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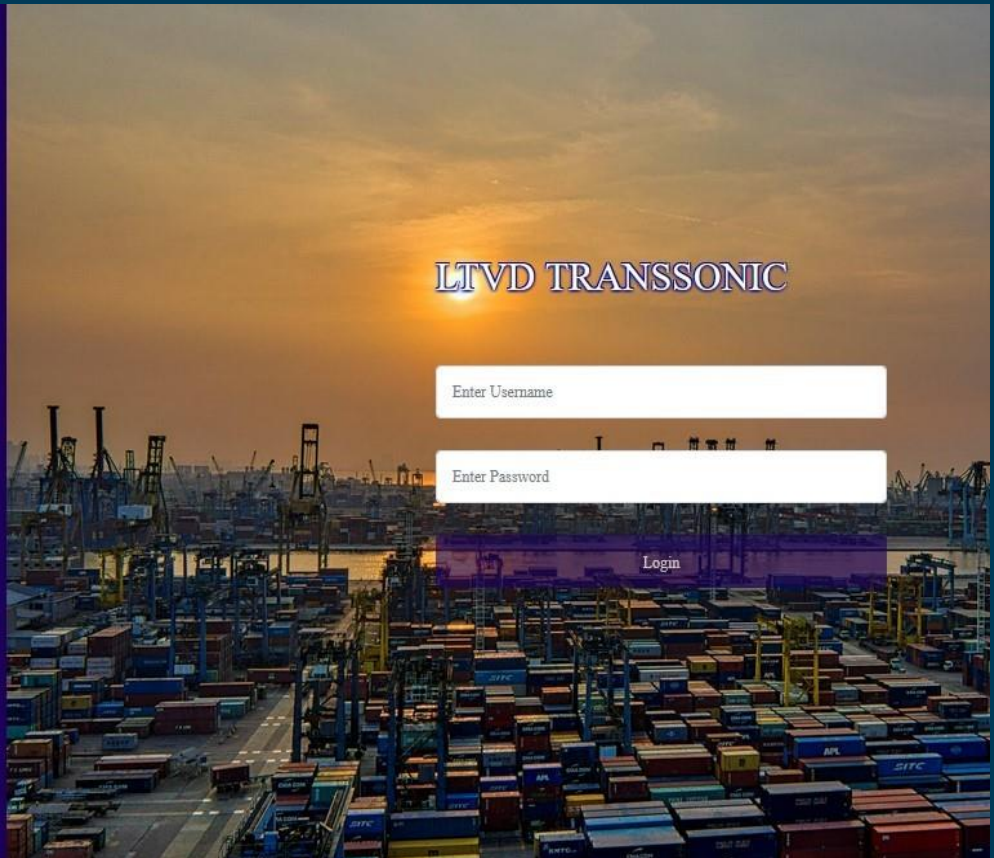
SUPPLY CHAIN MANAGEMENT TO CREATE TAX & TRADE VISIBILITY

REALISING A BLOCKCHAIN BASED SOLUTION FOR LOGISTICS IN INDUSTRY

TKI DINALOG
Dutch Institute for Advanced Logistics

SUMMARY

The "TransSonic Supply chain management Tax & Trade Visibility" collaboration project between TNO, Xedum and Henkel developed a blockchain (distributed semantic ledger) solution to define an industry-wide standard for data exchange of tax and customs information across companies and authorities. Blockchain (BC) based on BigChainDB was selected as technological backbone of the solution due to its unique combination of features such as immutability of data, encryption and decentralization.

The chosen tax/customs application to demonstrate the developed BC solutions relates to long-term vendor declarations (LTVD): A largely paper-based process to exchange master data information among companies. This process was selected as it is harmonized across the European Union and essential for every company that engages in international trade. The presented use case relies on four pillars: (i) improvement of compliance and control, including requirements to make the use of the technology more secure; (ii) efficiency of the technology; (iii) proof of originality, because of interchangeability and possibility to create many copies, which requires the development of a certification process and single source of truth; (iv) multi-stakeholder approach, which would engage companies, tax departments and customs functions, etc.

Background and challenges

International Trade requires companies to provide key master data when goods crosses a boarder, like the commodity code that clusters similar materials in a comparable categoryand the country of origin that indicates where the last substantial production step was undertaken. This information functions as "passport" for the shipped good that provide a nexus to both the importing and exporting country to levy duties or to enforce international trade compliance requirements.

Project partners & products

In the European Union, so-called long-term vendor declarations (LTVD) simplified and standardized this data exchange between suppliers and customers. As helpful as the LTVD is for operational trade procedures, in practice it still leads to a complex and manual process: From an internal point-of-view, the process of requesting the information from each supplier and transferring into the ERP system is time-consuming because of several communication flows. And from an external point-of-view, the data transparency is limited as the end-to-end tracking of the information flow is only sporadically possible at best.

Target and results

To overcome the above, this collaboration created an open ecosystem that provides automatization and digitalization of tax & trade processes across the industry. With our digital solution we foresee to digitalize trade data management in terms of efficiency, robustness, and control, which will provide information on the origin of material that is needed to decide if a product is eligible for a free trade agreement or not. The complementary international consortium developed a semantic ledger back-end BC solution based on BigChainDB (TNO), a user friendly Graphic User Interface (Xedum) which was tested by the above described use case provider and demonstrator of the BC solution (Henkel).

Future

Next to technical developments, also organisational developments were made in the direction of governance structures for future (large scale) utilisation of BC solutions in the tax and trade area, or logistics and supply chain in general. The governance will determine the working mechanisms and agreements within the ecosystem and allows others to join (companies, authorities, etc.). Besides, further applications are to be envisioned: e.g. for proof of delivery, excise taxes, VAT registrations, energy taxes and others.
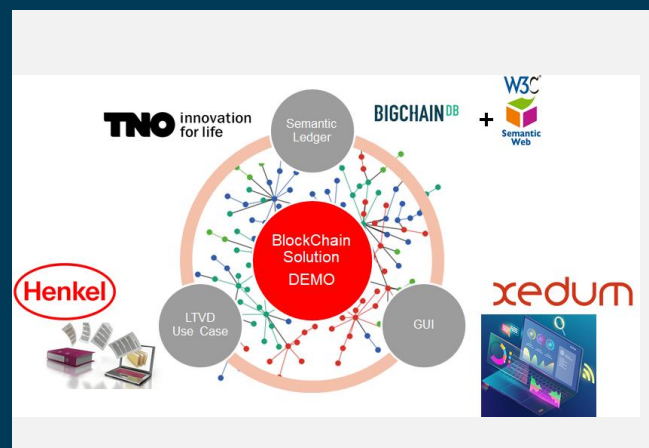
TABLE OF CONTENTS

"OPEN AND NEUTRAL GOVERNANCE OF
BLOCKCHAIN TECHNOLOGY SUPPORTS
LARGE-SCALE ADOPTION OF DATA
SHARING IN LOGISTICS & INDUSTRY"

WOUT HOFMAN
SENIOR SCIENTIST @ TNO

MOTIVATION

There are many different processes in the tax, customs & trade area that require change. Through new technologies there is a lot of potential to digitalize – for example – inefficient and heavy paper-based processes, that are defined by authorities in order to provide proof of 'original' documents.

Multinationals like Henkel are considering the application of blockchain technology to change and rationalize their business processes - internally and externally. Existing document-related information flows and legally binding agreements can be replaced, and person-independent actions (IoT) can be triggered. The ideal for Henkel would be a cross-system data and information platform accessible to all organizations involved in business processes (Henkel, suppliers, customers, banks, service providers and government institutions). The timely exchange of information and data combined with legally binding digital agreements for all business transactions, would lead to greater efficiency and transparency in the processes, cost reductions and competitive advantages for all those involved.

Project partners

CHALLENGE

Within this project, two companies and a research institute joined forces into a consortium, with the ultimate goal to accelerate the development of an industry wide standard for tax & trade, using Blockchain technology as a base to fulfil key criteria in terms of security (single source of Truth), compliance & real-time information.

The goal of this project is to apply the Blockchain technology to a single inter-organisational Business process and make a working pilot for this process as a showcase. For the showcase, example process selected is the Long-Term Vendor Declarations (LTVD) or Long-Term Supplier Declarations (LTSD), that certify relevant master data information between buyers / sellers for up to 24 months. These are necessary in order to prove a product's or material's origin to profit from lower duty tariffs through free trade agreements. 83% of all European companies' issue LTVD in paper-format. Currently, the issuance of LTVDs has high administrative and personnel costs. Authorities demand 'original documents' it is necessary to have an effective compliance-management system – which has to be regularly checked by an external audit firm.

Our Solution:
To create an open ecosystem that aims for the goal of automatization and digitalization of tax & trade processes across the industry. With our digital solution we see the potential to digitalize trade data management in terms of efficiency, robustness, and control, which will provide information on the origin of material that is needed to decide if a product is eligible for a free trade agreement or not.
The timely exchange of information and data combined with legally binding digital agreements for all business transactions, leads to greater efficiency and transparency in the processes, cost reductions and competitive advantages for all involved ecosystem participants. This is especially important in front of authorities, since tax & trade information must be safe & compliant. Based on the Blockchain technology we create value through trust & compliance in front of authorities and companies to ensure that data is 100% correct.

PROJECT DESIGN

The project was held in an international setting with partners Henkel(Industry), Xedum(Consultancy & Development) and TNO (research). It was centered around the development of a working digital solution, so an Agile approach was adopted. This meant the parallel development of work packages Requirements(wp1), Design(wp2) and development of the prototype(wp3). The project was rolled out in three phases, first developing a minimal viable prototype (TNO lead), then a graphical user interface (Xedum lead) and lastly the testing in the real LTVD process at Henkel(Henkel lead, wp4 & wp5).

The result is an actual digital implementation, a prototype for how a Blockchain-based solution can be realized for industry & logistics. This potentially saved a lot of paperwork and reinforces trust along the supply chain. Additionally, the governance structure was developed to get this going as a shared infrastructure in Europe (wp6).

This project is closely related to the NWO funded TransSonic project. It builds upon knowledge and experience gained in the blockchain development in the commodity trader use case by applying concepts and further refining specifications developed by the Digital Transport and Logistics Forum. In the main TransSonic project, a demonstrator movie is being developed based on the LTVD-showcase in this project.

1 **ANALYSIS OF REQUIREMENTS AND STATE OF RESEARCH**

Objective:
The aim is to specify all technical and legal requirements for the implementation of a blockchain-based technology platform and test environment, including the tax law processes, through analysis of the supply chain processes (also with associated partners) and the state of the art. Within this project, a specific trade (customs if you like) topic related to the Long Term Vendor Declaration is chosen since it involves a (short) supply chain between a minimum of two partners (Buyer and seller) and still includes interesting data to be placed on the Block Chain.

Methods:
Business process analysis with data and document flows will be done at the beginning of the project. This needs to results in a very detailed scope and process description (of the LTVD). Also all legal obligations and governance structure requirements will be mapped. Secondly the technical (minimal) requirements will be determined in order to start the development in the next WP's.

Results:
Process specification of all business processes (Flowsheet) with data and documents; identification and selection of potential supply chains; Research report on the state of the art regarding the technical, technical and legal aspects of blockchain technology; overview of relevant initiatives and available standards if any.

2 **DESIGN**

Design focusses on data and process modeling, also in relation to the GUI (Graphical User Interface). Such a GUI is required for at least a pilot setting, where existing IT systems will not yet be integrated with the solution. A focus is on development of APIs and data validation rules for the support of end-users and to read/write data to the blockchain.

> A business process choreography is a way to specify how two stakeholders share data. It makes the implementation of a use case generic for any organization, where this organization can have both roles. Internal policies and implementations are up to each individual organization.

3 DEVELOPMENT

Before actual implementation in a pilot setting, the various components will be developed. This is about GUI development, user management by the blockchain infrastructure and data validation of the APIs. When necessary, complex processes will be developed ('smart contracts') to automize particular process steps. This will make the solution ready for implementation in a pilot situation.

4 SETUP OF A TEST ENVIRONMENT INFRASTRUCTURE

A test environment is created as such that Henkel employees can test the technology based on normal LTVD processes. All kind of tests based on potential process flows will be made available. One could state: setting up a Blockchain Living Lab.
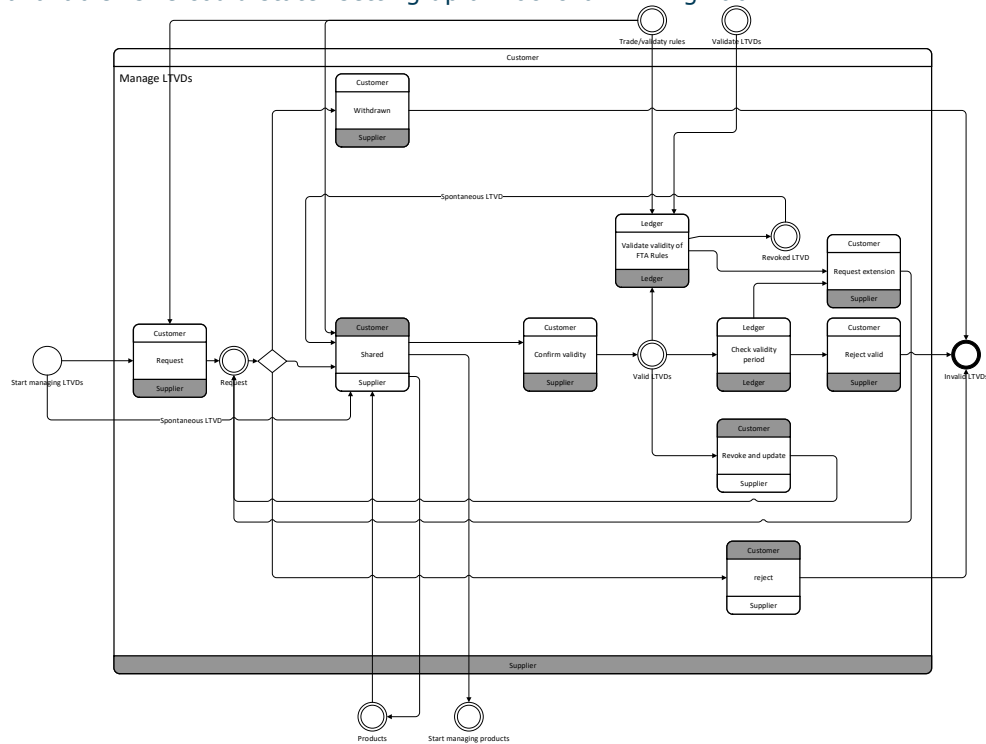
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PILOTING IN REAL BUSINESS PROCESSES

Objective: To review and test the Blockchain platform for the selected LTVD processes based on specific test protocolls. The testing will be an itterative process in close collaboration with the front- and back end developers of the project. Any outcome of the test will be updated in the development in short sprints.

Methods: software usage, testing and refinement of GUIs/APIs/Supply Chain Ledger data types, case studies, interviews etc.

Results: Documentation of the evaluation results for platform utilization in the defined processes in end-to-end and supply chain management.

6

LEGAL AND BUSINESS FRAMEWORK

Omschrijving werkpakket met doel, aanpak, beoogde resultaten

Goal: Specification of the tax framework conditions and transactions and tax processing at Henkel, audit of tax compliance; Integration of the findings on the legal security of blockchains.

The ultimate goal here is/was to setup a complete governance structure for using BlockChain technology for tax and trade processes. The governance structure should involve a description of all potential stakeholders in a "Go Live" setting, their rules and rights, their obligations, their benefits and costs etc. The governance structure should be based on standards as the ultimate goal is to have one governmental setup for all potential users of the BlockChain technology on at least EU level.

Methods: Analysis of tax standards, literature reviews, interviews, workshops, legal assessments; Research and evaluation of the results; business case development; governance scenario development and feasibility assessment

Results: documentation on tax processes and Tax Compliance; Reports on tax and legal aspects of blockchain technology; Henkel business case; **proposed governance structure**

7

PROJECT MANAGEMENT & DISSEMINATION

The project management has been divided among the partners. Each of the partners contributed to the plan, the meetings and to the organisation of the project. We adopted an agile way of working, adapted to working at a distance (which came in handy when the Covid-virus struck).

> Dissemination focussed on transferring of knowledge outside the consortium. This was done via research channels (papers, talks, etc.), but a far stronger message will be given by the organization driving the innovation, Henkel, which is setting up a blockchain management organization for industry.

The project was divided into three phases (1. Prototype, 2. GUI, 3. Implementation & testing). To guide the phases, live meetings were held.

RESULTS

The overall aim of the project: To develop a blockchain environment which is able to manage and process a specific customs related supply chain project (LTVD), is accomplished. With that, the basis is set for a future public available platform, which should be accessible for any company and stakeholder that deals with tax and/or trade topics. Within the project, a concrete pilot setting was chosen to demonstrate the working mechanism and principles without too many additional partners. Yet it is too early to claim societal results as expressed in the table on the side. However, the complete development is made such that it will be applicable for others as well.

Actually, that is the main principle and idea behind a blockChain environment, which will only become succesful when multiple players will join.
In order to get to that point, already within the project duration, a governance model has been created and a association has been initiated which will lead to the invitation of other partners to join. As such, the follow up is initiated already!

The new platform will lead to better connections and collaboration within the logistic supply chain in combination with tax and trade issues and therefore contribute to one of the aims of the TKI Dinalog. The timely exchange of information and data combined with legally binding digital agreements for all business transactions, will lead to greater efficiency and transparency in the processes, cost reductions and competitive advantages for all those involved.

SOCIETAL RESULTS	
CO_2 reduction	%
Cost savings	€
Avoided transport kilometers	-
Modal shift tonkilometers	-
Other results	-

SECTOR RESULTS	
Realized added value	+
Realized sustainable jobs	-
Reach: Number of companies	6
Reach: number of SME's	1
Researchers/students now employed at companies	-

SCIENTIFIC OUTPUT	
Master thesis	-
PhD promotions	-
Scientific publications	1
Citations scientific publications	-
Scientific seminars, workshops, presentations etc.	3

RESULTS THAT THE PROJECT PARTNERS ARE PROUD OF

1 A WORKING, STABLE AND ROBUST SEMANTIC LEDGER (BACK-END TECHNOLOGY) WHICH IS CAPABLE TO DESCRIBE AND MANAGE A SPECIFIC TRADE PROCESS: LTVD

2 A TESTED AND APPROVED (BY DAILY USERS) USER - FRIENDLY "GUI" WHICH IS THE INTERMEDIATE BETWEEN CUSTOMER AND TECHNOLOGY AND COVERS AL LTVD PROCESS ACTIONS

3 A GOVERNANCE STRUCTURE PROTOTYPE, WHICH IS BASED ON STANDARDS AND READY FOR ALTERNATIVE BUSINESS USE CASES TO BE CONNECTED TO THE BLOCKCHAIN PLATFORM

LTVD PROCESS GUI (FRONTEND)

Challenge and Solution

TNO has developed a blockchain backend (see below), in which LTVD requests and LTVD documents are stored. Access to the blockchain backend data is made available by TNO via a REST API. End users need an easy user interface to interact with the blockchain backend.

Xedum has developed a graphical user interface (GUI) in the form of a web application. End users can open the LTVD GUI in a webbrowser and then add LTVD documents to the blockchain backend.

### For whom is the frontend LTVD GUI interesting?

Companies involved in requesting and issuing long term vendor declarations, that want to request and issue long term vendor declarations with an easy tamperproof digital solution.

Technology used

The frontend GUI is a client-sided Single Page web application built with the open-source web application framework "Angular" and the open source Javascript runtime environment "Node.js".

What does the LTVD GUI yield?

A company that wants to request and issue LTVD documents electronically, can use the webapplication to manage all LTVD documents and exchange LTVD documents with other companies. The LTVD webapplication replaces the time-consuming manual activities involved in requesting and issuing supplier declarations.
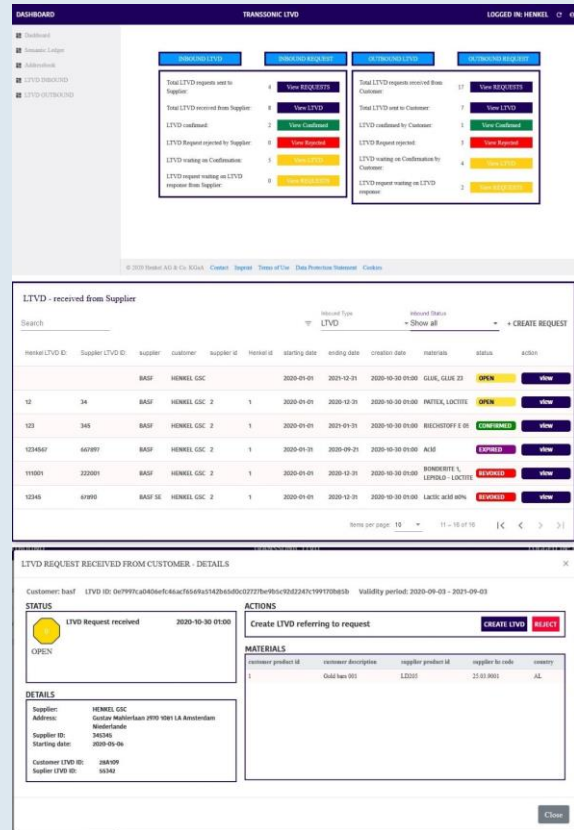
Some screenshots of the LTVD GUI

SEMANTIC LEDGER (BACKEND)

The project envisioned decentralized, immutable data sharing where the data is structured in accordance with a knowledge model (KM). With this tool, we enabled this data sharing, and integrated the data sharing process with the usage of the KM.

An API layer handles data publication and retrieval in JSON, shielding consumers of the tool from the complexities of the data semantics. Internally, JSON is transformed and enriched to RDF, which is the standard that the KM is also expressed in. The RDF is validated against shape constraints of the KM (following the SHACL standard for RDF validation).

Valid RDF is pushed to a node in a blockchain test network. The tool uses BigchainDB as its blockchain of choice, whose MongoDB document-based database allows easy storage of the RDF data through its JSON-LD standard. The asset ownership property of the BigchainDB data model is used to keep track of which party or parties have update rights for the LTVD throughout its lifecycle. The network also stores the semantic artifacts used for validation.

After data publication, consumers of the API can read out the contents and unique identifiers of the LTVDs and KM artifacts on the blockchain network.

Architecture of the Semantic Ledger

EXPERIENCES

The project had a small, but very clear consortium setup, in which each partner had a dedicated expertise, complementary to the expertise of the others. We developed the idea of the project and gradually worked it out together using an agile way of working. TNO had the lead and was responsible for the development of the core of the project, the BlockChain solution back end (Semantic ledger). The way they have been developing this back-end was completely based on the use case provided and described by Henkel. In parallel, Xedum was responsible for the User interface development, also based on test and real user data from Henkel. We believe that this clear distribution of tasks and the Agile way of working has led to the good collaboration within the project.

OPEN INNOVATION

The project organization remained stable during the project. Henkel provided the requirements and performed the testing, TNO and Xedum did the design and development. Furhtermore, Henkel had a similar project with support of Microsoft. They combined both projects and assured the support of other large enterprises. This resulted in the set up of a new organization with a set of rules, TaXchain.

DINALOG AND THE TOPSECTOR LOGISTIEK

The various project members have learned how to setup the digital communication between partners in the logistics supply chain. This required a combination of a business process with legal rules, innovative IT, and GUI development. From a technical perspective, the project members have learned that particular business rules have to be implemented by both the infrastructure, i.e. the blockchain, and the GUI to assure proper data quality for data sharing. Thus, a contribution to data quality improvement has been made.

During the project, experience has been gained of how to transform a specification into software code, where this software code is configured by the business rules. The configuration is based on semantic technology using an open standard, ShApe Constraint Language (SHACL). The specification mechanisms for these rules is to be integrated further with semantic modeling, which is currently done by the CEF FEDeRATED Action, led by the Dutch Ministery of IenW. Thus, Dinalog and the Topsector Logistiek contribute to creating an open and neutral data sharing infrastructure.
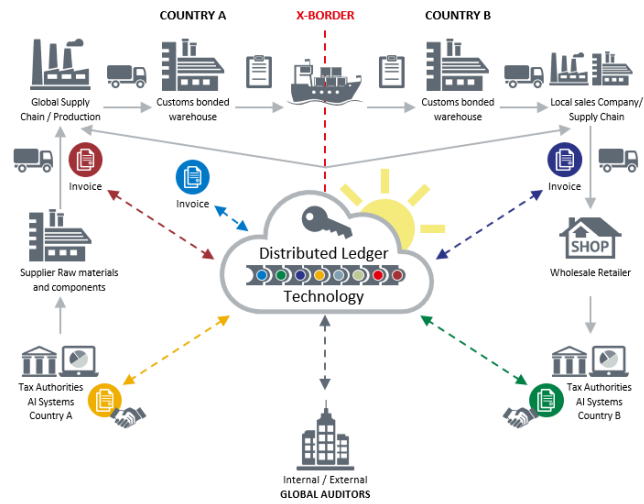
SUPPLY CHAIN VISIBILITY LEDGER - TNO

TNO, as RTO in the project, has provided what is called the Semantic Ledger as a basis for developing the solution. The lessons learned in the Cargill project, also funded by Dinalog and Topsector Logistiek, are applied in this case. It means an improvement of the specification that is the basis for the solution.

One of the learnings of TNO is to improve the design by not only specifying the functionality of the ledger, but also specify the user interface functionality by constructing mockups. This approach is currently applied in the FEDeRATED project. Improved specifications, GUI, and a ledger are considered as Proof of Concept that will increase the quality of the design and therefore the quality of the Application Programming Interfaces.

Since TNO research is not aimed at producing a complete operational solution, expectations have to be clear from the start of each project. It is up to a partner like Henkel to take the next steps; TNO can provide consultancy to take these next steps as we have done in the topic of governance.

A final learning is that standards are of uttermost importance. Many enterprises require solutions, but it is difficult to convince them of using Blockchain solutions while they are not universally accepted. Acceptance by national tax authorities will also be based on availability of (open) API standards.

Visualization of the Supply chain visibility ledger

LTVD USE CASE - HENKEL

A specific trade business case was used in this project, the Long-Term Vendor Declaration (LTVD). This is a very common trade process that Henkel has with its customers or suppliers. The schematic process of the LTVD is shown on the right side picture:

- Henkel purchases raw material from suppliers (pre-requisite) & requests LTVD
- Inbound LTVD issued by Supplier provides information on: HS Code, Country of Origin, and Preferential Origin → will be maintained in Henkel's system
- Henkel calculates preferential origin for materials sold based on inbound LTVD information
- Henkel sells goods to customer and verifies HS Code, Country of Origin and Preferential Origin via outbound LTVD upon request

The above described process (typical for EU companies in general) is still a very manual intensive (paper based) process and therefore, Henkel wants to digitalise the process (not only for itself, but as a standard for everyone) in a trusted and secure environment. Therefore, the idea and aim to manage the LTVD within BlockChain setting was key to be developed.

The digitalisation of this process is part of the overall digitalisation project within Henkel.
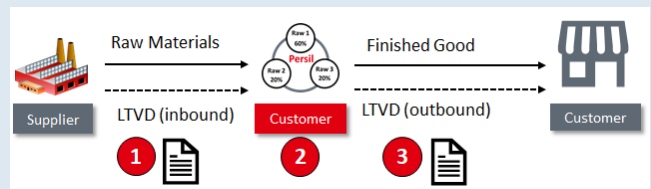

Simplified schematic of the LTVD process

VISION FOR THE FUTURE

The collaboration project has proven and demonstrated that tax and trade processes can be described and managed by BlockChain solutions. The use case used for this demonstrator was the Long term Vendor Declaration. However, not only the technical challenge has to be covered (as done in the project with an MVP), also the legal and governmental part is at least as important. Therefore one important task was to setup a governance structure for such processes, for which the result is scheduled in the picture on the right. Involvement of all mentioned stakeholders within the governance is crucial to implement the solution in "live environments" on a large scale. In the end, also (tax)authorities and multiple companies and auditors need to be aligned in the process to make a blockchain solution succesful. On a technical level, we have proven that this can be met, and also on a governance level we have provided the blueprint here for future developments and implementation. However, inclusion of all stakeholders is the next step which has already been taken by Henkel. Together with others, we have initiated an association ("taXchain e.V) to give the project a follow up. The beauty of the governance is that it does not only support a LTVD process, but could also easily include other tax and trade use cases on the platform.

Proposed governance structure

Important however is to do this based on standards in EU. This is also where TNO will play an important role as they are already working on standards in a follow up project: inventoring all requirements and standard data for supply chain processes in general!
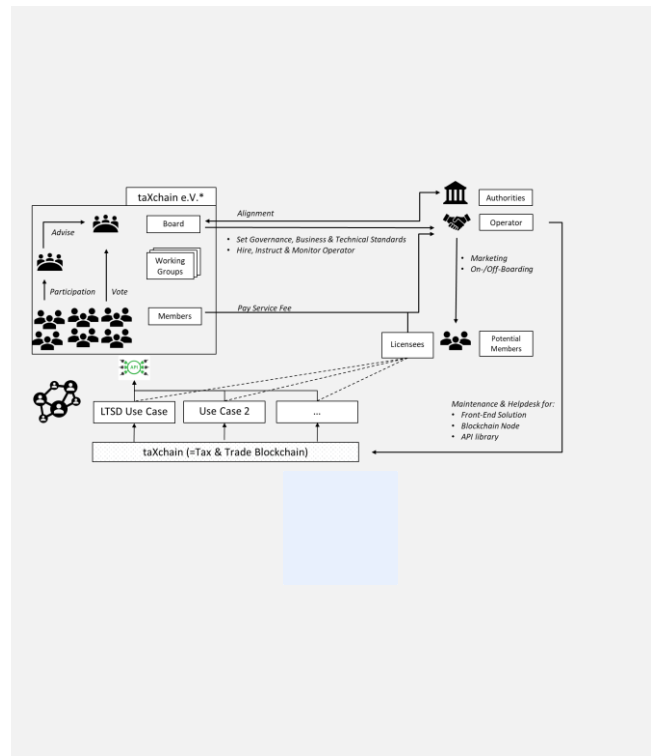
FOLLOW-UP ACTIVITIES

The project partners understand the need of governance of the solution in the short term, most probably the redevelopment using another blockchain technology, and the long term standardization of interfaces of such a solution. The latter will create a market for technology/platform solution providers and contribute to the adoption by National Tax Authorities. One aspect for market adoption, which still needs furhter consideration, is the market size of this solution and the business case. The latter has been briefly addressed by Henkel, but the main issue is relating tax issues like LTVD to supply and logistics chains. The LTVD functionality and interfaces should become part of for instance supply chain visibility solutions.

"STANDARDIZED GOVERNANCE & TECHNOLOGY WILL BE KEY FOR SUCCESFUL MANAGEMENT OF TAX & TRADE"

MARTIJN SPRINGER
R&D G&I MANAGER @ HENKEL

PROJECT PARTNERS

PUBLIC PARTNERS

PRIVATE PARTNERS

HENKEL AG&CO. KGAA

Henkel is a German based chemical company in the areas of Laundry and Home Care, Beauty and personnel care products and Adhesive Technologies. As a multinational, Henkel produces and sells millions of products per year and therefore ships lots of materials, intermediates and finished goods to her customers and from her suppliers. As such, Henkel has many tax and trade processes related to its business. In this role, Henkel acts as use case provider and end user of the developed BlockChain technology.

TNO

TNO (Nederlandse organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek) is one of the major independent contract research organisations in Europe. TNO functions as an intermediary between research organisations and industry. In this project, TNO combined Logistics knowledge with semantics-enriched blockchain technology named "Semantic Ledger".
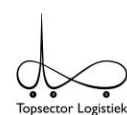
XEDUM BV

Xedum is a global management consulting, technology services and outsourcing company. We help our clients to reach their growth targets and improve their operational capabilities. Xedum partners with clients to transform their mindsets, reimagining businesses and meeting the competitive challenges of the future. New technologies like blockchain have the potential to further streamline the end-to-end business processes and revolutionize finance- and tax administration. In this project Xedum developed the GUI front-end to communicate with the blockchain back-end.