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DIGITALISATION OF FREIGHT TRANSPORT LICENSE BETWEEN FINLAND AND RUSSIA

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ABSTRACT

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Digitalisation has been a widely used topic in recent decades. While the private sector easily adapted into it, the public sector has been digitalising services at a slower pace. The European Union showed great interest in the digitalisation of customs for better services at the border. However, to this day, there are still a lot of documents that are needed from transportation companies to provide to customs to cross the border while transporting goods between Finland and Russia. The goal of this thesis was to find out if a software application can replace paper documents and if such system would improve efficiency in customs. According to the literature, long waiting times, costs, usability, and document forgery have been key issues found during the transportation process. The literature has been used to gather technical solutions to the identified issues and a new system has been implemented. The finished artefact has been evaluated through expert interviews with a special focus on the aspects of time, costs, usability, and security. The results showed that the developed artefact improved usability, lowered costs, decreased waiting time, and has the potential to prevent document forgery. The analysis of the results show that a software system can replace paper documents and has great potential to increase efficiency in customs.

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LIST OF SYMBOLS AND ABBREVIATIONS

API	Application Programming Interface
AEO	Authorized Economic Operator
ASYCUDA	Automated System for Customs Data
CIA	Confidentiality, Integrity, and Availability
CEMT	Conférence Européenne des Ministres des Transports
DSR	Design Science Research
MASP	European Commission when the Multi-Annual Strategic Plan
EU	European Union
EMCS	Excise Movement and Control System
TRAFICOM	Finnish Transportation and Authorization Agency
IS	Information Systems
ITAIDE	Information Technology for Adoption and Intelligent Design for e-Government
ICT	Information and Communications Technology
JWT	JSON Web Token
JSON	JavaScript Object Notation
JIT	Just-In-Time
MIS	Management Information System
MASP	Multi-Annual Strategic Plan
PWA	Progressive Web Apps
RWD	Responsive Web Design
SSL	Secure Sockets Layer
SW	Single Window
TREC	Tamper-Resistant Embedded Controller
UNECE	The United Nations Economic Commission for Europe
TA	Transport Authorisation
VAT	Value Added Tax
GA	Goal area
KPA	Key performance area
IT	Information Technology

1 INTRODUCTION

Over the last decade, computers and digitalization have become conventional rather than out of the ordinary innovation. Borg et. al. (2018) argues that although companies have increasingly become dependent on software systems for their daily tasks, the public sector, however, has been relatively slow in adopting this trend. One type of public sector organizations who need to advance their work into a more digitalized form are governmental agencies (Borg et al., 2018).

Digitalization is "the integration of digital technologies into everyday life by the digitization of everything that can be digitized" (Borg et al., 2018). In case the process of how a business is operated changes drastically, it is known as "digital transformation" (Matt et al., 2015) or "digitalization". Digitalization means changing the structures of an organization with new and innovative systems in which the business value is created (Matt et al., 2015). The digitalization era created entirely new and innovative approaches on managerial and governance processes for the private and public sector.

Considering the lack of digitalization in governmental institutions, in order for a document to be verified, a certain manual pattern needs to be followed: a document needs to be printed, signed, stamped, and scanned for electronic use, and then the original papers need to be sent via mail (Besson et al., 2015). This process of document verification had its flaws, which lead to the European Union (EU) to look into digitalisation. Governments have seen great potential and opportunities in digitalization, and are therefore investing more and more into it, in order to lead to a successful agenda for an electronic government (Falk et al., 2017). This led to the European Government taking actions into making an electronic customs (e-customs) standardized solution for all its member states (Raus et al., 2009).

The European Commission defines the electronic customs solution as “the project initiated by the European Commission that aims to replace paper-format customs procedures with EU-wide electronic procedures to create a more efficient and modern customs environment”. Several EU member states have taken initiatives themselves to tackle the paper-based customs procedures, but the main initiative for an e-customs solution has been taken by the

European Commission when the Multi-Annual Strategic Plan (MASP) was first introduced (Urciuoli et al., 2013). The goal of MASP is to have the vision, objectives, the strategic process and the milestones on which the e-customs solution would be implemented (Raus et al., 2009).

The EU member states continued their efforts to have an e-customs infrastructure that would help them solve their problems related to current paper-based customs approach, by implementing different projects such as the Information Technology for Adoption and Intelligent Design for e-Government (ITAIDE) (Raus, 2009).

In this thesis, two research questions related to digitalisation in customs have been defined. A literature review to look at the problems, solutions and the current situation in the e-customs domain has been done. An artefact has been developed that tackles key problems found from the literature review. Expert interviews have been conducted to assess if the problems have been solved with the developed artefact. Finally, the results have been analysed and presented alongside discussions and conclusions for the topic.

1.1 Problem statement

Considering that the public sector has been digitalising services at slower pace than other sectors, problems have been seen that affected both the people working in the sector as well as people who are receiving services. A report by the Digital Transport & Logistics Forum (2018) describes the situation of transport procedures within the EU member states and outside of EU borders. Also, it analyses the problems in the current state of border transport infrastructure within and outside of the EU, as well as the potential benefits of a paperless solution.

The main four problems of paper-based transport process are the following (Digital Transport & Logistics Forum, 2018):

High cost - Apart from the paper costs, substantial staff is needed to handle different customs procedures, compared to an e-solution. Additionally, if something goes wrong and errors

occur during the procedures, costs go even higher, making the current way of doing things unthrifty. Although customs officials use digital services in their workplace, the documents that are required by transportation companies that are crossing the border are not digitalised yet.

The long waiting time during transportation - Considering that each transportation process requires a new set of papers for each procedure, the time spent is substantial compared to having everything in electronic form and needing to present it only once. The delays may contribute to larger problems in terms of importing and exporting goods between the countries and may lead to financial loss for companies that get affected by it as well as customs.

Facilitating trade while securing the importing and exporting processes - Paperwork which is related to customs, Value Added Tax (VAT), and other necessary documents are processed by separate information systems even though the data structure is almost the same (Raus et al., 2009). This adds complexity and customs can take more time to process each of these documents in separate information systems, which will result in delays, added cost, and make the work of customs officials harder.

Document fraud - Paper-based documents are also known to show room for forgery, making the process of document sharing between different customs departments as well as 3rd party services very difficult. These problems show that there is a need for an intervention in the public sector, specifically for customs, that will tackle the aforementioned problems and improve the performance in that area.

1.2 Goals and delimitations

The primary focus of this thesis is the e-customs domain. The main goal of the thesis is to develop an artefact that solves key issues regarding bilateral transport license between Finland and Russia. In order to achieve this goal, digital documents and their use in governmental services are analysed.

The second goal for this thesis is identifying the problems that the current paper-based process has in place and how those problems can be mitigated. By reviewing the literature, the problems and the progress regarding electronic customs in different countries can be identified. Literature will also be reviewed to identify what is offered by the European Union regarding the digitalisation of customs services and documents, and how the frameworks that they provide can fit into the solution while developing the artefact.

Software solutions that tackle some of the problems mentioned in the literature review are presented as the artefact of this thesis. The artefact digitalises the bilateral transport license document that is used during transportation of goods between Finland and Russia. The evaluation of the developed artefact was done by conducting expert interviews. The experts participating were the people by which their daily tasks will be affected when the developed artefact is taken into use.

The artefact has some delimitations that need to be considered. First, the artefact is presented to a small-scale group, consisting of Finnish and Russian customs authorities as well as Finnish Transportation and Authorization Agency (TRAFICOM). The developed solution solely deals with the bilateral transport authorization document. However, the research is conducted in a larger scale on digital documents, electronic cross-border solutions, and e-customs concept as a whole.

1.3 Structure of the thesis

This thesis is separated into six sections, each section is focusing on specific aspects of the study. The first section contains introduction of the topic and the background as well as the motivation behind the thesis. Section 2 contains the literature review for the study which is done in two phases: the first phase contains identifying issues in the e-customs domain. The second phase is focused on typical solutions for the identified issues. Section 3 shows the research methodology that has been used. The research questions for this study have been described in this section as well as the literature review methodology and evaluation methodology used. Section 4 explains how the design and implementation of the artefact has been done, what are the key user tasks that have been considered during the implementation.

The section ends with a presentation of the developed artefact and the solutions it provides. Section 5 goes through the results of expert evaluations for the developed artefact and their interpretations. The second part of this section shows discussions about this thesis results and previous research results in the e-customs domain and a comparison of those results is done. Lastly, section 6 shows the conclusions, where all the main points of the thesis are presented.

2 LIRERATURE REVIEW

Developments in the international supply chain such as growth of international trade, decreased tariff and non-tariff barriers, new logistics models as well as the use of Information and Communications Technology (ICT) in trade operations is changing the Customs' role from a passive gatekeeper role to an active one. These developments are driving customs administrations to update their current operational approach and their existing models (Gordhan, 2007; Widdowson, 2007). Utilizing ICT solutions in customs processes makes them more automated, which results in increased efficiency, reduction of manual labour and validation of data (Wilmott, 2007).

According to Raus et al. (2009), applying ICT solutions in customs processes eliminates redundant tasks, which gives the public sector the opportunity to offer better and faster services to companies, as well as save time and money. Hesketh (2010) explains that by using electronic services, the custom procedures would be much simpler, and it would facilitate all parties in the supply chain ecosystem to gather the information that is needed.

However, aside from the benefits these ICT systems bring to the customs procedures, there are some challenges. Raus et al. (2009) defines and explains the barriers that prevent companies from adapting the ICT systems, such as:

- **Costs** – It is possible that some small and medium-sized companies do not have enough financial freedom to adapt and acquire the new hardware and software required.
- **Regulations uncertainty** – Governmental agencies may not provide templates and guidelines specifying the new regulations that would take place.
- **Insufficient infrastructure** – Considering that the standardization of processes and procedures are highly complex, the infrastructure may not support multiple standards and systems.
- **Lack of adaptability** – The employees can be hesitant and resist the new work procedures.

The current freight transport process that is followed between EU countries has proven to have its flaws, which will be presented in the forthcoming subsection. This literature review will also focus on the e-solutions that different EU countries have taken to solve the issues with their customs processes, and how they benefited from those solutions.

2.1 Current freight transport process

Trade liberalization and the technology enhancements and innovations have changed the international trading industry substantially during the last century. However, due to the increased demand in trade between countries, it is crucial for transportation companies and customs authorities to ensure safe and accommodating operations.

Shipping companies often process shipments without exactly knowing details about the nature of goods inside the containers (Hesketh, 2010). Nevertheless, customs need to be informed about the nature of the goods before they enter the country. Hence, they use transport documentation, and make it mandatory to transportation companies. However, this leaves room for document fraud, the most common of which is called miscoding (Triepels et al., 2018). Miscoding means providing incorrect information to customs about the goods that are about to enter a country.

Due to the fact that transport documentation in customs has traditionally been paper-based, there are issues that can be caused by it, one of which is the time needed to perform the transport process. On a report for Cross-border Research Association, Granqvist et al. (2010) explain the issues with the today's situation on Trade-Customs interaction between the EU and Switzerland specifically. The survey found that at least 15 companies that took the open-ended questions on the survey expressed their concern with long cross-border lead times. The answers ranged from as simple as "Lead times need to be reduced" to specific concerns that the companies had regarding competitiveness. One company explained that transporting goods from Switzerland to Germany takes three days, of which the customs process alone requires one full day. Transporting to Asia on the other hand takes four days.

Additionally, other problems arising from paper-based solutions are related to costs. Some companies expressed their concerns with customs compliance costs and highlighted the importance of cost-reduction on future e-Customs applications (Granqvist et al., 2011).

2.1.1 Finnish-Russian bilateral transport process

The transport documentation that is needed for cross-border transportation processes is in the form of permits. In Finland, Finnish Transport and Authorisation Agency defines the different types of permits that are needed for freight transportation which are required for any trade between Finland and a non-EU country (*International Freight Transport Permits | Traficom*, 2019). These permits include information such as: the dates of departure and arrival, the place of loading and unloading, the country code, the vehicle's registration, and the gross vehicle weight. Depending on the transportation type, the permits can be classified as follows:

- Freight transport permits
- Bilateral permits
- Third-country permits
- Conférence Européenne des Ministres des Transports (CEMT) permit

The main interest of this thesis is bilateral permits. These permits allow companies that have a Community license issued by the competent authority to run international commercial freight transport by one or more vehicles between Finland and a non-EU country. This includes bilateral freight transport operations between the two countries but does not give the right to operate domestic services.

All of the aforementioned types of permits are paper-based, which means that they are subject to the same problems paper-based solutions face. The current process that explains the Finnish authorities' tasks as well as transportation companies during freight transport procedures is shown in **Figure *1***.

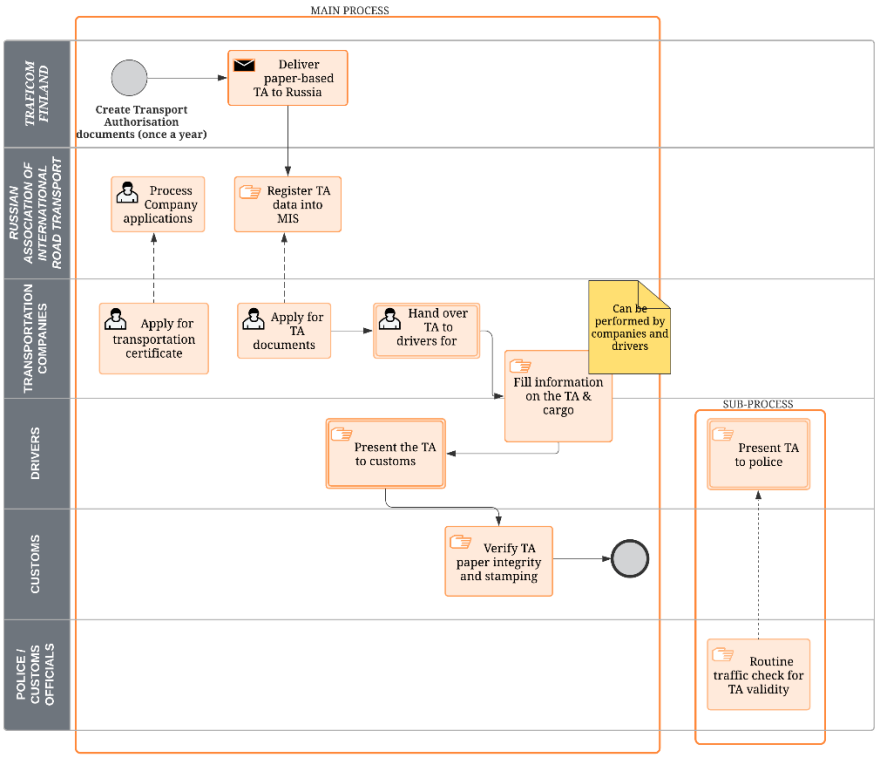

Figure 1. Current bilateral transport process between Finland and Russia

In the current process, TRAFICOM creates a specific amount of Bilateral transport licenses also known by the name Transport Authorisation (TA) documents, once a year. The TA documents are then sent out to the Russian Association of International Road Transport in Russia. The physical documents are then processed into the organisation's own Management Information System (MIS). In order for transportation companies to transport goods internationally, they need to own a transportation certificate by the aforementioned organisation. After the certificate is granted, transportation companies in Russia apply for the TA based on their transportation schedules in Finland.

Either the drivers or the company officials fill out the information into the TA before going to the border. When the TA is presented in the border to customs, the person that is on duty has a responsibility to check the integrity and verify if the TA paper document is authentic and then proceed with other steps. This process has been considered subpar, making people investigate new innovative digital solutions that removes the burden from customs and makes the process as well as the entire border crossing more fluent.

After a truck has entered Finland, Finnish police and customs officials have the right to inspect the TA while the transportation truck is still in Finland. The driver has to show the same TA at the border while they are going back to Russia.

2.2 E-customs initiatives taken in Finland

Finnish government bodies together with the cities of Imatra and Lappeenranta have taken initiatives for an e-customs solution for their border points with Russia. Those initiatives are shown in a research report conducted by Partinen & Niiranen (2019). The report explains the project called “eBorder”, an initiative with the aim of using digitalisation to facilitate and speed up the traffic between Finland and Russia, as well as develop new mobility services for the border.

This report shows the attempts that the Finnish government has done to digitalize services and increase collaboration between Finnish and Russian customs for better and faster border crossings. The report also finds that the existing software that is part of the eBorder project has improved the services between the two countries. The existing software shows real-time information on border traffic, WiFi networks and estimated waiting time on different crossing points.

In the report, a new solution is proposed which intends to increase efficiency and collaboration between the two countries, in which a new process for freight transportation is presented. **Figure 2** explains the new proposed process which includes the digitalisation of bilateral permit documents, which are needed to transport goods between Finland and Russia. The software solution that would implement the proposed process is presented as a continuation of the eBorder initiative and would function under the eBorder service umbrella.

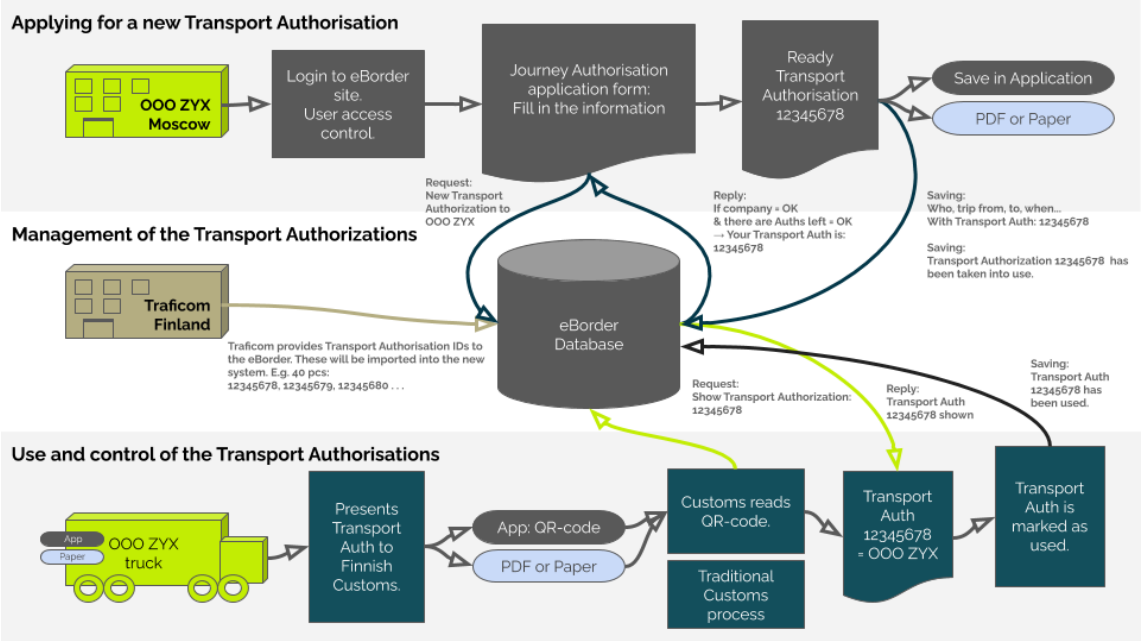

Figure 2. Illustrative top-level description of a digital bilateral transport license - document processes (Partinen & Niiranen, 2019)

2.3 Benefits of e-customs

E-customs are known for one significant transformation on the customs procedures: transforming physical documents into electronic ones. In addition to playing an important role in the digitalisation of customs processes, electronic documents are also a significant leap towards e-government solutions in general.

Civelek et al. (2015) categorises the benefits arising from e-customs solutions in the following areas:

- **Cost reduction** – Currently, a big part of the costs of products that are being traded across the world are related to paperwork. Those costs come from repetitive data entries, postal costs, document errors, loss of documents etc. When documents get replaced with the electronic version, the costs will go down because the abovementioned problems are non-existent in electronic documents. This observation is supported by many others, who also found that paper documents increase the costs and transforming them into a digital form would reduce those costs

significantly (Dawes, 1996; Gilbert et al., 2004; Hesketh, 2009; Holloway, 2009; Liao & Cheung, 2001; Overbeek et al., 2011; Raus, 2009; Raus et al., 2009).

- **Shorter transaction times -** Transferring paper documents by post takes days and sometimes weeks in foreign trade transactions. When electronic documents replace the paper-based documents, that timeline is shortened into 1-2 seconds. That is the amount of time required online to forward electronic documents as well as show them concurrently for all parties involved in the transaction. Document errors can be corrected within seconds since the data is stored on online databases. These findings related to transaction times have been noticed by other researchers too, who also found that having access to the documents electronically instead of on paper saves time (Gilbert et al., 2004; Holloway, 2009; Raus et al., 2009; Rogers, 2003).
- **Decreased effect on human factor –** Disagreements that parties can have for misinterpretations of the documents as well as any type of business process such as bribery and favouritism would be inexistent. The electronic version of the documents would work in line with common standards worldwide. Civelek et al. (2015) and Raus et al. (2009) support this observation by explaining that an electronic system would avoid misinterpretations of standard regulations.
- **Archive cost savings –** Archiving paper documents is very costly especially for governmental agencies. The documents need to be stored in rooms for a long period of time and be secured against anything than can damage them such as fire, humidity, theft. A lot of the costs can be cut down if the documents are archived electronically. Apart from the costs, the document retrieval would be a lot faster than compared to the paper document retrieval. Paper document retrieval can take weeks in larger organisations. However, when a document is stored in a digital form on a database, the retrieval time of the document is decreased significantly, into a matter of seconds. More arguments that support archive cost savings can be seen on a research made by Laryea (2002).
- **Recorded economy –** Documents in electronic form would be a huge help for elimination of unrecorded economy, tax evasion and irregular ways would be a lot more difficult. With statistical data stored, every process would be more transparent.
- **Prevention of fraud and usefulness–** Any type of corruption, fraud and forgery on the documents would be eliminated and alterations on documents would be

prevented. With the electronic system in place, risk management and tax revenue collection would be an easy process for customs. Many other researchers support the argument that an electronic system prevents fraudulent activities compared to paper documents (Davis, 1989; Dawes, 1996; Gilbert et al., 2004; Holloway, 2009; Rogers, 2003).

- **Language differences stop being a problem –** Having the documents in electronic form would make it much easier to make it available in different languages considering the ease of adding translated text into the electronic forms. Having the option to retrieve the document in several languages when needed, removes any obstacles in terms of document understanding when it comes to multiple languages.

Granqvist et al. (2010) conducted an open-ended question survey with 70 companies in Switzerland regarding border trade and logistics operations, in order to identify how the costs can be reduced and the efficiency can be improved. The companies that took the survey were Swiss-based manufacturing and trade/retail/wholesale companies with operations on import, export, and transit. Out of the 70 companies, 15 of the companies took part in the survey which dealt with customs problems and mitigation of those problems. The results emphasised that companies strongly believed that with the implementation of an e-customs solution, the costs would be reduced, and the whole movement of goods and procedures would be simpler and smoother.

To better understand the benefits of e-customs solutions, Liu *et al.*, (2008) suggested for a value assessment framework to be applied on e-customs projects such as the ITAIDE project specifically on the common web-based electronic customs application. The framework has been implemented by Raus (2009), studying the private and public sector. The results show the benefits of having such infrastructure for customs and which areas this implementation would affect and they will be discussed in the following subsections. The value assessments done for the private sector and the public sector are shown in terms of goal areas (GAs) and key performance areas (KPAs).

The authors explain that a goal area is the area on which the stakeholder's key objectives are shown in a more general way and their scope is to provide top level analysis. Key performance areas are business success factors and are assessed by key performance indicators (qualitative and quantitative measurements).

2.3.1 Value assessment for the private sector

According to the value assessment conducted by Raus (2009), the most important goal areas of the private sector that would benefit from e-customs solutions are: security, reduction of administrative burden, compliance, and communication for which nine performance areas were analysed:

- Fulfilment of safety regulations
- Increased service quality
- System harmonization
- Regulation and procedure harmonization
- Improvement of data exchange
- Resource conservation for the same task
- Faster process cycle time
- EU customs communication
- EU customs information sharing

The goal areas were then analysed based on the abovementioned performance areas to show the benefits of e-customs solutions to each of them:

- **Security -** Security is considered as a censorious part of trade and the European Member states consider it as one of their main goals. Liu *et al.*, (2008) research supports the finding by stating that a common web-based European customs system makes the international trade safer due to the fact that the application fulfils the safety regulations. The results from Liu *et al.*, (2008) show that the monthly irregularities would be reduced by a percentage as high as 50-75%. This would result in a faster execution of tasks and fewer personnel.

- **Reduction of administrative burden -** According to the study, another important goal for a new e-customs application is reduction of administrative burden. This means that replacing paper-based customs documents with electronic ones, will make an improvement of the overall procedures during trading. Private companies argue that a paperless system makes the services better than the current service by 50-75%. When it comes to the operational goals, the businesses identified some areas that would be improved. They argue that having different systems communicate with one another improves data sharing and leads to a completely paper-free environment. Considering that right now the data that is being shared between private companies and the EU customs is manual, the e-customs approach would improve information sharing quality, and the export process would be faster for 25-50%.
- **Compliance -** The companies emphasised the importance of compliance when it comes to regulations that a country has. The interviewed companies, although compliant with the current regulations, suggested that an e-customs application would mean less trial and error for new transportation companies. They state that to be able to be fully compliant with the regulations, companies are going through a trial-and-error approach where they might need to go back and forth until they can finalize a fully compliant export successfully.
- **Communication -** The interviewed companies stated that the communication experience varies, depending if the need to communicate with local customs officers or other EU member states for longer routes. They state that the former is easier for them and does not comprise any issues. The latter, however, is considered as problematic considering the language barriers that they might encounter with different EU member states. An e-customs system would harmonize and make the export procedures standardized, resulting in an electronic communication and information sharing. The solution would improve the strategic and operational perspective making the execution process faster.

To understand the benefits of e-customs in the private sector, in terms of both goal areas and value categories, a matrix that correlates the two is displayed in **Table 1** below. **Table 1** also introduces Authorized Economic Operator (AEO) status in one of the points. AEO status is defined by the Finnish Customs as “a business whose customs clearance and logistics

operations have been granted a security certificate by Customs and is therefore entitled to benefits across the EU".

Table 1. Value matrix of the private sector (Raus, 2009)

		Goal areas (GAs)			
		Security	*Reduction of administrative burden*	*Compliance*	*Communication*
Value Categories	*Strategic*		• Increased services' quality	• Harmonization of regulations and procedures (SW)	• Communication between EU customs offices and business companies
	Operational	• Fulfillment of safety regulations (thanks to AEO status)	• Harmonization of different systems • Increased services' quality • Improvement of data exchange • Faster process cycle time		• Communication between EU customs offices and business companies • Information sharing between EU customs offices and business companies
	Social		• Less people involved		
	Financial	• Fulfillment of safety regulations (thanks to AEO status)	• Harmonization of different systems • Improvement of data exchange • Faster process cycle time • Less people involved	• Harmonization of regulations and procedures (SW)	

2.3.2 Value assessment for the public sector

The value assessment for the public sector also defined the goal areas and the performance areas to be affected by the benefits of e-customs in the public sector: security, reduction of administrative burden, compliance, and communication.

The Danish tax and customs officers identified eleven key performance areas which are correlated with the aforementioned goal areas:

- Transparency of EU trade
- Information quality improvement

- Single access point for VAT
- Services' quality improvement
- System harmonization
- Data exchange improvement
- Faster process cycle time
- Resource conservation
- Communication between EU customs offices
- Collaboration between EU customs offices
- Access to the information of other EU custom offices

The key goal areas are then analysed and shown how the performance areas play a role on them and show the importance of e-customs as a platform.

- **Security -** According to the customs officials, security as a goal area is crucial for improvement. They emphasize that an e-border application would have a big impact on the financial and operational viewpoint. The participants stated that the process of risk analysis can greatly improve with the electronic system, considering that for the moment, that is being done manually for every export request. They also stated that the quality of the information that is being shared between the private and public sector can improve, which would result in a less controlled environment.
- **Reduction of administrative burden -** The key performance area identified is the improvement of quality of services, considering that an automated system can handle standardized data exchange without additional resources on administration. The second key performance area is harmonisation between different systems, such as the local tax and custom offices. It is predicted that in the future, different European systems can be harmonised to enable 100% information sharing capabilities. Because of the acceleration of execution time, it is estimated that delays are avoided, and process costs can go down by 15%.
- **Compliance -** Compliance was identified as a non-crucial aspect of the public sector. Even though the public sector is aiming to reduce the number of non-compliant regulations and procedures via the Single Window, it does not affect the social point of view. Having a decrease in irregularities can lead to cost reduction and time saved.

- **Communication and collaboration -** EU customs offices see a great improvement in communication with an electronic application taken in place. An automated communication system can improve the operational, strategic, and financial aspects. With a communication and collaboration system in place, employees' satisfaction increases due to better information sharing.

To understand the benefits of e-customs in the public sector, in terms of both goal areas and value categories, a matrix that correlates the two is displayed in **Table *2***.

Table 2. Value matrix of the public sector (Raus, 2009)

		Goal areas (GAs)			
		Security	*Reduction of administrative burden*	*Compliance*	*Communication / Collaboration*
Value Categories	*Strategic*		• Increased services' quality	• Harmonization of regulations and procedures (SW)	• Communication between EU customs offices • Collaboration between EU customs offices
	Operational	• Transparency of EU trade • Improvement of information quality • Single access point for VAT (no fraud)	• Harmonization of different systems • Increased services' quality • Improvement of data exchange • Faster process cycle time	• Harmonization of regulations and procedures (SW)	• Communication between EU customs offices • Collaboration between EU customs offices • Access to information of other customs offices
	Social		• Increased services' quality • Faster process cycle time • Less people involved		• Communication between EU customs offices • Completely new EU member states
	Financial	• Transparency of EU trade • Improvement of information quality • Single access point for VAT (no fraud)	• Harmonization of different systems • Improvement of data exchange • Faster process cycle time • Less people involved	• Harmonization of regulations and procedures (SW)	• Communication between EU customs offices • Collaboration between EU customs offices • Access to information of other customs offices

2.4 Paperless strategies

Considering the problems identified with paper-based processes, and the benefits that e-customs solutions bring, the European Union has defined and initiated regulations, initiatives, and high-level specifications to address this. Different projects have been studied, as well as their goals and objectives. Apart from the EU itself, there have also been country-specific e-customs solutions in different fields such as tax declarations, making border crossings easier and saving resources, which are studied in the subsections below.

2.4.1 E-Customs high level regulations and specifications

The European member states want to have safe trade, stressing the importance of secure import and export. Hence, the European Union has taken a lot of actions to achieve a simpler trade inside the community. During the last thirty years, the customs administration saw great progress in import-export processing from a paper-based process to the automation of those customs' processes. This ranges from the Automated System for Customs Data project (ASYCUDA) in 1981, to maximizing the internet utilisation and foundation of e-customs (Holloway, 2009). Holloway argues that with the increase of demands within the supply chain and the governments trying to keep customs profitable, an extended amount of pressure has been put for a better solution. This is where ICT solutions come in handy, specifically with the inclusion of automation in customs' processes.

The European Commission (2005) adopted two proposals to modernise the EU Customs Code as well as initiate an electronic and paper-free customs environment within the EU. The first proposal targeted the customs' processes and procedures to make them simpler and more efficient. The second proposal targeted several areas of collaboration between European member states such as: make the electronic customs' systems compatible between each member state, EU electronic risk analysis, information exchange improvement between control authorities and introduce a centralised customs clearance arrangement. The expected result of these agreements was to incentivise companies to do more business in Europe as well as improve security and reduce costs.

In order to have a successful e-Customs development, the European Commission defined three strategic goals (Bjorn-Andersen & Razmerita, 2008):

- **Achieving Pan-European interoperability -** European governmental systems will be able to exchange data between one another, irrespective of the technology standards used for implementation.
- **Establishing Single Window (SW) Access Points -** The United Nations Economic Commission for Europe (UNECE) defines Single Window as: "The single window environment aims to expedite and simplify information flows between trade and government and bring meaningful gains to all parties involved in cross-border trade. In a theoretical sense, a single window can be described as a system that allows traders to lodge information with a single body to fulfil all import or export related regulatory requirements" (Caraiani & Caraiani, 2013).
- **Granting Authorized Economic Operator (AEO) status to trading partners -** Finnish Customs define AEO as "a business whose customs clearance and logistics operations have been granted a security certificate by Customs and is therefore entitled to benefits across the EU". The company that has an AEO authorisation is considered as a reliable trader and benefits from customs all over the EU.

As one of their solutions, the European Union presented the Multi-Annual Strategic Plan (MASP) (Urciuoli et al., 2013). The goal of the MASP is to implement a system that is electronic and will be used as a standard customs system within all the member states. Some researchers were focused on the electronic customs topic and analysed local solutions within specific member states and new applications that come out of those solutions (Baida, Liu, et al., 2007; Baida, Rukanova, et al., 2007; Rukanova et al., 2007). The European Community Treaty presented the e-government model and the procedure of innovation-development process for MASP, as shown in **Figure 3**. The main aim was to show the goals, the vision, objectives and strategies in a higher level for all European member states. However, the implementation part would be a responsibility of each member state individually (Raus et al., 2009).

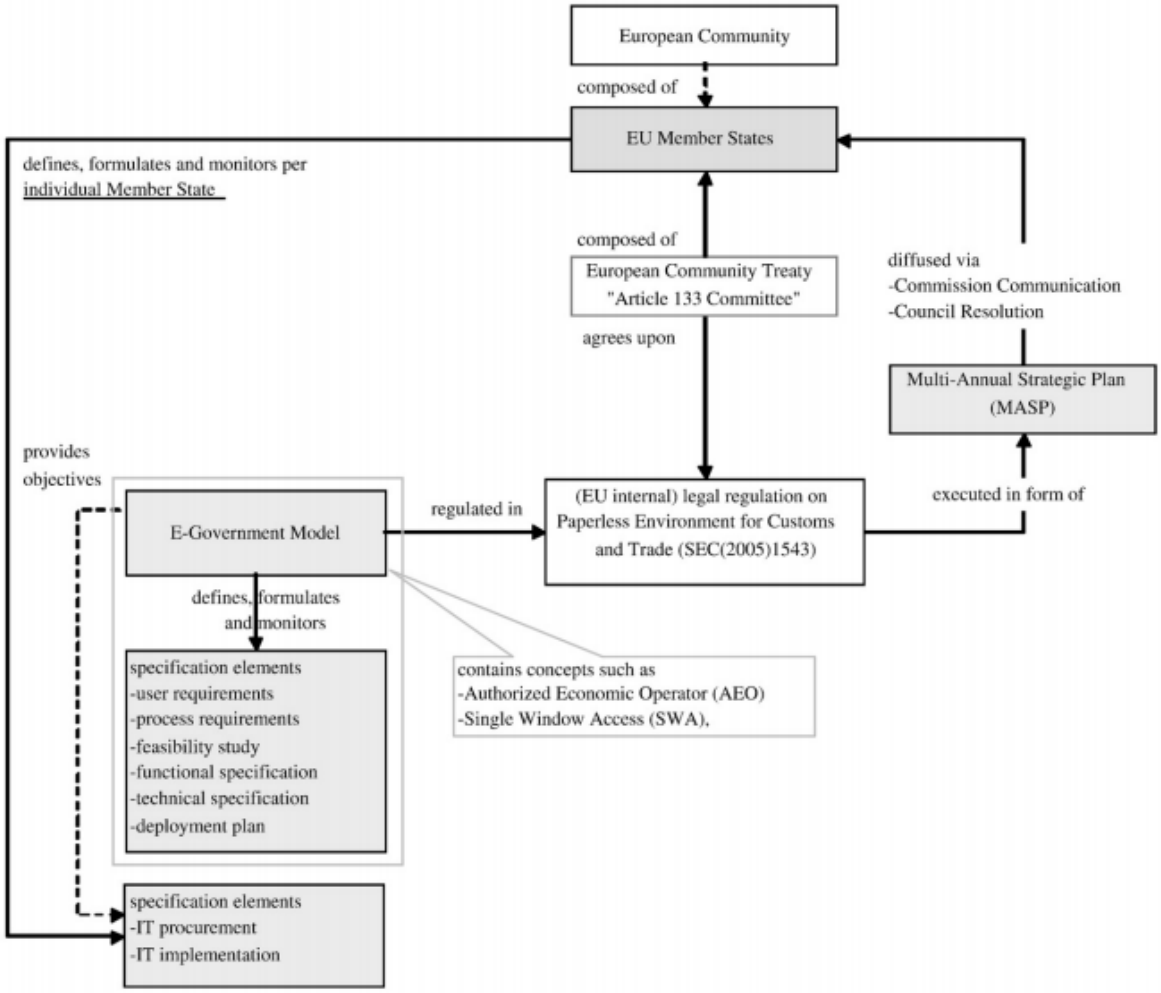

Figure 3. Regulative process for innovation-development in the European Union (Raus et al., 2009)

Apart from the MASP initiative, the European Union also funded the project Information Technology for Adoption and Intelligent Design for e-Government (ITAIDE). The ITAIDE project has been funded in order to provide e-customs solutions that would improve business-to-government partnership (Raus, 2009). ITAIDE has been projected as a research project for e-government innovation, comprised of universities, governments, and business partners. The project views how the customs situation is in four EU countries: Denmark, Finland, Netherlands, and Ireland (Raus et al., 2009). The goal for the ITAIDE project is to have a concept for new innovative e-customs application that contributes to SW and AEO (Raus, 2009).

2.4.2 Practical implementations

After the high-level regulations and projects were initiated by the European Union, a lot of applications based on them started to be implemented and used in various European Member states. This subsection focuses on applications that have been implemented based on the high-level initiatives defined by the EU.

One such application is the Excise Movement and Control System (EMCS). EMCS is based on SWA and AEO and its aim is to ensure that two goals are met: to be used as a national database for excise data in every member state, and to be an international message standard for data exchange between all systems that are EMCS compliant in each of the member states (Tan et al., 2006). According to Vătuiu et al., (2010), in practice, EMCS is an electronic platform that allows monitoring of movements for excise goods between Member States. The system also replaces the paper documents that were needed for the same task. EMCS managed to simplify the procedures in each tracking stage, eliminate red tape which was generated by paperwork, as well as effectively use the IT tools to improve security and prevent fraudulent actions in each trading phase though a fast exchange of information between customs and tax authorities.

Apart from software applications, hardware technologies were also being implemented as solutions in customs, such as Tamper-Resistant Embedded Controller (TREC). According to Bjorn-Andersen & Razmerita, (2008) TREC is a wireless monitoring device that is installed on containers. The device has been developed by IBM Zurich labs and allows customs to monitor movement, audit the trail of containers as well as gather information from the point of origin to destination. TREC has been used to monitor any fraudulent activities happening during cross-border procedures. Tan et al., (2006) explains that on a Dutch case study, it has been discovered that the EMCS system was not considered as a fully paper-less solution because paper was still being used. However, when EMCS and TREC were integrated with one another, the combination of the two technologies resulted in a system that did not need paper at all in order to operate successfully. The study shows that even though the solution was tested and produced promising results, the hardware of TREC

had issues, which made the product get back into development phase for further investigation of the issues and hardware improvements.

2.5 Technical approaches to common issues

The identified problems have been analysed and solutions that mitigate those problems have been found. The technologies that have been identified solve the problems with usability, security, costs, and infrastructure compatibility. The synopsis of the identified barriers for e-customs systems and their definitions can be found in **Table 3** below. The technical approaches to key issues are explained in the subsection below.

Table 3. Synopsis of identified problem areas for e-customs systems

Factor	**Definition**	**Sources**
Lack of confidentiality/privacy	Data must be private and protected as well as not used for other purposes.	(Liljander et al., 2002; U.K. Cabinet Office, 1998; Zhu et al., 2002)
Costs	Costs for digitalisation and IT projects are high which causes projects to fail or be postponed.	(Dawes, 1996; Gilbert et al., 2004; Hesketh, 2009; Holloway, 2009; Liao & Cheung, 2001; Overbeek et al., 2011; Raus, 2009; Raus et al., 2009)
Insufficient infrastructure	Technical barriers that include poor data quality, lack of or poor communication standards. Monolithic and not interoperational legacy systems are a big barrier to new technologies.	(Ebrahim & Irani, 2005; Fichman, 2004; Janssen & Veenstra, 2006; Kamal et al., 2009; Lam, 2005; Raus et al., 2009; Veenstra et al., 2011)
Lack of adaptability	People who use the system may be reluctant to use the system in case there is an	(Dawes, 1996; Holloway, 2009; Raus et al., 2009; Urciuoli et al., 2013)

	increase in complexity of the processes or digitalisation of operations.	
Reliability	The system should be reliable and gain the trust of its users. In case the system is not reliable for its users, it causes barriers that might hinder the processes.	(Berkley & Gupta, 1994; Hansen, 1995; Zhu et al., 2002)
Usability	The system must be enjoyable, easy to use, visually appealing and without complex added procedures with as simple steps as possible.	(Agarwal & Prasad, 1998; Dabholkar, 1996; Davis, 1989; Lederer et al., 2000; Meuter et al., 2000; Zhu et al., 2002)
Security	Security is a crucial part for a digital system and needs to be provided with the highest standards. Lack of security rules, policies or knowledge may lead to data breaches.	(Berkley & Gupta, 1994; Hansen, 1995; IBM, 2011; U.K. Cabinet Office, 1998)

2.5.1 Usability

Usability has been receiving attention from both the research community as well as the development community due to possible benefits that usability improvements brings to the table. Palmer (2002) explains that usability usually has been seen from an engineering viewpoint where people tried to come up with standards and common practices that would guarantee that usability is covered after a system has been designed. Before the spread of Web, when usability of information systems has been considered, there were five design principles that were taken care of : consistency of an interface, response time, mapping and metaphors, interaction styles, multimedia and audio visuals (Palmer, 2002).

However, when web became popular, there were more studies related to usability and more principles added to the list such as easy-to-use navigation, frequent updating, and quality content. In order to tackle these, developers and designers developed libraries and tools that will help them not only cover the principles but also create a new approach to today's design principles. Companies have turned to finding more suitable solutions for their applications which would also decrease the development price and would be more efficient for their customers. Responsive Web Design (RWD) was introduced as the more efficient and practicable solution for this issue (Groth & Haslwanter, 2016).

A case study by Groth & Haslwanter (2016) shows that web applications that had responsive design have been more effective and efficient than non-responsive web applications. The study also shows that the responsiveness increased user engagement and satisfaction with the service provided. Material design was created by Google to offer responsive web and mobile application views as well as cover the principles of design that were mentioned above. With its rich guidelines, principles and resources it provides, Material design has become leading industry standard for development (Awwad et al., 2017). Material Design is considered as a metaphor on its own (Google, 2019). It is used to tackle the usability problems while improving the user interface and making the views responsive.

In order to improve the usability of a software, the user interface frameworks needs to be able to handle fast view rendering when the data or the screen resolution is changed. Richard & LePage (2020) explain that Google's Angular framework has unique features that distinguish it from other frameworks such as robust change detection and routing, lazy-loading, animation and its backed by Observable APIs with Rxjs and Typescript. These different features and integrations make Angular an exceptional, capable, and fully developed choice for a software. Angular also has great Progressive Web Apps (PWA) support since version 5.0 which makes it an all-in-one framework for mobile as well as web application development (Hajian, 2019).

Another important usability factor that needs to be addressed is localization and internationalization. Localization and internationalization are often taken as the same thing

when developing software, however their meaning is different. Internationalization (i18n) is the process of designing and developing a software that adapts to different languages and regions (Ayyal Awwad & Slany, 2016). Localization (l10n) is the process of adapting internationalized software for a language or region and adding local components into it (Ayyal Awwad & Slany, 2016). Both are very important and affect the user usage drop rate for an application depending on its support and how well it is implemented.

Data collected by Google and Admob in 2014 show that there were users that stopped using an application just because the application was not localized properly. The data show that the percentage of users that stopped using the application due to bad or inexistent localization is as high as 48% (Awwad et al., 2017).

As a solution for this is to use Angular NGX-Translate library. Angular NGX-Translate uses JavaScript Object Notation (JSON) format which allows users to add key-value pairs for translations. This library uses Just-In-Time (JIT) compilation, which means the app will compile the code without needing to refresh the page. Although the JIT compilation can affect the performance in terms of loading time, it also depends on the amount of text that is being loaded. Angular components get notified for a changed state for their elements and each element gets triggered for re-rendering. While being re-rendered, the new values that are taken from the new translation document will be read and shown to the user. The fact that the page is not refreshed brings additional value to usability because the user can immediately proceed with the tasks they have, instead of waiting for the application to load.

2.5.2 Compatibility and system integrations

In Software Engineering, compatibility issues are often associated with monolithic architectures, and when communication between different systems has been required, Application Programming Interface (API) architectures have proven more suitable.

According to Reddy (2011), an API ”provides an abstraction for a problem and specifies how clients should interact with software components that implement a solution to that problem”. APIs offer reusable components that allow specific functionalities to be integrated

into an end-user application. In API-driven architecture, the backend and the frontend of a software are decoupled into two different stacks (Lazar, 2018). This kind of decoupling of the software makes the infrastructure of the system easily maintainable and expandable.

Apart from the architecture design, in order to make it easier for developers to integrate different systems and make adjustments to existing software, similar technologies that have been used for previous systems can be used for the new system as well. A study on e-government software architecture has been conducted by reviewing papers that deal with similar issues such as Beer et al. (2006), Brüstel et al. (2012), Greunz et al. (2001), Sedek et al. (2014). The papers reveal that Java programming language has been the preferred choice for the backend of the applications considering the extensive security features it provides. Winand (2018) covers the database aspect of the infrastructure compatibility by explaining that MySQL is the most popular SQL database that is free to use. A report by DB-Engines (2020), shows that MySQL is the second most popular database in use. Considering that MySQL is an open source project, using this database would ensure that the system has a wide community support as well as frequent updates for critical issues.

2.5.3 Security

In order to tackle security issues in a system, a standardised security model for information systems needs to be used. The classic model that is used for security in information systems is the Confidentiality, integrity, and availability (CIA) triad model.

CIA triad model refers to the fundamental elements that an information system needs to address in terms of security (Coss & Samonas, 2014). These security practices (Confidentiality, integrity, and availability) have been the key elements for organisations while developing security for their information systems. However, due to its limited targets that this model has, a new and improved security model has been introduced in 1998 by Don Parker called the Parkerian Hexad model (Reid & Gilbert, 2010). **Figure 4** shows the fundamental attributes that this security model presents: confidentiality, possession or control, availability, utility, integrity and authenticity.

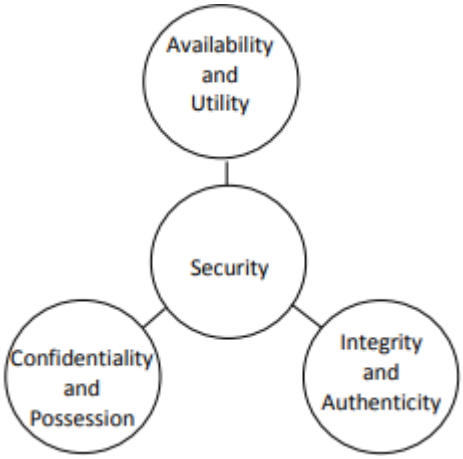

Figure 4. Parkerian Hexad model (Reid & Gilbert, 2010)

Reid & Gilbert (2010) explains what each attribute covers:

- **Confidentiality –** Confidentiality refers to ability to control access or exposure of information to certain people. One of the primary technologies to solve this is encryption be that symmetric or asymmetric encryptions.
- **Integrity** – Integrity or data integrity refers to the accuracy and completeness of the data over its lifecycle.
- **Availability –** Availability refers to the ability of having access to resources when needed. Ensuring availability of resources has been one of the biggest tasks for security professionals.
- **Possession or Control –** Possession or control refers to digital rights management. This has been added to Parkerian Hexad in order to allow people to protect their data from unauthorized individuals that might violate confidentiality.
- **Authenticity –** Authenticity refers to the assurance that an information that is being exchanged, is being done by the authorized person and identifying the source of the information being received. Secure Socket Layer (SSL) has been taken into consideration to mitigate any issues regarding authenticity as well as phishing detection, spoofing and other malicious ways of deceiving a user.

- **Utility –** Utility deals with the ability of the user to access information that has confidentiality and control but can have incompatibility when the information is shared, or access credentials have been forgotten.

To ensure secure communications over the network, standardised protocols such as TLS can be used. The Transport Layer Security (TLS) protocol is the successor of Secure Sockets Layer (SSL) protocol and is designed to secure end-to-end communication over insecure networks, including the internet (Cremers et al., 2017). TLS was initially presented as SSL and got updates over time with improvements in the protocol in regard to the encryption algorithms or the handshakes that the protocol uses. TLS works with handshakes between the client and the server and uses different exchange key modes to achieve security over the data that it being transferred on the network. A full TLS 1.3 handshake is demonstrated on **Figure 5**.

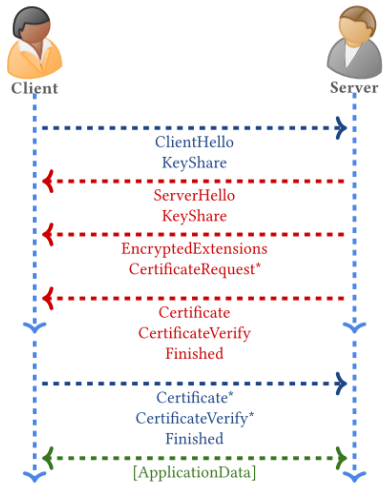

Figure 5. TLS 1.3 handshake between the client and the server (Cremers et al., 2017)

To tackle the authenticity aspect of security, JSON Web Token (JWT) can be used to ensure secure authentication and authorisation. JWT is a standard that defines how to securely send and receive information between parties as a JSON object. JWT can also be used for authentication of users in a software application. Using JWT-based access control scheme, the authentication is done with email/username and password combinations (Jánoky et al., 2018). After a successful authentication, there are user-specific information such as roles,

permissions, user identifiers etc that are packed into JWT. The token is encrypted using the shared encryption key called JWT secret.

A framework that works well with Java programming language as well as JWT is Spring Security. Spring Security is a framework that provides security services to Java based software applications in friendly and flexible way (Scarioni & Nardone, 2019). Spring Security provides different layers of security for an application and it's built on top of Spring Framework. Spring Security provides out-of-the-box support for different types of authentication models. **Figure 6** shows the layers and services that Spring Security has to offer. Spring Security can cover both the confidentiality as well as authenticity aspects of the security domain.

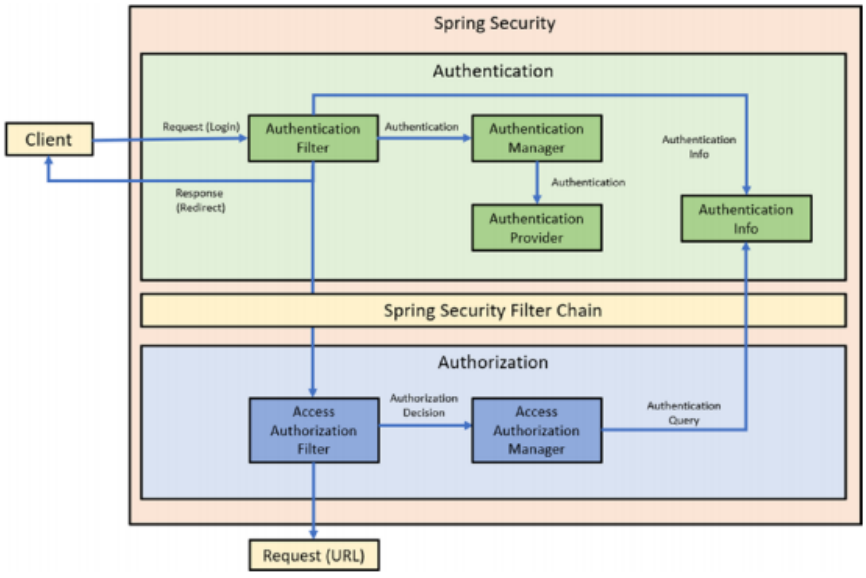

Figure 6. Spring Security authentication/authorization functionalities flow (Scarioni & Nardone, 2019)

2.5.4 Cost control

When it comes to implementing software solutions, typical factors proven to increase the cost of implementing software include the technologies used, the features the software needs to have, the platforms that the software has to be available for etc. If a software solution needs to be available as a web application for desktop and mobile application for mobile

phones, the costs may be high considering that each platform requires a separate project to be developed (Aguirre et al., 2020).

Progressive Web-Apps (PWA) has emerged by the need to have a more robust, cost friendly solution for these development problems. PWA can be defined as mobile web applications that take advantage of latest technologies such as Service Workers in order to look like and be installed like a native mobile application (Aguirre et al., 2020). Service Workers are scripts that run in the background and allow a web application to interact with mobile hardware as well as implement functionalities that do not require a web page or user interaction. This solution would then make it possible for users to use the same software in desktop using web browsers or mobile phones where the PWA app is installed, as well as reduce costs on product development.

2.5.5 Problems and solutions

On the subsections above, a more detailed explanation of the problems that are being tackled and the technical approaches towards those problems can be seen. An synopsis of the identified solutions that tackle key issues is shown in **Table 4**.

Table 4. Synopsis of identified technology solutions

Tackled problem	Solution	Description	Sources
Usability - Internationalization and localization	Angular NGX-Translate	Having the software in multiple languages and have multi-language support design enhances service utilization.	(Awwad et al., 2017; Ayyal Awwad & Slany, 2016; Kituyi & Anjoga, 2013)
Usability - Responsiveness	Material Design, Angular	Having the software user interface responsive increases the engagement of users with the software, improves usability and ease of use. Choosing a framework that supports fast and easy view rendering improves the overall usability of the software.	(Awwad et al., 2017; Groth & Haslwanter, 2016; Richard & LePage, 2020)
Insufficient Infrastructure	API Driven Architecture, Java	Decoupled architecture with high communication	(Beer et al., 2006; Brüstel et

	programming language, MySQL	standards makes the software easy to expand and support new technologies. Using similar technologies as the available software in the e-customs domain ensures infrastructure compatibility.	al., 2012; Greunz et al., 2001; Lazar, 2018; Reddy, 2011; Sedek et al., 2014; Winand, 2018)
Security	Parkerian Hexad Security model	Following a standardised security model for information systems makes sure that the software is secure and up to date with latest security aspects.	(Reid & Gilbert, 2010)
Security - Confidentiality	Spring Security	Using latest security frameworks that are frequently used to handle confidentiality issues makes the software more reliable.	(Scarioni & Nardone, 2019)
Security - Authenticity	TLS V1.3, JWT, Spring Security	Using latest protocols, standards and frameworks ensures that the Authenticity issues are covered, and the software is up to date with latest technology trends regarding this issue.	(Chou, 2002; Cremers et al., 2017; Jánoky et al., 2018; Scarioni & Nardone, 2019)
Costs	Cross-platform solution (Progressive Web Apps)	The use of cross-platform solutions such as Progressive Web Apps ensures that the costs for the implementation of the solution are low.	(Aguirre et al., 2020)

3 RESEARCH METHOD

This section introduces the research method used while conducting the research for the thesis. Considering that the thesis is concentrated around digitalizing bilateral transport license document, an artifact has been developed, hence the research method used was Design Science Research (DSR).

3.1 Design science research methodology

DSR is a research that is used to address the problem on what is relevant and what is rigour when it comes to Information Systems (IS) research (Baskerville et al., 2018). In terms of relevance, it gives prominence to practicality via artefacts, on the other hand it has scientific rigour by creating scientific theories to IS research. In a general form, artefacts are defined as constructs, models, methods, and instantiations represented as symbols, abstractions, algorithms and implemented prototypes, respectively. These combined, are presented as a pre-set rules to Information Technology (IT) researchers to fully understand and solve the problems that result in a successful implementation within organisations (Hevner et al., 2004). **Figure 7** shows a framework explaining the DSR in IT.

Hevner *et al.* (2004) shows the environment as a place that defines the problem in which the point of interest resides. It is composed of the Business side such as organisations and the Technology side. In the Business perspective, there are the problems, opportunities, organizational context and the business processes that define the business needs or "relevance". On the other hand, it contains the existing technological infrastructure, information systems, applications and communications architecture. The Technology part is either replaced with the new artefact or integrated altogether. The environment itself is considered as the problem. Once an artefact has been tested in the environment, it can serve as a conclusive test of relevance for DSR.

The knowledge base, provides the theoretical foundations and the research methodologies in which the artefacts are constructed and evaluated (March & Smith, 1995; March & Storey,

2008). Previous research is taken as a starting point whereas constructs, models, methods and instantiations that already existed before are exerted for the new artefact creation (March & Smith, 1995). Taking these into account, as well as using existing theories and methods, a rigor can be achieved. The newly created artefact can then be assessed as it extends the knowledge base for further research.

Hevner *et al.* (2004) also shows that in early stages of the artefact, the artefact itself is considered as an experiment. In practice, existing theories can be applied if appropriate, however, frequently, no prior theories exist. This makes the DSR artefact to be relied on creativity and trial and error in order to form the "best practice" for the discipline. When applicable, the artefact is refined by experimenting, simulations, case studies, field studies or analytic studies.

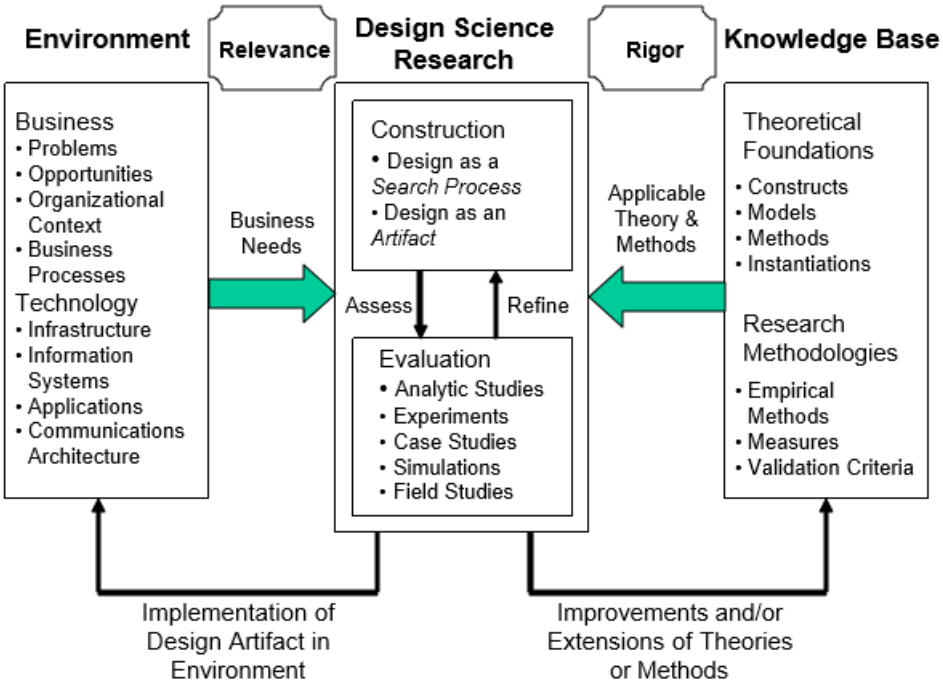

Figure 7. Design Science Research Framework (Hevner et al., 2004)

Peffers et al. (2006) explains the six steps that DSR process goes through. Definitions are given for these steps as well as how they will be tackled in this paper.

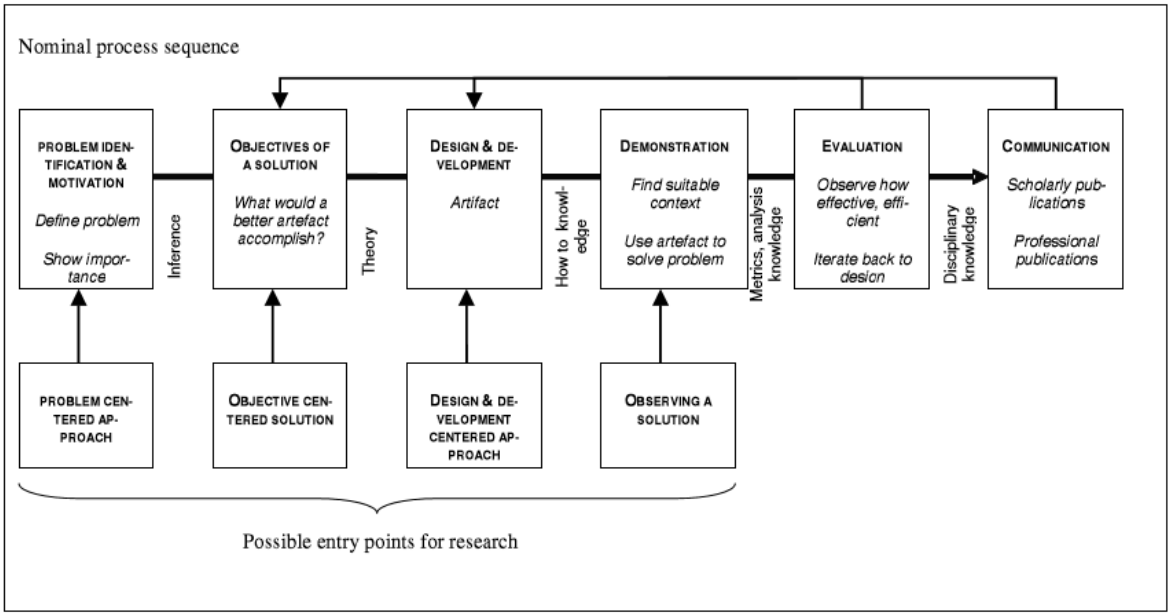

Figure 8. DSR process model (Peffers et al., 2006)

Based on **Figure 8** shown above, the process steps are described below:

Problem identification & motivation

These two define the research problem and explain what value the solution is giving to that problem. After a problem has been successfully identified, it will be used to develop the artefactual solution. Explaining the value of the solution will result in a higher motivation to the researcher and the audience to seek a solution as well as helps the researcher to get a better understanding to the problem.

Objectives of a solution

The objectives come out from the problem definition. The objectives can be qualitative and quantitative. Quantitative in terms of measuring the performance of the solution to the current ones and see if it outperforms them, and qualitative meaning it that the solution would be used as a supportive mechanism for the problems that are not addressed by the existing mechanisms. Apart from creating the objectives out of the problem definition, it also requires knowledge of the current solutions, if any, and their performance statistics.

Design & Development

This deals with creating the actual artefact. This activity deals with defining and developing the artefact's architecture and functionality. To have a smooth transition from the objectives to the artefact creation process, a good knowledge of theory can serve as a good support to the solution.

Demonstration

This process deals with demonstrating how effective the artefact was to solve the problem. This involves experiments, simulations, case studies, proof or any other activity that can show the results. This process requires to have the knowledge on how to use the created artefact to solve the problem.

Evaluation

This process includes measuring how well the artefact has supported the solution to the problem. This means to analyse the objectives of the solution to the results that have been observed while using the artefact in the demonstration phase. The evaluation process includes metrics and analysis techniques to have a better understanding if the artefact was an actual success. This may include measuring objective quantitative performance such as surveys, client feedback, simulations etc. This is the point where the researchers gather the results and see if they need to get back to the design & development phase to improve the artefact and make it more effective. It depends on the type of research venue, so the researches know if that kind of iterations are possible.

Communication

This process deals with communicating the problem, how important it is to fix the problem, the developed artifact, thoroughness of the design and the effectiveness of the artifact itself to researchers or practicing professionals.

3.2 Research questions

The research conducted in this thesis aims to answer two main research questions (RQ). The questions are related to the implemented artefact and how it fits into the context of e-Customs. The research questions are as follows:

RQ1: Can a software application replace paper-based transportation documents during a bilateral freight transport process?

The existing literature was used to get a better understanding on the process that is dealing with digitalising documents that need to be used during customs clearances and transportation procedures. To answer this question, RQ1, an artefact was developed to tackle the problems that are identified in the section 2 of this thesis *LITERATURE REVIEW*. After the artefact was developed, expert interviews were conducted. The expert interviews were then analysed and an answer for RQ1 question was taken by the results of the analysis.

RQ2: Would an e-Customs application increase efficiency in customs during freight transport procedures?

The second research question, RQ2, deals with the efficiency of electronic systems during customs procedures. To answer this question, the developed artefact needed to be evaluated by experts that have been working in customs, specifically during freight transport procedures. Based on their expertise and the artefact's performance during demonstration, the experts provided answers and feedback about different aspects of the artefact. A thorough analysis of the answers was done and the RQ2 question was answered.

3.3 Literature review methodology

The literature review research material has been found using the process described in the **Figure 9**. The process starts with defining the search terms that are relevant for the paper, as well as deal with the research questions presented. After the search terms have been defined, the query filters are defined and used in LUT Primo. LUT Primo was used as the main search

engine and the following research databases have been used: ACM - Association for Computing Machinery, IEEE Xplore Digital Library, Springer, and ProQuest. There have been searches done on the specific databases mentioned above as well as an advanced general search on the LUT Primo engine. World Customs Journal was also used to find relevant papers which are focused on the customs domain.

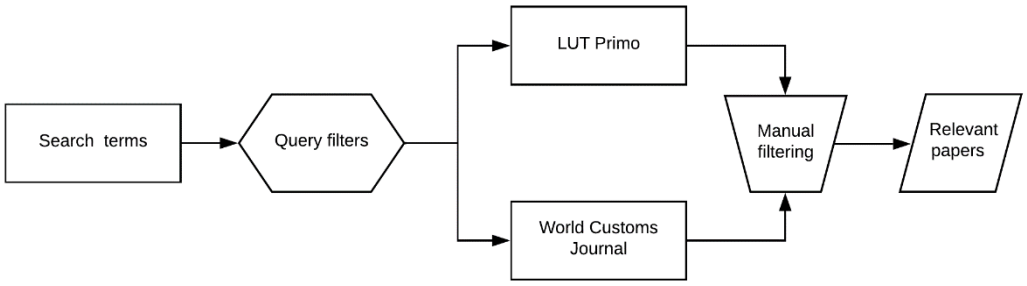

Figure 9. Literature review research process

After the initial search, a manual filtering of the papers based on relevance has been done by reviewing the abstract, results, conclusions, and a general overview of the papers. Additionally, based on the terminology found on some of the articles, official governmental documents for electronic customs issued by the European Union and Finnish Customs were also searched and included.

Key search terms used and queries are presented in the **Table 5** below:

Table 5. Key search terms and queries for literature review paper findings

Search terms	Search queries
e-customs, Electronic customs, paperless customs, electronic government, e-government, drivers, barriers, security, fraud, innovation, trade, digital, java, PWA, usability, JWT, Json Web Tokens, Spring Security, localization, internationalization,	(Electronic customs OR e-customs) AND innovation
	(Digital OR electronic) AND trade
	(Electronic customs OR e-customs) AND barriers
	(Electronic customs OR e-customs) AND drivers

material design, model, mysql, information, system, API, solution, cost, architecture	(Electronic customs OR e-customs) AND security
	(Electronic customs OR e-customs) AND fraud
	Security AND model AND information AND system
	(Electronic customs OR e-customs OR e-government) AND java AND solution
	PWA AND cost
	API AND architecture
	Material design AND usability
	Internationalisation AND locatization AND usability
	(electronic government OR e-government) AND usability

3.4 Evaluation methodology

The evaluation methodology that was used for the developed artefact is interview-based evaluation. Conducting interviews means the researcher is asking a set of questions to subjects about a specific area of interest and gathering the information from the subjects either individually or as a group (Wohlin et al., 2012). Interviews can be divided into unstructured, semi-structured and fully structured interviews. The interviews that were conducted for this thesis are unstructured and semi-structured interviews.

An unstructured interview is an exploratory method to see how individuals qualitatively experience the phenomenon. Unstructured interviews have been conducted during the simulation phases and development process of the artefact in order to explore different ways to achieve better usability, functionality, and final artefact. The subjects that were part of these interviews were representatives of Finnish customs, considering that they would use

the artefact the most in their daily tasks, if the artefact was being used. The process for the unstructured interview is explained in **Figure 10**.

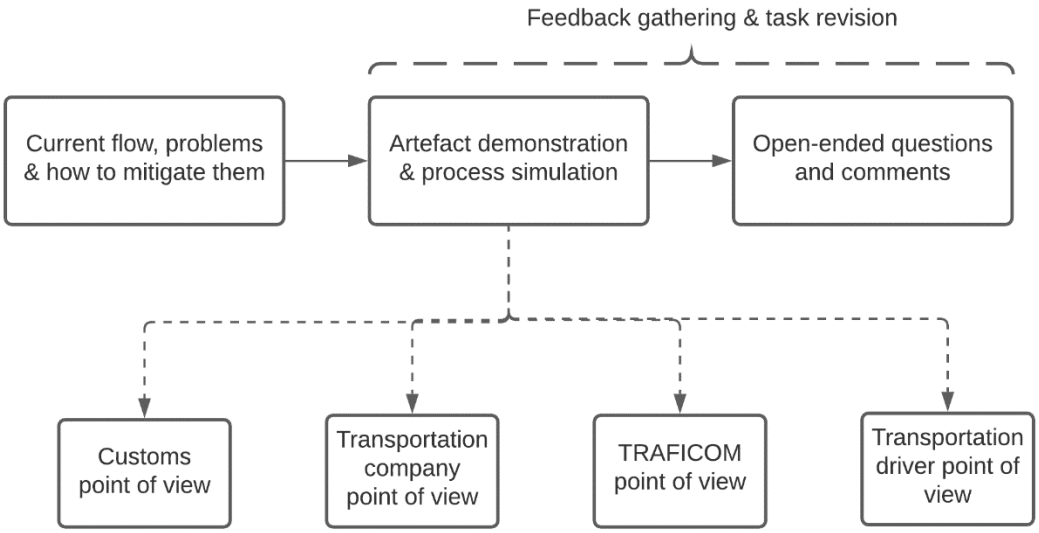

Figure 10. Process for the unstructured interviews (Adapted from Wohlin et al. (2012))

Semi-structured interviews focus on how individuals experience the phenomenon qualitatively and quantitatively and they consist of mix of open and closed questions. These types of interviews were conducted after the development of the artefact and was focused on the overall outcome of the artefact, if it solved the problems and if it completed all the goals for the thesis. The subjects that took part in this type of interview were representatives of Finnish customs as well as Ministry of Finnish Transport and Communications representatives. The subjects gave their impressions on the developed artefact, how the artefact affected the goals regarding the e-Customs approach and if the artefact can replace paper-based bilateral transport documents. The planned structure for the semi-structured interviews is shown in **Figure 11**.

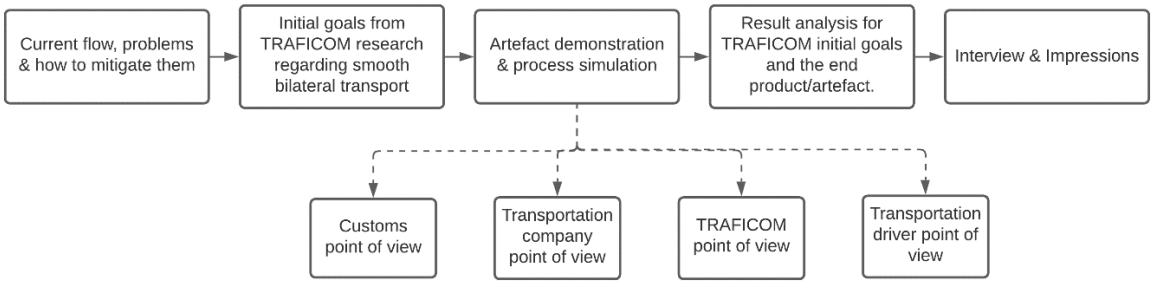

Figure 11. Process for the semi-structured interviews (Adapted from Wohlin et al. (2012))

Numerous simulations were conducted where different people had different roles depending on the point of view analysed. This was done so the subjects could understand the overall processes from different people during the border crossings as well as during the application procedures that transportation companies need to go through before starting the transportation procedure. Each interview was estimated to last one hour and was conducted remotely. The languages used for the interviews were English and Finnish depending on the person being interviewed.

4 ARTEFACT DESIGN AND DEVELOPMENT

In order to create an artefact that tackles the main issues of the bilateral transport license, an analysis of the current workflow was conducted. An overview of the current workflow for the bilateral transport license between Finland and Russia is explained in subsection *2.1.1 Finnish-Russian bilateral transport process*, **Figure 1** of this thesis. From the figure, the process shows as not optimized in terms of time and efficiency. Apart from the additional resources needed for printing the Transportation Authorisation (TA) as well as delivery costs for them to Russia, there are also additional steps required from the transportation companies to perform in order to successfully complete the transportation process. This leads to more time spent, more financial costs from both ends as well as inconvenience to the parties involved.

To successfully tackle these problems and inconveniences, the process that was proposed by Partinen & Niiranen (2019) which is also explained in section *2.2 E-customs initiatives taken in Finland* in the literature review, has been analysed to find out more about the issues that need to be fixed and improvement areas that need to be tackled. The report also explains the eBorder service umbrella and the developed artefact is part of that service.

The artefact that was developed can also be referred as "eBorder Matkalupa" application. Considering that the artefact will have an impact on customs processes, the barriers that were encountered with software adaption from the public sector were addressed and had high importance while designing the artefact.

Gilbert et al. (2004) explains the factors that were needed to be addressed in order for the public sector to have a smooth transition to the new software presented. These factors emphasize that the software should be confidential in terms of data, easy to use, enjoyable, reliable, safe and have a visual appeal. During the designing phase of the artefact, both high-level and detailed requirements were considered. To better understand the problems that were going to be tackled, key user tasks were formed and then later used for defining and refining requirements.

4.1 Key user tasks

The artefact has five user groups which are the Finnish customs, TRAFICOM, Russian transportation companies, transportation drivers, and police. Two software applications to facilitate different roles and permissions for each user group have been developed. The benefits for each user group as well as the mitigation of problems that they face are shown in the form of key user tasks in the following sections. Although the key user tasks do not show the complete details and capabilities of the software solutions, they give a general overview about the main functionalities of the solutions for each user group.

Digital Bilateral Transport License generation

Example TRAFICOM representative called Tuomas logs into the administration web application (Admin app) and goes to the Transport Authorisations section. Tuomas has two options, either create one specific TA or generate multiple TA-s at once. While generating one TA, Tuomas specifies the TA unique license number which will be associated with the generated digital document. In case Tuomas needs to generate multiple TA-s, he provides the number of TA-s he wants to generate, and the system will give randomized seven-digit unique license numbers. The process runs asynchronously and Tuomas gets an email when the generation has been done and everything has been processed in the database.

Company request-for-access review by TRAFICOM

Example TRAFICOM or eBorder representative called Tiina logs into the administration web application (Admin app) and goes to Companies section. She is presented with a list of companies that are already registered in the system. She selects the filter on which it shows all the companies that are waiting for approval. She goes through the uploaded company files to see if they meet the criteria to access the software. In case everything is ok with the documents uploaded, she approves the company request to access the software and the company can login to the Matkalupa software. An email is sent to the company to let them know that their access has been granted. In case Tiina notices something wrong with the documents, she denies the application and writes a custom note on what went wrong. The

company gets notified about the denial of access as well as gets the custom note that explains why the company was rejected.

Bilateral Transport License allocation to companies

Example TRAFICOM or eBorder representative called Edgar logs into the administration web application (Admin app) and goes to the Companies section. He uses the search functionality to find a specific company that he wants to allocate the Bilateral transport licenses, or he finds the company in the table presented to him. He then selects the option to assign TA-s for that selected company. Edgar checks the available TA-s that can be assigned and then types the desired number of TA-s he wants to assign to that company. He has the option to put Restrictions to the TA-s that he is assigning that are specific for that company. The application will not allow Edgar to allocate the TA-s in case there are not enough TA-s available in the system. Edgar can confirm allocation of the TA-s for the company. In case he does not want to send an email notification for the allocated TA-s he can only confirm the transaction, otherwise he can also confirm and send email at the same step. After the process is finished, Edgar gets a message from the software explaining if everything went ok or something went wrong along the way.

Company applying for access to the digital system

Example Russian company representative called Sinka wants to start using the software so they can receive digital TA-s so they can operate their transportation business to Finland. Sinka goes into the signup form and fills the company information required. Sinka also needs to upload a document, which is agreed upon with Traficom, that demonstrates that they can transport goods to Finland. Sinka uploads the required document and sends their application for review. Sinka will not be able to login into the system unless she gets approved by TRAFICOM or eBorder administrator. In case Sinka gets approved, an email notification is send to her that explains that she can access the system. In case she gets rejected, an email notification is sent to her explaining why she got rejected.

Company creating driver accounts

Example Russian company representative called Igor wants to give access in the application to his drivers so they can get a TA for their transportation journey to Finland. Igor logs into the application and goes into the Drivers section. He can see all the drivers that are created for the company as well as create new ones. Igor notices that the driver called Marko that will deliver goods into Finland in the coming days does not have an account yet. He goes into driver creation page and types the information about the driver as well as a password for Marko's account. After receiving the login credentials, Marko can start using the application.

Company giving access of a certain document to driver

Example Russian company representative called Igor has a scheduled transportation to be done in Finland in the coming days. Igor needs to give access to his driver Ana to the TA document so that Ana can show it to the customs and can enter Finland. Igor logs into his account and goes to the Drivers section. He searches for Ana's account in the search bar and proceeds with the TA assignment process for the driver. If Igor has the information about the goods that are going to be transported that day, he can fill out the information in the TA itself such as nature of goods, weight of goods, loading place, unloading place, vehicle information etc. In case Igor does not have that information yet, he can leave the information empty and the driver can fill out the information later on. After Igor assigns the TA to the driver, the driver can see the TA in their own application view.

Drivers filling the cargo and trip information

Example transportation driver called Ana has a scheduled transportation trip to Finland today. Ana already got the credentials to log into the application, as well as got a TA assigned to her account. Ana logs into the account in her mobile app. After a successful login, she gets redirected to the Transport Authorisations section where she can see all the TA assigned to her so far. She can see the archived TA-s that she used previously, the ones she used only for entrance or the ones she has not used yet. She selects the TA that has not been used yet

and that she will use for the upcoming transportation. She can then see all the information that are needed for the next transportation. If the TA already has pre-filled information, Ana only needs to show the TA to the customs, otherwise, she fills out the information just before her trip to the border. After saving the information, the TA is ready to be presented to the border.

Customs scanning and reviewing the presented digital document

Example transportation driver called Ana has a scheduled transportation trip to Finland today. She already got the TA in her mobile application, filled out the information and now it is presenting the documents to Finnish customs at the border. Ana opens her mobile application with her credentials. After successfully logging in, she is redirected to the Transport Authorisations section where she can see all the TA-s assigned to her so far. She selects the one she is going to use for the upcoming trip and the TA detailed page is shown. Apart from the information about the trip below, the first thing that is shown in the TA page is the QR-code which is the only thing that the customs need in order to process with the information. Customs representative Antti oversees checking all the necessary documents for transportation companies while entering Finland. He logs into the application and gets redirected to the customs page. Antti also has a QR-code reader on his desk. He gets the QR-code reader and scans the QR-code that was presented by Ana in the border. After the scanning is done, the application automatically validates the information and shows the TA information about the cargo, loading and unloading place, the weight as well as license plates for the vehicles (engine, dolly, trailer etc.). Antti double checks if everything is ok and then validates the entrance. After the entrance is validated, Antti has the option to cancel the TA for the next 2 hours in case something is wrong with the transportation vehicles. The vehicle can now proceed to the next step of customs checks.

4.2 Requirements

The artefact design and implementation has been affected by several factors: the problem statement, the goal of the thesis and the requirements that have been gathered from different sources including the stakeholders involved in the project.

In order to better visualize what each target group needs, high-level and detailed requirements have been gathered to analyse. These requirements have played an important role in architecture design of the artefact. High-level requirements and architecture requirements show important requirements that play a major role in the architecture design and the overall implementation of the system. Considering the importance of these requirements, they are shown as primary requirements for this thesis. Detailed (functional) requirements show the technical aspects of the software and therefore are considered as secondary for this thesis.

4.2.1 High-level requirements

The design process needs to go through some steps before implementation phase, and that is refining and requirements. Gorton (2011) demonstrates the steps in **Figure 12** and **Figure 13**. The first steps include analysing the detailed (functional) requirements as well as the general stakeholder requirements in order to determine the high-level (architecture) requirements.

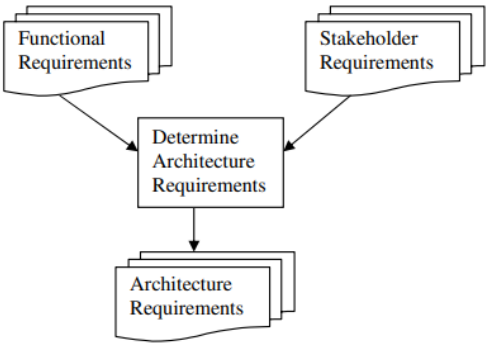

Figure 12. Inputs and outputs for determining architecture requirements (Gorton, 2011)

The involved stakeholders had concerns regarding the data accessibility and storage options. During the stakeholder requirements interview, the Russian representative that deals with customs digitalisation declared that the personal information data about the companies that are going to use the artefact need to be stored on a server located in Russia that is approved by them. The Finnish TRAFICOM stated that the information about the TA-s need to be stored in a server which is located in the EU.

Customs representative said that the application needs to be accessible all the time and very easy to use so the transition from paper-based document to electronic is smooth and successful. Another request was that the page is scalable to specific width and height considering they have other software applications that deal with other processes. The scanners need to be compatible with the upcoming application which will use QR-codes instead of the 1D barcodes.

Transportation drivers stated that in order to adapt to the digital version of the document, they also need to have a way to download the file in their phone which should look the same as the current TA document, with the data read from the forms that they filled digitally. This serves as a reference on where things go and which form is responsible for which part of the document.

After an analysis of the functional and stakeholder requirements, the high-level requirements have been defined. **Table 6** shows the high-level requirements and the quality attributes that the requirements affect. The high-level requirements shown on the table are separated into two categories: requirements that are not based on constraints and those that are. The former represents the architectural requirements that the system design should address, however they can be negotiated if there is room for change. The latter, however, shows those requirements that are non-negotiable and limit the choices during the architecture design (Gorton, 2011).

During the functional and stakeholder requirements analysis, some constraints that are non-negotiable have been found. These constraints have been shown in **Table 6** and have high priority during the artefact architecture design.

Table 6. High-level requirements

Quality Attribute	High-level Requirement	Constraint
Performance	The application should improve the process performance in terms of speed compared to the current paper-based document process.	NO
Security	Every action should be authenticated and have encryption certificate.	NO
Security	Every communication should be authenticated and have encryption certificate.	NO
Usability	The user interface should be platform specific, mobile app for mobile devices and responsive view for personal computers.	NO
Availability	The system should be available at all times throughout the year, with specific times for updates and maintenance upon request.	NO
Reliability	The system should make sure that no compromised TA that is not confirmed in TRAFICOM database is being used at any point in time.	NO
Scalability	The system should be easy to expand and function for different crossing points that Finland has with Russia.	NO
Localization	The system needs to be in three languages: Finnish, Russian and English.	NO
Storage	The artefact must split the database storage in a way that the Russian company data is stored in Russia and TA data is stored in Finland.	YES

Timeline	The first version of the artefact must be delivered within six months.	YES

Figure 13 shows the next steps after the architectural requirements have been defined. Based on the architectural requirements shown above, the architecture design has been done and an architecture model has been selected and it will be discussed in future sections.

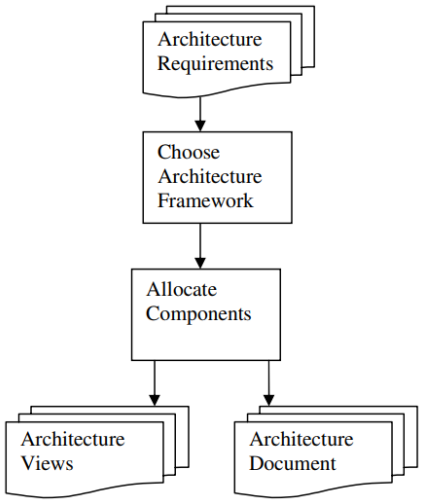

Figure 13. Inputs and outputs of architecture design (Gorton, 2011)

4.2.2 Detailed requirements

Detailed requirements have been defined and refined before and during the development phase of the artefact. They show what kind of features the artefact has for each user group and how the flow of information has been implemented.

Table *7* shows the main detailed requirements that have been gathered for each user group. These requirements show what each user group "MUST" do while using the system. Other detailed requirements are considered not relevant or with no major impact for the thesis, and therefore are not shown on the table.

Table 7. Main detailed requirements for each target group

User group	Low level requirement description
TRAFICOM	Generate TA in bulk
	Generate a single TA
	Assign certain number of TA to a company
	Review company applications
	Apply restriction notes to generated TA
	Create/Read/Update/Delete border site accounts
	Create/Read/Update/Delete company accounts
Customs	Scan QR-code to read TA information
	Validate TA
	Cancel TA
	Add Notes to TA
Transportation Companies	Create/Read/Update/Delete driver accounts
	Assign TA to driver
	Check TA quota for the company
	Fill in TA journey information while assigning TA to driver
	Assign TA to driver
Transportation drivers	See information about assigned TA
	Download TA in PDF format
	Fill in TA journey information
Police	Scan QR-code to read TA information

After the high-level and detailed requirements have been selected, the architecture design phase has been initiated. The next section shows what architecture model has been selected and how the development has been done for the artefact.

4.3 Architecture design and development

In order for the artefact to perform well, the system should have a well-defined and implemented software architecture. Bass et al. (2003) defined software architecture as ”The

software architecture of a program or computing system is the structure or structures of the system, which comprise software elements, the externally visible properties of those elements, and the relationships among them".

Based on the architectural requirements shown above, as well as having in mind that the software needs to be easily compatible with other future eBorder applications, it has been decided that the artefact needed to be built upon APIs and have an API driven architecture.

4.3.1 API Driven architecture

Having in mind future systems that may be taken into place for Finnish customs such as Single Window system, it is crucial for the artefact to have an easily integratable architecture. This is achieved by having the backend and frontend of the artefact decoupled into 2 different stacks, and API-driven architecture does just that (Lazar, 2018).

The artefact also needs to support expansion, in case other documents need to be digitalised and shown in the same software. This means the architecture needs to support scalability and be focused on the Business Logic rather than application structure. API-driven architecture offers scalability, reduces the complexity by making all component communications modular and is focused on the Business Logic of the software (Lazar, 2018).

Figure 14 shows a high-level architecture view of the artefact. It can be seen that the frontend and the backend of the artefact have been split into two stacks, communicating with one another through APIs. Having in mind the requirement analysis as well as constraints, two software applications were developed as part of the artefact which addressed the need of each user group as well as complied with the defined architectural constraints.

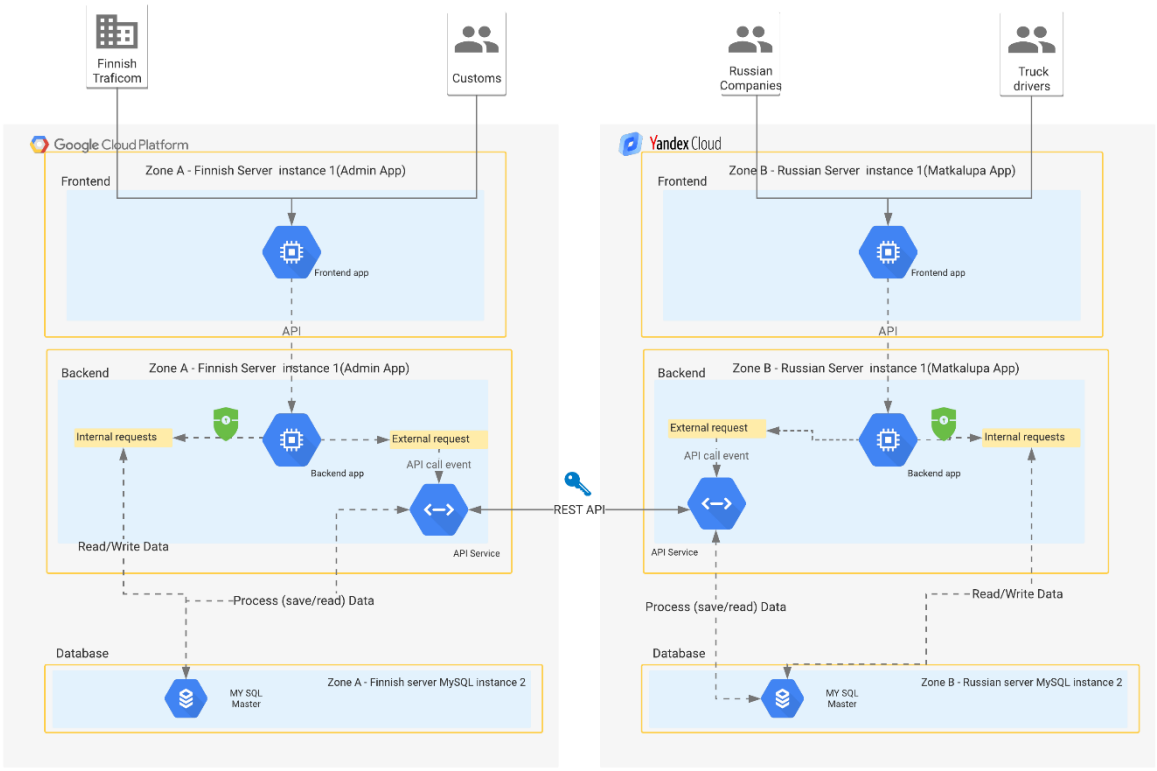

Figure 14. High-level architectural view of the artefact

When the software architecture design has been chosen, the next step was to select the technologies that will address the found issues. The next section shows the solution design choices that have been done that address the problems that the artefact is trying to solve.

4.3.2 Solution design choices

The high-level and detailed requirements as well as reviewed literature together contribute to the design choices for the artefact, which are presented in this section. In section *2.5 Technical approaches to common issues*, literature for technology solutions has been reviewed. Based on the reviewed literature, the following technologies have been selected:

- **Back-end** - Although any other programming language could have been chosen for the backend, the findings have been taken into consideration and Java has been the selected choice for this artefact.

- **Front-end** - The reviewed literature showed the perks that Angular framework has in terms of features, integrations, and robustness, therefore has been the selected framework for this artefact.
- **Database** - The artefact's architecture has a de-coupled logic between the Data Layer, Business Layer, and the Presentation Layer and the data source selection is independent of each layer. This means that the artefact can use different databases in the future with minimal efforts in the Data Layer and no changes in Business and Presentation Layer. However, considering the reviewed literature and the popularity of MySQL in the community, it has been the selected database for this artefact.

In the reviewed literature, **Table 3** shows the synopsis of identified problems for e-customs systems. This section is focused on tackling the problems which were considered as key issues and show what technologies have been used to mitigate those problems. The problems that have been tackled with high priority for this artefact are: security, usability and costs.

4.3.2.1 Security improvement

As seen in the reviewed literature, one of the issues that paper documents present for customs is the ease of replication and that they are prone to forgery. This means that the digital version of the bilateral transport license needs to mitigate those problems and make sure they are well addressed, as well as comply with security concepts for digitalisation using one of the security models available. For this artefact, Parkerian Hexad security model has been selected.

Table 8 shows how each of the attributes that are presented in Parkerian Hexad model have been covered for the development of the artefact and what technologies have been used to address them. The solutions are explained for each attribute in the following subsections.

Table 8. Parkerian Hexad attributes and used solutions

Attribute	**Used technology**
Confidentiality	Spring Security
Integrity	Data replication and two-way document verification
Availability	Google Cloud, Yandex Cloud
Possession/Control	Data replication and two-way document verification
Authenticity	TLS V1.3, JWT, Spring Security
Utility	Out of scope for this thesis

Data replication and two-way verification

In order to achieve integrity, possession, and control, a data authenticity process has been implemented. This includes data replication for TA-s as well as real time data validation and verification when a document is being checked by customs and police officials. This extra process was implemented to ensure that any fraudulent activities can be detected by officials and actions can be taken. **Figure 15** shows the process of data verification and validation that happens when customs or police scan the QR-code to check the TA.

Both databases that are storing information in both countries have replicated TA base information. Base information for a TA is considered a TA unique number and expiration date. When TAs are generated from the system they automatically get replicated into both databases. Whenever a QR-code is scanned, the two-way verification process is called.

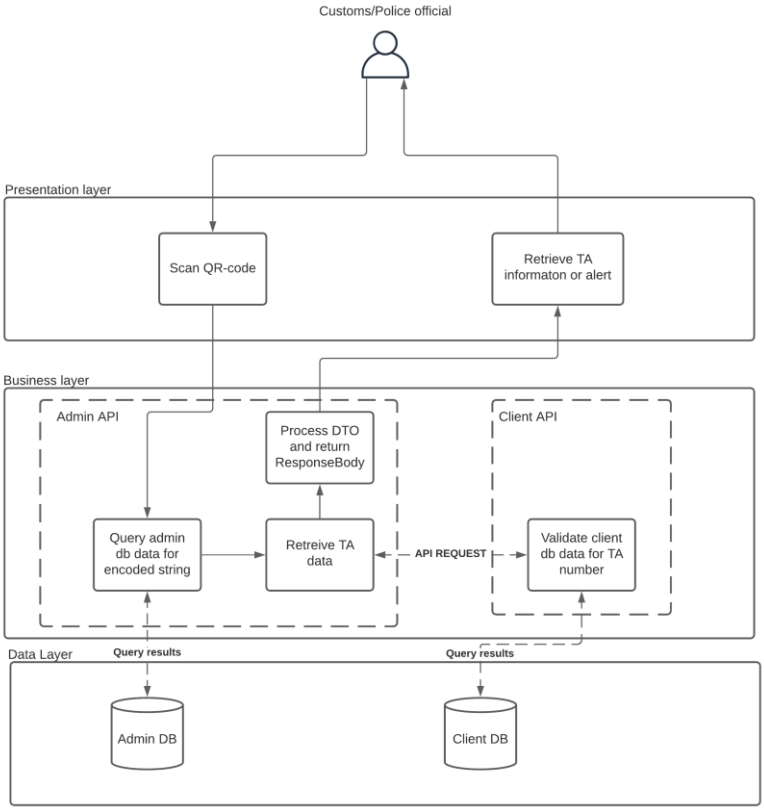

Figure 15. Two-way data verification

Environment & Availability

Although availability is one of the most crucial parts for such artefact, it has not been the priority for this pilot. The stakeholder and architecture requirements have been identified and based on them it has been decided that the applications need to be separated into two: one application to be deployed in Finland and the other in Russia.

Considering that this project is one of the first in Finland in regards to digitalisation of documents for freight transportation with non-EU countries, the pilot project didn't need to have 24/7/365 availability unless it passed the piloting phase and needed to be used in production. It has been decided, however, that for the piloting phase, Google Cloud with servers in Finland is the chosen cloud service for the Finnish authorities and Yandex Cloud is the chosen service for the application that will be used by Russian companies and drivers. Even though the applications are up and running and available, no extra steps have been

taken into configuring both cloud services for maximum optimization in regard to this attribute.

Transport Layer Security V1.3

The reviewed literature shows that TLS provides a high security for encryption of information over the network, therefore has been implemented for the solution.
Figure 16 shows the TLS protocol implemented for the artefact and the version that is used.

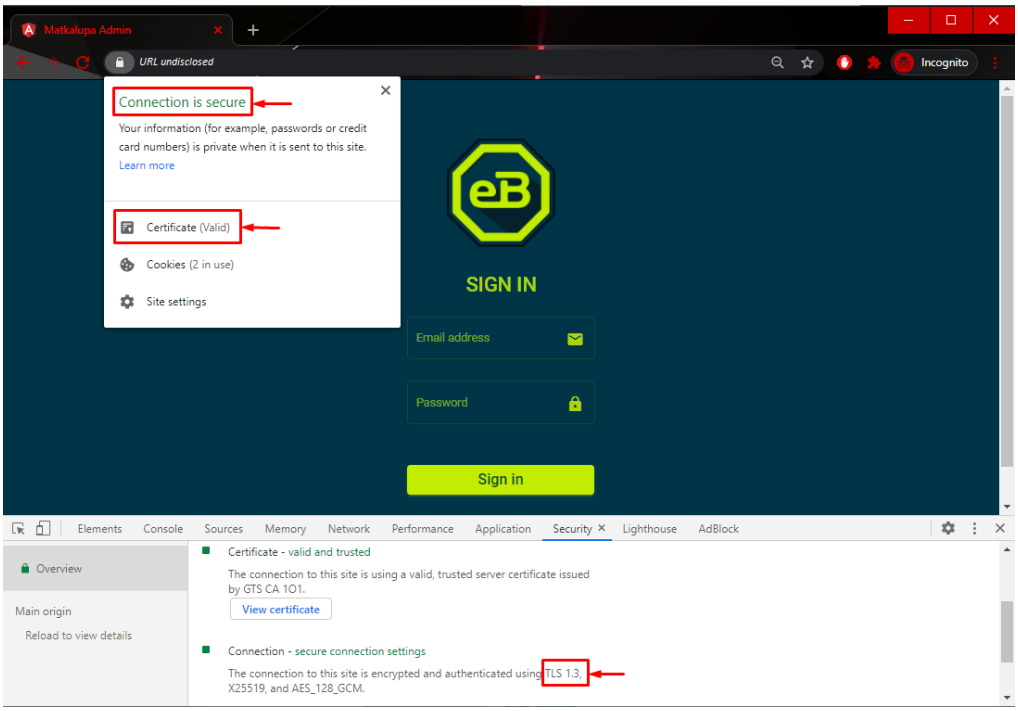

Figure 16. Developed artefact with TLS 1.3 encryption enabled

JSON Web Tokens (JWT) & Spring Security

The artefact uses a Split-Stack development model, which means the front-end and back-end are completely separated and communicate through APIs. In order for the front-end to communicate securely with the back-end while users are authenticated, JWT have been implemented into the artefact's software solutions. The process of JWT creation is done by Spring Security.

Because the artefact used JWT for authentication, Spring Security was configured to support JWT, create new tokens, decode, and read JWT information as well as secure the APIs from unauthorized users. The implemented solution takes care of authenticating users, resolving tokens, getting authentications, validating tokens, as well as creating new tokens. A snippet of the code for JWT creation can be seen in **Figure 17**. Before the token is sent back, an expiration date is attached to it as well as it is signed with HS256 algorithm.

```
public String createToken(String username, List<Role> roles, User user) {
        Claims claims = Jwts.claims().setSubject(username);
        List<String> roleNames = getRoleNames(roles);
        claims.put(ClaimsType.ROLES, roleNames);
        claims.put(ClaimsType.USER, user.getId());
        claims.put(ClaimsType.EMAIL, user.getEmail());

        Date now = new Date();
        Date validity = new Date(now.getTime() + jwtProperties.getValidityInMs());

        return Jwts.builder()
                .setClaims(claims)
                .setIssuedAt(now)
                .setExpiration(validity)
                .signWith(SignatureAlgorithm.HS256, secretKey)
                .compact();
    }
```

Figure 17. Code snippet for JWT creation

To ensure authenticity and confidentiality, there are different filters that are used by Spring Security. On each API call, JWT token is decoded by Spring Security and claims are retrieved. Based on the role that the user has, the request will either be denied or go through. To ensure confidentiality, Spring Security uses BCryptPasswordEncoder which has BCrypt strong hashing.

4.3.2.2 Usability improvement

The artefact also tried to tackle several usability issues such as: Internationalization and localization, responsiveness, and ease of use. Considering the reviewed literature for different technologies that tackle usability issues, the following technologies have been chosen for implementation:

Localization and internationalization

One of the stakeholder requirements defined shows that the artefact needs to support three languages: Finnish, English and Russian. The technology that has been chosen for localization and internationalization has been Angular NGX-Translate library. Angular NGX-Translate uses JavaScript Object Notation (JSON) format which allows users to add key-value pairs for translations. **Figure 18** shows the process of NGX-Translate from the moment user selects a language or the language is taken out of existing user settings.

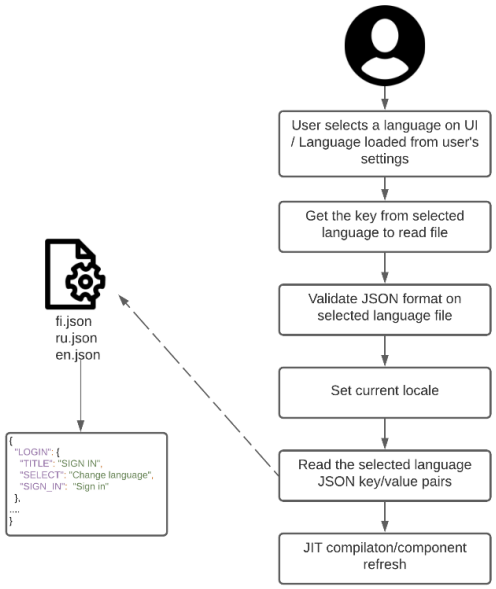

Figure 18. Internationalization and localization process for the developed artefact using Ngx-Translate library

The fact that the library is based on JSON files, makes the process of adding new languages to the system easy and straight forward. **Figure 19** shows the profile page of the user in the user settings page in mobile view where the user can change the language. Once the language is updated, the whole application is localized to that language, which makes the application easier and faster to use in user's perspective.

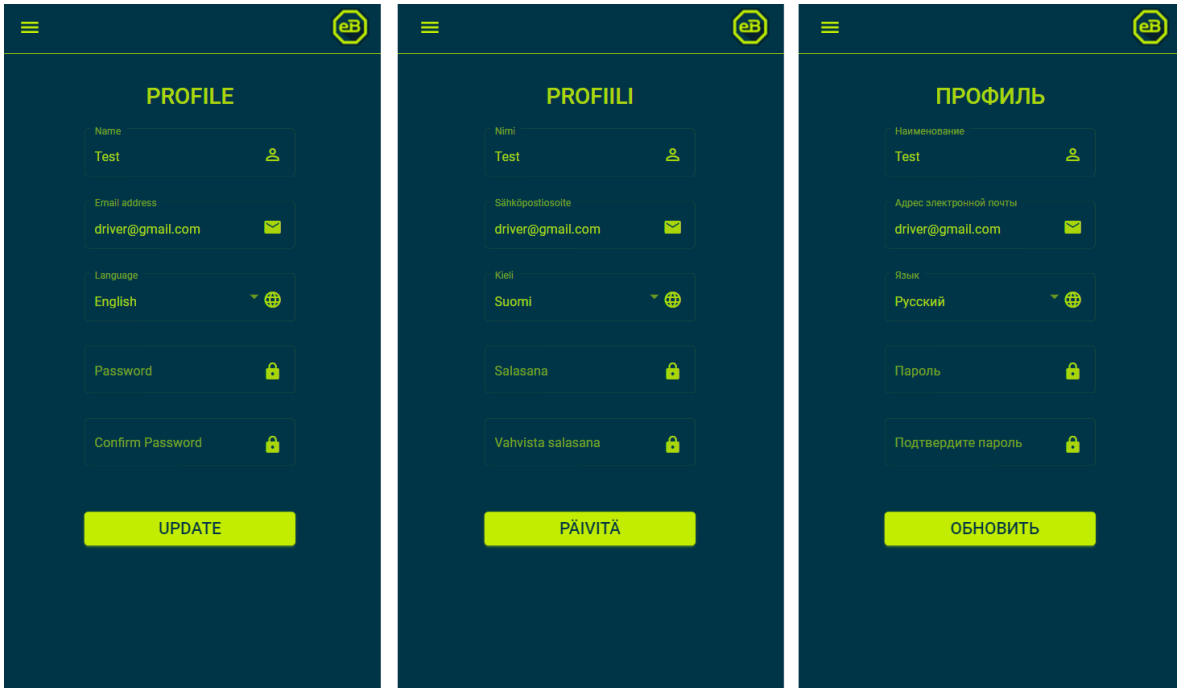

Figure 19. Example of how internationalization and localization is done for the artefact

Material Design & Responsiveness

The reviewed literature about the technologies that can be used to tackle the identified issues, Material Design is presented as a good option to make the software easier to use, responsive and visually appealing for users. Therefore, it has also been the preferred technology to use for these issues. **Figure 20** shows the developed artefact with Material Design components and responsiveness that Material Design provides.

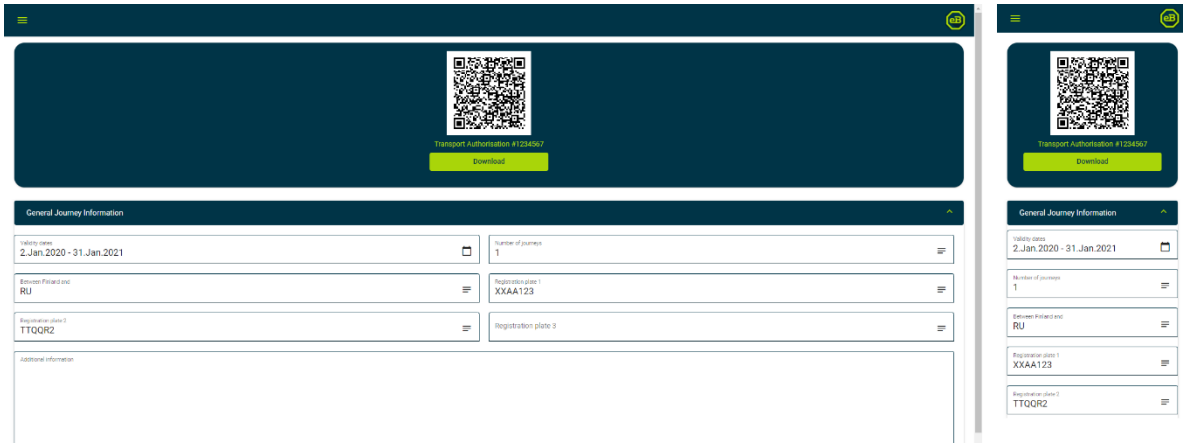

Figure 20. Artefact responsiveness laptop & mobile

4.3.2.3 Costs

As seen in the reviewed literature, **Table 3** shows that costs are a big problem when it comes to customs digitalisation due to limited budget that is allocated. This artefact has tackled the costs issue in two different ways: cost reduction due to cuts in paper usage and software development costs due to using Progressive Web-Apps (PWA). Considering that the new system eliminates the need for paper TA, the cost can be significantly reduced in long term just by cutting delivery logistics costs alone. The artefact can run in any Operating System, which results in cost savings and freedom to choose hardware tools.

Due to the nature of the artefact and the defined requirements, the artefact must be provided in desktop as well as in mobile devices. To reduce the costs on development, PWA has been used to make the software available in both platforms mobile and desktop. The process that explains how PWA was implemented into the artefact can be seen in **Figure 21.**

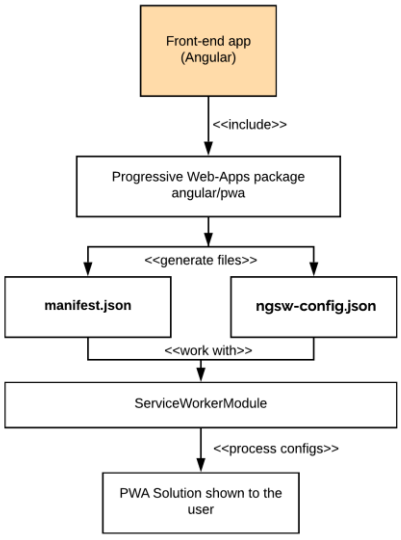

Figure 21. PWA process

4.4 Developed solution

The developed solution consists of two PWA software applications that are used to replace the paper bilateral transport license that has been used till now as well as change some of the tasks that have been either costly or not optimized during the freight transport process.

In subsection *2.1.1 Finnish-Russian bilateral transport process*, **Figure 1** shows the current process that is in use for cross-border transportation using the Transport Authorisation documents. In order to improve this process, literature has been reviewed to find better solutions that can be implemented. Subsection *2.2 E-customs initiatives taken in Finland*, **Figure 2** explains a new and improved process that shows the digitalised version of the bilateral transport license document between Finland and Russia. The developed artefact is strongly based on this new process presented. Based on the reviewed literature, stakeholder requirements and the goals for the thesis, the implemented artefact adapted the proposed process which is shown in **Figure 22**.

Figure 22 shows the new process which includes the usage of the artefact in different phases of freight transport. It can be seen that a lot of the tasks that were manual and time consuming such as the delivery of paper documents to Russia, registering the bilateral transport licenses into the Russian Association MIS etc, have been replaced with the new tasks that are performed under the artefact. Most of the tasks can now be performed by using the developed artefact, be that the client application which is intended for transportation companies and drivers, or the admin application which is intended for customs and TRAFICOM. The Russian Association of International Road Transport significantly reduce their costs and also save time by not handling the paper documents that were mailed to them yearly. By not having to add the TA-s into their MIS and provide support for transportation companies all year round, they save money and resources at the same time.

The developed artefact addressed three of the identified problems from the literature review: usability, security, and costs. In terms of usability, the artefact has been developed using the latest and leading libraries that specifically address many problems that people encounter when it comes to usability. With the implementation of the views using Material Design, the front ends have shown responsiveness, clean and user-friendly input fields as well as easy to read fonts. **Figure 23** shows the client application when it is used from a mobile application. Its responsiveness alongside with the PWA configuration, makes the application indistinguishable from native applications for mobile phones.

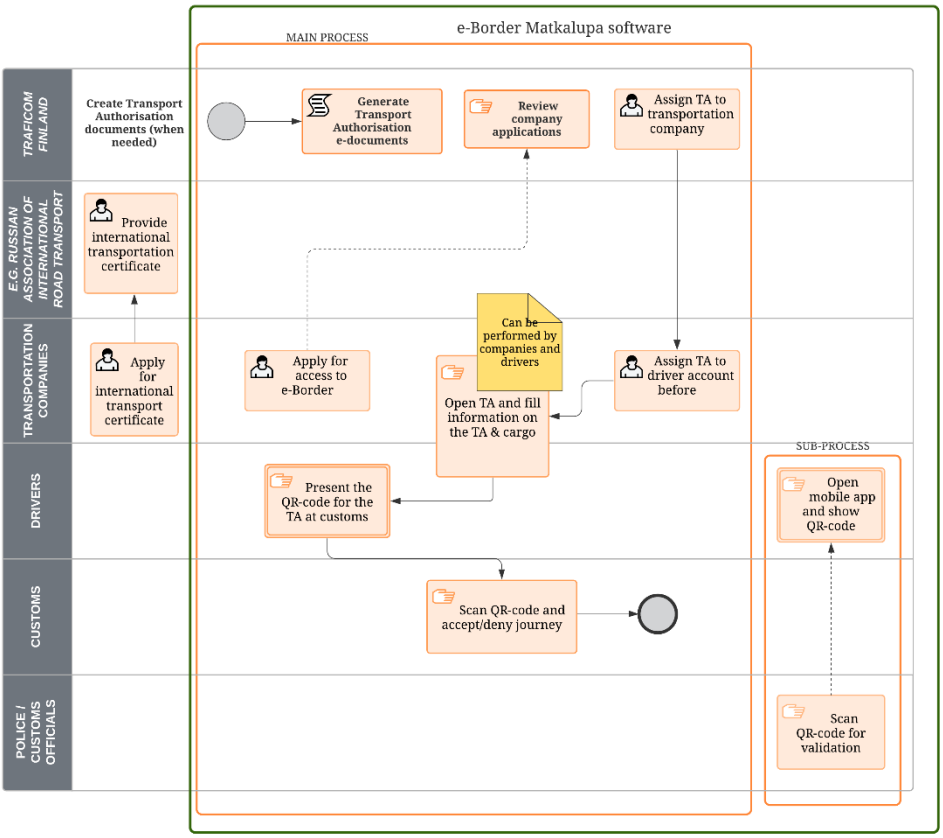

Figure 22. New transportation process between Finland and Russia using eBorder Matkalupa artefact

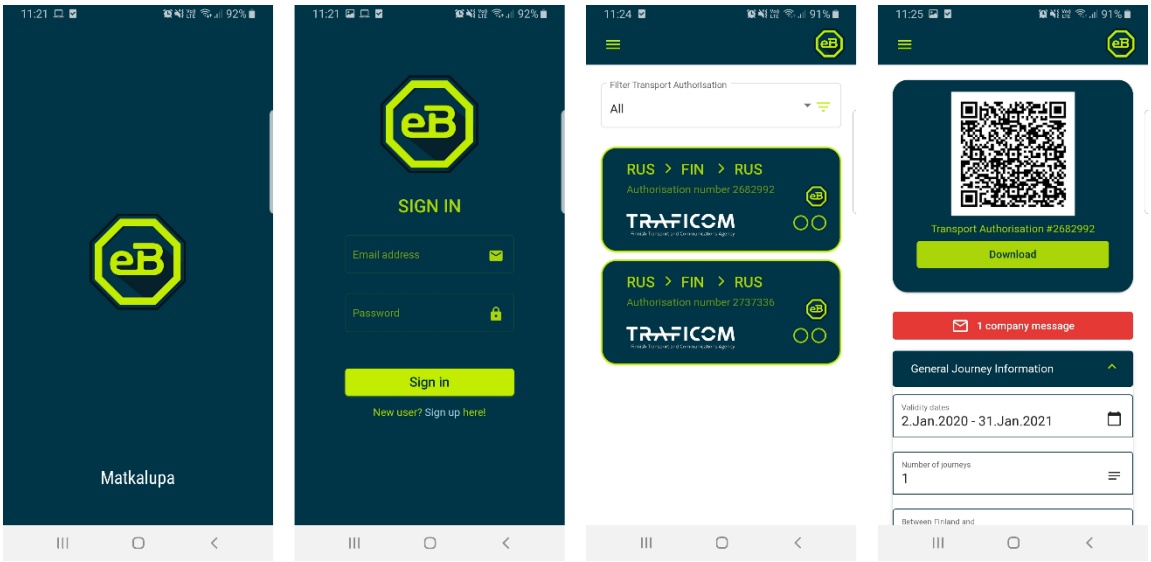

Figure 23. Mobile application used by the transportation drivers

When it comes to security, the developed artefact has been implemented having in mind that security is one of the most important quality attributes that need to be addressed. Considering

the nature of the project, it is essential for the software to be stable, safe and have the latest security libraries and tools that protect the application from various attacks that may happen in the future.

Therefore, the artefact has been implemented using Spring Security, one of the leading frameworks for security when it comes to Java programming. Apart from the technological part, the artefact also has an additional two-way verification process for any scanning that happens from customs or police officials at the border or during the random checks.

After a QR-code is presented to the officials, be that at the border or while the transportation truck is moving within the host country, the two-way process is initiated. There are three possible outcomes that can be returned depending on the case when two-way verification process is finished.

SCANNED CODE OK - This message shown to the customs or police shows that the two-way verification was completed, and the information exists in both databases and no suspicious activities have been found. This means the TA is valid and can be used for this journey. The customs officials can proceed with the other TA information that is shown on the screen. **Figure 24** shows the screen after a valid QR-code has been scanned and the information has been loaded to the customs view, alongside with the two-way validation message.

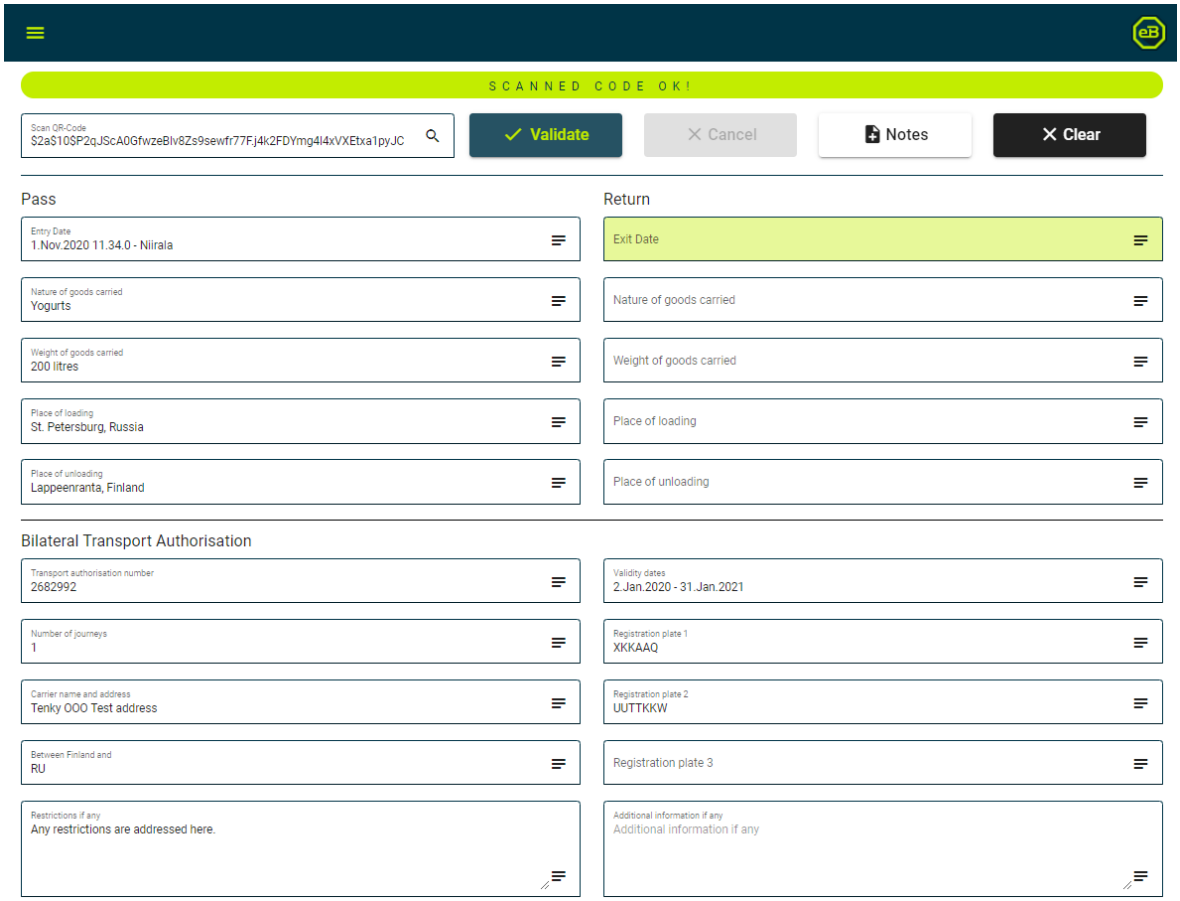

Figure 24. Example scanned digital bilateral transport license in customs view with two-way verification returning OK results

PROBLEM! PHONE: <number> - This message is shown when there is a problem with the journey information that is being checked. The software has detected that the digital bilateral transport license exists in the TRAFICOM database, which is located in Finland, but does not exist in the database that is located in Russia. It can be an issue with the database that is hosted in the Russian server or it can be some indication that the synchronization between the backend services in not working properly. A phone number is shown so that customs and police officials can call and report it to the administrator which can investigate immediately and act accordingly. **Figure 25** shows how the view would look like if such scenario would happen while someone is crossing the border.

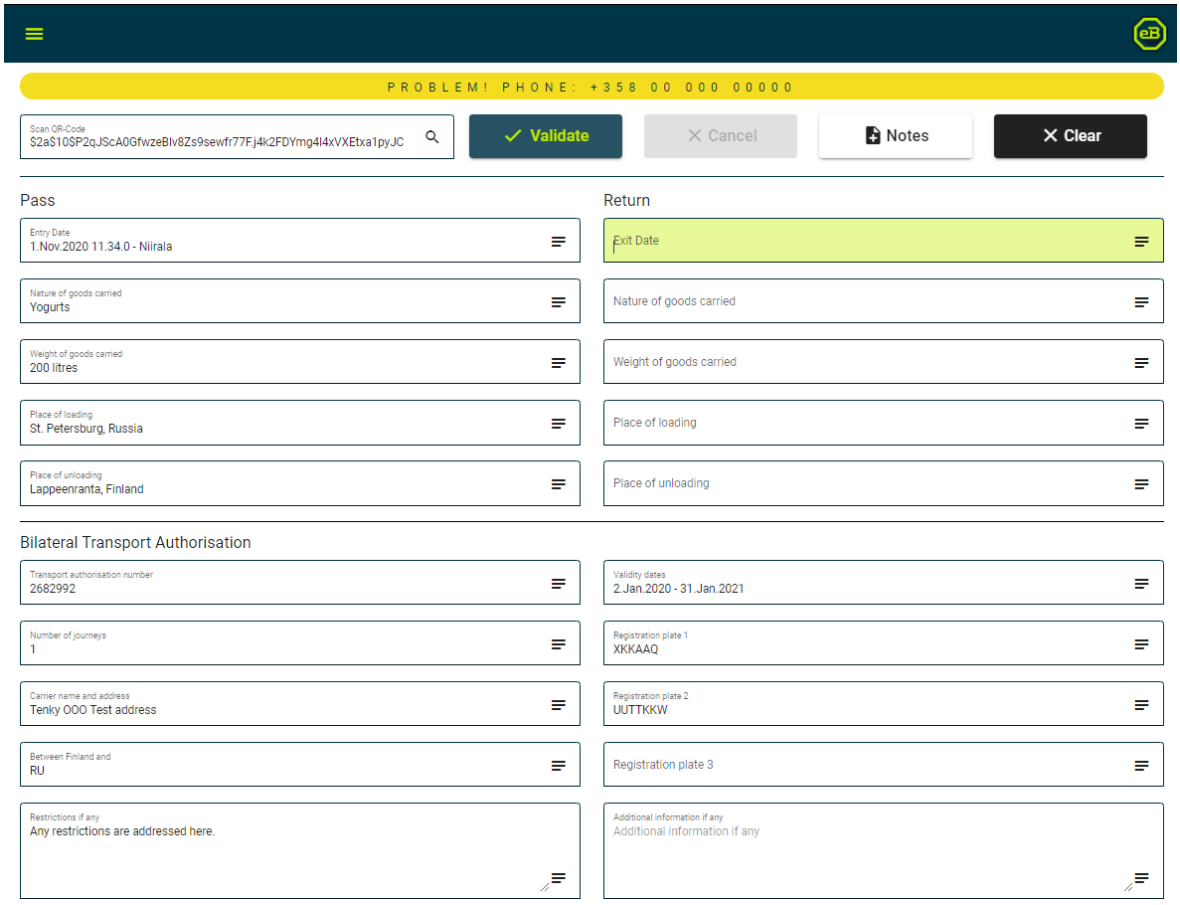

Figure 25. Example scanned digital bilateral transport license in customs view with possible problems detected

FORGERY! PHONE: <number> - This message is shown when there is a major problem with the two-way validation for the specific TA. The software detects that the digital bilateral transport license exists in the client database, which is located in Russia, but does not exist in the database that is located in Finland. This can indicate that the database hosted in the Russian server has been compromised and needs to be addressed immediately, or there is a problem with the admin database that is located in Finland. A phone number is shown so that customs and police officials can call and report it to the administrator which can investigate immediately with high priority. **Figure 26** shows how the view would look like if such scenario would happen while someone is crossing the border.

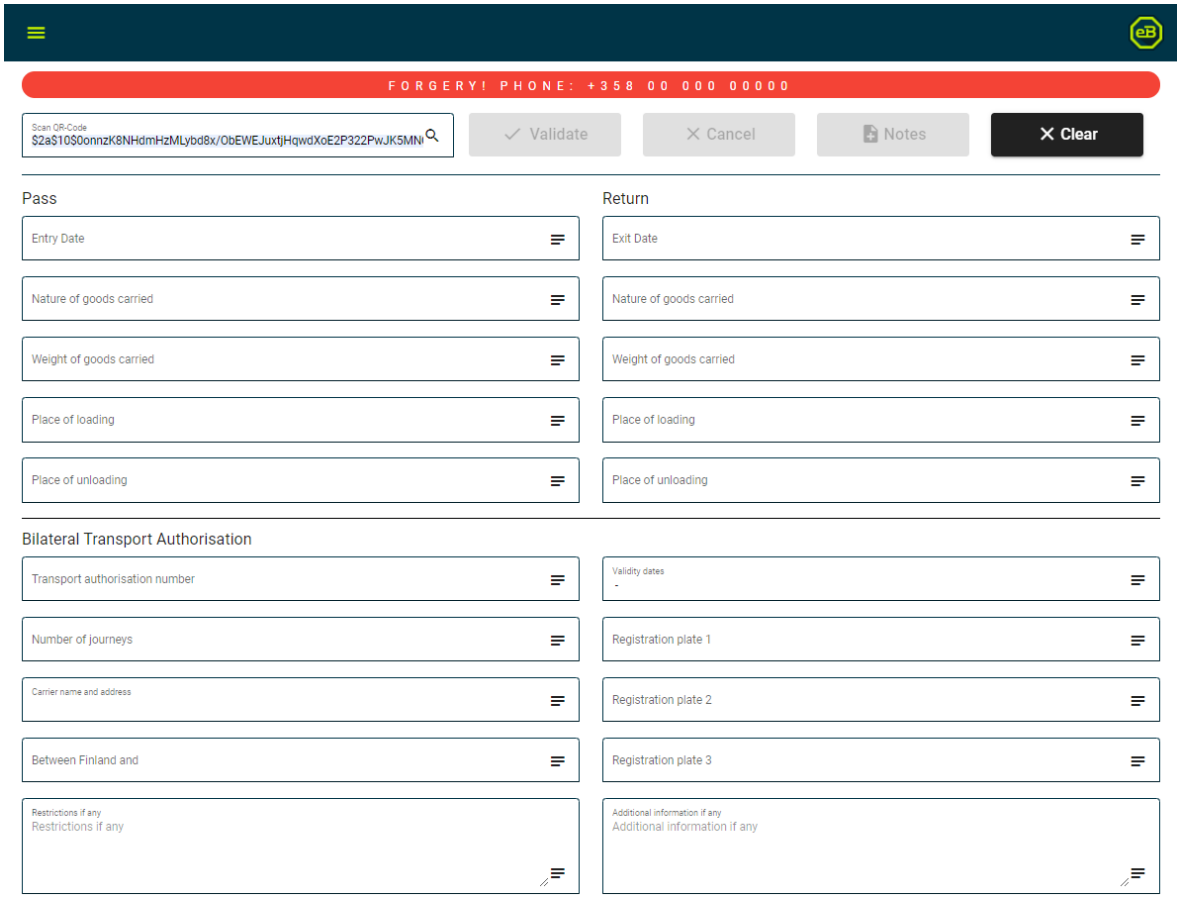

Figure 26. Example scanned digital bilateral transport license in customs view with possible problems detected

The developed artefact also tackled the third quality attribute mentioned, which is costs. Previously, it has been mentioned that costs are very high when it comes to developing software, especially when the needs are that the software is a mobile application as well as a web application for different use cases. Costs have been tackled by using PWA, a new way of developing mobile and web applications at the same time. This new way uses Service Workers, which have access to the hardware of the mobile phones, if needed or download the whole software offline and allow offline access to certain resources. Both were not needed for this artefact.

Figure 27 shows the developed artefact and the process of how the installation of the software is done via PWA service workers.

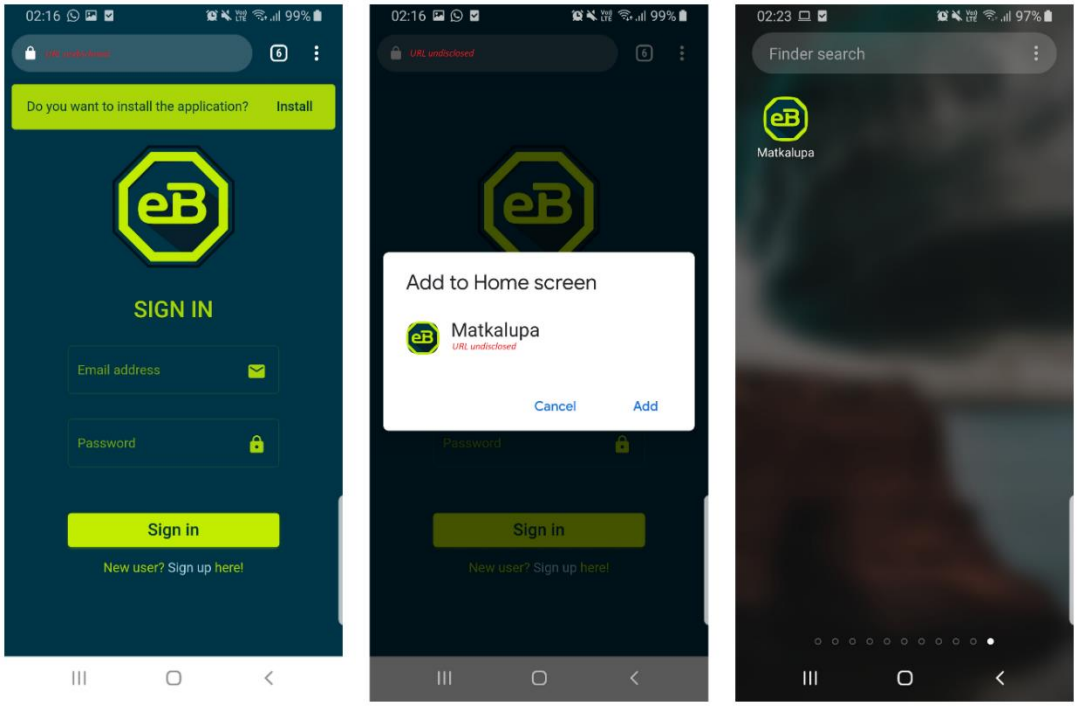

Figure 27. PWA in action when drivers visit the application with their smart phones

The source code of the artefact can not be disclosed due to security precautions and the nature of the project.

5 RESULTS AND DISCUSSION

In this section, artefact evaluation results are shown, as well as discussions about the outcomes is presented. Additionally, the future vision about the artefact and eBorder project as a whole is discussed.

Evaluation methods used for the artefact as presented in section *3.4 Evaluation methodology* of this thesis, were unstructured and semi-structured interviews. Unstructured interviews have been used during the design and development phase, where feedback has been gathered by customs experts about features and improvements that mainly tackled the usability issues from customs point of view. Semi-structured interviews have been used to evaluate the finished artefact, its performance, and if the artefact has fixed the issues that were being tackled.

The interviews for the evaluation were done with experts that have different backgrounds and belong to one of the impacted target groups. There were five expert interviews done. One interview was done with a transportation and logistics expert which evaluated the artefact as a whole, although the main focus was on the transportation companies and driver's perspective. Two more expert interviews were arranged with customs experts which gave their feedback about the artefact and they were mainly focused on the customs and police perspectives. Two experts were traffic experts, one of which worked at customs previously and one created the new process that has been presented in *2.2 E-customs initiatives taken in Finland.*

Table 9 shows the experts and their area of expertise as well as the target groups that they represent.

Table 9. Area of expertise of the interviewed persons and represented target groups

	Expert 1	**Expert 2**	**Expert 3**	**Expert 4**	**Expert 5**
Area of expertise	Customs expert	Customs expert	Transportation logistics expert	Traffic expert, proposed	Traffic expert, ex-

				the new process	customs official
Represented target groups	Customs	Customs	Transportation companies		Customs
	Police	Police	Transportation drivers		

For each of the experts, a demonstration about the artefact has been done and the process diagrams have been shown for an overall view of the changes that have been done.

A brief introduction about the experts and their expertise can be seen below:

Expert 1 & Expert 2– Both experts have 25+ years of experience working at customs in different positions, and they have been using software applications as part of their job.
Expert 3 – Expert 3 has been working with various transportation logistics including the development of the border crossing site for transportation between Imatra, Finland and Swetogorsk, Russia. He has been part of the process while goods have been transported to Finland and has first-hand experience with the TA documents.
Expert 4 – Expert 4 has been working in various traffic projects for the City of Imatra. He has presented the new process for the bilateral transport license digitalisation for Traficom, which has been implemented in this thesis.
Expert 5 – Expert 5 is an ex-custom official and ex-director of the Southeast Finland-Russia CBC Program for cross-border co-operation. She also worked for the Finnish governmental agency called Väylävirasto. She also has worked with the TA documents during the time she worked at the border.

All the experts have been asked open-ended semi-structured questions with the goal to get an evaluation of the artefact in regard to usability, security and costs and ultimately get an answer for the research questions of the thesis. Due to the circumstances, Traficom experts were unable to be interviewed, therefore their point of view is not shown on the results for this thesis. The solution will have a technical evaluation and be reviewed in due time.

The results of the interviews can be seen in the upcoming section, and discussions regarding the results will follow. Full transcript of expert interviews can be seen in Appendix 1.

5.1 Results

Most of the interview questions were addressed to all the interviewees, independently of the target group they represent, however, there were also questions that were specific to one target group and they were answered only by the relevant experts. The questions were focused on the problems that were identified in the previous process such as long waiting times, usability, security, costs, and system integration. The interviews have been analysed in order to validate if the artefact has tackled these issues successfully and eventually validate if the research questions were answered and showed positive results. The results regarding the focused problem areas is discussed in the subsections below.

5.1.1 Long waiting times

The interviews started with questions about the time that it takes to cross the border formalities at the Finnish-Russian borders and how they estimate that the new system would affect the crossing time. The artefact has been presented as the first document to be digitalised in the Finnish-Russian borders and there were two different approaches that customs officials took regarding the time implications: the artefact alone and the potential that the artefact has for other documents.

When it comes to considering the artefact alone, customs officials said that there are almost no time implications with the change. The current process is using stamps to validate TA-s for one-way transportation and transforming that process into a click of a button or QR-code readers is seen as no difference in terms of time. The time to go through the document is also considered as the same considering that it contains the same information as the paper-based document and the reading time is not affected by the fact that one is reading it from a paper or from their computer screens. When considering the potential that the artefact has for other documents as well, customs officials were highly positive that the time would decrease a lot in case other documents that are needed for transportation are digitalized on the same way. This indicates that the customs officials believe that the artefact when used for other documents as well would decrease the time to pass the border, however, since the truck

drivers still need a lot other documents to provide to customs in paper, when they are crossing the border, this can't be measured with only a single document. One ex-customs official stated that the system may not be time efficient in the beginning since it may take some more time until the customs officials are used to the system, however, it is believed that in longer term, it will make the customs process more fluent and faster.

One aspect where it is believed to save a lot of time, is the TA creation and assignment. It is stated that sending the paper documents from Finland to Russia by post can take up to 3 months. This is seen as a big inconvenience, especially if someone needs the paper documents within days. Digitalisation of this document made it possible that the TA documents are available in a matter of seconds and is considered as the faster approach.

When analysing the results from the perspective of the driver and transportation companies, the results are very similar to customs experts. They believe that one document alone would not make a huge difference in terms of passing the border, however the artefact as a whole has the potential to digitalize all the documents needed to cross the border and that would decrease the time for border formalities from 15-20 minutes that it takes currently to just 2-5 minutes. Considering these responses, it can be seen that the artefact would indeed decrease long waiting times at the border, in case it would be applied for multiple documents that are needed for border crossing procedures.

5.1.2 Usability

To figure out if the artefact resolved the usability issues, the experts have been asked about ease of use, understandability, functionalities, and usefulness of the artefact. When asked if the system is clear and easy to use, all the experts expressed that the artefact is very clear and very easy to use. Even though two of the experts were older in age, they showed a very positive attitude on using the artefact in their daily tasks because it's very easy to adapt to, comparing it to other software applications that they have. One expert explained that the artefact is handling only one document now and they like the usability of the software, they would like to put it into a test when there are multiple documents handled in the system. It has been noticed that for customs it would be easier if all the buttons in the customs view would be as far away from one another as possible due to possible misclicks from the

officials when they are working in longer shifts. However, allowing the user to select the preferred option, either the buttons or reading QR-codes has been seen as something very positive in terms of usability. All the experts agreed that the system is very useful, and they welcome this kind of system in their daily work.

Having in mind that the current process has paper-based documents, requires pen and stamps to be involved, and the responses from the experts, it can be concluded that in terms of usability, the artefact is better than the previous process. It shows a new and innovative way of dealing with documents and makes filling and reading the information easier for all parties involved. The artefact is easy to understand and work with and introduces new features that are very useful for customs which were not present in the previous process.

5.1.3 Costs

Reducing costs has been one of the goals for this artefact. Experts have seen cost reduction in two perspectives: cost reduction because paper is being removed completely for the document, and cost reduction for transportation companies because of the availability of TA-s shown in the artefact.

Customs believe that the costs will be reduced because there is no need to print and deal with shipping of the paper documents which are more expensive than regular paper due to water stamping that has been introduced to the document as a security measure. Shipping physical documents generally means that extra logistics is added to handle the shipping, packaging, and allocation. The artefact clearly removes these costs by making everything available online.

The artefact is believed to decrease the costs of transportation companies by a lot. Although the TA-s have been provided for free to transportation companies, they are limited in numbers and are only provided once in the beginning of each year. Currently, when some transportation companies have used all their TA-s across the year, but they need to send out goods to Finland, they start buying the TA-s from other companies that have some TA-s left. “It’s an auction house, it goes to the higher bidder” one expert states, referring to TA-s being sold to transportation companies by other companies who offer the most amount of money

during the end of a year. The cost to transportation companies in this case can be 2.000 to 3.000 euros for one transportation, just because there are only a few left on the market. The artefact presents the way to have the TA documents on demand, and Traficom can control the amount and when they get assigned to transportation companies.

Having these in mind, it can be stated that the artefact reduces costs for customs as well as transportation companies. All experts have shown positive answers and no doubt that the costs will be reduced, one stating that it will be life changing for transportation companies.

5.1.4 Security

When it comes to security, some experts said they do not have the necessary background to comment on the topic, while some, even though they have limited knowledge to security, they believe that the new system offers better safety for documents compared to paper-based documents which have a history of being forged. All experts were optimistic that the new system will stop the fraudulent activities that people are trying to do. Customs experts said that in the current process, one should have a lot of experience to figure out if a paper document is fake or original, and the new customs officials might not have that experience to figure it out, which would lead to document fraud. However, they strongly believe that the authenticity verification process presented in the artefact can prevent that from happening. Due to circumstances, no security or technical expert could evaluate the artefact, however, a thorough inspection will be done in due time.

5.1.5 System integrations

Customs officials have been very optimistic that the artefact can be integrated with other customs systems to improve efficiency and decrease time that is needed to cross the border. They noticed that most of the information that is stored in the artefact's database can be used in other parts of customs process such as x-ray cargo checks. They emphasized that they spend a lot of time in the x-ray department just by scanning physical documents that need to be attached to the x-ray pictures that have been scanned.

Customs experts also expressed their frustration with the current process. One of the experts said that this process is causing them to get tired and bored in their workplace: “I do this hundreds of times per day, and after ten times, I will get tired and bored because this is not my main job, this is not what I am supposed to do. My main job is not printing and scanning but clearing goods that are coming in”. They also expressed their optimism that one day the whole process would be digital, and no papers would be needed to be shown by their clients, where each customs system is connected with one another, sharing information in real-time. All experts agree that paper needs to be replaced with digital version, and all documents that are needed for freight transportation should be shown in their computer monitors, sooner rather than later.

Expert 4 explained that there is one project that is ongoing at customs which aims to use a centralised database where the data can be shared between customs applications. He said that the new process covers integrations and that he believes that the implemented system would be able to use such database and share information for a larger e-customs system.

The artefact has been developed using API driven architecture and information can be easily shared with other systems. It can be concluded that the software can be easily integrated with other systems and would make the daily tasks of the users easier and better, provide faster border crossings and make everyone involved more efficient.

5.2 Discussion and implications

The artefact was developed as part of the research process to get an answer for the research questions that are presented in section *3.2 Research questions*. The results from the expert evaluations have been used to answer those research questions for the thesis. The results clearly state that there has been improvement in usability and costs and can greatly affect the waiting times in case the artefact includes other documents that are required for crossing the border.

Previous research studies show that paper can greatly increase costs, however, having them in digital form reduced those costs (Dawes, 1996; Gilbert et al., 2004; Hesketh, 2009; Holloway, 2009; Liao & Cheung, 2001; Overbeek et al., 2011; Raus, 2009; Raus et al., 2009). The results from the experts show the same results. The artefact is presented as a new

digital process that does not need paper to operate. The artefact has digitalised one of the many documents that are required from transportation companies to cross the border, the bilateral transportation authorisation, however the presentation and functionality that the artefact had for that document has shown that the same can be done for other documents and that would have even greater implications on cost reduction.

When it comes to shorter transaction times, previous research shows that having documents in digital form instead of paper based, can decrease the time significantly considering that paper documents take days to sometimes weeks to be delivered by post in a foreign trade transaction. Previous findings also show that any error on the digital documents can be fixed within seconds since the data is stored in online databases (Gilbert et al., 2004; Holloway, 2009; Raus et al., 2009; Rogers, 2003). This can be seen in the artefact developed for this thesis, which takes few seconds to allocate TA-s to transportation companies instead of days with the previous process when TA-s were delivered by post from Finland to Russia.

Fraudulent activities such as document forgery have been a problem for customs as long as paper documents were around. Previous research has shown that electronic systems prevent fraudulent activities from happening due to the advanced verification processes for e-documents (Davis, 1989; Dawes, 1996; Gilbert et al., 2004; Holloway, 2009; Rogers, 2003). The artefact for this thesis was not able to be evaluated for its security features it provides by security experts but will be evaluated in due time. However, the results show that the experts that will be using the system in their daily work, trust that the electronic system will be able to prevent those fraudulent activities and they trust that generally the electronic system is safer.

The results show that the tackled issues for e-customs has been solved with the developed artefact. An answer to the research questions is taken from the analysis of the results and shown below:

RQ1: Can a software application replace paper-based transportation documents during a bilateral freight transport process?
Answer from the results analysis: The results show that a software application can indeed replace the paper-based documents during the transportation process. All the experts are

positive that this will have great implications on the process and that the paper-based documents should be left behind.

RQ2: Would an e-Customs application increase efficiency in customs during freight transport procedures?
Answer from the results analysis: The results estimate that an e-Customs application would increase the efficiency in customs by a lot. Customs experts have shown great interest in software applications sharing information in different parts of the customs procedures so they can avoid doing paper tasks that are considered as counter-productive and old fashioned. The experts explain that they are promoting such services to happen and would be very interested to help to make this happen.

The artefact has shown that it has potential for other documents to be digitalized within the same software system. The artefact has been implemented based on the proposed eBorder process for digital bilateral transport license, which has been presented as part of the eBorder service umbrella. There were limitations on evaluating the developed artefact. The COVID-19 pandemic made real life artefact testing impossible. Transportation companies from both Finland and Russia, as well as Finnish customs were ready for testing and a testing schedule had been agreed upon, however due to the circumstances, it was not possible to do so. Once the system gets into use at the border and feedback is gathered, it will be decided if there will be more initiatives for digitalisation of other documents that are needed for transportation. At the current state, the developed artefact serves only inbound traffic to Finland. A close co-operation with Russian customs is needed in case the artefact would be used for traffic coming from Finnish transportation companies to Russia. This part has been postponed until there is clear evidence that the concept and the artefact work as expected. While the initial feedback from the experts has been positive, it is still too early to predict the future of the eBorder service umbrella and the artefact specifically.

6 CONCLUSIONS

Digitalization has proven to be very effective in boosting companies' performance and efficiency. While this is true for the private sector, the public sector has been slow in transitioning from analogue to digital. The goal of this thesis was to analyse the problems, and solutions for the public sector regarding digitalisation, with an emphasis on the customs domain and the bilateral transport license. The second goal of this thesis was to develop an artefact, which tried to fix key issues that have been found and present the first digital TA that is used during a freight transport between Finland and Russia. The study showed the potential approaches and technologies available for the development of the artefact.

Having in mind what technologies are available and what approaches can be made, the artefact named eBorder Matkalupa has been developed. This study has tackled the following issues: costs, usability, security, and infrastructure compatibility. Two PWA applications have been presented for different target groups. The solutions are available in mobile devices as mobile applications and web applications for desktop. Both applications use Material Design to enhance user experience and make the software clear and easy to use.

The results of the study have been analysed and the research questions have been answered. The answer to the first research questions "*Can a software application replace paper-based transportation documents during a bilateral freight transport process?***"** is a clear yes. The answer to the second research question "*Would an e-Customs application increase efficiency in customs during freight transport procedures?*" is a strong yes. All the experts agreed that an e-Customs application is needed and would increase efficiency in customs by a lot.

The main take away from the thesis is the potential that the eBorder Matkalupa solution has to offer to customs. The experts were very excited to see the solution in action and were looking forward to using it in their everyday work. Apart from that, it is emphasized that the solution should interact with other customs applications to increase efficiency in customs as well as reduce the time for border crossings. It has been decided that the solution will be pilot tested in due time and it will be decided if other documents should be digitalized and introduced into the system.

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APPENDIX 1. Evaluation interviews – Raw transcript

What do you estimate, does the use of this new system affect the time it takes to pass the border formalities including customs at the Finnish-Russia border?

(a) If yes, how much do you estimate the new system changes the time needed for the border crossing formalities?

- **Expert 1 –** I estimate that the time will be no longer nor shorter than the current time it takes to cross the border, because now we have stamps and the new process is replacing that with QR-code scanners or clicking a button to validate the TA, so the time is the same.
- **Expert 2 –** From my point of view, when I compare this to the previous paper document, I believe the time would be almost the same. Of course, the time to read the document is the same because it is the same information. It takes me 15-20 seconds to go through the document and process it, so with the digital version, I estimate that it would take almost the same amount of time
- **Expert 3 –** The TA document, ultimately, is only one document out of a hundred that are required during transportation procedures. I have been a few times on a truck when it crosses the border and I remember the specific places that they check the TA document. During those times, checking the TA document and proceeding with the rest took 15-20 minutes. I suppose that this system would shorten that time to 2-5 minute, I think this is a reasonable estimate in this case.
- **Expert 5 –** Maybe not in the beginning but for the longer run, yes, like I said, people have to get used to it in the beginning but when after they get used to it, it becomes a custom and then the border crossing is more fluent.

Is there any functionality you would add to the implemented system? If yes, what?

- **Expert 1 –** I was part of the interviews that were taken during the development phase, so my concerns are already covered.

(continues)

APPENDIX 1. (continues)

I do not find anything else that can be changed or added.

- **Expert 2 –** Even though I did this kind of job previously, currently I am not doing this work every day, however, from my point of view, there is nothing else to add for this type of document.
- **Expert 3 –** It is the same thing with every digitalization process. The driver is still going to have to carry a lot of documents with them, invoices, CMR, and other kind of documents. Some of the drivers are in their 60s and they might not understand how the digital application works or what they need to do. However, this is something that eventually will need to happen. We are still using papers from the Soviet Union. But of course, I would like to see all those documents in a centralized application. We cannot have one software for invoices, one for CMR one for TA. I think it would be great if we had all the documents in one software application. If it was up to Finland, these documents would not be needed, however when it comes to Russia, it takes a lot of agreements and law changes to get rid of these documents, so eventually the digitalization of these documents has to happen so the driver does not need to carry all those paper documents.
- **Expert 4 –** Not now, we must wait until we can pilot the system with Traficom and customs and see how it goes, they will give initial feedback when it's actually being used but now nothing needs to be changed in my opinion.
- **Expert 5 –** I think what it would be very important for customs to be added is the seals number there. You have to seal the cargo when crossing the border. The sealing is made when the cargo leaves and that is also what the customs are very interested in, even though the seal itself is very physical and has to be in a condition that no one broke into it. When the cargo comes to the border and the seal is broken, then customs have the right to unload and check the cargo because there is reason to believe something is happening there. I think having the seal number included there would be very helpful for customs. Also the notes that are already implemented in the system are really good feature to have, it adds more value to the digitalised version from the paper one.

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APPENDIX 1. (continues)

Did you find the new system clear and easy to use?

(a) If yes, do you estimate that this new system is easier to use than the previous paper-based approach?

- **Expert 1 –** The new system looks clear and easy to use. Considering that QR-codes are used for everything and no writing is involved, it is easier than the previous paper-based approach.
- **Expert 2 –** I am not a master's in computers, but this system looks very simple. You just use the barcode and you read what you see there. Maybe first 10 times you need to get used to it but later on, you appreciate the difference that this system makes.
  My colleagues are younger than me, so for them it will definitely be easier.
  As for people my age, maybe its not easier but it is easy enough for us. With these kinds of systems, you will always find older people having a harder time to adapt to digital systems compared to the young generation.
- **Expert 3 –** As about easy to use as it can be. It's a quite simple document, the ease of use would need to be tested when all the documents are digitalized in one digital platform. I like the usability of this software. For me this new process is easier, for a 65-year-old Russian driver it might be easier to just show the paper at the customs, it depends on the perspective.
- **Expert 4 –** Yes, I believe this system is very easy to use, it is easier than the previous way of doing things.
- **Expert 5 –** This is hard to say, paper is paper afterall, and you can see it in front of you. If you're used to seeing the paper versions it's very quick, if everything is in the same form, it's a bit more work for the brain to read the information from the software, and in the beginning you might need to have both the software and the paper version as the customs might not trust the system at first, and then gradually make the transition to the digital version only.

(continues)

APPENDIX 1. (continues)

Did you find the new system useful?

- **Expert 1 –** Yes, this software is useful. As long as those additions that were discussed during the development process have been made and they are present, the system is definitely very useful for us. To make it even more useful, as a next step it can be sharing the information that we have in the digital TA with x-ray unit because they need the same information that is put in the TA to process the cargo vehicles.
- **Expert 2 –** For sure it is useful. When you explained the previous process and the new process it is obvious that this system is better than the paper system. I warmly recommend that we should use this kind of system.
- **Expert 3 –** Yes, this kind of system is always useful.
- **Expert 4 –** Yes, of course, I think this system is very useful and it's the only way forward.
- **Expert 5 –** Yes, definitely yes.

Did you feel that you have an easy understanding of the new system, its features and generally how it works?

- **Expert 1 –** It seems good and understandable.
- **Expert 2 –** The process explained gives the whole picture on how it is and how it will be when the process is changed and this is easy to understand, maybe the same can be used for training people that are going to use this. This new process is better than the previous one.
- **Expert 3 –** Ultimately, I only understand the end user perspective. The driver application would be very simple to start using it, it will not be much of a problem to adapt to it. I do not think it's too complex.
- **Expert 4 –** Yes, its very good and easy to understand. I have had the chance to talk to other people that were interested on this new system and said it is very easy to understand.
- **Expert 5 –** I think everything was very clear. The only think I was thinking about was that sometimes customs can be very tired because of long working hours or night shifts. So when they see the red button and a green button they need to make sure

APPENDIX 1. (continues)

that they are not clicking the incorrect one. So, I would suggest separating these buttons as much as possible, so the human error is avoided in cases when they feel tired. It is very good to know that they get to choose between QR-code readings and the buttons for validations and cancellations of the TA.

Is this solution better than the previous one, in general?

(a) If yes, do you think other efforts should be made to increase the digitalization of cross border activities? Should other efforts be initiated or this one expanded?

- **Expert 1 –** It is difficult to compare the paper world with the digital world because it's a revolutionary change, with papers there's always a risk that papers will get destroyed but when it comes to digitalization we can always go back to that. More initiatives need to be made and other documents need to be digitalized as well.
- **Expert 2 –** I still wonder why we have these papers that we are using, they are from the Soviet era and very old fashioned. I would like to have a formula that would digitalize other documents as well like this one that you already did. There are other documents such as insurance which are forged very frequently. Now that the TA document is digitalized, I would like to see the insurance documents to be next.
- **Expert 3 –** I believe that everything that can be digitalized should be digitalized. When it comes to security, I do not have that information and its implications, but in terms of usability, the less paper the better.
- **Expert 4 –** Yes, I do believe that we need to have other documents digitalised, that's the only way to go forward.
- **Expert 5 –** Definitely this is an improvement, this is something it affects the improvement of the border crossing points as well and make the traffic more fluent. Fluently moving the cargos and so on. And again, of course, there always are those that try to enter illegally, and this system is something that makes it more trustful, paper is something that is easier to forge.

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APPENDIX 1. (continues)

The digital form makes it more secure, if someone makes a fraudulent action, you can track who made the change but in paper-based version there is no way to verify who did anything. No-one is guilty in that case. I hope that many paper documents are digitalized so we don't have a lot of paper anymore. It makes the work for everyone easier. Customs still need to use software in their work as well as check paper documents. If you have the paper work and the digital work, looks like its double the work, if you had the digital form only then it's much easier.

Do you know about any cases where it has been reported that the documents have been forged?

(a) If yes, was it hard to verify the document's authenticity?

- **Expert 1 –** Yes, some copies were found. Some were very poorly forged and easy to identify, but there were some good copies, although not too many, 10 or were very hard to tell.

- **Expert 2 -**There were some cases years ago when they didn't have the water stamp document, but I haven't heard anything nowadays. There is always the possibility that people try to falsify this. You need to have some sort of experience when you're checking these documents. What kind of paper is it being used, what factors are built inside this document etc. That is something you do not need for this kind of system that you built because it verifies by itself. We have a case when we have new customs officer doing this work. They do not have enough experience to check the validity of the document. It can happen that the inexperienced person does not tell the difference between a false and an original TA document. This system helps us to avoid these kinds of mistakes and that is an important factor of course.

What do you estimate, does the use of the new system have any effect on costs?

(a) If yes, do you estimate the cost to be reduced or increased?

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APPENDIX 1. (continues)

- **Expert 2 –** What is important for me is that with this new system, all the costs that come from printing this special document, that is a water stamp document, which is more expensive than the normal paper, are reduced because you don't need them.
- **Expert 3 -** This is a difficult question because the document itself does not actually cost anything in Russia. The transportation companies get it for free from Traficom depending on the size of the logistical company that is registered in the Association of International Truckers, that is how I understand it. Every company has X amount of these documents per year. The costs increase by a lot when the end of the year comes and people start running out of these documents and it's only a few companies that have these TA left, at that point it's an auction house, it goes to the highest bidder. Someone has a cargo that absolutely needs to be in Finland for Christmas, the company that owns them will charge 2.000-3.000 euros for this document just because there are only a few available to get. Since this system can make TA documents on demand, it is life saving for some.
- **Expert 4 –** Of course, the paper version will not be used anymore, and I don't know how much this new system would cost but I think in the end of the year, it will be a huge money saver.
- **Expert 5 –** Considering the costs, now you have developed this system and the technology exists, after this it should be very cost efficient to further develop the eBorder services and the platform itself. For customs, the software doesn't really cost anything in the long run, this is about digitalisation of services also in the border side, it's more important that the costs. It might cost something in the beginning but in the longer run it costs less because you would not be using paper documents, by removing paper itself you would get some cost reduction alone.

Considering the developed solution do you think that a software application can replace paper-based transportation documents during a bilateral freight transport process?

- **Expert 1 –** Yes, I think so.

(continues)

APPENDIX 1. (continues)

- **Expert 2 –** Yes, I think it increases efficiency in customs.
- **Expert 3 –** Absolutely yes, for safety and security I cannot answer because I do not have expertise on that.
- **Expert 4 –** Yes, definitely.
- **Expert 5 –** Yes, and it should be scaled to other border crossings.

Having in mind that this application is just for one document, and eventually one whole e-Customs software would include more documents and all the customs processes would be sharing the information about the drivers and cargo, do you think an e-Customs appplication increases efficiency in customs during fregiht transport procedures?

- **Expert 1 –** I think it increases efficiency. It would be good to remove stamps for every document and would be good to have all the documents in one place and just go through the documents one by one in a software and move on with other procedures.

  Expert 2 – Yes, for sure, that would be a big help for us. There is extra documentation that is needed if you transport meat products for example. And they are old fashioned too. I have been promoting the idea about this kind of system, but it seems like no one is listening to me. So, I think it is very important for this to be promoted in a higher level. I think this kind of system would increase efficiency in customs and save time. As an example, in the x-ray unit, when the vehicle comes, the physical documents come and need to be scanned and attached to the screening images. In a digital system you do not need to do that, for sure it would increase efficiency. I do this hundreds of times per day, and after ten times, I will get tired and bored because this is not my main job, this is not what I am supposed to do. My main job is not printing and scanning but clearing goods that are coming in. If we can get that easily with digital systems, then it is always more efficient for the clients also.

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APPENDIX 1. (continues)

- **Expert 3 –** When going from Finland to Russia, the problem is to have enough customs guarantee for your goods. For this you need to show a broker, your invoices and packing lists. I have seen this take six to twelve hours. This is what takes the most from crossing the border, organizing your customs guarantee and invoices. When you arrive there, there are other trucks there doing this and it increases the waiting time even more. So absolutely yes, it would increase efficiency by a lot.
  When going from Fin to Rus the problem is have enough customs guarantee for your goods. For this you need to show a broker, your invoices and packing list etc. I have seen this take from 6 to 12 hours. This is what takes the most from crossing the border, organizing your customs guarantee and invoices is what takes the longest. You arrive there, you start doing it, there are other trucks there and it's the biggest. So absolutely yes, it would increase efficiency by a lot. I think it would be great if you could integrate CMR, invoices and these other documents into your document and I wish you luck with that.
- **Expert 4 –** Yes, I think it would increase efficiency, however we cannot know for sure until we pilot test it and get initial feedback. What is needed is to speak to the actors involved, Traficom and customs and see opportunities on how this system can be expanded into a bigger one that.
- **Expert 5 –** Yes, definitely, because it's a lot of paper with some cargos, if it would be in digital form it would surely make it more efficient in many ways not to mention the environmental benefits that the digital platform brings. And you can lose the paper version, something can happen to the paper version and if you lose it, it can be crucial. The reason why costs are up for transportation companies is exactly that, the paper gets lost and every hour, every minute at the border costs money for the company. If you can make everything digital for the driver and customs, it would make things much easier.

(continues)

APPENDIX 1. (continues)

Considering the developed solution and the process that has been presented by you to Traficom as a potential solution to the defined problems, do you think this system has taken care of everything that has been presented in that proposed process?

- **Expert 4 –** The implemented system looks good and looks like it has taken care of all the angles that have been proposed in the process, but as I said, we really don't know how it will go until it has been piloted but everything that has been presented in the report has been covered by the implemented system.

Are you happy with the implemented system, is there something that could have been done better?

- **Expert 4 –** I am happy with the implementation; it is looking very good. We can see that there have been very little changes for customs during their basic day per day tasks and it will have such a huge difference when looking at the opportunities that the system provides.