Blockchain-based smart contract for international business – a framework

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Abstract

Purpose – Cross border trade, involving different business environments between the sellers' and buyers' countries, may result in conflicts because of asymmetry in the information structure across the borders. The International Chambers of Commerce (ICC) has laid down ground rules on terms of shipment and payment, enabling harmonization and standardization of business process, and fixing of responsibilities for international trade. The international commercial (INCO) terms by ICC define the duties, obligations and cost borne by the exporter and the importer. An exporter's uncertainty looms once the goods cross his/her border. Therefore, there is a need for a smart contract that is secured, transparent, legitimate and trustworthy. The authors propose a blockchain technology-based smart global contract (BTGC) framework for international trade.

Design/methodology/approach – In this paper, the authors develop the framework based on value chain analysis (VCA) of international trade and an ontology-driven-blockchain-design approach. The paper analyzes the sequence of activities in the value chain of global trade, the terms of the contract, the data structure templates, the validation rules and the points-of-failure, and proposes the smart contract blockchain structure.

Findings – This paper proposes the BTGC framework considering the INCO terms 2020; it provides the validation rules and the probability of failures; and identifies the elements that cause the halting of contracts and conditions of creation of side blockchains. The framework also includes the governance of the BTGC system.

Research limitations/implications – The proposed framework not only has implications at the firm level as it automates and secures a global sale contract but also is expected to harmonize the global-trade process as well. The developers may use the attributes, data structure templates and the rules identified in this paper for developing the GC software. Future research may consider using case analysis, class diagrams and the related steps for developing the blockchain software.

Originality/value – This paper proposes a complete value chain of global contract (GC) concerning exports, an ontology of GC and a blockchain-based smart-contract framework based on global standards. Besides, it specifies the elements of fraud (such as the non-integration of side chains) and uncertainty, i.e. the probability of failures. Such a framework will harmonize the global-trade process and build an international standards for smart GC based on blockchain technology (ISSGCBT), which is not yet done.

Keywords International trade, Qualitative, Ontology, Value chain analysis, Smart contract, Blockchain technology, INCO terms, Side chains

Paper type Research paper

1. Introduction

Global business has two essential characteristics; first, it is a cross border, and second, it is multimodal (Sinha, 2019). The first characteristic leads to a difference in the business environment between the sellers' and buyers' countries. The two countries differ in terms of political, economical, social, technological, legal and environmental (PESTLE) perspective.

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The second characteristic makes the supply chain (SC) complex as the choice of modes of transportation, the carriers and the nodes where transshipment takes place are dependent on multiple factors, and some of them are even conflicting with each other. Thus, the following question arises:

RQ1. How can the contracts take care of cross-border requirements, mitigate the conflicts and avoid rejection of consignments because of non-compliance?

In global trade, there is an asymmetry in the information structure for business partners across the borders. The firms find customs procedures and payment terms difficult to grasp and rely on the efficacy of logistics service providers – freight forwarders (FFs) and third-party logistics (3PL) service providers. These aspects increase the uncertainty in international business. Hence, the following question arises:

RQ2. How would the primary stakeholders – the exporter and the importer – assure themselves of contract-compliance, timeliness and cost control?

The world bodies such as the International Chambers of Commerce (ICC) has laid down ground rules in terms of shipment and payment, enabling harmonization and standardization of terms of business, process and responsibilities. It makes things transparent and demands complete knowledge of the steps in fulfilling the global requirements. A stakeholder needs to comply with global guidelines, else in the event of any dispute face losses. Thus, the following question arises:

RQ3. How to ensure dispute and conflict resolutions across the multimodal chain?

There are 11 International-Commercial (INCO) terms describing the responsibility and obligation of the buyer and seller. These terms also clarify the cost to be borne by them. INCO terms were revised this year (INCO Term – 2020) to clarify some of the 2010 version issues. Clarification led to the introduction of a new term (DPU, i.e. delivery-at-place-unloaded in place of DAT, i.e. delivery-at-terminal), interpretation of insurance clauses under CIP (carriage-insurance-paid) and CIF (cost-insurance-freight) INCO terms and explained few more obligations. Exporters and importers need to understand the clauses, as any dispute leads a very costly settlement by international arbitrators, viz. around US $39,000 for a consignment of around US$1m (ICC, 2020b). Besides, payment through documentary credit requires the submission of documents. The documents vary with the INCO terms, and incomplete or improper documents result in delay, penalties, amendments and even payment rejection. Thus, the following question arises:

RQ4. How can the logistics activities get integrated with associated documentation and payment process?

Blockchain technology (BT) is well known for its distributed, decentralized, consensus-based immutable information exchange, enabling reduced transaction cost, time and fraud. A smart contract based on BT can also aid in reducing uncertainty. Wüst and Gervais (2018) concluded that blockchain is suitable in a situation where there is a lack of trust between entities or the flow of information from trustless sources. The technology enables us to make contracts secure and a structured approach in managing them. Four characteristics of BT – decentralization, persistence, anonymity and audibility (Zheng *et al.*, 2017), make it appropriate in a global business where stakeholders' credibility may not be certain.

Several authors (Segers *et al.*, 2019; Botton, 2018; Okazaki, 2018; Viryasitavat *et al.*, 2018) proposed using BT automation involving multiple parties, primarily focusing on customs-related processes for import clearances. In importing goods, the consignee needs to file Bill-of-Entry (BoE), a document seeking permission to import, before the customs. The customs assess the import duty based on declaration in BoE, following which the consignee pays for the duty. These activities may happen before the goods are unloaded from ship or aircraft. On unloading, the customs may appraise the cargo to check the goods physically. On satisfactory assessment and appraisal, the customs permit to take the goods out of the port. However, the import clearance is not the responsibility of the importer always; it depends on the INCO terms. In delivery-duty-paid (DDP) terms, the exporter takes the import clearance. These aspects need to be inbuilt in a smart GC.

The BSP_RDM or the Buy-Sell-Pay-Reference Data Model provides the use-cases in UN/CEFACT International Supply Chain reference Model (ISCRM) but does not incorporate the INCO terms and payment terms laid down by ICC (UNECE, 2019).

Thus, very few works address the questions raised here and provide a holistic framework, i.e. application of BT integrating INCO terms, associated documents and conditions in global contracts (GC). Literature also lacks in providing the blockchain governance framework for GCs.

In this paper, the authors attempt to explore the possibility of a symbiotic relationship between blockchain and smart GCs and aim to answer the four research questions. The authors identify the rules based on INCO terms, the contract conditions with primary and secondary data elements across different documents and their links to the payment process. This paper proposes the association rules connecting the contract with regulatory and commercial obligations, ultimately leading to a secured delivery and payment realization. The authors identify the external conditions and criteria which disrupt a contract and cause errors. They propose a governance framework as well. Thus, the paper provides a framework for a smart GC based on BT.

2. Literature review

2.1 Global supply chain management

A SC is the network of facilities performing material procurement for intermediate and finished products and distributing finished products to customers (Lee and Billington, 1993). Several authors stress SC managers to focus on improving customer service, lowering the cost, maximizing efficiency, mitigating SC risk, reducing waste, improving the new product design process, enhancing product service quality and creating an environmental-friendly SC (Spekman *et al.*, 1998; Skojett-Larsen, 1999; Tan, 2001; McCormack and Kasper, 2002; Sachan and Datta, 2005; Melnyk *et al.*, 2009; Dubey *et al.*, 2012; Randall and Mello, 2012; Machowiak, 2012; Dubey and Ali, 2013). The challenge of SC management is identifying and implementing strategies to minimize cost and maximize flexibility in a competitive and complex market (Wadhwa *et al.*, 2008). The increase in e-procurement has led to know-how collaboration and mutual competency creation and electronic visibility (Chang *et al.*, 2013). The cross-border regulations; the INCO terms; the payment terms; the multiple modes of transportation, terminals or nodes; and stakeholders make global SCs volatile, uncertain, complex and ambiguous (Sinha and Dey, 2018). Thus, there is a need for integrated, low-cost, traceable, flexible, time-bound and secured contracts. A BT-based smart global contract (BTGC) can be a good option to achieve these objectives.

2.2 Blockchain technology

BT becomes popular with the introduction of Bitcoin, a "peer-to-peer electronic cash system" created by Satoshi Nakamoto (2008). The concept was novel and different from all previous money exchange system. There is no need for a financial intermediary such as banks. The technology allowed immutable and consensus-based transactions, i.e. through a distributed ledger system (Abeyratne and Monfared, 2016; Wright and De Filippi, 2017), making it secured (Mougayar and Buterin, 2016).

A blockchain network provides storage space for secure, immutable and decentralized data (Xu *et al.* 2016). Data is updated in the system only if there is a consensus by all stakeholders in the network (Awwad *et al.*, 2018). This technology enables transparent, robust, auditable and secured transaction (Crosby *et al.*, 2016; Greenspan, 2015; Christidis and Devetsikiotis, 2016). The basic structure of a blockchain adapted from the work of Awwad *et al.* (2018) is illustrated in Figure 1.

Zhao *et al.* (2016) distinguished generations of blockchain into three versions such as Blockchain 1.0 (which includes applications enabling digital cryptocurrency transactions), Blockchain 2.0 (which includes smart contracts and a set of applications extending beyond cryptocurrency transactions) and Blockchain 3.0 [which includes applications in areas beyond the previous two versions, such as government, health, science and Internet of Things (IoT)].

A blockchain network comprises nodes of individual stakeholders intending to transact with each other. Every responsible person has a private key (for keeping it privately) and a public key (for sharing with all the other persons). As soon as the future owner of cryptocurrency (or digital tokens/representation of some other asset) shares his/her public key to the original owner, the transaction gets initiated, packaged with other awaiting transactions, in turn, creating a "Block." Now there is always a possibility that many blocks are created at the same time by different nodes. A mathematical framework is applied, known as "proof of work," to choose which block should be the next in the blockchain system (Srivastava *et al.*, 2018; Crosby *et al.*, 2016). After the blockchain's position gets decided in the next stage, called the verification stage, the blockchain system evaluates the transactions. It determines the database's validity through mathematical calculations based on agreed-upon rules, i.e. achieving consensus. The verified blocks get time-stamped with a cryptographic hash, which references the previous block's hash, forming an immutable record chain. The transaction gets over after completion of all of these stages. Blockchain does not require nodes in a chain to trust each other or behave in an arbitrary manner called Byzantine manner (Dinh *et al.*, 2018).

Babich and Hilary (2019) identified five key strengths – visibility, aggregation, validation, automation and resiliency; and corresponding five weaknesses – lack of privacy, lack of standardization, garbage in and garbage out, black box effect and inefficiency. The authors proposed three research themes of applying BT to operations management – information, automation and tokenization. Depending on the platform's management, there are three types of a blockchain network: public, private and consortium or federated (Buterin, 2015; Zheng *et al.*, 2018; Eris Industries, 2016; Christidis and Devetsikiotis, 2016; Kravchenko, 2016; Wood, 2016).

Source: Authors' creation (Adapted from Awwad *et al.*, 2018)

Figure 1.
Basic structure of a block chain

A GC requires collaboration between the seller (exporter), regulatory bodies (customs and similar), agents and service providers, buyer (importers) and related agencies such as banks, international forums – e.g. International Maritime Organizations (IMO), arbitrators and law enforcing agencies. Thus, BT requires the creation of a consortium of all these stakeholders.

Casino *et al.* (2018) illustrated blockchain architecture as a set of interconnected mechanisms between distinct elements – blocks, governance framework, consensus mechanism and transaction embedded in an information-technology infrastructure. Belu (2019) put forward five stages – P2P network (request for a transaction), communication (to members of the network), validation (of a transaction), control (creation of new block) and acknowledgment (inclusion of new block and completion of the transaction). In a GC, a block gets created on two occasions – an entity requests for a transaction (for example, raises an invoice) and completion of physical activities (such as inspection of material) leading to the generation of a document (such as inspection certificate), followed by acceptance by the concerned parties, say exporter, importer and customs authorities of both the countries. Thus, one needs to identify the different smart contract elements and their applicability in global sales contracts.

The primary concerns in this field have been the integration of the entire chain (Mougayar and Buterin, 2016), security breaches (Lim *et al.*, 2014) and ensuring independence and confidentiality when all the nodes of blockchain have access to the database (Atzori, 2016).

2.3 Smart contracts

Szabo (1994) defined smart contract as a computerized transaction protocol that executes the terms of a contract creating transactions, placing into a block and saving immutably into a blockchain ledger. Mougayar and Buterin (2016) observed that smart contracts promise to power the BT in the future. Swan (2015) and Amber Road (2018) put forward the advantage of block enabling "trustless" transactions assuring the sharing and visibility features as a "single version of the truth." Kakavand *et al.* (2016) showed that smart contracts are efficient, secure, transparent and cheaper, aiming to secure contractual processes. Linux Foundation (2020) stressed that smart contracts are free from intermediaries (lawyers, brokers or auditors) as anyone can develop it. These aspects make it autonomous, efficient, secured, immutable, cheaper and accurate.

In a smart contract, stakeholders get connected to the blockchain as nodes. The chains may be public where anyone joins anytime and begins transaction to be verified by nodes called full-nodes. The transactions in the form of blocks get created and retained only when an agreement or a consensus is reached among nodes to prevent fraud (Vukolić, 2015; Christidis and Devetsikiotis, 2016; Casino *et al.*, 2018). The initial public blockchains used different consensus mechanisms (Mingxiao *et al.*, 2017) such as Proof-of-Work (PoW) (Antonopoulos, 2014), Proof-of-Stake (PoS) (Pilkington, 2016) and Byzantine Fault Tolerance (BFT) (Castro and Liskov, 2002), along with its variants (Zheng *et al.*, 2018). In private and federated blockchain networks (i.e. permission category), a whitelist of allowed users is usually defined with particular characteristics and permissions over the network operations (Casino *et al.*, 2018). Because the risk of Sybil attacks is almost negligible there (Swanson, 2015), private blockchain networks can avoid expensive PoW protocol; instead, a more extensive range of consensus protocols based on disincentives could be adopted. Federated blockchain shares similar scalability and privacy protection level with a private blockchain; their main difference is that a set of nodes, named leader nodes, is selected instead of a single entity to verify the transaction processes, which enable a partially decentralized design

where leader nodes can grant permissions to other users (Casino *et al.*, 2018). In a GC, exporter and importer can be earmarked as leader nodes.

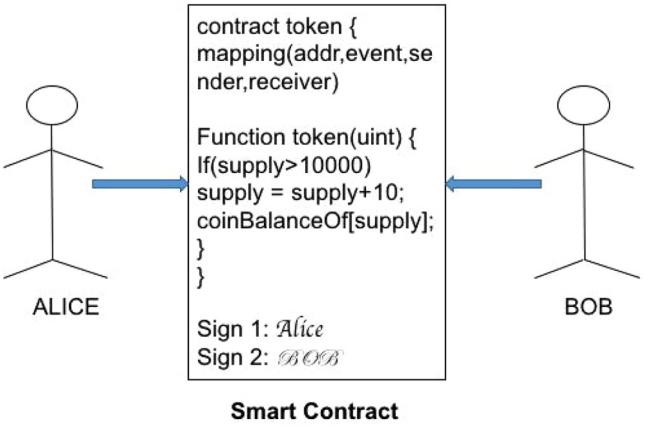
Blockchain framework, in smart contracts, allows storing of complex states that dynamically update using distributed computing to meet the specific criteria of the contract (Casino *et al.*, 2018). Finally, the governance layer widens the blockchain architecture to cover human interactions in the physical world.

GCs require risk management (Babich and Hilary, 2019) and traceability (Opara, 2003; Norton *et al.*, 2014; Fisher, 2015; Provenance, 2016), and identification of nature and root cause of problems (Alam, 2016) in managing the SCs. BT enables the seller to track the flow on a near real-time basis to optimizing cost and time (Koetsier, 2017; Nautiyal *et al.*, 2020). In international business, the seller may not be responsible for delivering the goods at the buyer's doorstep as it depends on the INCO terms. For example, under the free-on-board (FOB) contract, the seller is responsible for putting the goods on the ship, and the buyer manages the rest of the voyage. Thus, the buyer needs real-time tracking of his consignment from the port of origin until it reaches his/her site.

A smart contract is a digital and independent agreement in a coded language between two counterparts without liaisoning (Bocek *et al.*, 2017), making intermediaries' involvement (e.g. lawyers and bankers) redundant (Fairfield, 2014). In smart contracts, code in blockchain comprises the transaction conditions, so a contract is a part of the whole blockchain distributed across the network (Nautiyal *et al.*, 2020). This smart contract works automatically as soon as counterparties' terms and conditions are met (Nautiyal *et al.*, 2020).

Smart contract code is stored, verified and executed on a blockchain where each transaction consists of a nonce, ether balance, contract code hash and storage root (Sompolinsky and Zohar, 2015; Wood, 2018). Srivastava *et al.* (2018) illustrated an example of a smart contract code consisting of accounts, addresses and a state transition function, as shown in Figure 2. Dasaklis *et al.* (2018) provided a framework linking blockchain with smart health.

The smart contracts appear promising, but what is its application in global SC management? A probe into this aspect can give a lead to determine what remains to do.



Source: Adapted from Srivastava *et al.* (2018)

Figure 2.
A sample of smart contract between two entities

2.4 Application of blockchain technology in global operations

There are signs of BT used in global business; however, there is a need for further study on its application on all facets of export–import (EXIM) operations and suggest a global-smart-contract framework. For example, while shipping goods, the bill of lading cannot be altered as the original one is always visible through many sources. These features make SC trustworthy (Kshetri, 2018). Shipping lines such as Maersk (Jackson, 2017) and the retail chain, namely Walmart, in cooperation with IBM (Popper and Lohr, 2017), adopted this technology. Gupta (2018) illustrated the different stages in a smart contract, as shown in Figure 3. This illustration serves as a useful reference, but an international value chain study can make the work holistic.

EXIM business makes the customer's requirement of delivery-on-time-in-full in the right condition at the right cost at the right place (Flint, 2004; Rao and Holt, 2005) challenging. There is also a need to assure the customers regarding the source of the products (Quak and De Koster, 2007) and, thus, demand correct declaration of goods in documents (Hesketh, 2010; WCO, 2005), avoiding fraud in international trade (Triepels *et al.*, 2018). Manuj and Mentzer (2008) have suggested supplier evaluation to mitigate risk, but the same is hardly achievable because of information asymmetry. The INCO terms define the responsibility or risk transfer, obligation and cost separately for the exporter and the importer. Sometimes there is confusion between risk transfer and obligation. For example, under the cost and freight (CFR) contract, the exporter must engage a shipping line and pay for its freight, but his/her responsibility ends once the goods get loaded onboard the vessel. So, the question arises – what happens if the exporter's poor shipping line choice causes damage during the voyage. Such nuances need to be inbuilt in global smart contracts. Studies have shown BT's usefulness in international trade as it eliminates intermediaries, reduces costs and enhances security and transparency (Manuel and Andrews, 2016; Gonzalez, 2015).

Martincus *et al.* (2015) referred to the use of BT for customs' import-declaration, whereas Hu *et al.* (2016) pointed out BT can prevent fraud, such as undervaluation of imported goods' transaction value to reduce legitimate custom duties. Several authors (Weigand and Bukhsh, 2011; Okazaki, 2018; Segers *et al.*, 2019) substantiated that BT aids in the cross-validation of information provided in the import declaration and builds trust between the customs and

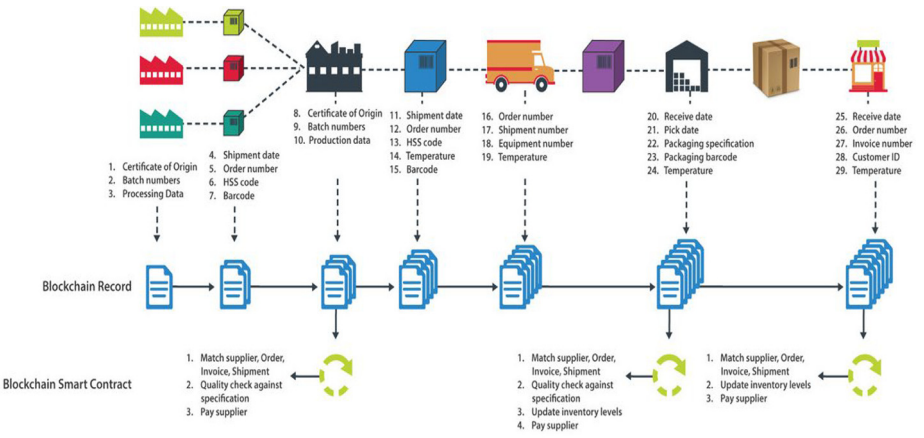


Figure 3.
Example of supply chain system using BT

Source: Adapted from Gupta (2018)

the importer. Van Engelenburg *et al.* (2017) proposed transactions to be signed by at least two parties to ensure the data's correctness. In case of the exchange of proforma invoice data elements, the consignor and consignee could sign the transaction so that customs authorities can rely on correctness. Complete coverage of smart contracts would require incorporating 11 INCO terms, with around five different payment terms with each payment term having different options, involving at least 15 stages of physical events and around 10–15 stakeholders.

The challenge lies in the standardization of processes across nations. Standards such as UN/CEFACT, the WCO Data Model and GS1 can serve as the industry standard for exchanging shipping documents (GS1, 2013; Thompson, 2017; WCO, 2009). Awwad *et al.* (2018) proposed integrating physical flows with contractual conditions using IoT-based smart containers that measure the conditions such as pressure, temperature, vibrations and locations to track the flow of containers. Such a system was tested successfully by IBM in collaboration with Capgemini at the Watson IoT center.

Sadouskaya (2017) expressed concern over the implementation of smart contracts in SC and logistics companies as it requires understanding the flow; the stakeholders involved; the terms and conditions; the rules of start, continuance and end of contracts; and the risk involved. Francisco and Swanson (2018) recommended an analysis of factors affecting the system's performance before the complete adoption of BT in managing SC. Kamble *et al.* (2019) surveyed 181 Indian SC practitioners and showed that the perceived usefulness, attitude and perceived behavioral control affect the behavioral intention in adopting BT.

Thus, to establish a framework for a smart global business contract involving the sale of goods, it is crucial to understand the concept of being, the relationships and the flow, i.e. developing the ontology and carrying out a value chain analysis.

3. Methodology

The authors develop the framework based on an ontology-driven-blockchain-design approach and value chain analysis (VCA) of international trade. Kim and Laskowski (2018) proposed an ontology-driven blockchain design for SC provenance. Yan *et al.* (2006) developed a framework for contract ontology. The authors extend this framework to develop the ontology for a GC for exports. Several authors (Gereffi and Fernandez-Stark, 2011; Kaplinsky and Morris, 2000) advocated VCA to understand the sequence of value added by a firm, from conception to production and end-use. There are also references for VCA of logistics and SC (de Souza and Márcio de Almeida, 2013; Zhou, 2013; Taylor, 2005). This study considers VCA from production to delivery across the border to identify the stakeholders, responsibilities, rules, documents and factors impacting each activity's quality.

3.1 Ontology of smart global contract

A GC has an exporter and an importer. It has other features (Yan *et al.*, 2006), namely, has-HScode, has-Value, has-Currency, has-INCOterm, has-NamedPlace, has-DeliverySpecification, has-TimePeriod, has-TechnicalTerms, has-CommercialTerms and has-DisputeResolutionClauses. Besides, it may include has-ThirdParty. Figure 4 illustrates the top-level ontology diagram.

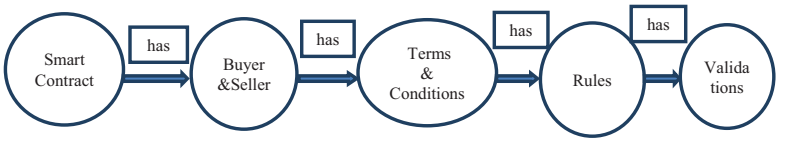
Figure 5 illustrates the second level of the ontology diagram. It relates to the parties, terms, rules and validations.

Figure 6 illustrates the third level of the ontology diagram. It relates the contract terms with its provenance and subsequent release of payment, marking the importer's acceptance. It describes the side chains that relate to contracts by exporter and importers with their

service providers such as logistics operators, FF or customs-house-agent (CHA), or 3PL operators, dry and seaports, insurance companies and others explained in the value chain.

Figure 7 illustrates the four primary sections of a contract – the contract's scope, the technical terms prescribing the specifications, commercial terms that include the delivery and payment terms and the non-fulfillment clause. It connects with specific crucial clauses of GCs.

Figure 8 illustrates the conceptual object-oriented structure of the blockchain of GC. It shows class descriptions in connection with blockchain implementation.



Source: Authors' creation

Figure 4.
Top-level ontology diagram

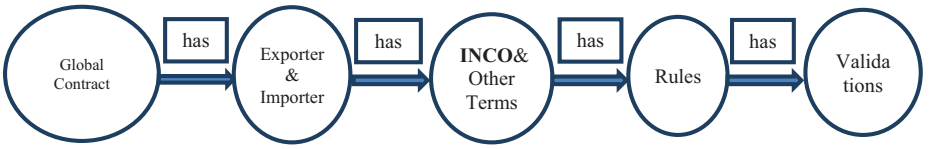


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Figure 5.
Second-level ontology diagram

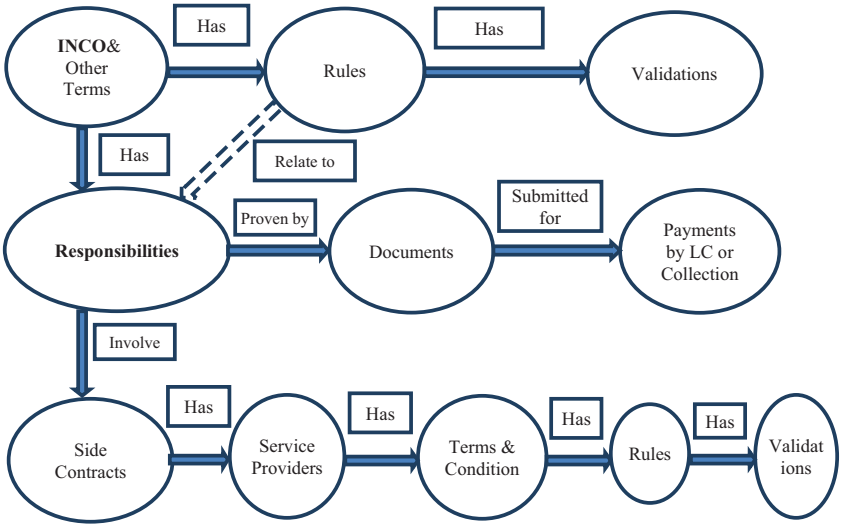

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Figure 6.
Third-level ontology diagram for global contract (GC)

Figure 9 illustrates the implementation of a smart GC. It shows the link of smart contract application (GC App) user interface (UI) with blocks' creation, the transmission of blocks to the nodes with a time stamp.

The ensuing sections explain the development of smart GC using BT.

4. International trade value chain analysis

In international trade, the number of value-added activities depends on the mode of packaging and transportation choice. An error in any of these stages either causes the contract to fail or leads to disputes. The maximum activities relate to the shipment of less-container-load (LCL) goods sent by containers, and it comprises at least 23 stages. The number of stages increases if there is no direct sailing and involves transshipments. It involves movement through dry ports referred to as inland container depot (ICD) or container freight station (CFS). All stages add value to the delivery process, or in other words, any error or defect in any of these activities leads to a drop in the quality of transportation (Dua and Sinha, 2019a). Figure 10 shows the sequence of activities in a cross-border sale, their associations and independent features that impact the success.

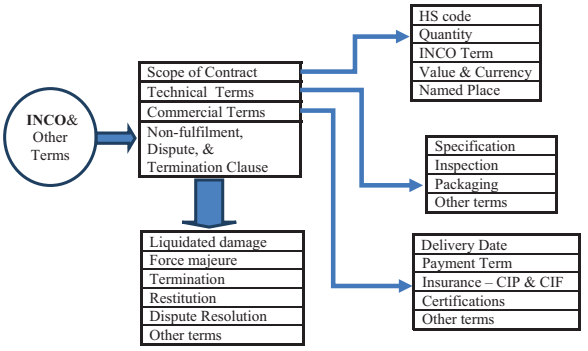

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Figure 7. Primary sections of a global contract (GC)

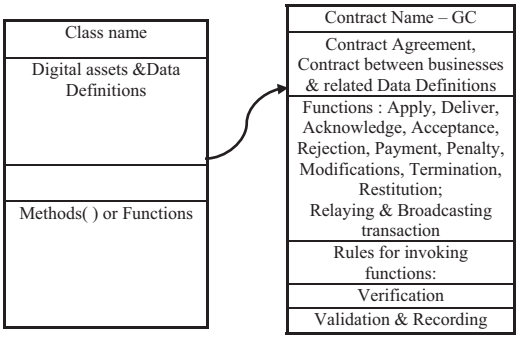

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Figure 8. Conceptual object-oriented structure of blockchain of GC

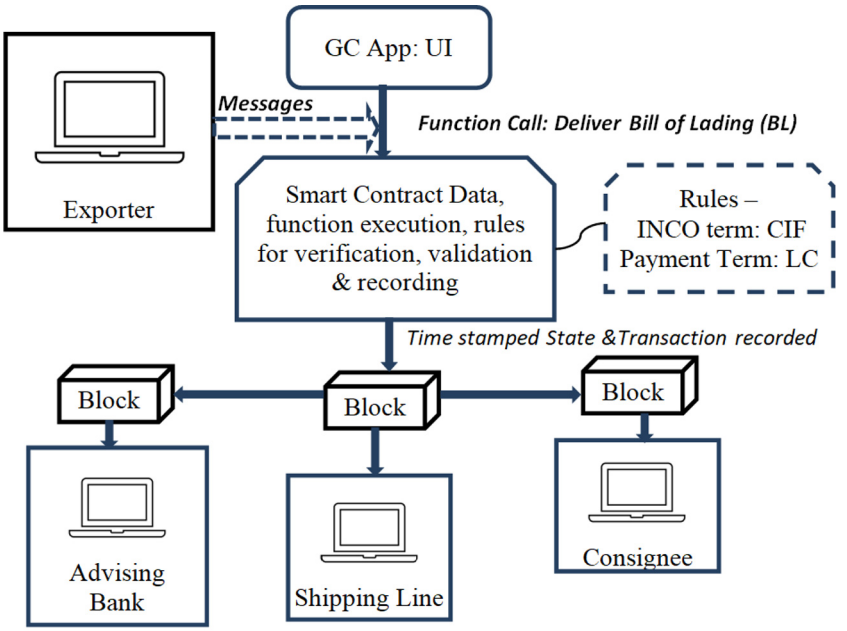


Figure 9.
Implementation of smart GC on blockchain infrastructure

Source: Authors' creation (adapted from Ramamurthy, 2020)

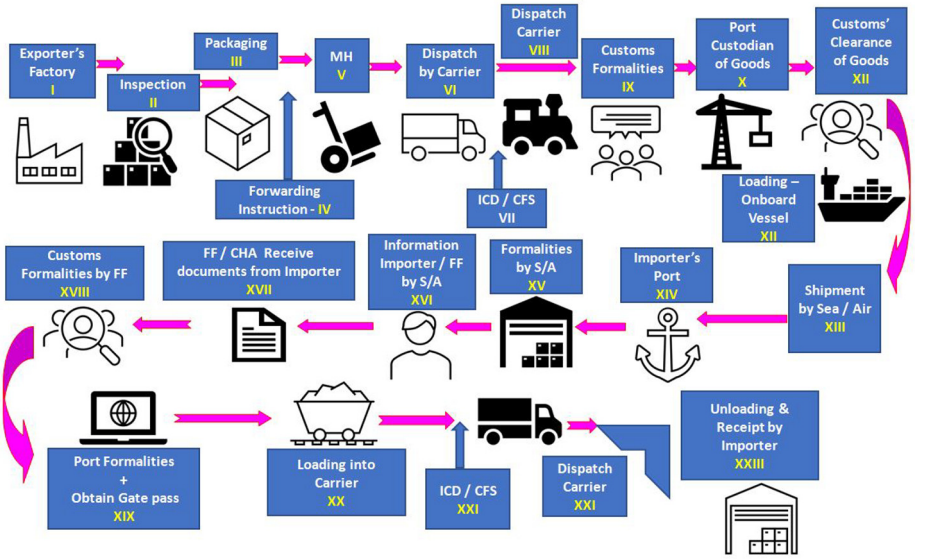


Figure 10.
Activities in an international trade value chain

Source: Authors' creation

Except for the first three stages, the exporter or the importer performs other activities depending on the INCO terms. For example, under ExWorks INCO term, the exporter's responsibility ends on completion of Stage III, whereas under DDP, he/she is responsible till stage XXIII.

Once the goods are made ready for shipment at the manufacturer's end (stage – I), the stages include:

- Stage II (X1): Pre-export inspection of the goods carried out to satisfy the customer. At this point, the exporter undertakes a contract with the inspection agency. Let the probability of success be denoted as P(X1).
- Stage III (X2): Packaging of goods completed for onward shipment. Here, the exporter undertakes a contract with the packaging agency. Let the probability of success be denoted as P(X2).
- Stage IV (X3): The shipper, i.e. either the exporter or the importer, depending on the INCO term, engages a FF to book space in containers or vessels. The FF interacts with the shipping agent (SA) representing the shipping line. Let the probability of success be denoted as P(X3).
- Stage V (X4): The exporter engages a material handling agency (MH) to load the cargo on board for the onward movement to the port. Let the probability of success be denoted as P(X4).
- Stage VI (X5): The inland carrier takes cargo to the dry port. The shipper undertakes a contract with the transporter. The shipper, either the exporter or the importer, depending on the INCO term, engages the transporter. This stage is valid only for cargo moved in containers. Let the probability of success be denoted as P (X5).
- Stage VII (X6): A dry port refers to an ICD or a CFS. Here, the goods get stuffed in containers, and customs clearance is obtained. The exporter is responsible for the export clearance, but arranging for containers is the shipper's responsibility, i.e. either the exporter or the importer, depending on the INCO term. Let the probability of success be denoted as P(X6).
- Stage VIII (X7): The inland carrier from ICD or CFS takes cargo to the seaport. The shipper undertakes a contract with the transporter. The shipper is either the exporter or the importer, depending on the INCO term. Let the probability of success be denoted as P(X7).
- Stage IX (X8): The customs formalities from the shipper's end is complete by now. Customs may have issued the permission termed as let-export-order (LEO). Let the probability of success be denoted as P(X8).
- Stage X (X9): At this stage, the consignment reaches the seaport, and the port admits the cargo for loading onboard the ship. Let the probability of success be denoted as P(X9).
- Stage XI (X10): If LEO is already provided, the customs checks the container's seals and other checks, if required, and gives the no-objection. Else carries out the appraisal and gives the consent to export. Let the probability of success be denoted as P(X10).
- Stage XII (X11): Cargo gets loaded onboard the vessel. The master of the vessel delivers a bill of lading as proof of a contract-of-carriage with the shipper. Let the probability of success be denoted as P(X11).

- Stage XIII (X12): Ship's voyage. Let the probability of success be denoted as P(X12).
- Stage XIV (X13): The ship reaches the importer's port. The FF of the exporter or importer, depending on the INCO term, files an application to the customs for import clearance. In the case of DAP or DPU, the importer does the customs clearance, whereas in cases of DDP, the exporter is responsible for the customs clearance as well. Let the probability of success be denoted as P(X13).
- Stage XV (X14): The SA gets all regulatory clearances. Let the probability of success be denoted as P(X14).
- Stage XVI (X15): The SA gives notice-of-readiness (NOR) to the FF or the CHA of the consignee for getting cargo clearance. Let the probability of success be denoted as P(X15).
- Stage XVII (X16): The FF or the CHA of the consignee collects shipping documents such as the bill-of-lading (BL). If the payment term is letter-of-credit (LC) and the INCO term other than DDP, the importer gets documents after the exporter meets its responsibility and submits the documents to the issuing bank through his bank. Else, if the payment term is the documentary collection, the bank hands over the document on receipt of payment from the importer or against acceptance (from the importer) to pay later. In all other payment terms, the documents are handed over as per the contract's commercial terms. Let the probability of success be denoted as P (X16).
- Stage XVIII (X17): The FF or the CHA gets the customs' clearance to import the cargo. Let the probability of success be denoted as P(X17).
- Stage XIX (X18): The exporter or importer, depending on the INCO term, pays the delivery order charges, port cargo handling and other charges to the seaport and obtains the exit gate pass. Let the probability of success be denoted as P (X18).
- Stage XX (X19): The exporter or importer, depending on the INCO term, arranges transport for moving the container to the ICD or CFS for de-stuffing. Let the probability of success be denoted as P(X19).
- Stage XXI (X20): The exporter or importer, depending on the INCO term, engages with the ICD or CFS for de-stuffing. Let the probability of success be denoted as P (X20).
- Stage XXII (X21): The exporter or importer, depending on the INCO term, arranges transport for moving the goods to the final destination. Let the probability of success be denoted as P(X21).
- Stage XXIII (X22): The consignment moves to the destination. Let the probability of success be denoted as P(X22).

A contract is a prelude to all physical actions. The dispute settlement section of the contract loses its significance if all actions are rightly taken, i.e. per contract. Thus, the conditions leading to the possibility of errors and, in turn, disrupting contracts need a clear understanding. A smart contract through BT implementation is a rule-based phenomenon (Fenu *et al.*, 2018); any deviation from the rules leads to failure. These authors suggest identifying factors that impact the contract and use a logit model to determine success. For example, in the Ethereum initial coin offerings, the success factors are country of origin and team size.

Similarly, in a smart GC, some factors affect the performance of the contract. However, the probability of success cannot be determined using a logit model as this contract involves transactions with some interconnections and independent features. For example, the performance of a node such as seaports is dependent on incoming carriers bringing cargo in the port, and also, the port's productivity affecting the performance of a port toward servicing a ship. Thus, the probability of success of the global smart contract depends on the probability of each event's success along the value chain, as expressed in equation (1).

$$\mathrm{P(X)} = \Pi_i P(X_i), \tag{1}$$

where $P(X)$ denotes the probability of success of the global smart contract and i denotes the stages. The success gets influenced by control variables such as government regulation, operating environment, availability of service providers and activity restrictions, say because of force majeure reasons (Cho *et al.*, 2008; Baker and Sinkula, 1999; Gani, 2017; Sinha, 2019). The complexity of government regulations regarding all cargo in general and regarding particular HS codes, the operating environment (say, measured in terms of logistics performance index by the World Bank) and activity restrictions in countries impacts the contract execution.

5. Global contract

A global (EXIM) contract generally has four main sections, namely, Section 1 – the scope of contract, section 2 – the technical specification, section 3 – commercial section and section 4 – settlements and dispute resolution. The terms of contract vary with 11 INCO terms; 5 payment terms – the documentary credit (at sight, or usance, or green or red LC), documentary collection (delivery against payment, or delivery against acceptance), open account (with or without bank guarantee or against standby LC), escrow account, advance payment (with or without bank guarantee); 15 stages of physical events described in Section 4; and around 10–15 stakeholders involved in each of this stages. Also, there are exclusive contracts between the stakeholders and the buyer and/or seller, depending on the INCO term. For example, under FOB INCO term, the seller signs contract or deals with his/her FW, the packaging agency, inspection agency, government agency, material-handling agency, the inland carrier, the dry port (for containerized cargo), banks, customs and port. The buyer corresponds with his/her FW, the shipping line or his/her agents, importer's port, banks, customs, inland carrier and dry port.

The contract lays down the exporter's and importer's responsibilities who, as per their responsibilities, sign contracts with their business partner or other stakeholders such as banks. In any secured and smart contract, integration with other contracts leads to a successful conclusion of the main contract. For example, an exporter may need funds to get his/her shipment ready to meet his/her contract condition and use the LC as collateral. However, the LC issued by the importer's bank has no relationship with the exporter's bank responsible for providing packing credit. The following sections discuss the aspect of interconnected contracts and explain their association.

5.1 Section 1 – the scope of contract

This section of the contract, among others, has six unique elements that make it different from a domestic contract. These elements include the HS code, quantity, the value (of contract), the currency, the INCO term and the named place. For example, an exporter selling goods at US$1 to a customer in the USA has no clarity unless the point of sale and the seller's responsibility are defined. For a price of US$1, the sale cost at the exporter's doorstep

will significantly differ with the sale taking place at the buyer's doorstep. This difference is because the activities and responsibilities of an exporter are different in the two cases. The ambiguity in the sale and the seller's responsibility are made clear with the use of the INCO terms and the named place. Say, when the exporter from Kolkata proposes to deliver goods to the importer at the exporter's doorstep, he/she would mention US$1, ExWorks, Rubypark-Kolkata, whereas, if the exporter needs to deliver the goods at the buyers' doorstep in Newark, the contract terms will be US$1, DDP, Newark-US.

Globally traders use a harmonized six-digit code to describe the nomenclature of all merchandise. The first two digits reflect the chapter, say ten refers to cereals, while the next two digits define the type (of cereal), say 1006 refers to rice and the next two digits define the specific products, say 100620 refers to husked brown rice. The structure of the HS code is, therefore, XX.XX.XX. Worldwide, the countries have agreed to accept the six-digit HS code. However, the six-digit code is extended to eight digits or beyond, differently in different countries, to assign customs-import-duty or keep track of value addition on the primary goods defined by the six-digit code. For example, in the USA, 1006.20.40.00 denotes basmati rice, i.e. exporters or importers use a ten-digit code when the rice type differs. The last two digits of this ten-digit code also vary with further change in quality or type, say, 1006.20.40.20 for long grain, 1006.20.40.40 for medium grain, 1006.20.40.60 for short grain and 1006.20.40.80 for a mixture of any of the grains. In India, the description of goods does not go beyond eight digits, and the last two digits may not be in sync with other country codes. Thus, if an exporter in India sells rice to the USA under door-to-door terms of sale (DDP INCO term) compatibility in information exchange across the two countries is needed. An exporter with buyers in n different countries needs to map the HS codes in n different formats. Figure 11 describes the mapping format of HS codes between two countries, say A and B.

There are 11 INCO terms under four categories E, F, C and D (ICC, 2020a). These terms describe the risk, cost and obligations of an exporter and an importer. Table B as Appendix list the different INCO terms.

Under E, F and C terms, the exporter's transfer of risk happens in his/her own country. In C category INCO terms, exporters have an obligation to bear cost beyond their borders. That is, the named place does not signify the point of transfer of risk, instead indicating the point until the exporter has to bear the cost. In D category INCO terms, the exporter bears the risk up to the buyer's country. Thus, the named place alone does not meet the contract's requirement under the C category of INCO terms; hence, there is a need to include the

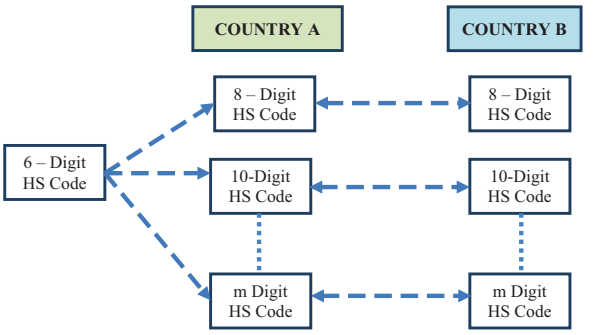


Figure 11.
Mapping format of HS codes

Source: Authors' creation

port-of-origin along with other elements. This inclusion is because the risk gets transferred here, but the exporter must pay for freight and/or insurance. The payment terms, such as documentary credit or collection, are related to the concept of risk transfer. An exporter is eligible to seek payment only after the risk is transferred and on submission of documents, indicating that he/she has fulfilled all his obligations. Under the C category, INCO term risk transfer can occur at a port, namely, dry port, sea, air, land, rail, tank port or custom-bonded place.

Section 1 of the contract needs to include data items – Contract Reference Number; HS code; HS code extension in the exporting country at eight or more digit levels; HS code extension in the importing country at eight or more digit levels; quantity and its units-of-measurement (UoM); the value and the currency; INCO term; the named place of delivery and the port-of-origin. The contract reference number serves as the primary key. Table A1 in the Appendix, illustrates a data structure template.

Specific INCO terms such as FAS, FOB, CFR and CIF are applicable only for marine ports. Thus, contract should have *validation rules* for different INCO terms. The rule is stated as follows:

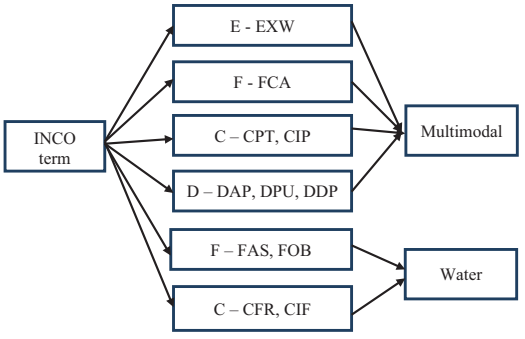
"If INCO terms are FAS or FOB or CFR or CIF, only water transportation mode can be used."

As such, the risk transfer takes place at a marine port only. Figure 12 shows the link between the INCO terms and mode of transportation. Multimodal refers to any mode of transportation, including waterways (Dua and Sinha, 2015; Dua and Sinha, 2019b). Table A2 in the Appendix enumerates the abbreviations.

Under the CIP and CIF INCO term, the exporter needs to take insurance until the named place. However, the coverage of insurance varies. In CIP, insurance includes comprehensive coverage, i.e. coverage under Clause A of Institute Clauses, whereas in CIF, insurance includes minimal coverage, i.e. coverage under Clause C of Institute Clauses. At the point of risk transfer, the insurance gets transferred in the name of the buyer. Thus, the contract should have provision to link with insurance in these two cases and transfer policy from the seller to the buyer. Figure 13 shows the link between INCO terms and insurance.

Here a validation rule – "If CIP, Insurance = Clause A, If CIF, Insurance = Clause C" is applicable.

The validation rules need to interlink the elements, namely, the HS code, INCO term, quantity, mode of transport, insurance, point of risk transfer, named place of delivery, value



Source: Authors' creation

Figure 12.
Link between INCO terms and mode of transportation

and currency along with other subsections of the contract – technical, commercial and dispute resolution.

Thus, the validation rules would stand as follows:

- If INCO term = FAS or FOB or CFR or CIF.

Then mode = Marine.
Else mode = Multimodal.

- If INCO term = CIF.

Then insurance = Clause C.
Else if INCO term = CIP.
Then insurance = Clause A.
Else insurance need not feature in the contract.

- If INCO term = C category.

Then point of risk transfer ≠ Named place of delivery.
Else point of risk transfer = Named place of delivery.

- If HS code (six-digit) of exporting country ≠ HS code (six-digit) of importing country.

Then contract should mention both HS codes.
Else contract should mention standard HS code.

- If M – digit HS code of exporting country ≠ M – digit HS code of importing country.

Then contract should mention both HS codes.
Else contract should mention standard HS code.

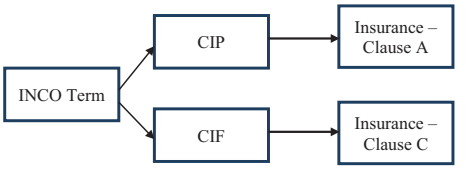
- If currency of exporting country ≠ Currency of trading.

Then exchange rate = Fixed or variable.
Else no exchange rates.

- If currency of importing country ≠ Currency of trading.

Then exchange rate = Fixed or variable
Else no exchange rates.

Validation Rule 6 stems from the fact that the banking system in sellers' and buyers' countries may have restrictions on currency in which overseas buying or selling can occur. If the currency of trading differs from the currency prevalent in sellers' or buyers' country, then the trading partners may wish to hedge the currency. In such a case, the same need not



Source: Authors' creation

Figure 13.
Link between INCO terms and insurance coverage

be a part of the sales contract but certainly a necessary accompaniment. Figure 14 shows the add-ons to the primary sales contract.

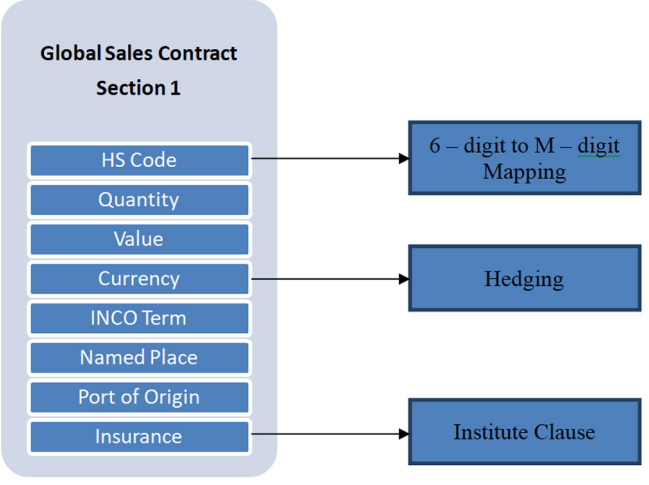
The underwriters specify insurance clauses from time to time referred to as institutes' clauses such as Clause A, B or C, or strike-riot-civil-commotion (SRCC), free-from-capture & seizures (FCS) and similar. The data items in the insurance contract include contract reference number; insurance policy reference number; insurance type (air, marine, road, rail, warehouse-to-warehouse); insurance clause (Clause A or B or C, FCS, free-from-riots-civil-commotion seizure); premium amount; and currency of payment. Table A3 in the Appendix illustrates the data structure template on the insurance contract.

The role of exporter and importer on customs clearance for exports and imports is also defined in INCO terms. In one INCO term, namely, ExWorks, the importer cannot insist for customs' clearance of exports by the exporter. Similarly, in DDP, the exporter does the import clearance. Figure 15 illustrates the responsibility for customs clearance.

The export clearance process starts with filing of export declaration to customs – referred as shipping bill or bill-of-export or simply export application following which the customs assess the export duty payable, if any, and appraises the cargo when it reaches the port to give its permission – referred as the let-export-order. Figure 16 illustrates the export clearance process from customs.

5.2 Section 2 – the technical specification

This section deals with the specification of the products or goods traded. For example, if exporter exports rice, then the variety and quality of rice (such as polished long-grain basmati rice) must be specified. In a smart contract, the specification may get linked with quality and country-of-origin (CoO) certificates. Thus, these certificates are the accompaniments of this part of the contract. The specification of goods or products will also include packaging specifications, such as rice exports in a one-kilogram pack or industrial bags of 100 kg. If the packaging involves the use of wooden materials, then in such cases, an ISPM-15 certificate, say a Packaging Material Certificate (PMC) is required. The standards



Source: Authors' creation

Figure 14. Add-ons to the primary global contract

for such certifications are laid down by International Standards for Phytosanitary Measures (ISPM). Figure 17 shows the interconnected contracts of Section 2. The exporter is responsible for all activities under Section 2. However, these activities are neither mandatory nor statutory and get carried out on the importer's behest.

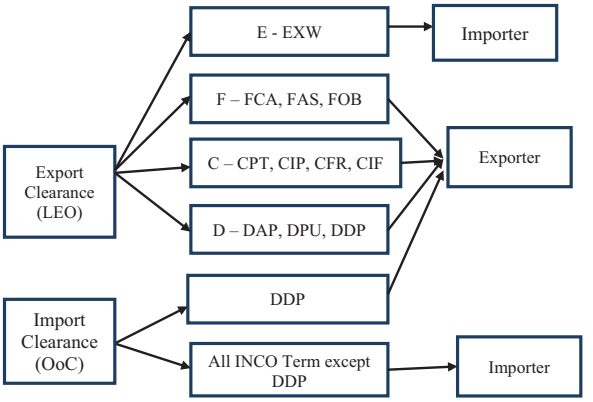


Figure 15.
Responsibility for customs clearance

Source: Authors' creation

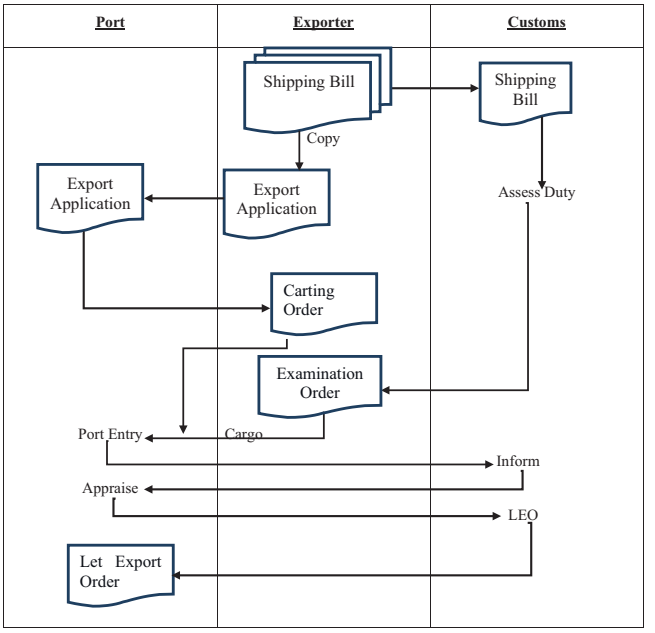
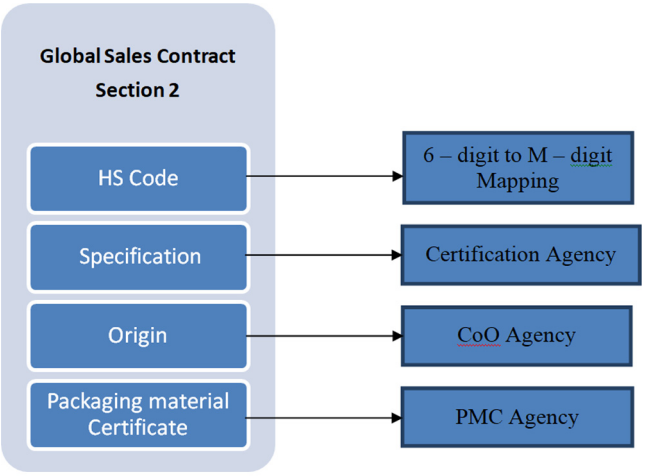


Figure 16.
Export clearance process from customs

Source: Authors' creation



Source: Authors' creation

Figure 17.
Add-ons to Section 2 of sales contract

A GC's technical specification includes information on specifications; inspection agency; CoO agency; and packaging material certification agency (if required). Once the inspection criteria are met, the information on inspection certificate (certification identification number and test results), CoO and results on packaging material used are fed into the system. Table A4 in the Appendix gives a conceptual data structure on the technical specification.

5.3 Section 3 – commercial section

This section includes the payment terms, the associated documents, non-performance of the buyer to pay (damages for non-performance of the contract by the exporter), delivery delay and lack of conformity (ICC, 2020c).

The payment terms include the stages of payment and mode of payment. There are five payment modes: the advance payment, documentary credit or LC payment, documentary collection, escrow account and open account payment. In case of advance payment, the seller may need to furnish under URDG-758 guidelines. URDG refers to uniform rules of demand guarantee. The demand guarantee, LC payment and documentary collection follow the URDG-758, UCP-600 and URC-522 regulations, respectively, laid down by ICC (ICC, 2020d). Any rule not covered under these regulations is taken care of by International Standards for Banking Practices (ISBP). In all modes of payment, banks of buyers and sellers are involved. Table 1 shows the payment conditions and sub-conditions.

There could be involvement of other banks acting as negotiating bank or confirming bank or counter-guarantee bank or so. The association or link gets established with the flow of documents between the seller and its bank (advising bank), buyer, buyer's bank (issuing bank) and banks collaborating with other banks (confirming or negotiating banks).

A contract may have more than one stage of payment, and the type of payment may be different for every stage. For example, the buyer may pay 10% in advance, 80% by LC and balance 10% against an open account, say after 90 days or so.

Thus, this section of the contract calls for associating the main sales contract with banks through documents. The documents substantiate the fulfillment of an exporter's responsibilities and obligations, making him/her eligible for payment, except in advance

Payment condition	Payment subcondition	Description	Associated conditions	Description
Advance payment	–	Payment made before submission of shipment documents	Demand guarantee	As per ICC URDG-758
Documentary credit or LC as per ICC. - UCP600	LC at sight	Issuing bank (buyers') makes payment on receipt of right documents	Confirmed or un-confirmed	If confirmed, any bank who confirms the payment makes the payment to seller and collects the same from issuing bank
Documentary credit or LC as per ICC. - UCP600	LC deferred	Issuing bank (buyers') makes payment on receipt of right documents but after certain days	Confirmed or un-confirmed	If confirmed, any bank who confirms the payment makes the payment to seller and collects the same from issuing bank
Documentary collection: ICC – URC522	DA (delivery against acceptance)	Buyers' bank collects right documents from sellers bank and on receipt of assurance for payment from buyer after certain days makes payment	BRO or bank release order	Unless the shipment and other documents are marked with BRO goods are not handed over by the shipping lines to the buyer
Documentary collection: ICC – URC522	DP (delivery against payment)	Buyers' bank collects right documents from sellers bank and on receipt of payment from buyer after certain days makes payment	BRO or bank release order	Unless the shipment and other documents are marked with BRO, goods are not handed over by the shipping lines to the buyer
Escrow account		Bank in which escrow account is opened and its details	Dispute resolution	In case exporter seeks release of fund, but importer is unwilling to release the same, then the fund remains in the escrow account till the dispute is settled. This can be true for payment modes as well
Open account			Standby LC or Export credit insurance	In case buyer fails to pay the standby, LC may be invoked or In case buyer fails to pay, export credit insurance company may make good the loss

Table 1.
Payment condition and subconditions

payments. Because INCO terms define an exporter's responsibilities and obligations, the documents vary according to the INCO terms. Stakeholders sometimes tend to make documents independent of INCO terms, causing delays or disputes. Figures 18 and 19 show the responsibilities and associated documents. The importer's bank releases the money on submission of documents, indicated in Figure 19, by the seller for payment by documentary credit (LC) or documentary collection (bill-of-exchange).

The *payment rules* as per payment terms are as follows:

Advance payment

If the contract specifies advance payment and a payment demand made

Then x per cent of the payment to be released by the buyers' specified bank

Responsibility (Tick Mark – Exporter's Responsibility)												
INCO Term	Inspection + Packaging + CoO (a)	Inland Transportation to Dry-port (b)	Forwarding Instruction + Dry Port Activity (c)	Inland Transportation to sea port (d)	Vessel Loading at Exporters' Port (e)	Insurance (f)	Ocean Movement (g)	Port Un-Loading (h)	Importer' Country			
									Customs' Clearance (i)	Inland Transportation (j)	De-stuffing (k)	Unloading from carrier at site (l)
EX-WORK	✓	-	-	-	-	-	-	-	-	-	-	-
FCA	✓	✓	-	-	-	-	-	-	-	-		-
CPT	✓	✓	✓	✓	✓	-	-	✓ *	-	✓ *	-	-
CIP	✓	✓	✓	✓	✓	✓	-	✓ *	-	✓ *	-	-
*	*Exporter will perform these function depending upon the **Named Place***											

Responsibility (Tick Mark – Exporter's Responsibility)												
INCO Term	Inspection + Packaging + CoO (a)	Inland Transportation to Dry-port (b)	Forwarding Instruction + Dry Port Activity (c)	Inland Transportation to sea port (d)	Vessel Loading at Exporters' Port (e)	Insurance (f)	Ocean Movement (g)	Port Un-Loading (h)	Importer' Country			
									Customs' Clearance (i)	Inland Transportation (j)	De-stuffing (k)	Unloading from carrier at site (l)
FAS	✓	✓	✓	✓	-	-	-	-	-	-	-	-
FOB	✓	✓	-	✓	✓	-	-	-	-	-		-
CFR	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
CIF	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-

Responsibility (Tick Mark – Exporter's Responsibility)												
INCO Term	Inspection + Packaging + CoO (a)	Inland Transportation to Dry-port (b)	Forwarding Instruction + Dry Port Activity (c)	Inland Transportation to sea port (d)	Vessel Loading at Exporters' Port (e)	Insurance (f)	Ocean Movement (g)	Port Un-Loading (h)	Importer' Country			
									Customs' Clearance (i)	Inland Transportation (j)	De-stuffing (k)	Unloading from carrier at site (l)
DPU	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	✓
DAP	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	-
DDP	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-

Figure 18.
Exporters' responsibilities

Documents – Tick Marks for Exporters

INCO TERM	Inspection Certificate+ Packing list (a)	Commercial Invoice (b)	Certificate of Origin (c)	Consignment Note (d)	Dry or Sea Port Carting Order (e)	Customs' Export Clearance (f)	Mate Receipt (g)	Bill of Lading (h)	Importer' Country		
									Customs' Import Clearance (i)	Agent – Delivery Order (k)	Port -Shed Deliver Order & Exit pass (l)
EX-WORK	✓	✓	✓	-	-	-	-	-			
FCA	✓	✓	-								
CPT	✓	✓	✓	✓	✓	✓	✓	✓		✓ *	✓ *
CIP	✓	✓	✓	✓	✓	✓	✓	✓		✓ *	- ✓ *
*	*Exporter will perform these function depending upon the **Named Place***										

Documents – Tick Marks for Exporters

INCO TERM	Inspection Certificate+ Packing list (a)	Commercial Invoice (b)	Certificate of Origin (c)	Consignment Note (d)	Dry or Sea Port Carting Order (e)	Customs' Export Clearance (f)	Mate Receipt (g)	Bill of Lading (h)	Importer' Country		
									Customs' Import Clearance (i)	Agent – Delivery Order (k)	Port -Shed Deliver Order & Exit pass (l)
FAS	✓	✓	✓	✓	✓	✓	-	-	-	-	-
FOB	✓	✓	✓	✓	✓	✓	-	✓	-	-	-
CFR	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-
CIF	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-
*	*Exporter will perform these function depending upon the **Named Place***										

Documents – Tick Marks for Exporters

INCO TERM	Inspection Certificate+ Packing list (a)	Commercial Invoice (b)	Certificate of Origin (c)	Consignment Note (d)	Dry or Sea Port Carting Order (e)	Customs' Export Clearance (f)	Mate Receipt (g)	Bill of Lading (h)	Importer' Country		
									Customs' Import Clearance (i)	Agent – Delivery Order (k)	Port -Shed Deliver Order & Exit pass (l)
DPU	✓	✓	✓	✓	✓	✓	✓	✓	-	✓ *-	✓ *
DAP	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓
DDP	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
*	*Exporter will perform these function depending upon the **Named Place***										

Figure 19.
Exporters' responsibilities and associated documents

Else it is a breach of contract.

LC payment

If the contract specifies LC payment at sight and a draft presented along with documents

If documents found correct and all relevant rules of UCP 600 met

Then x per cent of the payment to be released by the buyers' specified bank

Else if LC payment at sight is confirmed

Then x per cent of the payment to be released by the confirming bank

Else it is a breach of contract.

Documentary collection

If payment not made within the specified date and duly informed by the buyer and agreed by the seller

Then interest shall be paid at a rate of X per cent

Else it is a breach of contract.

Similar rules can be framed for other modes of payment as per the description in Table 1.

A sales contract must specify whether partial shipment and transshipments are allowed (Emmert, 2015). If such conditions are not specified, yet resorted to, the payment in LC mode is not released.

The data items in the payment section of the contract include payment condition (advance, LC or collection or open account); payment subcondition (stages of payment, say a three-stage payment); payment percentage (against each stage); days (days after which payment will be released in case of deferred payments); bank type; account number; SWIFT code; demand guarantee (optional); and partial or transshipment conditions. Table A5 in the Appendix illustrates the data structure related to payment. The data structure should be in sync with the SWIFT LC data structure [as per SWIFT (2019)].

5.4 Section 4 – settlements and dispute resolution

This section relates to settlements of disputes, termination of the contract, compensations and related issues. In terms of standard global format [as per United Nations (2010)], this includes details on the referee, transfer of property, avoidance of the contract, the effect of avoidance of the contract, restitution, damages, mitigation of harm, change of circumstances (hardships), force majeure clause, entire agreement, notices, the effect of invalid or unenforceable provisions, authorization, dispute resolutions and applicable laws and guiding principles. Table A6 in the Appendix illustrates the data structure related to dispute resolution.

6. Global smart contract disruption

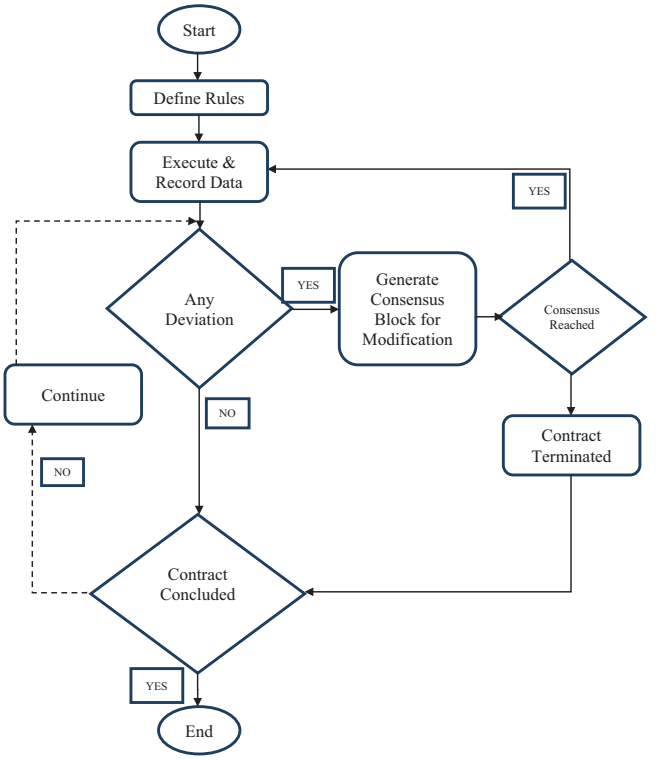
Cong and He (2019) concluded that BTGC enables decentralized consensus but may result in collusive behavior, an act not under the agreement. For example, under the CIF INCO term, the master of the ship may issue a clean BL instead of making it claused, as incorrect or damaged goods loaded onboard the ship. The buyer's bank releases the payment under LC payment terms against the fraudulent BL. They propose a regulatory solution to separate usage and consensus

generation on blockchains. This regulation aims to prevent any interested party from sustaining collusion, proposing a regulatory node in the blockchain to detect collusive behaviors. Because global smart contracts involve authorities across two or more countries, a collaborative effort is recommended to lay down the harmonized and standardized regulations.

However, the most practical issue is that blockchain does not allow smart-contract rules to be changed, and hence, modifying a contract is an issue. There is a minimum of 15 stages, with possibilities of disruption in these stages that call for changes in rules. Hence, the BTGC should enable a separate usage and consensus generation on blockchains. For example, with initial rules, the channel initialized continues to operate until it is interrupted with a consensus generation on blockchains for change or modification in contract conditions. Figure 20 shows the flow chart of the integration of initial and modified blockchain.

Marino and Juels (2016) laid down the principles behind the rescission or reformation or modification of initial contracts. The system should be capable of changing variables and functions as per court orders, arbitration or mutual consensus. The authors prescribed the protocols for modification and reformation unless there is consensus (for modification) or court orders (for reformation) and the original contract auto halts.

The primary variables and functions that may undergo modification, at each stage, include the following:



Source: Authors' creation

Figure 20.
Flow chart of integration of initial and modified blockchains

- Stage 1 – results of inspection agency.
- Stage 2 – packaging type.
- Stage 3 – change in choice of mode of transport, the port of loading and unloading.
- Stage 4 – time to load on the inland carrier, number of carriers and routes.
- Stage 5 – change in dry port.
- Stage 6 – amendments or additional customs requirements, change in container agent or service provider.
- Stage 7 – time to load on the inland carrier, number of carriers and routes.
- Stage 8 – amendments or additional port requirements and change in port charges.
- Stage 9 – partial shipments (short shipments or shut out cargo), transshipments (change in routes) or claused BL.
- Stage 10 – change in the port of unloading, amendments or additional port requirements.
- Stage 11 – change in shipping line charges.
- Stage 12 – change in port charges, amendments or additional port requirements.
- Stage 13 – time to load on the inland carrier, number of carriers and routes.
- Stage 14 – change in dry port, change in dry-port charges, amendments or additional dry-port requirements.
- Stage 15 – change in delivery time (delay), change in the quality and or quantity (damages).

Other modifications: payment terms, delay in submitting documents for payments as stipulated in UCP600, amendments in LC, insurance terms and named place of delivery.

7. Discussions and managerial and policy implications

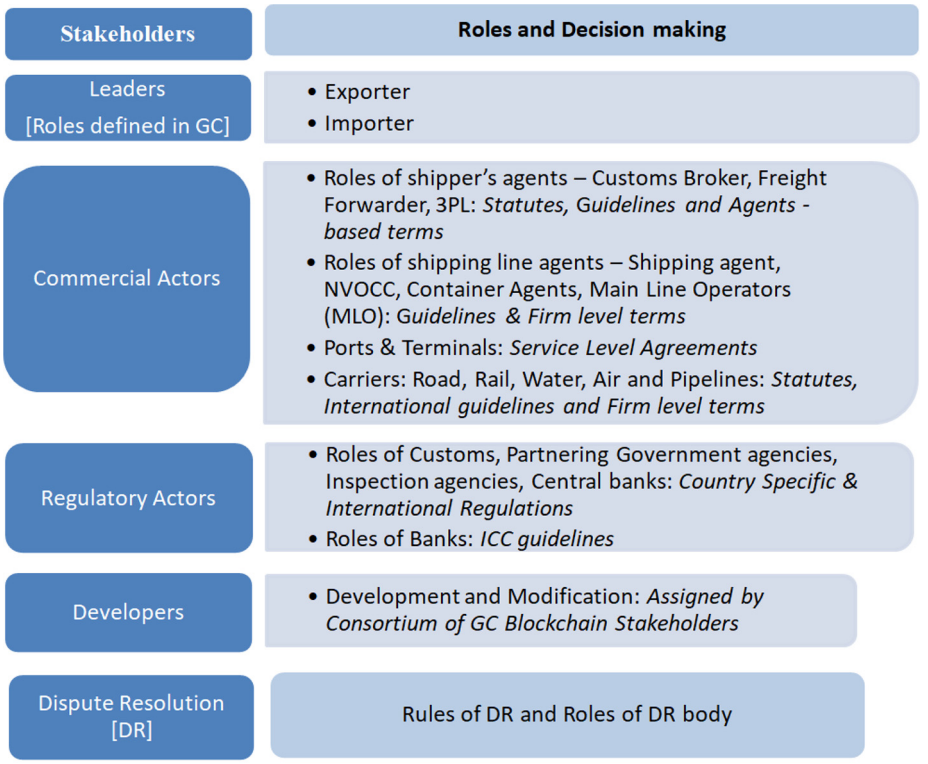
BT introduces transparency (The Blockchain Trust Accelerator, 2018), dramatically reduces the cost of transactions and, if adopted widely, can reshape the economy (Iansiti and Lakhani, 2017), and provides a safer and synchronized way of recording transactions in a SC (Morley, 2017). However, GCs are complex, resulting in multiple stakeholders' multiple interactions requiring documentation for each activity or compliance. Thus, there is a lack of trust unless there is a system to negate this phenomenon. A blockchain-based smart GC can help establish trust provided the rules associated with events are comprehended and coded.

Ontology helps establish the concept of being; in this paper, three ontological levels have been proposed that form the basis of the design of a smart GC framework. The global business's value chain analysis identifies the stages, the stakeholders in each stage, the activities, the rules to perform the activities and the associated documents that flow among the GC partners.

In an LCL shipment, there are 23 stages in the value chain involving 12 stakeholders and at least 12 documents. A BTGC system can generate consensus among stakeholders, ensure execution of activities following the mutually agreed rules, communicate information and documents with immutable records. All these lower the cost, cross-validate and ensure timely completion of contracts without intermediaries. The number of activities and documents varies with country regulations; hence, GC's performance depends on logistics service providers' operating environment and expertise. These factors act as control variables.

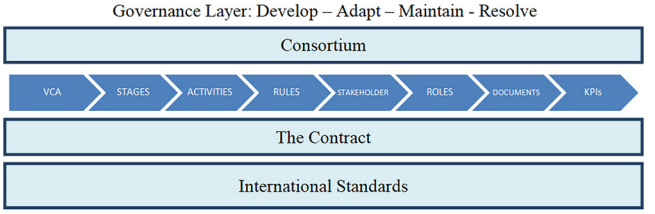
Three other aspects that affect the performance of a GC are the integration of side chains such as interactions with banks, the disputes and restoration of disrupted chains. These aspects are

taken care of through blockchain governance. Pelt *et al.* (2020) defined blockchain governance as "the means of achieving the direction, control and coordination of stakeholders within the context of a given blockchain project to which they jointly contribute." The above sections lay down the framework for governance by blockchain; however, there is a need for blockchain governance to develop and adopt changes, maintain and resolve conflicts (Ølnes *et al.*, 2017). A GC governance framework can be proposed based on Pelt *et al.*'s (2020) works. Figure 21 illustrates the BTGC governance framework.



Source: Authors' creation

Figure 21. Blockchain technology-based global contract (BTGC) governance framework



Source: Authors' creation

Figure 22. Framework for smart global contracts based on blockchain technology (BTGC)

The BTGC governance (BTGC-G) framework proposes a creation of a consortium of GC blockchain stakeholders who define the consensus mechanism, developers' selection, roles and development framework; monitors the infrastructure; and sets up a dispute resolution body and its guidelines. This body gives a node permission to join and excludes an existing node based on specific criteria. Thus, the BTGC-G framework needs to specify the inclusion and exclusion criteria. Following this, the governance by the BTGC system happens based on the criteria of contract and rules.

Thus, this paper proposes a complete framework for smart – BTGC, illustrated in Figure 22.

This study's findings have implications for managers in pointing out the utilities, guidelines, rules and smart GC governance based on BT. The proposed framework has implications at the firm level as it automates and secures a GC and is expected to harmonize the global-trade process. The developers of the platform may use this framework for developing the GC software.

There are policy implications at the country level as this framework proposes a cross border consortium of stakeholders, including policymakers. There is a need for an international standard for smart GCs based on BT (ISSGCBT) developed at the country level. Organizations such as ICC can take the lead to bring together the member countries to develop the governance protocol. Future research may consider using case analysis, class diagrams and the related steps for developing the blockchain software.

8. Conclusion

This study focused on the complexities of a global sales contract using VCA. It identifies the concepts of GCs involving exports, the entities, the activities, attributes and the relations between them. This paper critically studies the use of BT in implementing the contract. It applies an ontology-driven approach and carries out VCA to propose a framework for smart GC. The framework distinguishes the role of exporter and importer as per the INCO terms and defines payment rules under different global standards. This paper identifies the exogenous factors that affect GC and the possibility of disruptions. It proposes a framework such that both governances by the BT and governance of BT are in tandem. The paper suggests templates of GC data structures for a precise understanding of coders.

This paper contributes to the literature proposing smart GCs' ontology and a framework for its implementation and governance using BT, a BTGC system.

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Appendix

Table A1.
A data structure template on the scope of contract: an illustration

Data element	Data label	Description	Type	Space
Contract reference	ConRef	Contract reference number	String	20
HS code	HSC	Product description	Numeric	6
HS code extension exporting country – 8 digit	HSCE**E**C8	Product description at eight-digit level in exporting country	Numeric	2
HS code extension exporting country – ten digit	HSCE**E**C10	Product description at ten-digit level in exporting country	Numeric	2
HS code extension exporting country – *m* digit	HSCE**E**CM	Product description at *m* digit level in exporting country, where *m* is any number of digits beyond six-digit HS code	Numeric	2
HS code extension importing country – eight digit	HSCE**I**C8	Product description at eight-digit level in importing country	Numeric	2
HS code extension importing country – ten digit	HSCE**I**C10	Product description at eight-digit level in importing country	Numeric	2
HS code extension importing country – *m* digit	HSCE**I**CM	Product description at *m* digit level in importing country, where *m* is any number of digits beyond six-digit HS code	Numeric	2
Quantity	Qty	Quantity in pieces, units of weight or volume	Numeric	10
Quantity – UoM	QUoM	Unit of measurement of quantity	String	10
Value	VALUE	Value as quoted in the sales contract	Numeric	20
Currency	Curr	Currency of payment	String	10
INCO term	INCO	International commercial terms laid down by ICC	String	3
Named place	NP	Place of delivery	String	25
Port of origin	PoO	Port where risk transfer takes place or where goods are loaded for moving across border	String	25

Sl no.	INCO term	Full form
Category	E	
1	EXW	Ex works
Category	F	
2	FCA	Free carrier
3	FAS	Free alongside ship
4	FOB	Free on board
Category	C	
5	CPT	Carriage paid to
6	CIP	Carriage insurance paid
7	CFR	Cost and freight
8	CIF	Cost, insurance and freight
Category	D	
9	DAP	Delivery at place
10	DPU	Delivery at place unloaded
11	DDP	Delivery duty paid

Table A2. List of different INCO terms

Data element	Data label	Description	Type	Space
Contract reference	ConRef	Contract reference number	String	20
Policy reference	InsREf	Insurance policy reference number	String	20
Insurance type	InsType	Type of insurance (air, marine, road, rail, warehouse-to-warehouse)	String	6
Insurance clause	InsClause	Institutes' clause	String	6
Premium	Prm	Amount of premium	Numeric	6
Premium currency–UoM	Prm-UoM	Unit of measurement for payment of insurance premium	String	6

Table A3. Conceptual data structure on the insurance contract

Data element	Data label	Description	Type	Space
Contract reference	ConRef	Contract reference number	String	20
Specifications	SPECS	Specifications of the item	String	100
Inspection agency	INSPECT	Name of the inspection agency	String	20
Inspection certificate	InsCert	Reference number of inspection certificate	String	20
Inspection result	InsR	Test results	String	100
Certificate of origin authority	COO	Certificate of origin issuing authority	String	20
Certificate reference number	COORef	Certificate of origin reference number	String	20
Packaging material certificate reference number	PMC	Reference number of packaging material certificate	String	20
Packaging material certificate agency	PMCA	Agency issuing packaging material certificate	String	20

Table A4. Conceptual data structure on the technical specification

Data element	Data label	Description	Type	Space
Contract reference	ConRef	Contract reference number	String	20
Payment condition	PayC	Mode of payment, e.g. advance, LC or collection or open account	String/logical	25
Payment subcondition	PaySc	Subcondition of a particular mode of payment	String/logical	25
Payment percentage	PC	Percentage of total value by particular mode of payment, say 10% in advance	Numeric	3
Days	DAY	Days after which payment will be released in case of deferred payments	Numeric	4
Bank type	BT	Role of bank – buyers' bank or sellers bank, confirming bank and so on	String/logical	25
Account number	AC	Account number of stakeholder	Numeric	20
SWIFT code	SWC	SWIFT code of stakeholder	String	11
Demand guarantee	DG	Demand guarantee reference number to back any advance payment (optional)	String	20
Partial shipment – allowed	PS	Whether partial shipment is allowed in the contract	Logical Yes or Y/No or N	1
Transshipment – allowed	TR	Whether transshipment is allowed in the contract	Logical Yes or Y/No or N	1

Table A5.
Payment condition-specific data structure

Data element	Data label	Description	Type	Space
Contract reference	ConRef	Contract reference number	String	20
Dispute resolution agency	DR	Arbitrators reference, say email	String	25
Sellers delay (non-performance of buyer to pay)	SD	Penalty or liquidated damage payable by seller when he/she delays – in percentage	Numeric	3
Seller non-conformity	SNC	Penalty for seller's deviation from contract regarding specification or any other matter as specified in contract – in percentage	Numeric	3

Table A6.
Dispute resolution condition – data structure template

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