TFA obligations. Harnessing the key technical functionalities of blockchain could help countries towards their TFA ambitions as well. Table 2 presents some of the functionalities of blockchain that are relevant to TFA provisions.

Table 2. Blockchain functionalities relevant to the Trade Facilitation Agreement

TFA Provisions	Relevant blockchain functionalities
Article 1: Publication and Availability of Information	Distributed data redundancies protect key data and make them available to key stakeholders.
Article 7: Release and Clearance of Goods	Secure encrypted payment, secure storage and transfer of data, and the immutability of data in storage and in transit can expedite declarations and release of goods.
Article 7.1: Pre-arrival Processing	Secure transfer of trade declarations, documents and information within and across borders could support pre-arrival processing.
Article 7.2: Electronic Payment	Secure and encrypted payment rails on blockchain represent one of the most common uses of blockchain in finance.
Article 7.4: Risk Management	Data encryption, hash functions, timestamps and encryption can prevent falsification, alterations and corruption, while enhancing compliance and risk management.
Article 7.5: Post-clearance Audit	Hash functions, timestamps and encryption can prevent falsification and alterations, support the checking of authorizations and protect records.
Article 7.7: Trade Facilitation Measures for Authorized Operators	Certifications, identifications and declarations can all be secure and provisioned by the blockchain database.
Article 7.8: Expedited Shipments	Availability of information, elimination of cumbersome in-person processes and creation of paperless processes through a shared blockchain database can promote expedited shipment.
Article 8: Border Agency Cooperation	Distributed and secure shared databases of blockchain can enhance cooperation among key stakeholders at the border.
Article 10: Formalities Connected with Importation, Exportation and Transit	Digitalization and automation of processes by smart contracts and other blockchain features can help cut the time and cost of formalities for importers, exporters and transit processes.
Article 11: Freedom of Transit	Blockchain databases that allow for cross-border data harmonization, controls and data sharing can improve trade in transit.
Article 12: Customs Cooperation	Distributed shared databases of blockchain make cooperation among key stakeholders, especially across borders, easier than proprietary closed systems.

Source: Compiled by ESCWA.

D
Overview of the implementation process

The complexity of implementing blockchain is a common disincentive for the adoption and use of the technology. At the same time, a technical understanding of the technology shows that it is more resilient than conventional computer networks. It also has several parallels with legacy technologies such as cloud computing and other mesh networks. The distinction lies in blockchain's primitives – in other words, the security protocol components – reliability guarantees and technical architecture. While it is currently limited in storage capacity and processing speed across a number of computational indicators, the security, transparency, resilience, quality assurance, auditability and improved compliance of blockchain, as well as its ability to protect process continuity, make it particularly useful for certain trade facilitation purposes. As a decentralized technology by default, blockchain usually presents several implementation challenges for centralized entities like Government, especially in relation to design and architecture.

The present sub-section of the guide briefly presents technical, policy and regulatory implementation options and considerations. To build a blockchain system that meets international standards and ensures that Governments get the most value from this digital infrastructure, the following aspects need to be understood:

A

The areas of need and level of readiness for the technology

B

The implementation options

C

The technical trade-offs of implementation considerations

D

The steps required to build suitable stakeholder dynamics

E

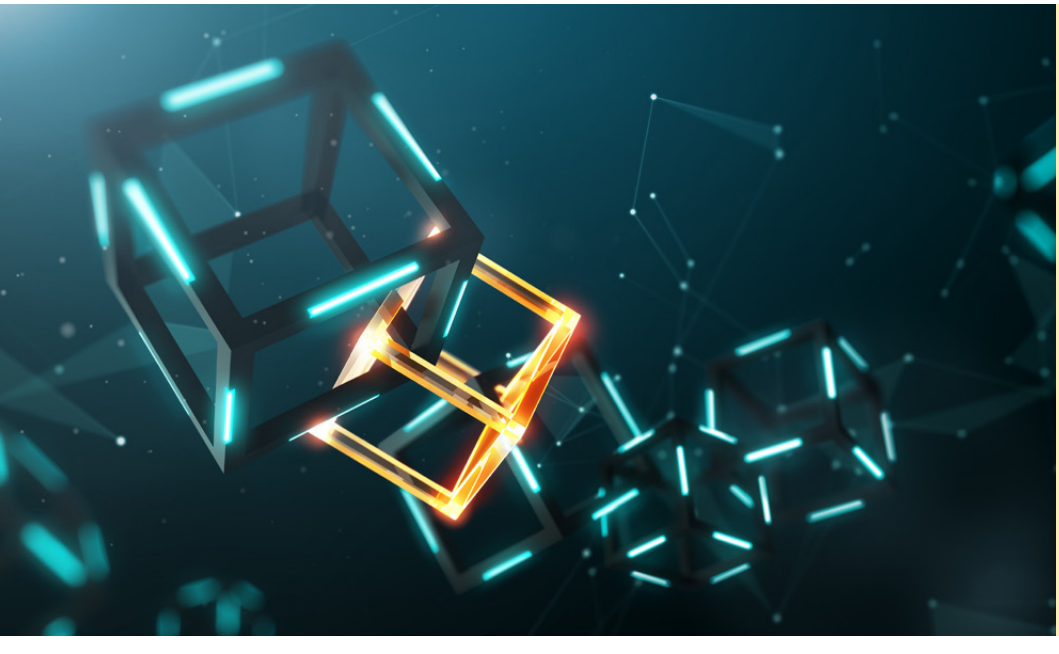
The process of achieving regulatory and legal compliance

Blockchain usually presents several implementation challenges for centralized entities.

Thus, the three broad considerations in implementing blockchain technology to support Government trade processes comprise architectural design, stakeholder coordination and regulatory compliance. Once a Government has determined that it needs a blockchain-based system for certain trade processes after undertaking a needs assessment and has ascertained the country's preparedness for the implementation of the technology through a readiness assessment, the Government's implementing body must make important decisions around technical considerations, options and trade-offs in relation to the system's design and architecture and the governance of the implementation process. Alongside this, a policy and regulatory environment that will support the implementation process must be built.

Technical design choices will largely consider trade-offs around sovereignty, security, performance, feasibility, reliability, value addition and sustainability. These technical choices may also influence some aspects of the policy and regulatory choices. Some of the key questions for the implementing body to consider include:

- What kind of blockchain should be used for trade facilitation applications? Should a public permissionless blockchain be used or should the Government deploy its own private, sovereign blockchain?
- What are the cost considerations of these design options?
- If the Government wishes to deploy its own private blockchain, would it be feasible, reliable and sustainable in the context of existing infrastructure and the regulatory and policy environment or would some adjustments be needed?
- What policy, regulatory and infrastructure adjustments or overhauls would be needed in the existing environment for the technology to function optimally?
- If the Government chooses to build trade facilitation applications on a public permissionless blockchain network, would the Government be prepared to give up sovereignty and control over certain trade data?
- What kind of public permissionless blockchain systems already exist that could be well-suited to the envisaged trade facilitation use-case, if any?



Technical design choices will largely consider trade-offs around sovereignty, security, performance, feasibility, reliability, value addition and sustainability.

These considerations are elaborated in table 3.

Table 3. Considerations for choosing the type of blockchain for trade processes

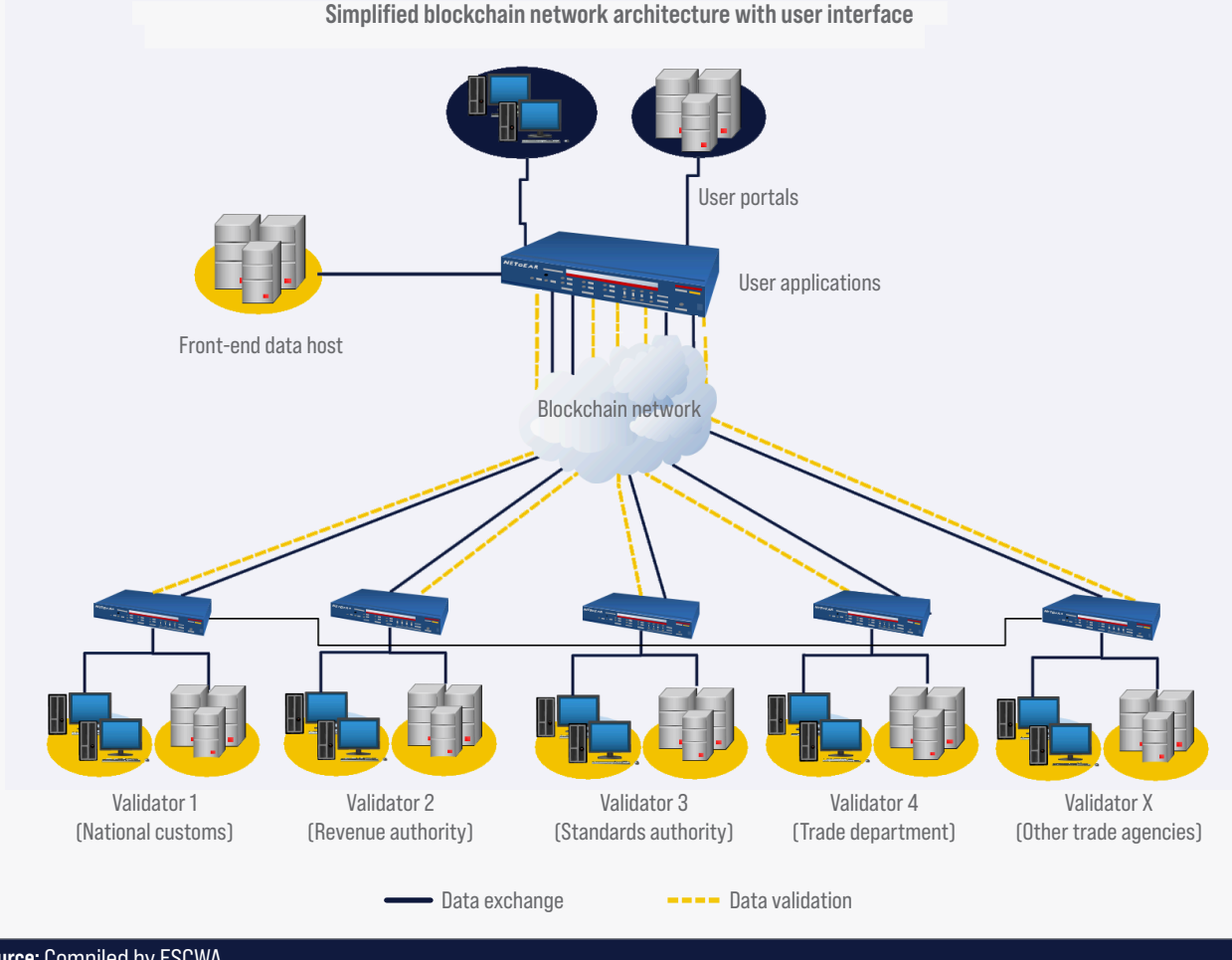
Considerations	Building on a public blockchain	Building on a shared permissioned blockchain/ consortium chain	Building on a private blockchain
Implementation	Involves building only the business logic and applications on top of an existing blockchain.	Involves building the business logic, applications and portals the Government may choose to support the infrastructure by building a server/node.	Involves building a full blockchain, as well as the business logic and the applications on top of the blockchain.
Cost	Involves costs for application and transaction costs for recording data on the blockchain.	Involves cost of hosting front-end data as well as operational development of business logic. Government may add cost of supporting the infrastructure with nodes/servers.	Involves infrastructure costs for maintaining servers/nodes and running the blockchain, as well as costs for the accompanying applications and portals.
Maintenance	Maintenance only required for the applications and business logic on top of the blockchain.	Maintenance may include applications and business logic as well as network infrastructure such as servers/nodes.	Maintenance and updates is required for the whole blockchain as well as for the process logic and applications.
Sovereignty	The implementing body would not have full sovereignty over the infrastructure.	The implementing body may has medium level of sovereignty over application logic and use-case but does not have full sovereignty over network infrastructure.	The implementing body controls the network and holds full sovereignty over the infrastructure, data and usage, depending on where the blockchain servers are hosted.
Security	Offers higher security due to global reach, permissionless systems and broad decentralization.	Offers a medium level of security. Not as secure as public permissionless blockchain but more secure than private blockchain networks	Offers lower security due to limited decentralization.
Flexibility	Offers limited flexibility on scaling, speed and adjustments.	Offers medium level of scalability, but not as flexible with scalability as private blockchain networks.	Offers total flexibility in choosing parameters and specifications based on users' needs.
Prerequisites	Requires a competent team and resources to implement applications and business logic.	Requires a team and resources to implement business logic and applications/portals, but the Government may also choose to commit resources to network infrastructure.	Requires infrastructure such as reliable electricity and internet connection, as well as the resources and expertise to implement the full blockchain and supporting solutions/ applications.
Suitability for trade facilitation	Less suitable for most trade facilitation purposes due to limited flexibility around key parameters.	Suitable for trade facilitation but reduced sovereignty and limited flexibility with scalability and parameters can be a disadvantage.	Flexibility to adjust specifications and parameters means higher suitability for trade facilitation purposes.

Source: Compiled by ESCWA.

Though potentially more cost-effective, public blockchain networks can bring both data sovereignty challenges as well as uncertainties around the transaction cost of recording data on the blockchain. Using a shared permissioned blockchain as in the case of regionally focused blockchain network, LACChain, also means full sovereignty over the network is not guaranteed even though cost of implementation could be minimal. This second option may require the Government to only design and operate a user-facing portal/applications on the shared consortium/regional blockchain together with regional counterparts. Lastly, if a Government builds a private blockchain, the Government will be required to run and maintain infrastructure to keep the network live at all times, in addition to bearing the associated operational and maintenance costs of the trade facilitation applications. This third option though could be costly, allows the Government great flexibility to choose the network features as may be suitable for its use in trade facilitation and beyond. Furthermore, this option, at the minimum, requires reliable electricity and internet connection to be secure and useful. Unfortunately, in most developing countries these two pre-existing conditions cannot be guaranteed.

Thus, while building a private blockchain requires developing and maintaining the entire architecture, which could comprise the components shown in figure 1, building on a public permissionless blockchain or on a shared permissioned blockchain may only require the Government to build and maintain the user portals, business logic and host front-end data.

Figure 1. Simplified blockchain network architecture with user interface



Source: Compiled by ESCWA.

Figure 2. The stages of the blockchain development and deployment process

Source: Compiled by ESCWA.

Thinking about the use-cases beforehand will help the Government choose the specific type of public or private blockchain required and make the right trade-offs around speed, security, reliability and sustainability.

In any case, it is critical that the Government adopts a process that will cause the least disruption to existing trade processes and that it implements the blockchain in a controlled environment before going into production. As shown in figure 2, the development and deployment process should be sequenced as follows: design, proof of concept, pilots, beta testing, limited user access and final deployment.

Based on user-specific login details and taking cues from the stakeholder credentials during login, the smart contracts could be designed to render different business logics to the user portal.

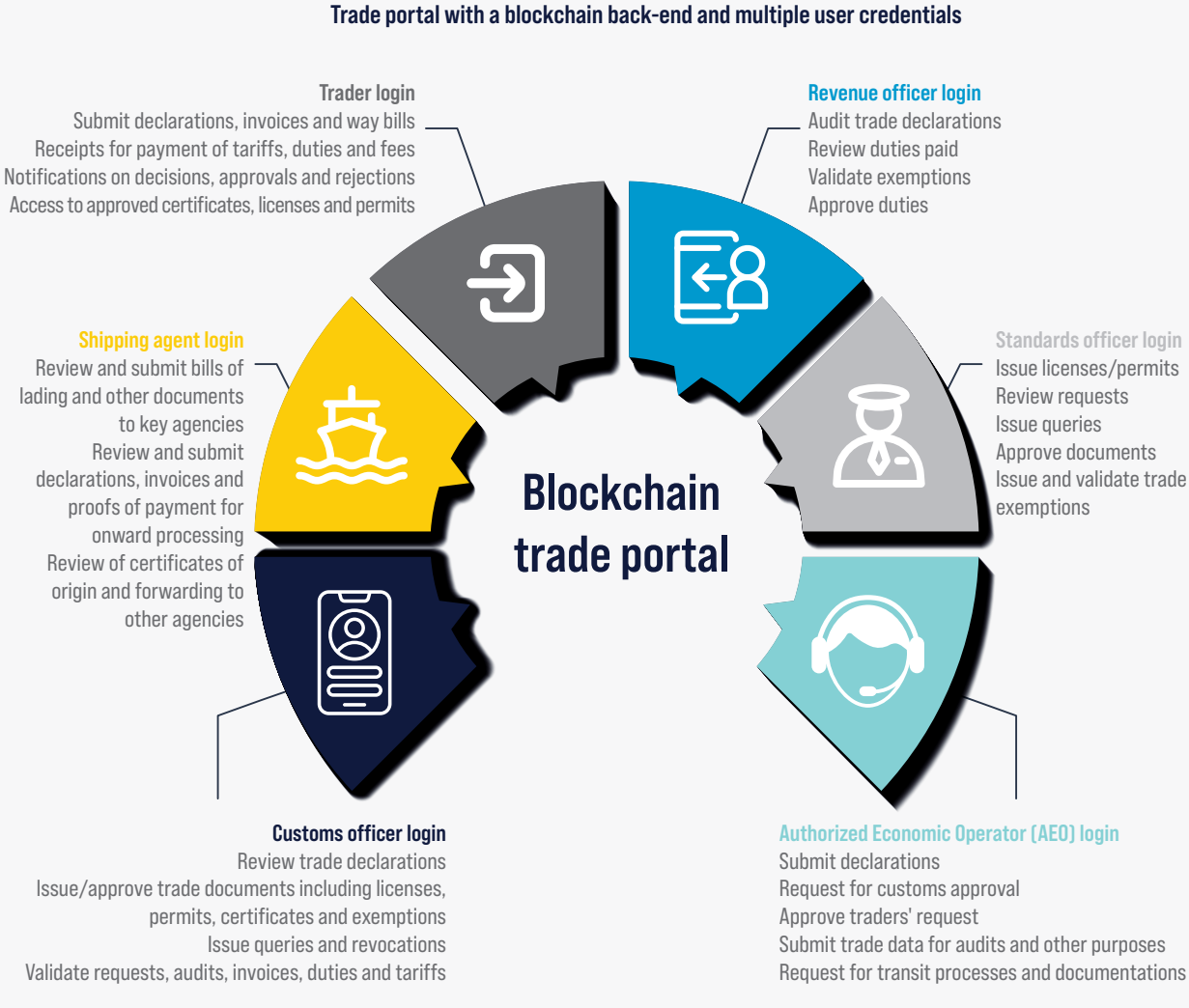
Lessons from each stage should be fully incorporated into the final product before full deployment, and each step should cover all the basic elements of a fully functioning and usable blockchain, including the application flow, the business logic and the middleware, as well as the user facing portals and interfaces that allow users to interact with the blockchain logic to deliver the intended trade facilitation processes, flows and user expectations.

Finally, user credentials can be created and entered at the portal level or business logic level with various rights and access controls. The business logic and middleware (in other words, the smart contracts stored on the blockchain) can be programmed to have different pathways depending on the credentials of the user that logs in. This should grant different levels of authorization, rights and privileges to the user and should allow for multiplicity of use and user interactions within the same portal, as well as the compartmentalization of various logics and access rights based on the user type, user needs and user demands. Based on user-specific login details and taking cues from the stakeholder credentials during login, the smart contracts could be designed to render different business logics to the user portal and grant

different user rights based on the stakeholder type, need and/or level of authority within the Government. This aspect, which is largely a policy, regulatory and compliance issue would be mainly informed by Government processes, stakeholder coordination mechanisms and leadership dynamics within the Government. Figure 3 demonstrates how multiple functionalities are possible using a multi-user interface or portal that could be built and supported by back-end blockchain. Such a set-up could give traders the opportunity to submit trade declarations while supporting customs officers to review, validate and approve the declarations.

Multiple functionalities are possible using a multi-user interface or portal that could be built and supported by back-end blockchain.

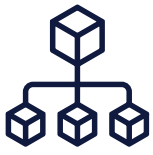
Figure 3. User interface of a blockchain-supported portal with multiple user functionalities



Source: Compiled by ESCWA.

Most Governments already use digital tools, applications and portals for trade processes. The implementation of blockchain should therefore consider three key user experience needs:

A



The implementation of the blockchain should, as far as possible, be done in the context of the existing infrastructure to allow for integration with existing legacy systems and future applications.

B

The implementation process should avoid disruption to the existing user experience within the various portals and interfaces and should instead aim to build efficiency, resilience and security into the existing business logics.

C

Where new portals or interfaces are created during the implementation process, they should enhance the average user's ability to undertake their daily operations with ease and minimize the possibility of human error.