

# The impact of a context-aware architecture for B2G information sharing on data quality in the container-shipping domain

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Submitted in partial fulfilment of the requirements for the degree of

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**MASTER OF SCIENCE**

in Management of Technology

Faculty of Technology, Policy and Management

by

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## Acknowledgement

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## Executive summary

Information sharing among parties in a supply chain is perceived as a method to improve supply chain performance. Customs Department officials expect businesses to share high quality data with them so that they can perform risk analysis effectively. Furthermore, it is expected that businesses will become more compliant with Customs regulations and procedures when they share higher quality data with Customs officials. Therefore, various system architectures are introduced to support users in sharing high quality data more completely, accurately, and conveniently. One such system designed to support business-to-government (B2G) information sharing is the context-aware architecture. In this architecture, the context is sensed and adapted to, to provide appropriate information flow in a variety of situations. However, before the context-aware architecture is publically implemented, the architecture should be evaluated to assure that its use will indeed positively influence businesses to both share better quality data and improve reporting compliance. Accordingly, the research question is **How does introducing the context aware architecture affect data quality in the container shipping domain?** Choosing the appropriate data quality dimensions to evaluate the architecture is important, as measuring compliance is often complex and hard to measure directly.

The main research methods employed were the review of existing literature and interviews with people involved in this industry. Literature review and interviews were used to define which data quality dimensions most meaningfully impact the information sharing processes in the container shipping domain and thereby could be employed to improve compliance. The results from the interviews provided suggestions for the best dimensions to use to evaluate the context-aware architecture. Data accuracy, data completeness, and data timeliness were selected as the main surrogates for measuring compliance. A total of seven semi-structured interviews were conducted. The interviewees were from businesses involved in the importation processes, such as exporters, importers, and freight forwarders. The initial interviewing goal was to determine what the current information sharing process looks like. From the interviews, we found that businesses used email as their main communications and information sharing channel. It also determined which data quality dimensions had impacts on the information sharing processes. After analyzing the data from the interviewees-from several businesses, data accuracy, data completeness and data timeliness were found to have the impact upon the information sharing processes in the container shipping domain. Based on this analysis, only data accuracy and data timeliness were found likely to be improved by sharing information through the-context aware architecture. More extensive research with larger and more high-technology oriented companies, to learn about their data exchange systems, may provide further insights that could be used for evaluating the benefits of the context aware architecture.

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# 1 Introduction

This Introduction provides the background for understanding the system architecture-and introduces the context aware architecture for the container shipping domain. Data quality dimensions have been chosen to be the area of the study in the container shipping domain which is the subject of the main research question-and presents the outline of this thesis.

## 1.1 Background

Technology can help businesses to be more productive and competitive. Technology is used by businesses to support communications between various parties such as in business-to-business(B2B) information sharing. Governments can also use technology to make their processes more efficient and to improve citizen satisfaction. For example, the US Department of Treasury is studying using blockchain to replace the current system that manually tracks the movement of physical assets (Deloitte Insights, 2018). There are however challenges for governments when adopting new technologies, such as privacy protection in the information sharing system, human capacity limitations, and so on(Behara, Vardhan Varre, & Rao, 2009). As it is a government responsibility to protect people, the acquisition and analysis of information from businesses is one of the government's duties, in anticipating and preventing uncertainties. To facilitate this government oversight, businesses are obligated to share their information with the government.

The Customs Department (hereinafter "Customs") is a government organization charged with the collection of import duties on goods and also with the protection of citizens from threats due to the export or import of harmful or illegal goods(EUROPA, 2016). In order to protect the safety and security of the public, Customs officials perform various duties to ensure that harmful goods are not imported or exported. One of roles is to perform risk analysis on goods being imported into Europe before allowing these goods to cross the border. Although businesses already share information with Customs, additional higher quality information is required to perform more accurate risk assessments and to prevent harmful/illegal situations such as human trafficking.

To support this Customs risk analysis role, there are a number of ICT architectures designed to improve information sharing systems, allowing the various parties involved to feel more comfortable about sharing information. For example, the CASSANDRA project, an EU Commission project for supply chain risk assessment of 2011, which introduced a data pipeline into the data exchange architecture (CASSANDRA, 2011). This data pipeline linked different IT systems, permitting the sharing of in the same channel, with a dashboard filter for the particular data of each party. The downside of this data pipeline is that it cannot protect sensitive data.

This brings us to another potential architecture that researchers are attempting to apply to risk assessment in the import process, context-aware architecture. Context-awareness is the ability to sense and adapt to context (Engelenburg, Janssen, & Klievink, 2017). Context-awareness is applied in various industries. For example, if Facebook knows that a user is in Japan, when that user accesses my Facebook page, the display will start popping up Japanese advertisements to his Facebook display of my page. When using context-aware architecture in information sharing between businesses and government each party's information requirements are detected and only the information that the parties are-willing to disclose is shared.

Designing a good system architecture for the supply chain is challenging for a software architecture designer, because the software architecture must be secure enough for businesses to use to share their information but be adequate to meet legitimate government needs to receive and verify information from the businesses. The most important issue for the system is to confirm that

businesses share their information lawfully. Lawfulness is a complicated issue for businesses as there are many laws and regulations in various jurisdictions which govern businesses and there will be more regulations in the future (Brindley, 2017) for which the system adopted by businesses must be compliant. For example, in the case of transporting roses from Africa to the Netherlands, there are currently nine-rules to comply with ranging from growing the roses through distributing the roses to retailing them (Jensen & Vatrapu, 2015). Therefore, besides its basic ability to sense and adapt the context, other components must be added to the context-awareness component to enable the system to facilitate users being in complete compliance with regulations.

The concept of distributed ledger is perceived to be secure-because users believed that various ledgers in the system would enhance the system's security (Underwood, 2016). Additionally, the decision component and adaptors allow users to manage their data. Once the system is assumed to be safe and users can direct their own data, we can assume that users would share additional high-quality data in this system architecture.

## 1.2 Problem statement

Many technologies are invented to upgrade the quality of life, but the impact of these technologies is not fully determined. Future managers, before launching a new technology in society, should analyse the impacts of these technologies to anticipate undesirable consequences, especially new technologies that involve various stakeholders. Before arriving at the phase of evaluating the architecture, suitable criteria should be selected for evaluating the architecture. For the context-aware architecture in the importation process, the architecture has not been fully evaluated yet due to its new design. Selecting criteria for evaluation is important because if the right criteria are chosen, architecture designers would save time-in evaluating the architecture, and be assured that the architecture would be able to deliver what it has promised (Clements, Kazman, & Klein, 2003). To measure compliance, we did some research-on the regulations for importing goods into Europe , and found that each of them has different documentation requirements (EUROPEAN COMMISSION, n.d.). To illustrate this, importing cultural goods require more documents than importing clothes. Measuring compliance not only involves the imported good's category, but also involves the particular rules of each country. For example, transporting roses from Africa to the Netherlands, both national and regional rules are applied, with which each actor in the chain of supply has their own responsibility to comply with (Jensen & Vatrapu, 2015). Measuring compliance directly will be too large scope of study for this thesis, as illustrated by figure 1. As compliance is too complicated to measure the system architecture directly, data quality is assumed to be an appropriate aspect to use for measuring the architecture instead of compliance. However, there are many data quality dimensions about which further research should be conducted. Hence, data quality is chosen as criteria to measure the architecture with the assumption that a better quality of shared data leads to better regulatory compliance. For example, if businesses provide high quality of information to Customs, Customs can more easily detect abnormalities such as drug smuggling.

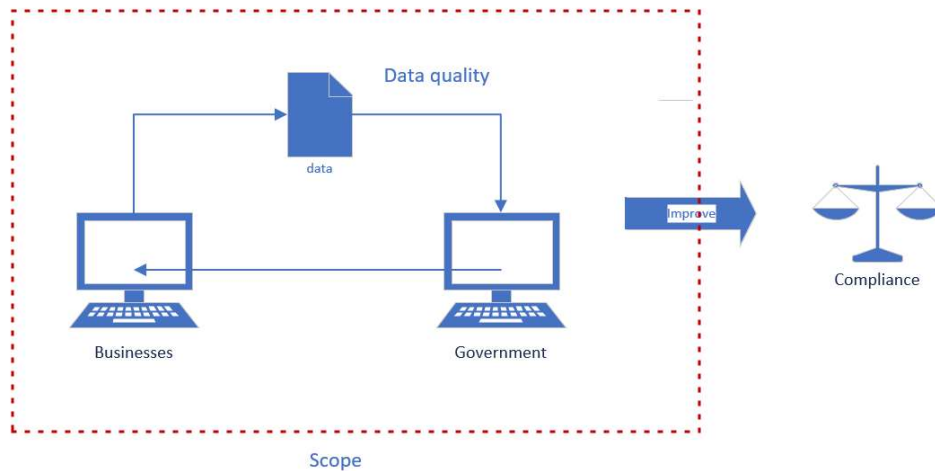


Figure 1 Scope of study

The purpose of this study is to study the relationship between data quality and shared data in the container shipping domain. Due to time limitations, the scope of study deals only with the import process in the container shipping domain. Networking is essential for conducting interviews because it helps to connect with interview candidates. However, in this case, contacting large enterprises requires a level of networking which it is difficult for an international student to achieve. Therefore, businesses selected to the interviews are small and medium companies. Although the architecture design's objective is to improve compliance, the definition of lawfulness is sometimes unclear, and laws and regulation are too complex to be a criterion to measure the system for this thesis.

Based on the discussion of scope, the main research question to identify the data quality dimensions for evaluating the architecture is: **How does introducing the context aware architecture affect data quality in the container shipping domain?**

### 1.3 Thesis outline

To answer the main research question, the research approach is presented in chapter 2 in finding a suitable approach to find the answers and sub-questions are formulated to help finding the answers.

Chapter 3 presents a case of the current importing process in the container shipping domain which is within the scope of this study. The current process is studied based on the CASSANDRA report and interviews with businesses. The processes, viewed from the perspective of both the report study and the interviews, are compared to find the differences of the processes.

In chapter 4, journal articles are reviewed to learn about academic aspects of the field of study, in this case the supply chain management, information sharing systems and data quality. Reviewing the literature helps a researcher to find gaps in the field of study where a researcher can conduct his research to fill the gap.

The case and the literature review of information sharing systems in the import process are analysed and processed into the evaluation framework in chapter 5.

After creating the interview framework, the essential data quality dimensions will be retrieved from interviews with businesses and the results from the interviews will be presented in a chapter 6.

Chapter 7 explains what can be determined from the interviews and how the context aware architecture would affect the data quality dimension in the container shipping domain.

Finally, chapter 8 will wrap up results of this research by answering each sub-research question and provide some recommendations to the architecture designer. Also, limitations of the research are presented to guide other researchers who would like to conduct the similar research to prepare to tackle the difficulties that we have experienced.

The figure 2 presents the research framework of this thesis.

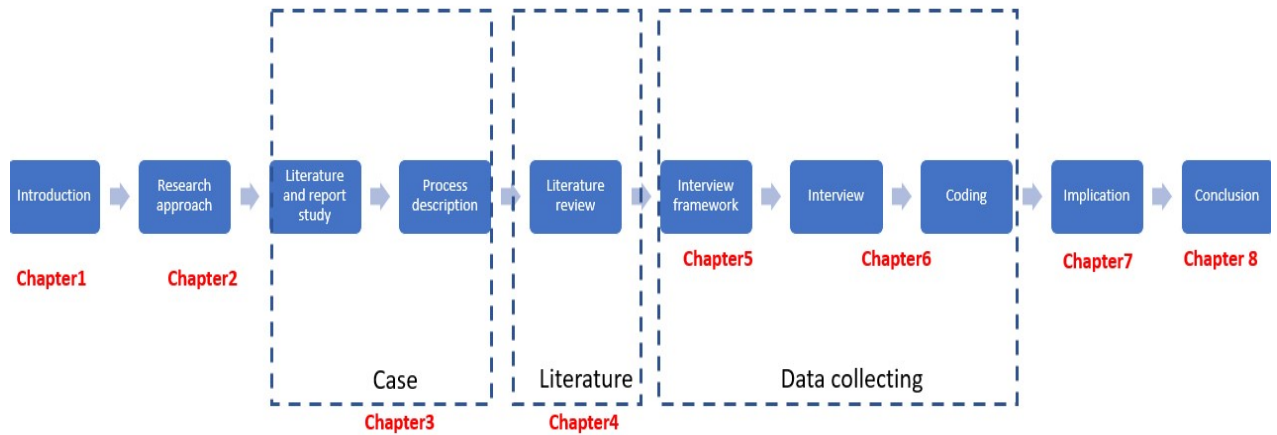


Figure 2 Research framework

## 2 Research Approach

The main research question is “**How does introducing the context aware architecture affect data quality in the container shipping domain?**”. This chapter presents sub-research questions to help us answer the main research question. The research approach is introduced to find answers of the sub-research questions and, ultimately, the main research question.

### 2.1 Research sub questions

To answer the main research question, there are four sub-questions that will help to answer the main research question.

1. What data quality dimensions can be applied for measuring the context-aware architecture’s performance?
2. What does the current information sharing process look like and what are the issues with the quality of the data shared?
3. What does the information sharing process look like for businesses when applying the context-aware architecture?
4. What are differences between a context-aware architecture and the current system in encouraging businesses to share higher quality of data?

According to the sub-questions, these questions have been formulated to facilitate understanding of a current situation of the import process and find out how the context-aware system impacts on the data quality when information sharing between businesses and government. It is vital to understand the current situation, by which a researcher could learn about a real-life situation of using information sharing in a supply chain and alter the architecture to match with the usage. Moreover, although the architecture concept sounds innovative, this conceptual design has not been tested yet to confirm this concept. End users can share high quality information, enabling the better-quality information to be more compliant with regulations. With this objective in mind, a deductive approach is an approach that fits with this research, because it helps researchers to understand phenomena (Dudovski, n.d.)

The deductive approach is an approach that tests a hypothesis based on an existing theory to understand or explain some current phenomena (Sekaran & Bougie, 2016). This approach is used to find a linkage between variables by testing hypotheses. The hypotheses will scope down the result until a relationship which explains a phenomenon is figured out. The deductive approach consists of two methods: deductive reasoning and Inductive reasoning (Sekaran & Bougie, 2016). Deductive reasoning is applied to test a theory, in which research will bring up a theory and narrow down by testing the theory. In contrast, inductive reasoning will start from observing a real-life context and develop a conclusion. Both deductive and inductive reasoning are often used in business research, but inductive reasoning has received criticism because of its specific observation. However, this thesis focuses on a specific context, which is the relationship between the context-aware architecture, and regulatory compliance. Thus, the deductive approach is applicable for this thesis.

According to *Research Methods for Business* by Uma Sekaran and Roger Bougie, there are seven steps to conduct a deductive approach.

1. Identify a broad problem area
2. Define the problem statement
3. Develop hypotheses

4. Determine measures
5. Data collection
6. Data analysis
7. Interpretation of data

Following the seven steps of the deductive approach, the table below presents the scope of this thesis.

Methods	Scope	Sub question
Identify a broad problem area	Data exchange in import Customs declaration	1
Define the problem statement	Improve data quality	1
Develop hypotheses	The context-aware architecture enhances data quality	1
Determine data quality	Data quality dimension	2,3,4
Data collection	Literature review, Semi-structured interviews	1,2,3,4
Data analysis	Coding	2,4
Interpret data	Compare	2,4

Table 1 Research method

## 2.2 Research Methods

### Sub research question 1

Sub-question 1 is created to understand the definition and the contribution of data quality in the context-aware architecture. Since the context-aware architecture is involved with the data quality, a literature review is conducted to understand the data quality and how it can be applied with the container shipping domain. As there are several data quality dimensions such as accuracy, timeliness, consistency, accessibility and completeness, the overview of regulations such as EU laws and the Netherlands Customs regulations are explored to select the most suitable data quality dimension for evaluating the system architecture.

### Sub research question 2

Sub-question 2 is to discover current working processes of businesses and Customs to determine data quality issues. Conducting a literature review will provide a procedure that a certain business is currently following. The CASSANDRA final report was studied by the researcher of this thesis to gain a better understanding of the current import and customs procedures found in the *Taxation and Customs Union* website. The CASSANDRA report provides an in-dept case study of importation from Non-EU to EU country. In the *Taxation and Customs Union* website, the Customs Regulations and Procedures provide details of shipping documents, including the deadlines for submitting Entry Summary declaration (ENS). Moreover, we studied Thomas Jensen and Ravi Vatrapu's (Jensen & Vatrapu, 2015; Jensen, Vatrapu, & Bjørn-Andersen, 2018) which explain the import process and the information sharing system for trading goods from Non- EU to EU States. Jensen and Vatrapu mentioned the data quality of the international trade in their papers.

In addition to the literature review, semi-structured interviews will be conducted to gain more information to support the works of the literatures. The working process of a business is a process that has a flow of information between business and government.

Moreover, the context-aware architecture is assumed to improve data sharing between businesses and Customs. Thus, the import Customs declarations process is chosen as a unit of analysis to analyse whether the context aware could improve sharing data. In the import process, each imported item requires a different set of shipping documents and Customs verifies the imported item with a specific procedure depending on the category of the goods. To illustrate, businesses must enclose, together with commercial invoices and packing lists, a material safety data sheet (MSDS), while importing chemical compounds. The process of importing chemical compound is different from importing normal commercial goods, which requires different information. Besides the import process, actors that we are focused on in this research are responsible parties for Customs declarations such as the freight forwarder, the courier or the consignee itself.

After retrieving enough information, the process of businesses' Customs declaration will be drawn by using the Business Process Modelling Notation (BPMN) in order to discover the information flow in the import process, which will help us to gain a clearer understanding about the process. There are three reasons why BPMN is suitable to use for answering the sub-research question 2. First, it is easy to compare. In this case, two systems will be compared so that using a tool that supports this will be beneficial to find the answer of the sub-question 3. Second, the Netherlands government uses BPMN as a standard (N. Bharosa, Van Wijk, de Winne, & Janssen, 2015), so it would be better for other people to apply these BPMN diagrams for their further research. Third, many software programs have BPMN applications especially, Microsoft VISIO, for which TU Delft purchased a licence. Thus, the software can be accessed easily and remotely via VPN.

### **Sub research question 3**

The literature review about the context aware architecture in the container shipping domain is conducted to understand about how the architecture will affect the flow of information in the current process. Based on the context aware architecture, the context aware process will be created from the current working processes by designing suitable working processes of applying the context-aware architecture, and either adding or changing working process of the import Customs declaration. The amended processes will be created by using BPMN because the current process was already created by BPMN. Using the same tool to create diagram can make the process differ explicitly which is easier to compare (N. Bharosa et al., 2015).

### **Sub research question 4**

Since the context aware architecture is first applied in the container shipping domain, we initially collect raw data by ourselves. The semi-structured interview will be conducted to identify the data quality dimension from businesses, leading to the sub-research question 4. The data is gathered from businesses directly by interviewing people who are working in either a supply chain department or importer department.

The semi-structured interview is more open than a structured interview, so that an interviewee would feel more comfortable, because an issue about sharing information is assumed to be quite sensitive (eVALUEd Project, 2006). The type of interview depends on the preference of the interviewees. It could be either face-to-face or telephone interviews, depending on his/her availability, but the most preferable would be a face-to-face interview, because an interviewer could see non-verbal expressions such as discomfort, so the interviewer could change a question or talk to

reduce the interviewee's discomfort and continue the interview session (Sekaran & Bougie, 2016). Each interviewee will be asked if they are willing to be recorded.

During the interview session, businesses will be asked about working procedures of the amended processes. What we will learn from interviewing businesses is to identify data quality dimensions and how they will respond if they are using the amended processes that we create by using the context-aware architecture. The interview transcript will be investigated to discover the effectiveness of the architecture, based on the semi-structured interview. Further detail about conducting interviews is present in the next section 2.3 and 2.4.

### 2.3 Semi-structured interview

To explore the situation of the sea container transportation from Non-EU to EU States, information such as the current working procedures and the requirements are collected from businesses during interviews.

The conceptual framework of the context-aware architecture is mainly based on Customs officer's requirement, but the architecture will be used by both businesses and government. Thus, it is better to learn more from other potential users which in this case are businesses. There are many ways to collect raw data: interviewing, questionnaire, site visit or from literature reviews. Since this is a new design and it is confidential, an interview is the most suitable method to collect data and to gain insights from.

A semi-structured interview is chosen as a method to collect field data. The semi-structured interview has a structured and unstructured part. The structured part of the semi-structured part is the section which interviewees are asked closed-end questions, and the open-ended questions are asked in the unstructured part. Although the semi-structured interview is often viewed as an easy method of the interview for data collection, interviewers must be well-prepared and well-planned to conduct the interview. The open-ended questions is the hard part of conducting interviews, because the interviewer must be able to figure further questions from the prepared interview questions (Wengraf, 2011)

To get the most information from interviewees and to organize the interview, an interview protocol or interview guidelines are created to control the unstructured interview section, and to encourage the communication with open-ended questions (Arksey & Knight, 1999) An interview protocol is a list of interview questions; the list of questions is orderly arranged and includes a script for an interviewer to ask for permission to record the interview; to open and close the interview session; and to ask for consent to disclose the information. Some people call the interview protocol interview guidelines, because it prompts an interviewer to go through all the prepared questions with more confidence (Jacob & Furgerson, 2012). It is important for an interviewee to formulate a good interview protocol, because an interviewer may have only one chance to get someone to interview (Cohen & Crabtree, 2016). In this case, the time is limited to collecting data and the interviewees may be hard to reach. Some of them may be busy with work, so the interview's duration can be compressed to encourage the interviewee to accept the interview invitation. To save time during the interview, and to quicken the selection of the interview candidate, the interview permission letter is created and sent to the candidates. The interview permission letter also provides brief information about the interview topic, which the potential interviewee can choose to either accept or decline to be interviewed.



Given the many potential obstacles to conducting interviews, a well-prepared interview protocol can aid the interviewer to conduct the interview and to invite people to participate in the interview. To do so, there are four steps to formulate a good interview protocol, which will make the interview session productive, and retrieve useful and rich interview (Castillo-Montoya, 2016).

### **The Four Phase Process to Interview Protocol Refinement (IPR)**

The interview protocol framework is comprised of four phases:

Phase 1: Ensuring interview questions align with research questions

Phase 2: Constructing an inquiry-based conversation

Phase 3: Receiving feedback on interview protocols

Phase 4: Piloting the interview protocol

#### **Phase 1: Ensuring interview question align with research questions**

The way to ensure that the interview data will answer the research question is to check the research questions. For this research, the interview is chosen to gather the data for the sub-research questions 2 and 4.

For the sub-research question 2, the intention is to explore the real situation of the current process besides the literature. Due to the CASSANDRA project, the project was conducted in 2014. As there are many new and innovate technologies for improving the chain of supply, we should prepare questions to ask about the background of each interviewee to explore their most recent methods of information sharing.

The sub-research question 4 is to identify data quality dimensions from businesses which are suitable as criteria to evaluate the context-aware architecture. According to the chosen data the quality dimension is to measure the context-aware architecture; the interviewees are asked directly about data quality dimension and asked to explain the current problem they are facing to identify the data quality dimension indirectly.

#### **Phase 2: Constructing an inquiry-based conversation**

After learning about the objective of the interview, the interview questions were created by aligning with the sub-research questions. However, the wording chosen for interviewing should be simplified for respondents to understand, especially people from businesses.

The sequence of the interview questions can also help an interviewer gain information. First, the interviewer starts the interview with introductory questions to prep respondents with easy and background related questions. Then, the transition questions are asked for bringing interviewees toward to the key questions. Afterward, the key questions are asked to collect data, which in this case, the key questions are about the data quality in the context-aware system in the container shipping domain. To end the interview, the closing question is to ask for advice and suggestion toward the research.

#### **Phase 3: Receiving feedback on interview protocols**

Receiving feedbacks for the interview protocol is to improve the interview protocol's reliability and to improve the quality of results from respondents. The objective of the interview is to get insights from respondents, so the interview protocol should be designed to support interviewers to get insights as much as possible. There are many methods to review the interview protocol, but due to the researcher's capacity, this researcher's interview protocol was reviewed after conducting interview, because we can hear feedbacks from the respondents as to whether they understood or answered unclearly. The revision aims to get the better insights and results from the respondents.

#### **Phase 4: Piloting the interview protocol**

Before starting the field study, the pilot interview session should be conducted to refine the interview protocol with actual people. It is better to choose people who have similar characteristics with the sample, but unfortunately, due to time constraints and the limitation of finding interview candidates, the interview protocol was tested with a friend who worked in the shipping industry before starting graduate school. Conducting a pilot interview provides an overview of the actual interview. Many incidents could happen during the pilot session, which the interviewer should prepare - such as obtaining the consent from the interviewees; creating a positive rapport; and the duration of the interview. For the semi-structured interview, the difficulty is to be able to probe interviewees, so conducting the pilot interview provides a practice for the interviewer to perceive the right moment to ask the probe questions.

#### **Finding interview candidates**

To find interviewee candidates, interview candidates were chosen by judgment sampling (Sekaran & Bougie, 2016). These interviewees were chosen on purpose, because we expected to get in-depth information from people who work in the container shipping industry, or a related area. The interviewees sampled were picked by looking at their profession, working position and work experience (Sargeant, 2012). However, judgment sampling is questionable as results do not represent the population, but the thesis objective is very specific, and we need insightful information. Thus, we accept this condition and find candidates by judgment sampling. To find interview candidate, snowballing was used by contacting through a friend, my family and my ex-colleagues for recommending a person and then we contacted them later by email or by electronic message. We sent an interview invitation to the interview candidates to inform them of the scope and duration of the interview. The interview invitation letters are in Annex 1, in both English and Thai. Thirty people were contacted by email and instant messaging, but only seven people replied and accepted the invitation to interview.

## Interviewees

Interview number	Date	Description of organization	Organization Size	Position of interviewee(s)	Length of interview	Method of recording
7	18/07/2018	Tuna processing	Small	Logistics manager	1 hour	Transcription
5	19/07/2018	Clothing manufacturer and exporter	Small	Deputy Manager	1 hour	Note
4	25/07/2018	Cement and building material company	Medium	Export officer	1 hour	Note
3	27/07/2018	Energy company	Medium	Crude Operation Planner	1 hour	Note
6	01/08/2018	Thai freight forwarder in Thailand	Small	Marketer	40 minutes	Transcription
1	06/08/2018	Japanese freight forwarder located in Belgium	Small	Assistant Manager	40 minutes	Transcription
2	25/07/2018-08/08/2018	Customs brokerage business	Small	Customer brokerage team	(instant message interview)	Transcription

*Table 2 Interviewee profile*

There are many ways to conduct interview, such as face-to-face interviews, focus group interviews, phone interviews and instant messaging interviews. Face-to-face interviews have the advantage of being able to conduct long duration interviews, suitable for conducting semi-structured interviews (Sturges & Hanrahan, 2004). Also, a researcher could notice the social cues of the interviewees. However, the geographical limitation and cost-limitation of doing research are reasons why the phone interview is chosen for this research as a method to conduct interviews. Besides the advantages of cost saving and geographical accessibility, the phone interview is preferable by respondents to answer sensitive topics (Sturges & Hanrahan, 2004). Interviewees can protect their identity when carrying out interview by phone. Therefore, the phone interview may increase data quality, due to the sensitivity of the topics which interviewees may feel comfortable to reveal in a face-to-face interview. Referring to the effectiveness of the context-aware architecture, the topic is considered to be sensitive, because respondents will be asked about complying with laws and regulations. They might reveal their opinions toward the government since they might perceive it as a sensitive issue. Moreover, thanks to technology, email and instant messaging interview are more acceptable as an interview medium.

From seven interviews, one interview was conducted through instant messaging application. In this case, we used Line, because this interviewee requested to do so. Nowadays, researchers are more accepting of instant messaging or email interviews as tools for interviewing, due to the cost-saving and the accessibility. Email interviews and instant messaging interviews are an asynchronous communication of time, which they have time gaps between the interview session (Opdenakker, 2006). The advantage of a time gap is that the interviewee has some time to think before answering the interview questions. Asynchronous communication is considered to be valid as the context-aware architecture is complex in which the interviewee took some time to understand the

mechanism. Thus, the results from the asynchronous might be more valid after the interviewee had more time to investigate on the architecture and thereby more understanding the architecture. However, the interviewee can also manipulate the answer as well.

## 2.4 Data analysis

After collecting data from interviewing, the interviews were transcribed by using online transcribe service such as *Speechmatics* (<https://www.speechmatics.com/>) and *HappyScribe* (<https://www.happyscribe.co/>). These two websites provide free-trial service for 60 minutes. Thus, both of services were used for different transcriptions to save costs. After using the online transcribe services to transcribe, the transcriptions were checked by listening to the records again and revising the transcriptions manually because the online transcribe services did not transcribe accurately. There were many incorrect transcriptions but using the services can save time to type the transcriptions. Some interviews were recorded by note taking due to the confidentiality.

After transcribing and re-writing the notes from the interviews, ATLAS/ti was chosen for analyzing the data from the interviews. There is various software available for qualitative analysis. Having attractive feature, good designed interface and unlimited coding (Barry, 1998), ATLAS/ti is a well-known qualitative analysis software program. Moreover, Barry (1998) recommended ATLAS/ti for a simple project which is matched with this thesis. However, besides the recommendation from the paper, TU Delft purchased ATLAS/ti 7's license.

Coding is for aiding researchers to develop ideas from data and draw conclusions for the research question based on the existing data. ATLAS/ti presents lines of coding in format [X:Y]. X is the respondent number and Y refers to the line quote within an interview X. However, due to the error caused from uploading documents into ATLAS/ti, this table presents X of each respondent from table 3.

<b>X</b>	<b>Respondent</b>
1	1
2	2
3	3
4	4
5	5
6	6
16	7

Table 3 ATLAS/ti code and interviewee

After coding, all codes are queried to find themes and patterns from the interviewees' response to each question. This method of analysis is called 'thematic analysis'. Thematic analysis is a qualitative analysis method, which identifies patterns from a data set (Nowell, Norris, White, & Moules, 2017). Thematic analysis is the most applicable method for analyzing the data from interviews, because the objectives of the interviews are to explore the businesses' opinion toward the context-aware architecture in terms of measuring the effectiveness of the architecture, and to provide suggestions to an architecture designer to improve the system architecture.

## 3 Case of importing containers from Non-EU to EU

To analyze the impact of a context-aware architecture while applying in a current system, it is better to understand a current system in order to create a scenario that applies the context awareness. The research is conducted by reviewing works of literature and comparing with the findings from the interviews.

In this chapter, a list of stakeholders in the container shipping is introduced in section 3.1. Then, the current process based on the report and website was brought up in section 3.2 and 3.3 to give an overview of this domain. In section 3.4, we determined the data quality in international trade based on a paper by Jensen and Vatrapu (2015). To either support or oppose the finding from the website and the report, we interviewed businesses to update the import sea container process which is presented in section 3.5.

### 3.1 Stakeholders

Customs is in charge of maintaining trade flows and protecting EU citizens by performing various tasks. Also, Customs collects duties on goods importing from outside Europe (EUROPA, 2016). To protect EU citizens, Customs performs a risk analysis to prevent particular situations that harm people. For example, Customs helps police to track down human trafficking, drugs, firearm and pornography which can cause crime.

In the context-aware architecture, the Customs needs information from businesses to perform risk assessments. The information can be received from an Entry Summary Declaration (ENS) in which Customs uses for a risk assessment.

#### **Carrier**

According to Customs Procedures, a carrier is "a person who brings, or who assumes responsibility for the carriage the goods into the customs territory of the Community". The carrier has to submit an ENS to customs within the deadlines. The carrier can be the owner of the goods or the third party who is assigned by the owner of the goods to submit an ENS (CUSTOMS CODE COMMITTEE, 2010). In other words, the carrier inputs information in form of an ENS into the context-aware system so that customs could perform a risk assessment before a container has arrived at the customs territory.

#### **Forwarding agent or freight forwarder**

A forwarding agent or freight forwarder is a person or company who arranges transportation for goods and processes the formalities on behalf of either importer or exporter (Brodie, 2006). A freight agent takes responsibility of booking a space on a ship, providing all important documents, and conducting customs clearance. A forwarding agent could submit an ENS if he is also a consolidator.

#### **Consolidator**

A consolidator is a person or company who fills a full container with consignments. He or she is also in charge of issuing a house bill of lading. A forwarding agent can act as a consolidator depended on an agreement between a consignor and a forwarder (Brodie, 2006).

#### **Consignor**

A consignor is a person or company who exports goods. A consignee is a person or company who receives goods. In other words, a consignee imports the goods (Brodie, 2006).

### 3.2 Current working procedures

Although there are procedures in exporting goods from non- EU countries to Europe, the current working procedures regarding the businesses are different from the one from the customs regulations. These procedures involve more actors such as freight forwarders, shipping agents and businesses.

1. Entry summary declaration
2. Customs approved treatment

The first step for exporting goods to Europe is to prepare for shipping documents.

#### *Entry Summary Declaration*

In 2011, the European Commission issued a new procedure to assess risks on goods before entering Europe. Due to various situations that effect on EU citizen's security and safety, customs added this new process to ensure that imports goods meet requirements and comply with the union regulations to enter to EU territory.

The new process requires a carrier, or a ship's agent, to submit information related to goods that will be carried to the territory. The regulation covers almost methods of delivery except for post. Customs at the first port of entry is responsible for performing risk analysis based on the provided information from carriers. The difference between the pre-arrival goods and the customs declaration is the Pre-Arrival process is performed before loading goods by carriers. Thus, carriers must submit information to EU customs of the first port of entry. In the case of the sea, a ship delivers goods for a various port. For example, a ship might stop at Port of Antwerp as the first stop and later stops at Port of Rotterdam. Information will be submitted to customs at the first port of entry which is the Port of Antwerp. The information will be passed to the customs at the port of loading for the next process.

Information that customs requires for the risk assessment is a form called Entry Summary Declaration (ENS). This ENS is submitted by carriers via the Import Control System(ICS), Electronic Data Information(EDI) that exchanges information between national customs administrations(European Commission, 2016b). If the information cannot be submitted via ICS, the customs at the first port of entry will perform the risk assessment. It is mandatory for carriers to submit ENS in advance. For containerized maritime cargo from Non-EU, carriers must submit an ENS at least 24 hours before loading containers on the ship in the port of departure. The data that is needed to submit in the ENS is following:

- Shipper's full style name and address
- Consignee's full style name and address
- Notify party's full style name and address if the consignee is "to order"
- Container number
- Seal number
- Number of packages
- Cargo gross weight
- UN dangerous goods code for shipments containing hazardous goods
- Cargo description

A person who is responsible for filling data in ENS and submit is a carrier or a person who brings or assumes to take responsibility for carrying goods into Europe. Also, a third party such as businesses and freight forwarders can fill an ENS, but they need a contractually agree from a carrier to fill ENS.

The third party not only is consented by a carrier to fill the ENS, but also the third party must have the carrier's EORI number and his transportation document number.

After complete ENS filling, the carrier will receive Movement Reference Number (MRN) from customs to confirm that customs receive the declaration. There are three type risks that customs will reply to a carrier after assessing data in ENS: risk type A, B, and C.

**Risk type A:** "Do not load." This will happen when customs find serious threat from ENS. This consignment cannot be loaded in a ship.

**Risk type B:** Goods are inspected at the first port of entry. For example, if the port of discharge of the goods is Port of Rotterdam, but the first port of entry is at Malta, the goods will be inspected by customs at Malta.

**Risk type C:** Goods are inspected at the discharged port.

An ENS should not be edited after the notification of arrival. If an ENS is used for declaring goods for Temporary storage, goods are stored for special customs procedure, the ENS can be edited after the notification of arrival. When a vessel leaves for the following EU port, an ENS cannot be changed. There is a possibility that an ENS can be double filled by the carrier or freight forwarder. Thus, the information from both ENS can be used for the risk analysis.

#### *Notification of arrival*

The notification of arrival is a notification sent by an operator of the certain means of transportation, in this case, vessel, to notify the Customs office at the port of entry (EUROPEAN COMMISSION, 2016a). The operator submits the identification of the ENS that were previously submitted before vessel departing. The notification of arrival reminds the Customs officer at the port of entry to check the results of previous risk assessment and to prepare for the proper treatment for this shipment.

#### *Customs declaration*

As Non-EU goods are brought into Europe, the goods must be presented to the Customs at any port of destination in Europe. There are two ways to present the goods to Customs officers when they arrive at the port of destination in Europe:

- Remain on board, the presentations of goods are at the place of unloading,
- Storage, in this case the goods are stored at the Customs warehouse or free zone. The declarants must present documents at the Customs office.

When goods are placed under Customs supervision, the goods are placed in the temporary storage, and Customs officers treat goods depended on their condition. There is no ultimate treatment for each shipment. Goods are placed under Customs procedure so the declarant or his representative must submit the Customs declaration. The goods are released for free circulation when tax duties are paid for these goods, and all certificates and documents are presented to the Customs officers. However, when goods are required for a further process such as passing the health and safety check, the goods are under Customs' supervision and are not released for free circulation

During the Customs declaration process, businesses are asked to fill Single Administrative Document (SAD). The document is presented to the Customs by either physically at the Customs office or electronic system. The document is submitted either by businesses themselves or representative of businesses. In SAD form, businesses are asked to declare information such as identifying a role in the import process, identifying goods' information, the means of transportation, country of origin, financial information (Incoterm, invoice value, and so on) and documents related to SAD (EUROPEAN

COMMISSION, 2015). The documents related to SAD are additional documents requested by Customs control that businesses must present together with the SAD such as Inspection Certificates, Import licenses, Certificate of Origin and so on. In each category of import goods, the Customs requests different additional documents. Businesses must carefully prepare documents for declaring to the Customs.

Businesses not only must present SAD to the Customs but also, they must present these following documents together with SAD(EUROPEAN COMMISSION, 2015):

- Commercial Invoice
- Packing list
- Bill of Lading
- Freight insurance

As the declarant has Authorized Economic Operator (AEO) status, he grants several privileges in international trade such as less inspection by Customs officers(Netherland Enterprise Agency, 2018).

However, each Member State requires different information and has its information system(EUROPEAN COMMISSION, 2016a). For example, the importation information system for the Netherlands differs from the one in Belgium. Hence, to study information sharing in the shipping container domain, a specific case is chosen to study the information sharing system in the importation as a way to initiate the context-aware architecture's effectiveness.

### 3.3 Current process based on CASSANDRA project report

From the EU import procedure, there are many stakeholders and processes involved with. According to both ENS and import declaration, businesses can submit the document via the electronic system, but there is no specific electronic system mentioned in the website. As the context-aware architecture was designed for improving information sharing system in this process, I should find information to learn how businesses indeed submit information to Customs. The final report from CASSANDRA project is chosen as a case study for exploring the current information sharing system of the import process.

CASSANDRA project was EU Commission's project for enhancing supply chain's security in container shipping domain for both businesses and government authorities(CASSANDRA, 2011). The project conducted with various countries in both Europe and Asia for improving the securities of the chain of the supply chain by becoming more visible among parties. The project aimed to improve data exchange system that supports both businesses and government for sharing information. CASSANDRA project started in 2011 and finished in 2014 with the introduction of Data Pipeline which is a technology that improves the entire supply chain. Several companies joined CASSANDRA project including TU Delft. The CASSANDRA's final report was chosen as a case to study about the current process of the importing process from Non-EU to EU because the context-aware architecture was developed based this report and one of the thesis committees participated in this project so I can ask him directly for further detail and explanation of CASSANDRA project. The methodology for collecting data and demonstrating the Data Pipeline is Living lab. The living lab methodology focuses on the relationship and voluntary among partners in a real-life context. The scopes of the living lab were information sharing between business-to-business and business-to-government.

For the living labs, a trade lane is a particular flow of goods from the port of unloading A to the port of destination B(Lucassen, Klievink, & Griffioen, 2014). There are many trade lanes in the CASSANDRA project.



- The BAP Logistics Yantian-Felixstowe trade lane
- The Seacon Logistics Penang – Venlo trade lane
- The DHL Shanghai – Ridderkerk trade lane
- The Singapore – Rotterdam trade lane

The BAP Logistics Yantian-Felixstowe was chosen as a case study from the CASSANDRA report because the report for the BAP Logistics Yantian-Felixstowe trade lane provided the most detail about import Customs declaration compared to other trade lanes. The provided information was enough to construct the flow of information sharing among parties in the Yantian-Felixstowe trade lane.

*Summary the import process and its information flow based on the BAP Logistics Yantian-Felixstowe trade lane.*

The Yantian-Felixstowe by the BAP Logistics started from the consolidation center in Yantian (China) and ended at the deconsolidation center in Felixstowe (UK). The retailer and buyer in this trade lane preferred to remain anonymous. The shipments in this trade lane are consumer household wares and they are shipped by containers in LCL term.

There were many parties involved in this trade lane.

<b>Company</b>	<b>Role</b>
BAP Logistics	Import inland transport
Cargo Services	Export freight forwarder
Allport (Cargo Services UK subsidiary)	Import freight forwarder
UK Customs	Customs at EU
UK retailer (anonymous)	Buyer
Maersk, MSC & Evergreen	Carrier

*Table 4 Role of stakeholders*

These are the main processes of the BAP Logistics Yantian-Felixstowe.

1. Purchase Order
2. Export booking
3. Export Custom declaration
4. Import booking
5. Import Customs clearance

#### *1 Purchase Order*

Cargo Service (CS) received a copy of Purchase order in the LIMA system which the details of the shipment were informed in the purchase order. The LIMA system was organized around the purchase orders and shipment details in the purchase orders.

#### *2 Export booking*

CS booked a sea shipper, arranged containers to stuff goods and picked up the goods at the seller's location and delivered at the port terminal. Shipper is responsible for submitting ENS to EU Customs, in this case, UK Customs. Shipper picked the goods and moved to the shipper's warehouse to arrange the export declaration. The document for the export declaration was prepared and attached to the goods for the export Custom declaration.

#### *3 Export Custom declaration*

Customs declaration not only performs in the import process but also performs in the export process. For the Yantian-Felixstowe, the export Customs declaration was performed at the container freight station (CFS) warehouse where a special Customs team run by third-party company checked

the export declaration information and forwarded the export declaration to China Customs. The special Customs team checked whether the documentation-- Commercial invoice, Packing list, etc.-- was aligned with the goods sample. Once the Customs team accepted the document.

At the port of loading, the Customs used different systems in the exporting process:

- QP system: National customs system provided by the Chinese government;
- WMS with East Ports module; provided by the regional, Yantian Customs authority.

For Customs in China, there are several steps for export Customs declaration. Firstly, the Customs officer generated a UCR number in the Est Port module and the UCR was linked to the QP system for export Customs declaration. CS must submit information such as origin and destination, packaging, weight, goods description, value and HS code. As this is LCL shipment, other shippers must submit the information to the Customs. When the Chinese, Customs accepted the shipment. An MRN like number was created. Afterward, a regional Customs checked the export declaration which both UCR and MRN were used to reference the shipment in the warehouse. The Yantian Customs received the export declaration information via EDI messaging. Based on the information that the Yantian Customs had received, the Customs made a decision whether the physical inspections were required which the physical inspections were done in the CFS warehouse. Without the acceptance, the goods cannot leave the warehouse and the shipping agent cannot load the goods in the vessel. It took one day for both filling export declaration and receiving the responses from the Chinese Customs, and it took longer when the Chinese Customs required the physical inspection. It took 2 hours for filing the export declaration by manually key-in for both systems: QP and WMS with East Ports module.

The goods can be unloaded and ready for the exportation. CS booked sea shipping agent and arranged the empty containers. The booking process was done through EDISON system. EDISON was another system of CS and used for creating shipping instruction for the shipping agent, job for loading and invoices. CS had to input the details for each item the PO number, SKU number, destination, goods description, HS code, number of pieces, packaging, and weight. The booking response stated the container number and type, vessel, port of loading and port of destination. This information was used to create a shipping instruction for the shipping agent which was sent by email to them. The shipping agent created the ENS based on the information in the shipping instruction and sent to EU Customs before loading the container into a vessel.

#### *4 Import booking*

After booking sea carriage and arranging for the empty containers, CS prepared and provided ENS information for the shipping agent. Due to the Customs regulation, shippers must submit ENS to EU Customs 24 hours before loading the containers. The ENS declarations were submitted via the ICS system (Import Control System). The system provides three types of result--green, yellow and red--based on the information provided in the ENS declaration.

- Green means that goods presented no risk and can be loaded into vessels.
- Yellow means that goods were needed to be inspected by Customs officers due to insufficient information for risk assessment.
- Red means the goods cannot be loaded and needed to be physically inspected.

Basically, the results from the risk assessment are either the permission to load the goods or the requisition to inspect the goods physically. Customs officers requested businesses to provide more information for further risk assessment. According to the report, Customs officers called or other manual procedures to collection more detail related to shipments.

After the vessel had left the port, the B/L was issued by the shipping agent. In the Yantian-Felixstowe trade lane's case, the B/L and other shipping documents, the invoice, packing list, A form (original document) and inspection reports, were handed in at the CS office. The shipping document was scrutinized by CS and CS sent the shipping document to Allport by mail for import Customs clearance. Within three days after vessel departure, the information was keyed into LIMA and updated to the particular purchase order with container and vessel details.

#### *5 Import Customs clearance*

As Allport was responsible for import Customs clearance, in this case, UK Customs, firstly Allport needs to upload the digital shipping document in LIMA and receive the Hardcopy document by mail. There is a possibility that UK Customs request for hard copy document so Allport should have the hard copy document with them and also the soft copy for printing which was uploaded in LIMA.

Before the Customs declaration at the port of destination, UK Customs had another team, Border Force in the UK, to perform risk assessment of the goods before the vessel arrives. Border Force used a separate system, Destin8, for carrying out the risk assessment. The Destin8 differs from the ICS as the carrier submit a Vessel Manifest, a list of all Bills of Lading, to Destin8 as the ENS information is submitted before issuing the B/L. The Border force used a various source of information to perform a risk assessment. According to the CASSANDRA final report, UK Customs claimed that 60% of vessel inward manifests did not provide enough information for performing proper risk assessment so, UK Customs used separate risk engine to carry out risk assessment and Customs declaration

As there are many cases for the importing process, to communicate with the interviewees with the same understanding. A BPMN diagram of the overview of the import process in the container shipping domain was created from the case of Yantian- Felixstowe trade lane as a tool to communicate with the interviewees. Figure 2 is the BPMN of the import process based on the Yantian-Felixstowe trade lane.

Information sharing between businesses and EU customs for importing by sea from Non-EU country based on FOB term

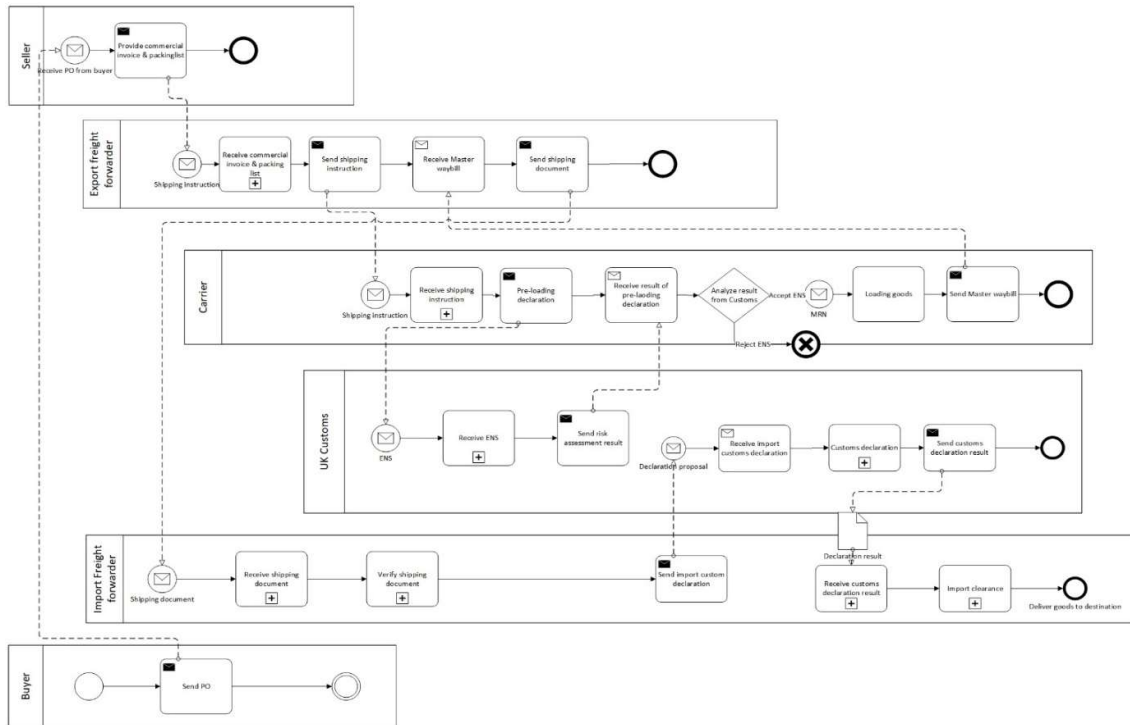


Figure 3 the import process based on the Yantian-Felixstowe tradelane

The import from Non-EU to EU begins with a seller in the non-EU country receives a purchase order from a buyer. So, the seller prepares a shipment and sends shipping documents, Commercial invoice, Packing list and so on, to a freight forwarder for the exportation. After receiving the documents from the seller by email, the export freight forwarder verifies the documents. If the shipping documents are correct regarding the Customs regulation, the export freight forwarder will book a vessel with the shipping carrier by submitting the shipping instruction to the carrier. In this process, we assumed that the carrier would have some system to manage the booking. After that, the carrier submits the ENS to the EU Customs at the port of entry. EDI is assumed to be a system that the carrier submits the ENS to Customs. Customs will reply the result to the carrier, and the carrier prepares to load containers into a vessel. After finishing loading containers into the vessel, the ship agent issues Master Bills of Lading and sends to each export freight forwarder. Referred to the Yantian-Felixstowe, the export freight forwarder passes the shipping documents including Bill of Lading to an import freight forwarder. The import freight forwarder receives the documents by email and then verified the document and prepares from the import Customs declaration. When the vessel arrives at the port of destination, the import freight forwarder submits the import declaration form to the Customs at the port of destination by EDI. After the Customs procedure, the Customs sends a response back to the import freight forwarder. If the goods can be released for free circulation, the import freight forwarder can start preparing for the Customs clearance. If the Custom does not accept the declaration proposal yet, the import freight forwarder will coordinate with the importer to retrieve the request information by the Customs until the goods are released for free circulation or re-export back to its country of origin

### 3.4 Data quality dimensions in the current process

After investigating the current import process from the CASSANDRA report, information was necessary for actors in the international trade, and the quality of information was needed to be

improved. To illustrate this, Thomas Jensen and Ravi Vatrapu (2015) discovered that sharing information to actors in the import process was a time-consuming action because there were various actors in a rose shipping process. Each actor needed documents such as packing lists and commercial invoices to proceed its action. There were hundreds of emails received by all actors in the process, and it took time because the shared information was verified, sent back and forth, and forwarded until actors receive emails. By the time that actors receive a document, the data might not be up-to-date (Jensen & Vatrapu, 2015). Moreover, to share information to all actors, actors copied and pasted information to match with each actor's information sharing system which was data may be inaccurate and incomplete because the copy-and-paste process was done the various time. The quality of information might be deviated from what Customs officers expected because the documents such as packing lists were filled prior (Jensen & Vatrapu, 2015). Thus, the information in the packing lists was only estimation values which affect the accurateness of data. According to the case from Jensen and Vatrapu's paper, it shows that the quality of data is varied depended on the information sharing system and actors. The quality of information is vital for authorities to perform risk assessments (van Engelenburg et al., 2017). Customs need high quality of information to decide to scan containers and identify goods smuggling. The precise information would save time and costs for Customs from scanning suspicious containers randomly. As Ravi Vatrapu's paper was written in 2015, it is questionable whether the quality of information in the container shipping domain today remains the same as the Jensen and Vatrapu's paper.

### 3.5 Current process from the interviewing

Because the CASSANDRA project's report published in 2014, the working procedure to share information might change from what is reported in the CASSANDRA. Thus, asking businesses for their current working procedure can cross-check with the one in the CASSANDRA report and apply it to this research. During the interviewing, businesses are asked to explain what they do for either importing or exporting goods from Non-EU to EU and how they share information with other parties. Table 7 in Annex 3 shows all codes grouped as the current process of the importing process.

#### 3.5.1 Overview process of importing goods from non-EU country to EU country

According to seven semi-structured interviews, these are an overview of the information flow among stakeholders in importing containers from Non-EU countries to EU by sea.

1. After receiving purchase orders from clients, exporters prepare to ship goods by preparing shipping documents: commercial invoices and packing lists. Moreover, some companies even draft SAD, the Customs declaration form, by themselves. Before sending out the goods, the shipping documents are thoroughly verified by both internal parties of the exporters—managers and financial department—and external parties—sellers and buyers—until they agree with the detail. The shipping documents are shared by using email which they send and receive emails back and forth between the exporters and the buyers until both parties agree with the context in the shipping document [3:1] [4:11] [5:2].

2. Besides commercial invoices and packing lists, exporters must provide additional documents to Customs for some specific goods. Some documents can be issued by the exporters themselves such as chemical compositions on Ingredients, production process, certificate of acceptance, a spare part specification in automobile manufacturing and so on [1:11] [1:25]. The exporters issue these documents because they are companies' specific details, but some of the information is trade secret which companies are not comfortable to reveal this type of information to their unrelated parties. For example, some chemical compound is special ingredients which are trade secrets. Businesses would not want their rival companies to know about them, so they do trust other parties including Customs to know about the ingredients. Government authorities issue some documents. For

instance, to import a veterinary product into Europe, Customs need a health certificate, a catch certificate, and a veterinary inspection. A government authority issues these documents at the exporter's country [16:28].

3. Meanwhile, the exporters prepare to ship out the goods. The exporters arrange the shipment based on INCOTERM that they deal with the buyers. Based on information from the interviews, the exporters hire freight forwarders—third-party company—to organize the shipment [5:1] [16:13]. The freight forwarders provide various services from inland transportation to booking a vessel from their clients. According to the interviews, businesses agree to purchase goods under FOB term—Free on Board which is the same scenario that we studied from CORE project report to create the current process. One case uses CIF—Cost, Insurance, Freight—because the interviewee claimed that his company did not have enough people to arrange the vessel booking and negotiate the freight price. For FOB term, the buyer is accountable for the cost and risk of the leading international carriage—in this case, is sea transportation (MALFLIET, 2011).

There are many ways to arrange the shipment under the FOB term. In one case from the interviews, the exporter arranges only inland transportation and export Customs clearance [5:1]. The buyer has to book vessel and warehouse on their own and inform the exporter to place the goods in the particular warehouse. The rest of the shipment process is responsible by the buyer. To share the information and communicate with freight forwarders, both buyers and sellers share shipping documents by email and communicate among parties by email and phone call. In some case, sellers upload shipping documents in the website, and freight forwarders retrieve the documents by receiving passwords to access the document stored in the website [1:24]. Furthermore, some freight forwarders update the shipment status to their clients by email so that their clients can track the shipment. Sometimes, especially for urgent shipment, clients call freight forwarders to track the shipment status [6:15].

4. To book vessels, based on the interviews, freight forwarders book vessels for their customers or the seller. The respondent six from a freight forwarder mentioned about ship carrier's procedure that "Some of them request me to send emails directly and their customer service officers will follow up data from customers for me. Some of them request us to register in their system and then we will receive confirmations from them by email." [6:1]. It can be implied that there is two system for booking vessels which are via email or EDI. Another freight forwarder, the interviewee 1, mentioned that he booked vessels for his customers via EDI because he said that "For example, now shipping liner by customers. Tracking system. We access the website and fill in container's number, and then it shows where the container is now. Yesterday, visiting Singapore or landing at Antwerp. It is a real-time updated. I think always it is automatically updated. So, always updated system gives us useful information." [1:12]. After booking vessels, freight forwarders receive B/L as booking confirmation documents which they send to their clients and clients share B/L to other parties to process. For instance, buyers use B/L for arranging Customs declaration. There are two formats for B/L: Original B/L and soft copy B/L called either Telex-release or Surrender B/L [4:5]. Businesses prefer electronic copy B/L to Original document because they do not have to wait for the hard copy document sent by post and they want to save costs from delivering the document to buyers, especially sending by courier which is fast, safe but costly. However, there are cases that original B/Ls are lost during mailing mentioned by an ex-importer officer from company 4 [4:5]. He said that it took more time for him to arrange Customs leading to pay more demurrage cost. Moreover, the freight forwarders can amend the data in the B/L by accessing into EDI, amending and printing the document [6:3].

5. Unfortunately, we cannot arrange an interview with any of ship carriers. According to the interviews, the interviewee 6 mentioned that Customs authorities in China has a similar process as ENS but since she does not fill the information by herself. There is no information related to the ENS process [6:29].



### *Summary of current information sharing system*

To share information among parties for importing containers process, all stakeholders use emails to communicate and share documents [1:3] [2:3] [3:13] [4:2] [5:8] [6:20] [16:9]. Sometimes, people still use a phone call to book vessels, but information is officially received and confirmed by email [6:5]. Also, the costliest option like postage is still used to send documents among parties, but it is unavoidable since some government authorities request businesses to send hardcopy documents to them [5:7]. Conversely, some businesses use an informal way to communicate to other parties by using an instant messaging application such as WhatsApp and Line Messenger [2:4]. The messaging application varied on user's locations. Referred to the interviews, a Customs broker in Thailand uses Line Messenger to communicate with his customers. Line is a messaging application that is similar to WhatsApp, but this instant messaging application is popular in Japan, Thailand, Indonesia and Taiwan (Russel, 2016). Line has a function to enclose documents in the chat conversation. For booking vessel and submitting documents for Customs declaration, nowadays, EDI is a system which businesses upload data. According to the interviews with freight forwarders, many ship agents have their EDI systems which freight forwarders have to submit their client's shipments via website EDI [1:4] [6:12]. To access the EDI, forwarders register into the agent's systems to get usernames and passwords [6:9]. Afterward, whenever freight forwarders book vessels, they can do it by themselves by submitting the requests via web EDI. The booking confirmations are sent by email to freight forwarders [6:5]. However, for emergency cases, a freight forwarder officer uses her connection to fasten the booking process by calling a sale representative to hasten the process. After that, she receives the unofficial confirmation by phone and official confirmation by email [6:5]. Figure 4 provides an overview of the current information sharing system from Jensen and Vatrapu's papers that are similar to the findings from the interviews.

### 3.5.3 Stakeholder

The stakeholders mentioned by interviewees are coded "Stakeholders" to find out which parties are involved in this importing process. Due to the complexity of the import process in the container shipping domain, each interviewee is dealing with different stakeholders. The information from the interviews provides more insights which add up the case from CASSANDRA report. Table 9 in Annex 3 shows all codes grouped as the stakeholder of the importing process.

According to the interviews, there are two main categories of stakeholders: businesses and government.

Businesses that are involved in importing process are importers, ship agents, freight forwarders, exporters, Customs brokers, and domestic trucking companies. Both exporters and importers in the interviews hire freight forwarders to organize the transportation. The freight forwarders contact inland trucking companies, Customs brokers and ship agents [1:2]. Some freight forwarders own inland trucking and Customs brokerage services. So, freight forwarders can be a one-stop service for the exporters. However, some exporters either have their inland trucks or already deal with ship agents. They can also hire freight forwarders to manage other processes for them.

For the government side, the government authority that is in charge of controlling the flow of goods is Customs. Both importers and exporters have to declare goods to Customs at each country. Customs perform an initial inspection based on information in shipping documents. For further inspections, Customs co-operate with other government authorities which are more specialized in specific fields to inspect goods. For example, the health certificate, veterinary inspection, and the catch certificate are submitted to NVWA –Netherlands Food and Consumer Product Safety Authority [16:6]. Customer brokers are more specialized in the regulations that businesses (BusinessDictionary,



n.d.). Thus, they facilitate businesses which import the controlled goods because they know how to prepare documents to these government authorities.

#### 3.5.4 Other findings?

Besides the codes for the current process, the current information sharing system and stakeholders, identifying other issues such as data quality's problem provide us further information which might imply something about the current process or what businesses would like to improve. Because they are random codes, so they are put in the other finding's category. The other finding codes are coded based on our assessment that they might impact on the data quality and the context-aware architecture. The table 10 in Annex 3 shows other codes in various groups related to the current process.

There are eight codes in the other finding's category: cost, incomplete data, Inconsistency, language issue, original paper documents, repetitive work, timeliness, and compliance.

##### **Cost**

Cost is the most concern issue claimed by businesses as 5 interviewees mentioned the cost of 7 interviewees. Most businesses mentioned about demurrage cost, a fee that charges when a container stays at a terminal too long (FreightHub, 2017). There are various causes of demurrage charging, but these reasons are related to the information sharing system.

- Buyers receive a document for Customs clearance late which the customs clearance cannot be done within the free of charge duration.
- Documentation received by consignee is incorrect or insufficient. Buyers received incorrectly in details or insufficient documents.
- Customs suspect containers and the inspection takes a longer time to finish. Thus, businesses have to pay extra fees.
- Consignee was unaware of the arrival of the cargo and was unable to do the customs clearance in time buyers did not notice the arrival of the shipment.

Another similar cost to demurrage costs that was mentioned during the interviews is a storage cost. The difference between a storage cost and a demurrage cost is that storage costs are service fees for using places in the port to store the containers (Dyck, 2017). Besides costs that happened at the port, the document delivery fee is also the concern. As Customs request original documents, sellers must send the original documents by post or by courier to the buyers [5:9]. It is more expensive when buyers need to clear goods from ports, and they need the documents as soon as possible which the cost of delivery increases due to the urgency. Also, the interviewees mentioned about tax duties during the interviews. One of them claimed that they were fined by Customs when they unintentionally declared with wrong HS code [4:10].

##### **Incomplete data**

Incomplete data is an issue of the EDI that is used for issuing Certificate of Origin. The system prevented businesses from filling complete item description compared to spaces in B/L [6:26]. It could lead to the misinterpretation by Customs. Another code is an issue of insufficient documents which Customs requested businesses to provide more documents.

##### **Inconsistency**

For inconsistency issue, there are two issues: inconsistency in working procedure and in HS code usage. What was found out from the interviews is that each Customs officer had different

standardizations of inspection. Referred to the interviews, one freight forwarder said that “why this time they ask and last time, they did not ask” [1:21]. It is interpreted that Customs officers treated the same item differently. Another example from the interviews is that sometimes Customs officers ask for the complete document, but sometimes they do not [1:22]. The latter issue is the usage of the HS code. Customs in different countries prefer different HS codes [4:9]. For example, Thai Customs interpreted the same HS code to differ from the Chinese Customs as well as the EU Customs.

### **Language issue**

The case of language issue is that some Customs officer did not communicate in English to the declarant. This might lead to the misunderstanding of Customs requirement [1:18].

### **Original paper documents**

Interviewees experienced Customs requested them to hand in original documents to Customs. It can be either for Customs declaration or further information besides the regular declaration requested by Customs, especially other government organization such as FDA and Health authorities [2:6] [3:7] [16:22].

### **Repetitive work**

As freight forwarders are intermediary parties which have to support businesses in importing containers, it is inevitable for freight forwarders to do repetitive work such as receiving and forwarding information to other parties [1:20]. Moreover, freight forwarders have to facilitate businesses to ensure that goods are arrived at the destination smoothly and in times. Although freight forwarders are experts in dealing with Customs, they also face difficulties in submitting documents to Customs. According to the interviews, one freight forwarder mentioned the different interpretation of HS code leading to repetitive submitting documents [6:28].

### **Timeliness**

Timeliness is another issue that businesses concern related to the importing process. From the interviews, results are grouped into three categories related to timeliness.

1. Waiting time
2. Processing time
3. Duration for searching for information

Due to the current process, there are waiting times in several processes such as waiting for receiving documents by post, waiting for the confirmation and waiting for declaration results [3:10] [3:16] [6:24] [16:24]. Because importers do not want to pay for demurrage costs, they would like to reduce waiting times as many as they can to save money. Secondly, it takes some time to confirm the vessel's booking. One interviewee said that some of her customers could not wait for such long because they had to prepare to ship out products which other parties needed information to process [6:22]. Lastly, the duration for searching for information is extended. This happened when officers received many emails. Some even received 100 emails per day [4:13]. It took some amount of times for them to read all emails and to reply emails. Also, it took times for them to look for specific emails as well.

### **Compliance**

As a corporate, one interviewee mentioned that it was mandatory to comply with regulations [4:16]. He said to prepare documents properly for Customs and willing to do what Customs officer requests. The company is audited by Customs regularly so; every Customs declaration must be done correctly and accurately. Otherwise, the company will be fined.

### 3.5.5 Discussion

#### *Different between literature and interview's results of the current process and its impact on the context-aware architecture*

Based on the report from CASSANDRA project and EU Trade Helpdesk which we used as references to create BPMN of the current process, two findings are different from the hypothetical situation. The first different finding is that original documents or hardcopy documents are used in the process. It is a matter to the impact of the context-aware architecture because the context-aware architecture was created based on the digitalization format, which sharing information must be all digitalization. As it was discovered that government officers were still requesting the paper document, the usage of a paper document will reduce the effectiveness of the context-aware architecture. This finding represents the current situation of the importing process. Today paperless in an international trading system is not fully existing yet (World Economic Forum, 2017). To encourage a paperless system, governments need to issue national rules to enforce a paperless system and to solve these issues: the legal validity of electronic documents, electronic signatures, and other data-regulation requirements. Moreover, to increase the effectiveness of paperless, governments must accept data without requesting businesses to submit paper-based documents. Otherwise, the implementation of digitalization will fail as well as the context-aware architecture.

The second finding is that there are various types of information sharing system among parties. Based on the interview results, there are three methods of sharing document: EDI, email and post. Based on the hypothesis scenario, we created the current process with an assumption that information is shared by only one system, which there were three methods based on the interviews: EDI, email and post. Email is the common platform to share information with other parties. Small and medium-sized companies prefer to use asynchronous methods like phone, and e-mail to share information with supply chain alliances such as customers and freight forwarders. Email and phone are cost-effective and convenient for them to communicate among parties (Huong Tran, Childerhouse, & Deakins, 2016). The large organizations also remain using the simple information sharing system such as email for remainders. A post is the most expensive method to share information, but it is surprisingly to find that government authorities still prefer businesses to send paper-based documents to them. Also, the most effective systems like EDI are adopted by ship agents, and not all businesses are appreciated with the systems. For a small business, EDI still is not considered as something that helps a business to gain competitive advantages. Small businesses prefer immediate and direct benefits to new technology adoption so, small businesses do not perceive the long-run investment in EDI. Also, the lack of financial resources and technology experts in companies hamper small companies to invest in EDI as well as other technologies. (Chau & Hui, 2001). As the context-aware architecture is built on the assumption of the digitalization supply chain, which EDI should be at least a fundamental technology for information sharing system in the flow of supply. It can be implied that the impact of the context-aware architecture perceived by businesses is not solely due to the architecture's features because businesses still accustom with non-digitalization information sharing systems such as email and phone.

### The current process and its data quality issues

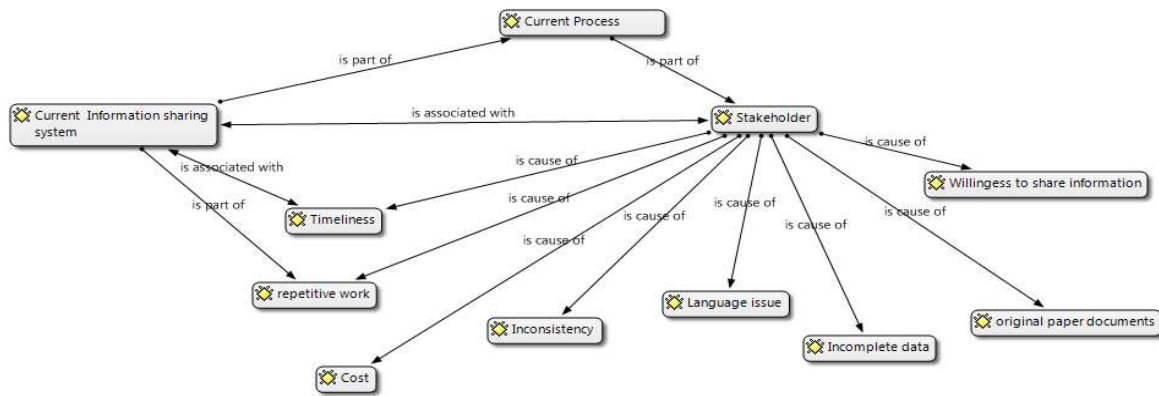


Figure 5 The relationship between the current process and its issues

From all codes, each code has a relationship with each other, and the relationship is shown on figure 3. From analyzing the meanings of the codes, it shows that the current information sharing system and stakeholders are parts of the current process. Although both the current information sharing system and stakeholder are the part of the current process, they are associated with each other. Stakeholders share and communicate through the current information sharing referred to codes in the current information sharing category.

Moreover, after analyzing the contexts of other codes besides the current processes, the current information sharing system and the stakeholder, most issues raised by the interviewees were caused by the stakeholders. For example, certificates are not issued immediately by the government officers [16:15]. It can be implied that one stakeholder, the government officers, is the cause of the timeliness issue according to respondent 7. Also, there are two issues that are caused by the current information sharing system: timeliness and repetitive work. To illustrate this, the respondent 6 said that it took 2 hours to confirm the vessel booking by submitting information via EDI of shipping agent [6:22]. This is a case of timeliness which it took some time to receive the confirmation. For the repetition issue, the respondent 6 mentioned that she submitted the document through the Chinese's EDI and the system rejected her application five times due to the different interpretation of HS codes [6:28]. From our understanding, the EDI has linked each HS code to specific declarations so that the system caused declarants to work repetitively.

From the relationship among codes, it concludes that stakeholders play an essential role in technology adoption. In other words, stakeholder's opinions toward the system are important because they affect the technology adoption. For the case of the context-aware architecture, it can be implied that people would be willing to share more information in the system if the system can indeed facilitate their works. Moreover, the system itself also affects the technology adoption. If the new system of the information sharing system is good, people are looking forward to changing the system.

According to the data quality (Batini & Scannapieca, 2006), data accuracy, data completeness, and data timeliness are measured to find the difference between the current system and the context-aware system. From investigating the current situation from the interviews, there are the findings related to the data quality.

Sharing more detail to the system will increase the data accuracy. According to the current process, the systems of information sharing do effect on the data accuracy. As the system does not allow its

users to fill more detail of the information, the data accuracy of the system reduces. For example, the EDI for issuing the certificate of origin that limited spaces for filling item descriptions [6:26]. Thus, the data accuracy reduces due to the system.

Moreover, the different interpretation of HS codes by different Customs officers or systems effects on the data accuracy. Because HS codes refer to the good descriptions if the HS codes change, the item descriptions also change. The item descriptions will not be accurate to the exact item descriptions if the system forces to change or Customs officers interpret the HS codes differently.

For the data completeness, businesses share the complete data as laws and regulations required referring to the compliance code. What is an issue for businesses is the inconsistency of Customs officers that businesses found as a problem of the current process such as the inconsistency requirement of documents for Customs declaration.

Data timeliness is to share information on time. According to the interviews, both stakeholders and systems are an issue for the data timeliness. Due to the timeliness code, the current information sharing systems such as EDI and post to provide the data on time. For most, it takes a few days for receivers to receive the data, and for EDI it takes 2 hours to receive the data. Moreover, stakeholders also have difficulties to receive the data on time because of themselves that they cannot find the data or the other parties that cannot provide share data on time.

## 4 Literature review

In the literature review section, a concept of the supply chain is introduced to understand its complexity and to emphasize that information sharing is necessary for improving a supply chain efficiency in section 4.1. Because a supply chain is a hot issue in the European Commission, several projects such as Data pipeline related to information sharing are conducted to improve the supply chain in section 4.2. After that, the context-aware architecture is introduced as an approach to improve the information sharing in a supply chain in section 4.3. Additionally, the definition of compliance is included to clarify the objective of the context-aware architecture in section 4.4. After introducing the compliance, in section 4.5 we explain a concept of data quality, which is our main study. The last part of the literature review presents the context-aware architecture in the container shipping domain which we would learn how the context awareness is applied in this domain in section 4.6.

### 4.1 A concept of supply chain and its problem

A supply chain is a network that involves the transformation of goods from a raw material stage to delivering to end users (Papazoglou & Ribbers, 2006). In the supply chain, the network consists of people, resources and information that are involved in various activities such as procurement, resource planning, production scheduling, warehousing, delivering and aftersales service. However, nowadays most companies have their supply chain department to manage the flows of goods and service. To achieve a competitive advantage, a term "Supply chain management" is introduced.

Supply chain management (SCM) is to manage operation activities by optimizing the entire flow of products and services from supplier to end customers concerning improving a delivery performance (Slack, Brandon-Jones, Johnston, & Betts, 2012). Activities in a supply chain are planning resources, purchasing raw material, managing inventory, delivering products and so on. The supply chain consists of dispersed facilities, transportation and a communication system that links all these components together (Papazoglou & Ribbers, 2006).

In the supply chain, information flow is essential for coordinating among teams. Because once the information is distorted, it will affect the entire chain. For instance, information was distorted by misperception between players during an experiment named Beer Distribution Game (Lee, Padmanabhan, & Whang, 1997). The Beer Distribution Game simulates a process of delivering beers from a warehouse to customs. During the game, the customer's demand is stable, but each team in the supply chain overestimate the customer's demand leading to the overstock in the inventory. This phenomenon is called "Bullwhip effect" where small changes at a demand side magnify into large one when information is transferred to the other parts of the supply chain. The Bullwhip effect can be lessened by these three methods: information sharing, channel alignment and operation efficiency (Slack, Brandon-Jones, Johnston, & Betts, 2012).

Nowadays, information sharing in a supply chain has developed. Many information system technologies used in organizations to promote information sharing such as Enterprise Resource Planning (ERP) and Electronic Data Interchange (EDI) (Lee & Whang, 2000). Nevertheless, Lee and Whang (2000) claimed that there were many challenges in sharing information. The first challenge was the incentive of sharing information among partners. Each partner in the chain discloses information at a different level. Secondly, businesses were reluctant to share information because of disclosing of their confidentiality to competitors. Thirdly, technologies in information sharing were costly, time-consuming and risky. Implementing ERP for an entire chain of supply was a high investment, and it took times and resources until the system was widely used. Lastly, an information sharing system was not accuracy and timeliness. These challenges encouraged researchers to

continue to improve the information sharing system by adopting new technologies, and there are many government-funded projects to support these improvements.

#### 4.2 Data pipeline in a supply chain management

In the beginning, an information sharing system is used within an organization, and between businesses and their partners for displaying order status, sale forecast and so on. Because of the increase in international trade (Prasad & Babbar, 2000), supply chains expand to global scales in order to support businesses. Moreover, more parties are involved not only with businesses but also with government.

Data pipeline is a web-based IT infrastructure that integrates data from various sources in the chain (van Stijn et al., 2011). The system was first introduced by "CASSANDRA" which was a 3-year project funded by EU commission to improve the effectiveness of the supply chain (CASSANDRA, 2011). An objective of the data pipeline is to track and monitor information in real-time. This system could reduce administrative works, reduce waiting times in the supply chain and improve goods visibility but all parties need to collaborate (van Stijn, Klievink, Janssen, & Tan, 2012). A concept of piggybacking is used in this data pipeline for reducing traditional paper works by reusing information in the system (van Stijn et al., 2012). In a piggybacking system, businesses share their information to their partners or other businesses (B2B) to reduce administrative work, but governments also need the information from businesses (B2G) to measure a compliance's level of each business regarding regulations (Nitesh Bharosa et al., 2013). Although businesses are reluctant to share the information, they could benefit from this by gaining opportunities to modify regulations by participating in the information sharing system (Nitesh Bharosa et al., 2013). To do so, both businesses and government should cooperate in this system by sharing their information (Klievink et al., 2012).

Although information sharing can enhance a supply chain performance, supply chains are complex because there are various parties in the chain. Thus, a collaboration in the chain is not easy. To build the alliance between parties, psychological states or beliefs of partners should be identified (Wu, Chuang, & Hsu, 2014). A favourable climate should be built to encourage voluntary, informal and reciprocal bond, but it takes times and consistency to build collaboration in the chain. Moreover, when all parties in the supply chain become closer, they are willing to share information (Du, Lai, Cheung, & Cui, 2012).

Technology helps in the collaboration between the parties leading to a software architecture that includes as many requirements from various parties as it can to enhance information sharing (Wu et al., 2014). However, there are many concerns such as cost efficiency, resilience supply chain, and data security from various parties in the supply chain.

#### 4.3 Introducing a context-aware architecture

Safety and security are concerns from businesses in order to share their information, especially the sensitive one, but a government needs it to analyze risk assessment. Besides CASSANDRA, CORE project is another supply chain collaboration between EU members and other countries that focus on security issues in a supply chain and aligning supply chain procedures within EU to improve the chain's efficiency, especially coping with uncertainties such as natural disasters (CORE, 2015). This project emphasizes co-operating among parties, reducing friction costs and security technologies. There are many technologies involved in this project such as data pipelines. A goal of this project is to enhance the quality and amount of data which needs co-operate from both governments and businesses.

However, encouraging businesses to share information is not easy. Not all business is willing to share information and sharing information to governments is more challenging than sharing to the businesses. Because governments need information for their works, *JUridical and context-aware Sharing of information for ensuring compliance*(JUST) is another supply chain researched project that focuses on sharing data between businesses and government. According to a research by JUST project, a context-aware architecture is designed by using certain technologies to ensure businesses and improve a level of willingness to share information. The architecture uses a blockchain because it is perceived to enhance business' trustworthy level to share information (van Engelenburg, Janssen, & Klievink, 2017). To increase a willingness of businesses more, a different type of businesses with encryption functions allow businesses to control over their data (van Engelenburg, Janssen, & Klievink, 2015). Last but not least, a concept of context-awareness should be added to help designers select necessary contexts for including in systems (van Engelenburg, Janssen, & Klievink, 2017). A data pipeline is a complex system which too many complicated contexts might tire users so choosing only necessary contexts should encourage users to use the system at ease.

#### 4.4 A definition of compliance

As a role of government is to monitor businesses' compliance (Bonazzi, Hussami, & Pigneur, 2009)and the context-aware architecture is designed for b-to-g information sharing system, it is better to understand a definition of compliance. Compliance is to make sure that businesses would follow with laws and sets of norms (Nitesh Bharosa et al., 2013). There are two ways of complying rules for businesses (Governatori & Sadiq, 2008). The first approach is to hire auditors to investigate and create reports for businesses, but this approach is quite expensive. The second approach is to be compliance by design which is a preventive approach by using software that could detect regulations, monitor users and perform a risk assessment.

#### 4.5 Data quality issue

##### 4.5.1 Why data quality is related to the context-aware architecture in the container shipping domain?

To verify the architecture, there should be criteria to measure it. For the context-aware architecture, the objectives of the architecture are to ensure that businesses are:

- Lawfulness
- Obligation to submit documents to Customs
- Willingness of businesses to participate

To prove that the objectives of the context-aware architecture are valid, it is mandatory to measure a change due to the context-aware architecture

##### **Lawfulness and Obligation to submit document to Customs**

Lawfulness is an action of obeying laws. Compliance is to conform to rules, regulations, standards or laws. Thus, for the definitions, lawfulness is a part of an action in being compliance. According to the context-aware architecture, the architecture aims to improve information sharing between businesses and Customs targeting the shipping container in the importing process. The responsible party in the particular process is Customs. Customs is a government organization that observes goods transported from foreign countries into the Customs' territory and deals with people entering the territory. In the trade between countries, Customs has to enforce the national legislation to imported goods entered into the land(World Bank, 2016).This confirms the information sharing



between businesses and Customs must be obligated to laws to support Customs work. In the other words, the information must be **lawfulness** to EU laws.

Because it is an import process into Europe, EU Customs is in charge of this process as well as EU commission legislations are enforced in the process. The EU customs' objective is to prevent and protect the society from human trafficking and drug smuggle, to protect consumers from dangerous goods, to protect global environment and cultural heritage, and control the financial interests of the EU and the Member States(Taxation and Customs Union, n.d.). Nowadays, Customs plays an important role in the security because of the increasing of terrorism and other serious crimes happened on a cross-border. Especially, there is a civil war which refugees are seeking for a safe place to live. To prevent all of above situation, Customs must acquire as much information as they can to achieve their duties. One of the strategies is to control the import and export goods between Non-EU and EU.

According to Article 163 from Union Customs Code applying for both import and export procedures, it is mandatory for businesses meet with Customs requirements(EUROPA, 2013, p. 60).

"Article 163

Supporting documents

1. The supporting documents required for the application of the provisions governing the customs procedure for which the goods are declared shall be in the declarant's possession and at the disposal of the customs authorities at the time when the customs declaration is lodged.
2. Supporting documents shall be provided to the customs authorities where Union legislation so requires or where necessary for customs controls."

Because of Article 163, it can be implied that an obligation to submit a document to Customs is a part of being lawfulness.

### **The willingness of businesses to participate**

In order to facilitate Customs on performing risk assessment, businesses should co-operate with Customs as well. It is mandatory for businesses to provide information to Customs in which Customs will retrieve information from ENS, the pre-departure declaration, and shipping document such as commercial invoice, packing list and so which Customs acquire when businesses declare imported goods. The high quality of information will help Customs assessing potential risks(van Engelenburg et al., 2017). Besides assessing risks, documents will be used for evaluated for tax duties or excise tax depending on a category of goods. Moreover, some types of goods are controlled.

To illustrate this, to import for medicinal products for human use, a seller must follow these requirements(EU Commission, 2018):

1. Importing authorization
2. Marketing authorization
3. Labelling and packaging provisions
4. Control of each batch
5. Pharmacovigilance system

Related to the import process, importers of human drugs into the EU must obtain an authorization from an authorized party of EU Member State. To the authorization, the importers must oblige to these following requirements(COMMISSION DIRECTIVE 2005/28/EC, 2005):

- specifies the medicinal products which are to be imported as well as the place where they are to be manufactured and/or controlled;
- has at his disposal suitable and sufficient premises, technical equipment and control facilities as regards both the control and storage of these products;
- has at his disposal the services of at least one qualified person in one of the following scientific disciplines: pharmacy, medicine, veterinary medicine, chemistry, pharmaceutical chemistry, and technology or biology.

According to the above example of importing human drugs into EU, it is complicated and related to many sets of regulations. Businesses have to oblige to not only Customs law, but also the European Medicines Agency (EMA). This could discourage businesses to share information to Customs due to the complication of regulations. Moreover, the abovementioned is only an example for importing medicines to Europe. Other products follow different rules such as fishery products. It is difficult to directly measure the level of compliance by comparing the regulations because there is a plenty of rules and regulations to obligate and there is also an exception for certain products.

To sum up, due to the complication of laws and regulations, the information sharing in the supply chain is cumbersome and discourages businesses to share their information to Customs. Also, it is difficult to measure the level of compliance directly with the laws and regulations because of the complexity and exceptional of laws. Because the context-aware architecture was designed to improve the level of compliance in the container-shipping domain, this brings to the question of how to measure the level of the compliance that the context-aware architecture can improve in the supply chain.

#### 4.5.2 Data quality

From the previous example of laws and regulation, being compliance to the regulations is explicit because there are a plenty of exceptions and different products are complied with different regulations. To overcome these conditions, there must be a methodology to measure the level of compliance for the information sharing system. In this case, we assume that the data quality possibly indirectly measures the level of compliance, so we studied on the data quality to determine the applicable content to apply with this study.

#### **Data quality**

According to the context-aware architecture, businesses have to input data to have complied with EU regulations. Thus, the measurement criterion is compliance. Referred to Union customs codes and the customs control, the regulations are in Boolean data type. For example, in customs control, to import live animals and products of animal origins, importers must have health certificated to import the goods(European Commission, n.d.). If the importers do not have the certificates, they are considered to be noncompliance because they violate the Customs regulation by not presenting the certificate to the Customs. To verify the condition, the information sharing system should allow businesses to upload and detect whether certificates are uploaded. Moreover, there is a possibility that businesses will share as many data as possible in order to secure that they meet customs requirement leading to exceeding information sharing and over-compliance.

To measure information sharing by businesses, we reinterpreted the regulations measurement as data quality. Speaking of data quality, they are essential for both business and government to measure data quality because most services from both are in the electronic platform which it is inevitable to deal with electronic data which are widespread and become more complicated than before when more data exchange to external sources. Moreover, data integrity is also another

meaning of data quality. Data integrity is to *keep up and guarantee the accuracy and consistency of information over its whole life-cycle. So, for data integrity, they should be accurate and reliable*(Solutions, 2013). Therefore, it is essential to know about the quality of data so that unqualified data can be detected, and the overall quality of data will be improved.

According to *Methodologies for Data Quality Assessment and Improvement* by C. Batini et al., there are various data quality methodologies that use to measure and improve the quality of data. Moreover, each methodology has different definitions of qualities, dimensions, and metrics to assess data, so the definitions are important to select the methodologies and apply to a case or a project.

## 1. Dimension

In Batini's paper, he collected information and categorized the definitions of data quality dimensions from many works of literature. In his research, the data values are the main focus for defining the dimensions and metrics. As a result, there are fundamental four data quality dimensions: accuracy, completeness, consistency, and timeliness(Batini, Cappiello, Francalanci, & Maurino, 2009). Because there are no exact definitions of data quality, the following definitions are presented to give an overview of them, and these definitions will be selected and adopted in this thesis.

- Accuracy: there are several definitions of accuracy depending on DQ methodologies. There are two types of accuracy: temporal accuracy and structural accuracy. Temporal accuracy is that data are stable and unchanged in a specific time. For structural accuracy, based on Batini's paper (2006), accuracy is the closeness of a value considered to syntactic accuracy. In syntactic accuracy, we are interested in checking whether V is any values in a certain domain. Syntactic accuracy is to look for the distance between V the values in domain and evaluate. Semantic accuracy is the closeness of the value v to the true value v0(Batini & Scannapieco, 2016). The difference between syntactic and semantic is that a value is correct in syntactic accuracy as long as it is in a domain, but it might be incorrect in the semantic one because a value is not the same. So, the semantic accuracy can be assessed by a Boolean function which is either yes or no, or a correct or not correct.
- Completeness: completeness is "the degree to which all required information is present in a particular dataset"(Batini & Scannapieco, 2016, p. 130). To assess the completeness, sometimes results calculating completeness are Boolean values.
- Consistency: the dimension of consistency is that semantic rules are violated by defining over a set of the data item. This definition came from analyzing the meaning from the statistics and the related theory. There are two issues related to data consistency: Integrity Constraints and data edit.
- Time-related Dimensions: the time-related dimensions are currency, volatility, and timeliness based on the literature review. The definitions of currency and timeliness from many works of literature are similar even some papers referred to as the same concept. As there are many definitions, these are characteristic of currency, volatility, and timeliness.
  - Currency in time-related dimension focuses on how punctually data are updated regarding changes in the real time. If information updates in a system fast, the currency of this is high.
  - Volatility represents the frequency of updating data measuring by time constraints. The information that shows high volatility is stock. It changes from time to time depending on bid-ask prices in the stock market.
  - Timeliness is to guarantee that current the data is ready or up-to-date to use. The timeliness dimension could mean that the data is up-to-date but they are late

considering specific activities. For example, students need a class course syllabus before a class starts, but a teacher distributes it after the class.

- Accessibility is an ability to access the data from his or her own culture, physical status, and places where technologies available (Batini & Scannapieco, 2016). In this case, the accessibility is included the accessibility of people with disabilities. For example, information systems have audios, images or textual equivalent content to support people with difficulty in reading.

## **2. Phases and steps**

Besides the dimensions, each data quality methodology has different phases, but these phases can be concluded into these following three main phases:

1. State reconstruction: this phase is to collect much information such as data corresponding costs and so on.
2. Assessment/measurement: the quality of data collections and the related quality dimensions are measured.
3. Improvement: this phase is to select a strategy to improve the data quality to reach a target of a system.

In this thesis, the assessment phase is the focus because the objective is to identify the data quality dimensions for evaluating the context-aware architecture. These are the steps of the assessment phase.

- Data analysis: To completely understand data and related architectural, examining data schemas and interviewing are conducted.
- DQ requirement analysis: collecting opinions of data users and administrators to identify quality points and to set new quality targets.
- Identification of critical areas: the step provides a model of the process data.
- Measurement of quality: after identifying the quality issues, the data quality dimensions are selected. The metrics could be either quantitative or qualitative depending on data users.

## **4. Costs**

According to the literature, costs are one perspective considered in the methodologies because low data quality affects other module's function negatively (Haug, Zachariassen, & Liempd, 2011). However, costs are out of scope in this thesis because it is irrelevant to the research question and costs are not considered in the context-aware architecture yet.

## **5. Types of data**

Data are the main focus of DQ methodology. The data can be stored, processed, received by a software and be transmitted in a network. To analyze data quality of certain systems or architecture, it is important to know types of data that are used so that the right DQ methodology is chosen to assess. Data can be classified into three types.

- Structured data are aggregations of items within a domain. Data are mostly searchable by human and machine as long as they are in the relational databases. Examples of structured data are numeric values, strings, alphabets. Long text strings are also structured data. (Christine Taylor, 2018)
- Unstructured data are a typical sequence of symbols. Data are stored in a non-relational database. They could be non-textual formats such as images, audio files, and text files (Christine Taylor, 2018).

- Semi-structured data are data with a certain level of flexibility. What makes semi-structure data differs from the former ones is that they have internal tags and markings. Because of tags and markings, semi-structured data can be grouped and orderly sorted. Emails are an example of semi-structured data. An example of semi-structured data in figure X is markup language XML.

To illustrate this, figure 4 shows an example of data in each type. Because most of the literature regarding data quality focuses on measuring structured and semi-tortured data. So, unstructured data are out of scope.

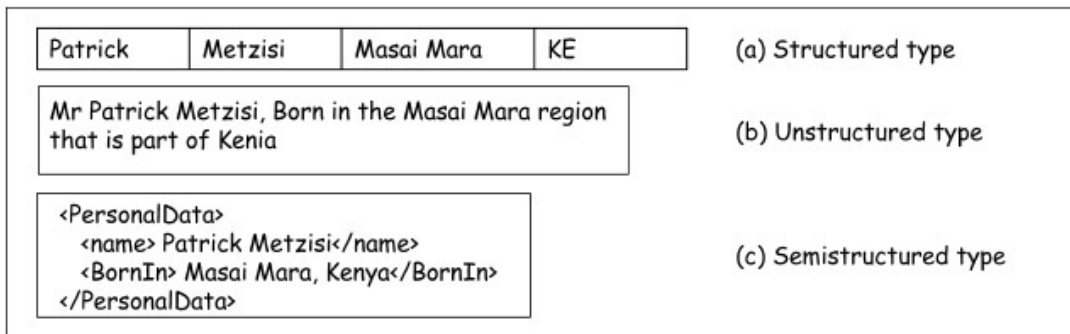


Figure 6: Batini paper 2006

## 6. Types of Information Systems

As data are the main focus for assessment and improvement in DQ mythologies, understanding about types of Information Systems is needed so that the context-aware system can be analyzed correctly. These following information systems are separated by their degree of data, process and management integration.

- A monolithic information system is data storage with no data access services. Also, separate modules don't share information leading to the data duplication.
- A data warehouse is a centralized data storage which retrieves data from many databases. The data warehouse refreshes data to update data in actual time.
- A distributed information system has many applications divided into many tiers, but the system has seamless interoperability. Data also can be stored in different databases in different physical locations(BOOTH, 1976).
- A cooperation information system(CIS) has multiple different systems that are connected and has an autonomous information sharing system with market-oriented coordination(Jarke, Jeusfeld, Peters, & Szczurko, 1996). Although data are stored separately in different data, data are exchanged at a process level.
- Web Information System (WIS) is a system that adopted Web technologies.
- A peer-to-peer information system(P2P) is a system that shares data between users and servers without central approval.
- Cloud information systems, which are commonly used by now, consist of groups of remote servers but they are connected so that these remote servers perform as a centralized data storage which users can access online from any computer services(Batini & Scannapieco, 2016).

## Data Quality methodologies

According to seven aspects for analyzing for a suitable methodology which stated from the previous paragraph, there are thirteen methodologies proposed by C. Batini that can be applied as an approach to assess the context-aware architecture.

DQ Methodologies	Reference
Total Data Quality Management (TDQM)	Wang 1998
The Datawarehouse Quality Methodology (DWQ)	Jeusfeld et al. 1998
Total Information Quality Management (TIQM)	English 1999
A methodology for information quality assessment (AIMQ)	Lee et al. 2002
Canadian Institute for Health Information methodology (CIHI)	Long and Seko 2005
Data Quality Assessment (DQA)	Pipino et al. 2002
Information Quality Measurement (AMEQ)	Eppler and Munzenmaier 2002
ISTAT methodology (COLDQ)	Falorsi et al 2003
Activity-based Measuring and Evaluating of product information Quality methodology (AMEQ)	Su and Jin 2004
Loshin Methodology (Cost-effect Of Low Data Quality) (COLDQ)	Loshin 2004
Data Quality in Cooperative Information Systems (DaQuinCIS)	Scannapieco et al. 2004
Methodology for the Quality Assessment of Financial Data (QAFD)	De Amicis and Batini 2004
Comprehensive methodology for Data Quality Management (CDQ)	Batini and Scannapieco 2006

Table 5 Data quality assessment

From many aspects of data quality, this brings to the question of how data quality applies for measuring the level of compliance. The context-aware architecture is still a conceptual model. Thus, costs, types of information system and data methodologies are not applicable for measuring the level of compliance for the context-aware architecture. The most related data quality issue is the data dimension. From *Data quality: concepts, methodologies, and techniques* (Batini & Scannapieca, 2006), there are 5 dimensions of data quality: accuracy, completeness, consistency, time-related and accessible.

## 4.6 The context-aware architecture

As I assumed that the context-aware architecture has a potential to solve problems in the container shipping domain, before applying the conceptual model into the current system, the concept of the context-aware architecture must be clearly understood by myself and also, I must be able to explain to interviewees with expectations that they would be able to provide some insights into the architecture's designer.

To begin with, there are many definitions for a context. Many researchers tried to define the context in a various way. For example, Dey defined the context as "Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves." (Dey, 2001, p. 5). The context, in this case, is defined as "a set of context variables that have a context relationship with the focus"(Engelenburg et al., 2017). A context relationship is a relationship between context and focus. The focus is depended on where the system will be applied. In the case of the container shipping domain, the focuses are lawfulness, an obligation by business to submit documents and willingness to participate in the system. The relationships of context explain the way that context impact on the system. A context element is used for describing the context. So, the context element is characteristics of the context. After

acknowledging the context and its composition, this brings to a question of how we can do with them. A context-awareness is to sense and adapt to the context. To do so, a particular system must contain context elements and context relationships. The context elements consist of sensor and adaptor which make system adapt to rules, and the context relationships are context rules. To illustrate this, when data entry into a context-aware system, the sensor detects the context of data and the adaptor will adapt the surrounded context to match with the data's rules.

Due to a design science approach, a context-aware architecture for B2G information sharing in the container-shipping domain, new system architecture, was developed for influencing businesses to share more information to a government by interviewing with experts and analyzing document from CASSANDRA and CORE projects. From the data collection, the architecture designer found that to improve information sharing system, businesses must be a willingness to share more information to Customs, the shared information must be lawful, and businesses must agree to provide documents to Customs. To illustrate this, these following are examples of what the designer found during the data collection with experts.

Category	Example Results
Lawfulness	<ul style="list-style-type: none"> <li>• The flow of information that is sensitive that only permitted businesses can access.</li> <li>• The flow of information has commercially sensitive information that a third party control this information.</li> </ul>
Obligation	The government requires businesses to share information, but the businesses hire third parties to execute processes and share information for them.
Willingness	<ul style="list-style-type: none"> <li>• Shared information is sensitive to share with other parties when information is gathered.</li> <li>• Shared information is sensitive to share with other parties but the system in the flow will broadcast the information.</li> </ul>

*Table 6 Data collection from experts*

From the results, it can be concluded that information's flow requires in different context based on the difference requirement on each objective. Developed for the previously mentioned data collection's results, the designer has developed the system architecture with the concept of the context-awareness with the expectation to improve the data quality in the container shipping domain.

The context-aware architecture in the domain of container shipping has 4 main components: sensors, repository, decision component, and adaptors.

**Sensors**

Sensors have the ability to detect the requirement of the information. The sensors can detect what parties want to share, the condition and agreement of the particular information. In the case of the context-aware architecture, parties such as businesses, government, and third parties act as sensors.

- Businesses as sensors provide context information about the contractual agreement. Businesses know which information is sensitive or confidential and also, they know their

relationships in the network. To make the system aware of the context, businesses can access control rules to set criteria.

- Third parties in the sensors are auditors or identity managers who are assigned by the government to verify information stored in the system such as certificates and contractual agreement. Another party in the third parties of the system is the trustee is a group of specialists appointed by the government to provide specific information related to the specific industry.
- Government organizations provide information related to laws and regulations.

### **Repository**

Repository is a system that is designated to store information such as context information and other information for decision making. The blockchain is a technology that is chosen to store context information and rules because of its security. Only verified parties can read and write on the context information. The difference from the usual blockchain is that there is no proof of work in the context-aware system. Thus, the repository stores context information, context rules, proposed flow for dataset and access history.

### **Decision component**

Decision component is a system that proposes the most suitable information flow. In this system, the decision component is called an information flow planner. The inputs of the information flow planner are information stored in the repository such as context information and the flow request from parties. After analyzing, the information flow planner proposes flows of the information. There are two types of information flow request: pushing and pulling systems.

### **Adaptors**

Adaptors work in the context-aware system as a function to manipulate data. Adaptors consist of data routers—a special router—and access control components. After the information flow planner suggests flows for the information, the data router shares data via the proposed flow. To share information, a data router receives the proposed flow via a ledger copy and the data router send out the data to the destination and the data router adds the record of the information sharing into the history. For the context-aware system, each party must own data router for share information with other parties. To control the data access, Access control components provide functions for parties to control the information sharing. There are 4 components for controlling the information's access: Encryption component, Anonymization component, Think maker and Masker

- Encryption component is a component to encrypt data and share keys to only specific parties. The information flow planner will assign the data to be encrypted by the encryption component and keys are share to the specific parties via the data router.
- Anonymization component is for removing sensitive data from datasets before sharing to other parties as some contents are perceived to be sensitive, and parties would like to exclude from the data set such as a Commercial value in the Commercial invoice.
- Think maker is a component that makes a thick dataset become a thin dataset by creating link and metadata and sharing via data router.
- Masker is a component to mask the shared link and then send to other parties via data router.



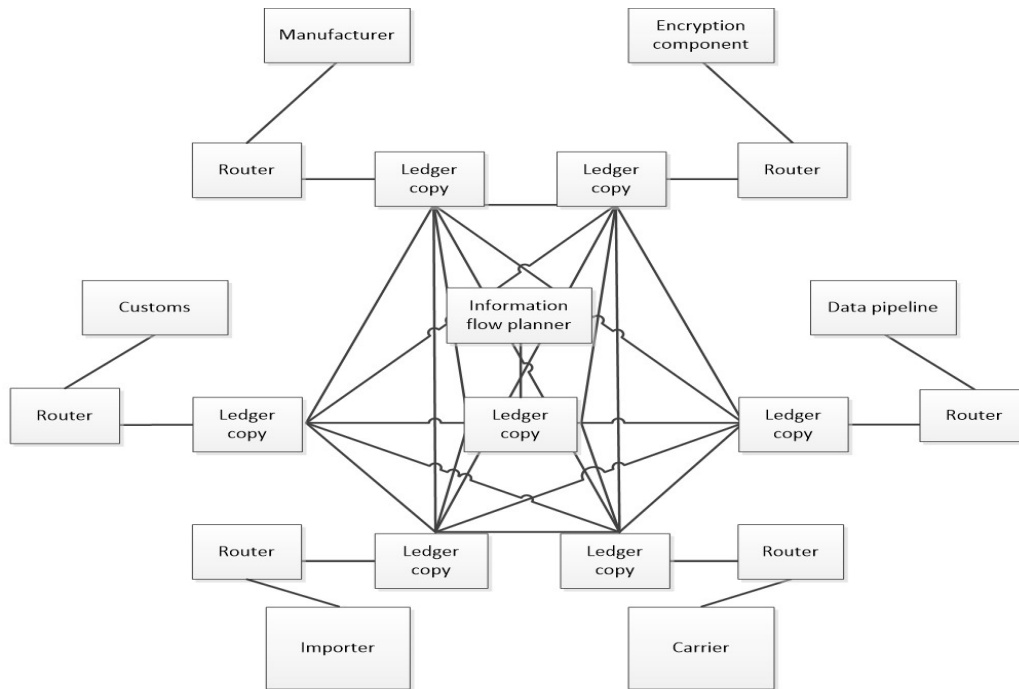


Figure 7 The context-aware architecture in the container shipping domain (van Engelenburg, 2018, p. 48)

The context-aware architecture is designed to improve information sharing between businesses and government focused on lawfulness, willingness, and obligation. As the concept of the architecture is abstract, before interviewing businesses to gather data, the flow process which applied the context-aware architecture must be created with clearer description to help businesses understand a new process created from applying the context-aware architecture.

To sum up, this chapter, we have presented the definition of the supply chain and its problems. One problem is the supply chain is sharing information among the chain of supply. There are many system architectures designed to influence actors to share more information such as EDI and Data Pipeline. A context-aware architecture is an alternative system architecture for encouraging businesses to provide more data Customs with an intention to improve compliance. However, measuring compliance is broad so, we introduce the literature of data quality, which we assume that the data quality has a connection with the compliance and the information sharing in the supply chain. Lastly, we have presented the in-depth detail of the context-aware architecture in the container-shipping domain.

## 5 Interview frameworks

From the literature, we provide a background of the information sharing system in the supply chain and alternative system architecture such as Data Pipeline. Further, we introduce the context-aware architecture and the data quality which we assume that it has a relation with the information sharing in the container-shipping domain. In chapter 5, we will combine data quality dimensions, a current process in the container shipping domain and a context-aware architecture to create the interview protocol. In section 5.1, we propose the application of the data quality that is relevant to our study. We initiate the context-aware architecture on the import process in the international trade in section 5.2. Lastly, in section 5.3, we illustrate the interview protocol elaborated from section 5.1 and section 5.2.

### 5.1 Implication of the data quality in the import process

Many documents are studied to look for the application of data quality dimension in both supply chain and law context to apply as criteria to measure the compliance of the context-aware architecture.

In supply chain management, data are a hot issue in the supply chain as data are produced as same as goods (Hazen, Boone, Ezell, & Jones-Farmer, 2014). Normally, we are familiar with the supply chain for the manufacturing process, which data are also produced as well. Speaking of manufacturing, a quality control is an important process to maintain and improve the quality of products. Hence, the quality control is also applied for data to control the data quality in the supply chain.

For the data quality dimension in the supply chain, there are 3 data dimensions that are most relevant to apply for the context-aware architecture: **data accuracy, data completeness, and data timeliness.**

In the current situation in the international trade, data are important to all actors because of data deficiencies and an outdated data tracking system resulting in a safety and financial risks (Hesketh, 2010). Hesketh (2010) illustrated that a shipping carrier was not sure about what was inside its containers because businesses tended to reduce the goods' descriptions and omit the exact values of goods to reduce insurance costs. Accordingly, the information provided by the carrier was inaccurate and incomplete. Without opening the containers, Customs and businesses would not know what was inside these containers which the importers might stuff illegal in the containers. This example can be implied that complete and accurate data are important for all actors to protect themselves from the harmfulness of goods inside the containers. For the financial risk, from the interviewing with businesses, three interviewees mentioned about costs and times [2:10] [4:15] [4:15]. Businesses claimed that they would like to reduce the amount of time in waiting for information or documents because the more time they waited for data, the more costs they had to pay for the other services such as storage fee. Furthermore, Hesketh (2010) mentioned that a slow document tracking system and uncertain situations sometimes caused delays in the process, which affects other consequent processes. It can be implied that time of sharing data has an important role in the import process and need to be improved.

To interpret the data accuracy in the context of the supply chain, filling a customer's address in a customer relationship management system is an example for the data dimension. What is considered to be accurate is that the customer fills his street address and the street address matches the street that this customer actually lives at present. Once the customer's street address is accurate.

From the abovementioned definition of data completeness, to complete the customer's address, a name, street address, state, city and zip code should be filled into the database. If a customer fills only his name and street address, these data are considered to be incomplete.

For time-related or timeliness of data, data timeliness is to measure the latest version of the data set in the system and the frequency of data updates. The high data quality in term of the data timeliness is to receive the most recent data set from users. For an example in the supply chain, Hazen et al. (2014) mentioned that the timeliness could be measured by the time that data was entered into the system and the length of data in the system.

Another data dimension that was mentioned in the Batini's paper is data consistency--the data are the same data value in all case. In case of the context-aware architecture, the container shipping process is the fluctuating process in which data would be changed and updated frequently and sometimes depended on Customs authorities that businesses may have to submit documents several times for one shipment before the Customs' approval (Jensen & Vatrapu, 2015). Thus, the data consistency is not proper for measuring the level of the compliance for context-aware architecture because it is difficult to identify the data consistency unless businesses have collected the statistic of the document amendment.

In sum up, according to the data quality, the data quality dimensions are used as criteria to measure the improvement of the regular compliance by the context-aware architecture. The criteria are data accuracy, data completeness, and data timeliness.

With the expansion of international trade, a ton of shipment enters Europe due to the claim that Europe has lowered tariff(eurostat, 2018). As well as numerous information submits to EU customs so that it can work with it to do several tasks such as risk analysis, tariffs collecting and trade facilitation. After many incidents happened such as 911 in American, Customs has to work harder to secure EU citizens by preventing dangerous goods or people entering into Europe(Hesketh, 2010). This means that even more information is acquired by Customs so that it can prevent tragic events to happen. Customs needs not only more information but also a high quality of information for its tasks.

As Customs has many functions such as immigration, export declaration and so on, and all these tasks are dealing with data. The scope of this study focuses on the process of importing sea containerized cargo into Europe from Non-Europe country. Every day a ton of marine cargoes enters seaports. The cargoes can be either bulk or containerized marine cargo, but it is more likely the marine cargoes are exploited for concealing contraband goods and other illegal trade such as human trafficking.

For preliminary inspection, Customs screen the goods in the container by obtaining documents from pre-loading declaration and import customs declaration(EUROPEAN COMMISSION, 2016a). According to the mentioned process, these are fundamental documents that Customs require to carriers and declarants to submit.

### **Pre-loading declaration**

#### **1. Entry Summary Declaration (ENS)**

## **Import customs declaration**

1. Commercial invoice
2. Packing list
3. Customs Value Declaration
4. Freight Documents (In the case of the sea, it is Bill of Lading)
5. Freight Insurance
6. Customs Import Declaration (SAD)

More documents are required if the goods relate to Customs control goods such as medicine and veterinary products.

Although Customs receive some information to perform risk analysis, it is hard to pinpoint the specific consignment that should be seized among other cargos while waiting for Customs clearance at the seaport. Whole quantity inspection is almost impossible for Customs to open and check every container(Hesketh, 2010). Even though Customs has a machine for screening cargoes like passengers' check-in luggage, people in Customs administration are not enough to screen every container. To improve risk management, Customs needs instead need more and better information so that it can found suspected containers the and approach that specific containers in time. The next paragraph is to apply the data quality as criteria to measure the data in the importing process.

### *Example of the implication of the data quality*

Entry Summary Declaration is a form to submit in advance before lodging the goods into a ship(European Commission, 2016b). The information in ENS is used for risk assessment by the EU Customs. In case of discovering the potential danger or violated to laws. The Customs will send to a result back to inform a carrier not to load this cargo on the ship. The information will submit via EDI by the certain carrier and these below details are required by European Customs to submit as ENS:

- Shipper's full style name and address
- Consignee's full style name and address
- Notify party's full style name and address if the consignee is "to order"
- Container number
- Seal number
- Number of packages
- Cargo gross weight
- UN dangerous goods code for shipments containing hazardous goods
- Cargo description

According to the above information, Customs has an issue with goods descriptions. For ENS, Customs require businesses to use a plain language description that is accurate enough for Customs to identify the goods(EUROPEAN COMMISSION, 2016b). For the cargo description, general terms such as general cargo and parts are unacceptable. The provided descriptions should be detailed enough for Customs officers to perform risk analysis. Vague descriptions lead to a risk of misinterpretation, so the below pictures are a list of good descriptions referred to the Customs' acceptable level.

According to figure 13 and 14 in Annex 4, if businesses exports clothes, they must declare a specific type of clothes such as men's shirts, lingerie, girl's vest and so on. It could be assumed that brand

name is not necessary information for Customs to verify the goods description. To illustrate this, from figure 13, for both non-hazardous and hazardous, it is not mandatory to inform the brand name of the chemical. However, the list of acceptable can be changed due to nature dynamic of everyday practice(EUROPEAN COMMISSION, 2016b). However, businesses are required to provide the accurate detail to Customs. Thus, the more detail of the cargo description that businesses provide, the more data accuracy has improved, but businesses themselves must aware of the appropriateness of the goods description that they share. Moreover, the new unacceptable terms are added to the list depending on the SAD committee decision. This means that declarants and businesses must keep up-to-date with Customs because the goods description today might not be accepted in the future.

Based on timeliness in the data quality, it is mandatory to submit the ENS ahead of time. For the earliest, a carrier should submit 200 days before the arrival. For the latest, ENS must be submitted 24 hours before loading a container onto the vessel at the port of departure. Thus, the measure of submitting the information by the time that the Customs request is data timeliness.

For the data completeness, as the Customs request businesses to provide shipper’s full style name and address, consignee’s full style name and address, notify the party's full style name and address if the consignee is "to order", container number, seal number, number of packages, cargo gross weight, UN dangerous goods code for shipments containing hazardous goods and goods description in the ENS application. If businesses fail to provide all of this information, this means that businesses do not provide complete data. In other words, businesses do not meet the requirement by Customs so that they fail to pass the data completeness as criteria.

#### 5.1.1 Criteria to measure data quality

As three data quality dimensions are selected for study in this research, these are criteria to measure the data quality in the container shipping domain.

#### Data accuracy

To consider that actors provide accurate data is that the provided data must have the closest value to the reality. In the container shipping domain, actors must provide accurate product descriptions to Customs. For example, businesses deliver shirts to the Netherlands. They must declare the product description in the commercial invoices as shirt referred to a sample of acceptable goods description by Customs(EUROPEAN COMMISSION, 2016b) in Annex 4. For this sample, it is considered that businesses provide accurate data to Customs. If businesses declare shirts as trousers in the invoice, this product description is considered to be inaccurate and the Customs should reject this commercial invoice and inspect this shipment. If businesses deliver blue shirts and they declare to Customs as they deliver blue shirts, this case is a totally accurate data because Customs expect businesses to declare as same as a sample in the acceptable goods description in Annex 5. Figure 8 shows the criteria of data accuracy in the container shipping domain.

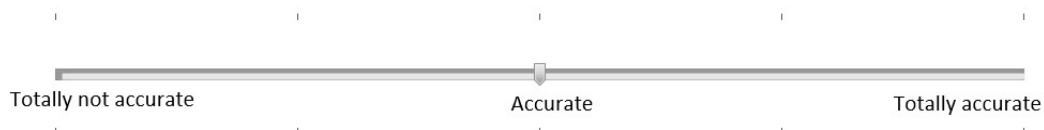


Figure 8 a criterion for data accuracy

## Data completeness

The completeness as data quality dimension is the ratio of the given data and the data supposed to be collected (Batini et al., 2009). The criterion to pass the data completeness is either complete or not complete. In the container shipping domain, the data completeness would be applied with the documents that exchange between actors during the transportation. In EU trade helpdesk website, they provide the minimum information that businesses should provide to Customs authorities. For example in a commercial invoice, these are minimum required data that should be stated in the commercial invoice (EUROPEAN COMMISSION, 2015):

- Name and address of exporter and the importer
- Date of issue
- Invoice number
- Description of the goods
- Unit of measure
- Quantity of goods
- Unit value
- Total item value
- Total invoice value and currency of payment.
- The terms of payment
- The terms of delivery according to the appropriate Incoterm
- Means of transport

To meet the data completeness' criterion, businesses should provide all of this information to Customs to pass the criterion. If they failed to provide these above data in the commercial invoices, they did not pass the data completeness criterion, and Customs authorized should request businesses for more information. For the case that businesses provide more data than the above list, it is considered to pass the criterion as well. Figure 9 illustrates the criterion of assessing data completeness.



Figure 9 a criterion for data completeness

## Data timeliness

There are many time-related definitions in the data quality dimensions (Batini et al., 2009). What would be considered as a criterion for data timeliness is the time that data were entered into the system. According to Customs rule, a shipping carrier should submit ENS at least 24 hours before loading containers (European Commission, 2016a). For submitting ENS, to pass the timeliness' criterion, the shipping carrier should submit the ENS 24 hours before the beginning of container loading. If the carrier submits the ENS before 24 hours, it is considered that the submission passes the timeliness criterion referred to the figure 10 below. The late submission is considered not to pass the timeliness criterion.

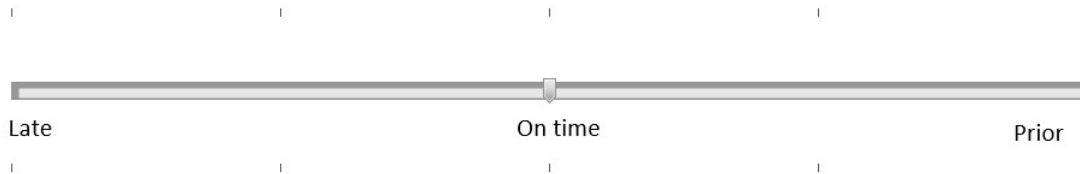


Figure 10 a criterion for data timeliness

## 5.2 Context-aware architecture in the importing process

The context-awareness is an ability to sense and adapt the context. Due to its ability, the context-awareness technology is used in many industries such as smartphone and health care. Because of the need for more data in data exchange between Customs and businesses, the context-awareness is assumed to be applicable technology to improve data quality leading to sharing more information in the shipping domain.

However, the context-aware architecture is at an architecture level which is quite abstract for businesses to understand the system. To help businesses understand about the architecture and be able to identify data quality issue, there should be a way to communicate with businesses simply so that businesses would be able to provide some useful information for us. To do so, the architecture was interpreted into a business process level. According to the scenario created for a current process from the chapter 3, the context-aware process was designed based on the current process of the importation in the container shipping domain, and the flow of information exchange was changed in accordance with the context-aware architecture. The scenario with the context-aware architecture is presented in figure 7.

From figure 7, when businesses share information, data will be sent by data router which every party must have data routers to send out any information. The data router will send a request to an information flow planner. The information flow planner will check the context information which the business as a user stored in the repository. Then, the information flow planner proposes the flow to the data router, and the data will be sent to the right parties.

For example, a seller shares a commercial invoice, and a packing list to the trusted a freight forwarder and a shipping agent. Because the documents are set by the seller either to share or to not share to the particular freight forwarder and carrier, the information flow planner detected these criteria and proposed information flow based on the criteria. In this case, the business chooses to reveal the document to only trusted parties. Thus, the documents are assigned by the information flow planner to the encryption component to encrypt the document with a key. The encryption component will send the key to the trusted parties, in this case, the freight forwarder, to unencrypt data and they can access to data. The seller can share shipping documents with other businesses by the context-aware system manages the accessibility of the documents. For the context-aware system, each business access to information individually. Moreover, to submit shipping documents and information to Customs, once either the carrier or the freight forwarder sends out the information. The information flow planner will deliver the information to the Customs.

For Customs, Customs receives the accessibility to the information because the Customs is one of the parties in the system. Referred to figure 11, the documents are encrypted as the seller's preference, but the shipping documents are obligated to share with Customs due to the laws. The Customs receives a key from the encryption component as well. However, when Customs need more information from businesses for the investigation, for the system with the context-aware system,

Customs can access businesses' information. Customs' data router will send a request to access to businesses' data, and the information flow planner will grant access and propose the flow of data to send the request. Information in the obligation documents requested by Customs will be inspected. Therefore, the Customs receives permission by the information flow planner to access to that particular information. However, businesses can choose not to share information to the Customs, especially the sensitive one. After Customs accesses to the information, the access history will record, and businesses will acknowledge that Customs has checked their information.



Information sharing between businesses and EU customs for importing by sea from Non-EU country with an implementation of the context-aware architecture

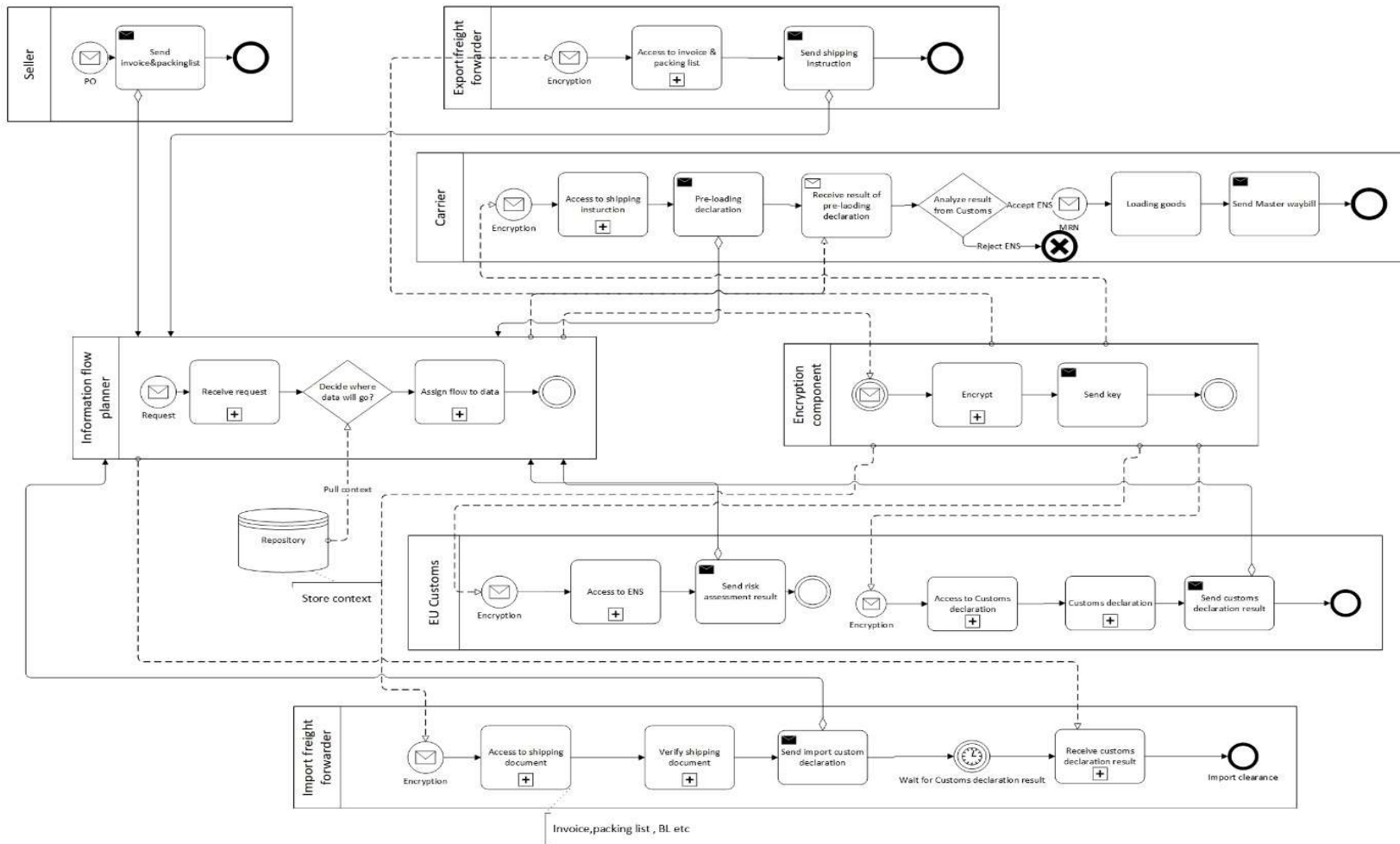


Figure 11 The context aware process

### 5.3 Interview protocol

According to the data quality and the current data sharing situation in the container shipping domain, these two topics are the main framework which is expected to be identified by semi-instructed interviewing with businesses. Due to the nature of the semi-structured interview, the interview protocol was developed to explore the reality of the data exchanging in the import process and to measure the effectiveness of the context-aware architecture in data quality aspect.

The actual interview protocol is enclosed in the appendix B. This interview protocol was developed to explore the actual data exchange process in the container shipping domain between non-EU and EU countries and to identify the data quality element in the context-aware architecture. As the information sharing process in the container shipping domain is our research interest, we created the interview protocol based on it (Jacob & Furgerson, 2012). There are four parts in the interview protocol.:

1. Introduction
2. Transition
3. Main question
4. Closing

These four types of question help the interviewer to preserve the conversational tone and gain insights from the interviewees (Castillo-Montoya, 2016).

The introduction part informs that interviewees about voice recording, an overview of the research topic and a research objective. After that, interviewees are asked about their background and the method of current information sharing to Customs or other parties. These questions help to understand the background of the interviewees. Starting the interviews with a fundamental question such as background would build trust to the interviewee and build confidence to the interviewer so that the interviewee would reveal more information and would not withdraw the interview sessions (Jacob & Furgerson, 2012).

Transition part is intended to explore the current situation of the import process before introducing the context-aware architecture to the respondents. The transition questions guide the respondents to the critical question but still keep the tone of the conversation (Castillo-Montoya, 2016). With the assumption that the context-aware architecture can improve the information sharing, if the context-awareness could solve the current problems or facilitate the current process, businesses would agree that the context-aware architecture can improve the data quality of the system. The questions in the transition part are asked to prove the assumption. If businesses, especially the immature technology one, do not agree that the context-aware architecture can influence them to share a higher quality of data, they would express their opinions that could be used as advice to improve the aware context architecture.

Leading questions are asked to answer the research questions or at least related to the research questions (Castillo-Montoya, 2016). In this case, the interviewees are asked about the effectiveness of the context-aware architecture. This section begins with the explanation of the importation situation based on Yantian-Felixstowe trade lane from the CASSANDRA report to determine the interview framework of the import process that is improved by using the context-aware architecture to exchange information. After that, the process with the context-aware architecture as information exchange is explained to respondents. For both explanations, the BPMN flows of both scenarios are shown to the respondents to help them to understand the processes. The data quality dimension

questions—data accuracy, data completeness, and data timeliness--are asked to receive feedbacks from respondents.

Moreover, the question about Customs rewarding system is asked to gain more information from the respondent's opinions. This is a leading question, but Customs considered to reward businesses in the future(Customs Administration of The Netherlands, 2014). Because the context-aware architecture was designed to support the future rewarding system, the feedback from businesses would provide insights that both architecture design, together with EU Customs, does indeed perceive the business's requirement toward the information sharing between businesses and Customs.

To end the interview sessions, as a manner, follow-up questions are asked to allow respondents to reflex about the interview sessions and to show respect to their ideas(Arksey & Knight, 1999; University of Leicester, 2009). Respondents are asked to provide feedback about the interview sessions to suggest a person who can join this interview and keep up-to-date with the research.

In chapter 5, we illustrate the application of three data quality dimensions—data accuracy, data completeness, and data timeliness—in the importation of the containers into EU, and we set criteria to measure these three data quality dimensions to confirm whether the data quality has improved in this domain. Furthermore, we propose the business process of the context-aware architecture in the import process illustrated as figure 11 and present how the context-aware architecture works based on the current import process. As we would like to gather more information related to the data quality from businesses, we designed an interview protocol based on three data quality dimensions and the context-aware data exchange process in the container-shipping domain.

## 6 Findings from the interviews

According to the research approach, a semi-structured interview is an approach that was chosen to collect for answering the sub-research question 4: *What are differences between a context-aware architecture and the current system in encouraging businesses to share a higher quality of data?* In chapter 5, the interview protocol was designed to gather information from businesses so that we can identify the data quality issues from businesses. After conducting seven semi-structured interviews with seven interviewees who are working in the supply chain department in companies or working in freight forwarders. This chapter reports the results from data collected and the data are analyzed to answer the sub research question 4 in section 6.1. In section 6.2, we analyze results from the interviews with the concept of the willingness to disclose information to explain responses from interviewees.

### 6.1 Impact of the context-aware architecture

To answer the sub-research question 4, seven semi-structured interviews were conducted to discover how three data quality dimensions impact on the context-aware architecture. After explaining the concept of the context-aware architecture and its application in the container-shipping domain and presenting the context-aware importing process, three questions related to the data quality of the context-aware architecture were asked to the respondents to identify the data quality from the business side. After analyzing the interview transcriptions, results were grouped into three categories and assigned by three different codes—data accuracy, data completeness, data timeliness. According to the coding, these following tables provide codes in each category

#### 6.1.1 Data accuracy

Data accuracy from the data quality dimension is providing data that their values close to their existing values. In other words, data accuracy is that businesses agree to provide more detail of goods. The more detail they provide, the more accurate the data they are. The table 11 in Annex 5 shows the coding from the interviews under the data accuracy category.

According to the results under data accuracy category, the interviewee 1 said that he would share more detail, especially the trade secret, because he trusted the security of the context-aware architecture which the documents were sent to the encryption component to lock and only particular parties could access to the locked documents and blockchain is applied as the repository to store the context [1:27].

For the interviewee 2, in the end, he said that he would share more information because of blockchain technology in the context-aware architecture [2:9]. However, he stated that the accuracy of the sharing data depended on a person who submitted the data into the system and the context-aware system should be able to detect the inaccurate data [2:5]. However, he pointed interesting information that HS codes were interpreted differently by different Customs officer in each country, so the Customs should fix this issue first [2:11].

The respondent 3 agreed to share more detail via the context-aware architecture, but she said that the information was already shared to other parties such as rival company because sharing information was unavoidable [3:9].

The interviewee 4 agreed to share more detail via the context-aware architecture because he said that it was mandatory to share information to Customs [4:9]. The interviewee 5 did not agree to share more information through the context-aware architecture. She claimed that she already provided enough information to Customs [5:4].

The interviewee 6 also agreed to share more detail to Customs but at a certain level. She mentioned that besides chemical goods, she said that she would share more detail through the context-aware system [6:21]. Also, she mentioned HS code as well. She mentioned that the current Customs declaration system was able to verify HS codes [6:29]. HS codes are related to data accuracy because the more item description provided, the more accurate of HS codes. HS code is a set of number that identifies an item name and description (World Customs Organization, n.d.). The HS codes are widely used in 200 countries for import and export Customs declaration, paying tax duties and monitoring controlled goods (LogisticsGlossary, n.d.). When HS codes change, the good descriptions change, and Customs tariffs might change.

The interviewee 7 resisted sharing more detail if he were using the context-aware system [16:19]. He claimed that what he shared to Customs was only data received from the supplier and these were only enough that he would provide either with or without the context-aware architecture [16:17].

### 6.1.2 Data completeness

From data quality dimension, data complete is the ration between the share data and the required data. Data completeness in the container shipping domain is that businesses provide information enough to meet its requirement. The table 12 in Annex 5 shows the coding from the interviews under the data completeness category.

According to the codes related to the data completeness, there are what can be identified from the interviews while asking about the data completeness.

For the interviewee 1, his concern is Customs officers still prefer hardcopy document, and he mentioned that Customs should use the context-aware system as well [1:26].

For the interviewee 2, he also agreed that the context-aware architecture would improve the completeness of shared data, but the system must ensure that the context-aware architecture can detect the accuracy of the information otherwise excess shared information was not necessary to share in the system [2:8].

The interviewee 3 claimed that she would provide more completeness data because the architecture would be better than the current system in which mainly based on manual system—manually human verification [3:10].

The interviewee 4 also agree to share complete information because he believed that sharing complete information lead to a better condition of working between his company and Customs such as fasten the Customs declaration process and reducing Customs inspection [4:12].

The interviewee 5 claimed that she was not willing to work beyond what she agreed with her customers [5:5].

The interviewee 6 did not feel confident about how the context-aware architecture would work out for the completeness because she did not know whether people or the context-aware architecture made decisions to share information [6:20].

For the interviewee 7 also will share the same amount of information because he believed that this amount required by Customs and sufficed for Customs declaration [16:17].

### 6.1.3 Data timeliness

Data timeliness is the latest version of shared data. In the container shipping domain, shared data should be up-to-date and be shared on time. When businesses mentioned a time of data sharing and processing, they were coded as data timeliness. The table 13 in Annex 5 shows the coding from the interviews under the data timeliness category.

The last issue of the data quality is the data timeliness. The interviewee 1 said that he usually kept tracking his customers to send data to him so that he could work on these data [1:13].

The interviewee 2 claimed that data timeliness depended on people who filled the information [2:3].

The respondent 3 said that the technology would improve the data transferring time among businesses [3:11].

The interviewee 4 only claimed that the context-aware architecture would improve the data timeliness of the information sharing [4:13].

The interviewee 5 said that emailing was already sufficient for her as the method to share information [5:6]. She added that it took three months by vessel for delivering her products. So, she does not face the late of the information sharing issue.

The interviewee 6 also said that each party would work individually to retrieve data from the system--the context-aware architecture [6:23].

The interviewee 7 stated that the context-aware architecture would reduce paperwork so that the timeliness of sharing data would improve [16:18].

### 6.1.4 Willingness to share information

The table 14 in Annex 5 shows the coding from the interviews under the willingness to share information category.

Besides the results for the data quality's questions, the interviewees also reflected their opinions toward Customs which are related to the willingness to share information. These opinions are coded as "the willingness to share information" because some opinions cannot be classified into the data quality category.

The respondent 1 perceived Custom as an authorized party which he explained that it was better for him and his company to obligate with laws [1:28].

The interviewee 2 answered the question in the way that Customs should fulfill business requirements first before implementing a new architecture [2:13]. He claimed that if Customs was able to solve what he purposed, he believed that businesses would be more willing to share information to Customs. He proposed that Customs should enhance the speed of Customs declaration process and be precise with HS code interpretation [2:13].

The interviewee 3 mentioned that it is avoidable to share information with other parties such as Customs and rival company so that she would share information in any system [3:14].

The interviewee 4 stated that his company and he were willing to share information to Customs because it was avoidable to share data to Customs [4:14].

The exciting opinion is that sharing information depended on the intention of the declarant claimed by the interviewee 6 [6:26]. If the declarant intended not to share accurate information, they would

find a loophole of the system, and declare the Customs clearance and successfully pass through the process which skillful freight forwarders who were well-known of HS codes and system could aid businesses to do so [6:30].

#### 6.1.5 Discussion of results

Overall most interviewees were impressive with the application of the context-aware system. They claimed that the context-aware architecture was innovating and some of them claimed that it might improve the timeliness of sharing information and reduce the redundant processes of sharing information such as following up the documents from other parties. Besides its positive comments, the result from the interviewing appears that interviewee agreed that data timeliness needed to be improved in the information sharing system. The context-aware architecture might affect the data timeliness of the information sharing in the container-shipping domain. From the interviews, interviewees did not perceive the change in data accuracy and data completeness from the concept of the context-aware architecture as data exchange system in the container shipping domain, but data accuracy was an issue that can be identified from the interview.

### 6.2 The willingness to disclose information

The results from the interviews show that businesses share information because of the regulation. After explaining the context-aware architecture, the interviewees claimed that they would share information through the context-aware architecture due to the enforcement of the law by Customs—not the functionality of the context-aware architecture. Businesses perceive that complying with laws is the best solution to pass through the Customs declaration process. This finding is not unusual. As businesses perceive customs authorities as an authorized organization which businesses do not allow to negotiate with the Customs. Referred to the study of e-Government by Ramon Gil-Garcia, Chengalur-Smith and Dechessi(2007), the result reveals that the expectation of information sharing system is limited by the perception of users when they are managed by a controlled-oriented management style(Ramon Gil-Garcia, Chengalur-Smith, & Duchessi, 2007). Stakeholders in the control-oriented management feel that their opinions are not valued, their decisions are criticized, and actions by government officers are delayed. The perceptions by businesses reduced the favorable presumption of the information sharing system which the results are in the same direction as the results from interviewing businesses in the case of the context-aware architecture. Although the context-aware architecture might have an impact on the information sharing in the container shipping domain, the control-oriented management like the relationship between businesses and Customs might limit the perception of the context-aware architecture's benefits. Due to the role of Customs in the importing process, if sharing information through the context-aware architecture was obligated by Customs, businesses should share information through the context-aware architecture to obligated with Customs.

The lack of agreement on goals is another issue that can limit the perception of the context-aware architecture's benefits (Ramon Gil-Garcia, Chengalur-Smith, & Duchessi, 2007). According to the interviews, the interviewees mention the inconsistency of the document requisition by Customs officers. For example, the interviewee 1 said that "why this time they ask and last time, they did not ask." [1:21]. This represents the inconsistency of the Customs procedure that Customs officers will possibly ask for extra documents when businesses submit documents for the Customs declaration. As the requisition by the Customs constantly changes in each Customs declaration, businesses perceive the lack of the agreement among Customs officers as a negative perception toward the Customs. This case also applied to the requisition to submit hardcopy document to the Customs. Businesses still question about adopting the context-aware system since the Customs still request them to submit the hardcopy documents. This negative perception reduces the perception of the

benefits of the context-aware architecture leading the results that businesses will agree to share more information in the context-aware architecture not because of its functionality. Instead, they agree to share information because of the Customs regulation.

Moreover, medium-sized corporations such as the interviewee 2 and the interviewee 3 claimed they were willing to cooperate more with the Customs by agreeing to share more information through the context-aware system whereas the small companies such as the interviewee 7 and the interviewee 5 denied providing more information to the Customs. This finding also is not a surprising result. The larger-sized firms from both private and public tend to share more nonfinancial information than the small one (E. Karim, Robin, & Pinsker, 2013). In other words, the disclosure of the information is positively related to the firm size which is similar to opinions from the interviews.

In summary, we conducted semi-structured interviews with seven businesses. We asked them about three data quality dimensions which only data timeliness and data accuracy would affect while using the context-aware architecture as an information exchange platform. Moreover, interviewees had issues with the current data timeliness of the current process. We also found out that businesses had various feedbacks on sharing information to Customs. Firstly, they claimed that they were willing to provide information due to regulation. From the literature, we learn that the relationship between businesses and Customs is control-oriented management so that businesses would comply with Customs regulation in anyhow. Secondly, businesses claimed that Customs declaration procedure was inconsistency on the agreement. Sometimes Customs asked for more document, and sometimes they did not. Businesses perceived the inconsistency as a negative perception leading the biased feedback on the context-aware architecture. Lastly, the willingness to share information with other actors depends on the size of the firm. Although we did not interview large-sized companies, we found that interviewees from the medium-sized firms said that they were more willing to disclose information when compared to the feedbacks from interviewees from the small-sized firms. What we found out during the interviews will be applied for assessing the context-aware architecture which is conducted by the writer in the next chapter.



## 7 Implication

From the interviews' results, it appears that the interviewees do not completely understand about the context-aware architecture but, they clearly understand about the current process which they can point out what they want for an improvement. From the interviews, these three data quality dimensions—data accuracy, data completeness, and data timeliness—are assumed that they could improve the data exchange in the container shipping domain. This chapter compared the data quality dimension in the container shipping domain with the context-aware architecture based on my assessment.

### 7.1 Data accuracy

Data accuracy in the container shipping domain is that businesses share the closest value to their existing condition. In other words, businesses share exact data in the data exchange system. Privacy of the information sharing system is an important issue for businesses. There is information that businesses are not willing to share with other parties but sometimes it is avoidable to share this particular information. For example, businesses must provide chemical compositions to Customs when they import chemical compounds. Even this chemical compound was a trade secret of this business, Customs would have to ask for information due to the Customs regulations. This is an example that shows that some information that businesses are not comfortable to share with Customs and other parties. If businesses would want to avoid sharing the information, they might not share information accurately by sharing other information or avoid that process. Moreover, the security of data exchange system is considered by businesses. They are also afraid of their information being hacked or leaked by third parties, especially their trade secrets. Because of the security issue, businesses might also share only what they believe they can share to protect themselves from data hacking, leading to reducing data accuracy.

To possibly enhance the accuracy of shared data, businesses should be able to choose what they want to share but it should not violate a law. Considering the context-aware architecture, businesses can configure the condition of the share information and can select particular parties to share information. To illustrate this, a seller can choose to share Commercial invoice to a particular freight forwarder. To do so, the seller chooses to encrypt the document and share in the system which the particular freight forwarder is an only party that receives the key to access to that document. Furthermore, a repository of the context-aware architecture is using a blockchain to store the context. The blockchain is more secure than other technologies because it is difficult to change when data are accepted by other parties in the system. Because the data are hard to change, businesses' data should be secure from other parties to manipulate.

However, to improve the accuracy of data, not only could the context-aware architecture encourage businesses to provide more accurate information but also Customs should set the level of the accuracy of data that the Customs expect businesses to share. As it is avoidable to share information, Customs should set the standard procedure so that businesses would share useful information seamlessly to Customs and Customs can perform better in risk analysis. For example, HS code for Customs declaration should be interpreted as the same item in every country.

Hence, data accuracy plays an essential role in the data exchange between Customs and businesses in the container shipping domain. The context-aware architecture has a function that might influence businesses to share more accurate data, but Customs also must set the standardization for businesses so that businesses would know what they should share to be beneficial to Customs.

## 7.2 Data completeness

According to the data quality dimension, data completeness is to the proportion of shared data compared to the required data. For example, for submitting ENS to Customs, carriers must fill data in every category that Customs require such as gross weight, container number and so on. Otherwise, Customs will reject the submission and carriers are not allowed to load that container.

From exploring the current process's problems in the interviews, submitting complete documents to Customs seems to be a problem for data completeness in the data quality. As sellers and buyers are typically not specialized in international trading and Customs regulations, sometimes they unintentionally submitted incomplete documents referred to the interviewee 2's comment for incomplete data in the current process [2:12]. With helping from freight forwarders, sellers and buyers do not experience this problem directly but they have to amend the documents and send to freight forwarders several times until the documents are ready for submitting to Customs. When businesses have been exporting or importing for a long time, their systems are stable that they reduce a time for preparing shipping documents. For example, one interviewee from clothing manufacturer said that she did not experience incomplete data. The documents that she has prepared were standard and she provided the same set of shipping documents for twenty years. Otherwise, imported products are not targeting by Customs such as clothing. It can be implied the incomplete data problem depends on a category of imported goods and working experience. Submitting the complete data to Customs is important for businesses because the costs of storing containers in the warehouse are expensive. Businesses try to save cost by providing enough documents and data when they declare goods to Customs so that they pass the Customs declaration and deliver their containers to their destinations before being charged with extra fees.

Considering the context-aware architecture, it is unclear how the context-aware architecture could effect on data completeness. However, when analyzing the context-aware architecture thoroughly, if Customs stored the required document context in the repository, the sensor should be able to notify businesses about the requirement from Customs and encourage businesses to submit complete documents. Although the context-aware architecture might enhance the data completeness, many businesses are already submitting the shipping documents sufficiently to pass the Customs declaration by following either the guideline in the Customs procedure website or recommendation from freight forwarders. Because interviewees claimed that they already submitted shipping documents enough to meet Customs requirement, while asking the question related the completeness of data, businesses did not understand what they have to provide besides what they are currently providing, leading to unable to comment on the effectiveness of the context-aware architecture on data completeness. Therefore, the data completeness is important to the data exchanging system in the container shipping domain, but the context-aware architecture might not significantly affect the data completeness of the current process.

## 7.3 Data timeliness

Last but not least, data timeliness is a duration between when data present and when data are required. Data timeliness is a significant data quality element in the information sharing system between Customs and businesses which businesses agreed as well.

According to the interviews, businesses perceive two problems of data timeliness in the current process. The first problem is that the repetitive process of sharing information. When businesses share information with parties, sometimes other parties do not retrieve the information instantly. As they still use email to share data, parties will receive data when they open an email. For urgent case, some people would call to remind other parties to retrieve data. After that, if the data are needed to

be revised, emails are sent back and forth until the data are correct which it consumes time and reduce data quality. The second problem is the data processing time. Businesses claimed that it took time to receive data back from one party such as carriers. For example, it took more than three days to receive the Customs declaration results back from Customs. According to the port regulations, a container that store in a warehouse more than three days must pay an extra fee. Thus, businesses expect to do Customs clearance before paying an extra fee. Another issue that businesses brought up during the interviews is the requisition for hard copy documents by Customs. The process to issue hard copy document takes more time than the soft copy one because compared to issue soft copy documents businesses spend extra time on waiting for documents to be issued and then sending documents to other parties by post. Because of the requirement for hard copy documents, it takes for more time for Customs to approve the Customs declaration. Based on interviews, data timeliness also is important for businesses in the data exchange in the container shipping domain because all interviewees mentioned the timeliness of data sharing. Hence, if the context-aware architecture could improve the data timeliness of data sharing, the information sharing process in the container shipping domain would improve.

From analysing the context-aware architecture, the information flow planner, together with the context stored in the repository, would impact the data timeliness of the data exchange system. The information planner would manage the information by proposing the flow for exchanging data. All verified parties would receive the information immediately after the information is shared. Together with the context in the repository, the sensor would be able to verify what type of data should be shared with other parties before sharing the information. The context-aware architecture should at least reduce the amount of time in amending document and sending back and forth to other parties. However, only one flaw of the context-aware architecture is that users are notified of the incoming data or submitting the data. The context-aware architecture would not be able to improve the data timeliness if users themselves do not pay attention to incoming data. Hence, the context-aware architecture possibly improves the data timeliness by removing the repetitive process. To solve the data processing time, only the context-aware architecture could help is to increase the data transferring time. Because once data are shared in the system, all verified parties would receive data. Hence, the duration compared to the current process that data are transferred to other parties before they arrive would reduce because of reducing the number of intermediary parties. However, the data processing time depended on the parties. The context-aware architecture could only fasten the process of receiving data. Referred to the requisition for hard copy documents, the context-aware architecture cannot solve this issue because the context-aware architecture was designed based on the digitalization platform. To solve the hard copy documents, other systems such as e-certificate might be more relevant than the context-aware architecture, but it would be compatible with the context-aware architecture to enhance the data timeliness.

Therefore, the timeliness of data is essential in the import process in the container shipping domain, and the context-aware architecture could support parties in the system to receive the data faster.

In the implication chapter, three data quality dimensions—data accuracy, data completeness, and data timeliness—have an impact on the information sharing system in the container-shipping domain. However, only data accuracy and data timeliness could be improved by the context-aware architecture while it is unclear to what extent that the context-aware architecture could enhance the data completeness of the information since businesses would provide the complete set of shipping documents to Customs.

## 8 Conclusion

This section presents the conclusions of this research. In addition, section 8.2 provides recommendations for future research. Subsections 8.3 and 8.4 contain discussion on its limitations and further reflections on the research conducted for this thesis.

### 8.1 Conclusion

With the objective of enhancing safety and security, Customs officials believe that collecting high quality information from businesses will support them in performing more accurate risk analysis, which will in turn help them to effectively protect people from harmful situations. There are many system architectures designed to support Customs' objectives, such as the data pipeline from the CASSANDRA project and context-aware architecture. Context aware architecture is a system architecture designed to influence businesses in high-quality information sharing and improved compliance with Customs procedures.

The data quality dimensions were used to evaluate the architecture. The premise was that higher information quality will result in higher levels of compliance. Semi-structured interviews with small and medium-sized companies were conducted to explore the current situation of information sharing process, and to determine which data quality dimensions were relevant to fulfilling the objectives of this study. The interview candidates work in small and medium-sized companies in Thailand, the Netherlands and Belgium and their duties involve importing goods from Non- EU countries into the EU by container shipping.

The main focus of the research was to investigate the relationships between the context aware architecture and the data quality dimensions in the container shipping domain. Hence, the main research question for studying this relationship is: **How does introducing the context aware architecture affect data quality in the container shipping domain?** In the research it was found that only data accuracy and data timeliness are likely to be improved by sharing information using the context aware architecture.

To answer to the main research question, the following sub-questions were created to guide us to finding the answers. The research resulted in the following answers to the sub-research questions:

*1. What data quality dimensions can be applied for measuring the context-aware architecture's performance?*

After studying the literature about data quality, together with Customs regulations for importing goods into the EU, the data quality dimensions that are most suitable for evaluating the architecture are data accuracy, data completeness, and data timeliness.

The definition of data accuracy is "the closeness between a value  $v$  and a value  $v'$ , considered as the correct representation of the real-life phenomenon that  $v$  aims to represent" (Batini & Scannapieca, 2006, p. 23). The application of data accuracy to the import process is to measure whether businesses are providing accurate information to Customs. For example, have the businesses filled in addresses which match their actual registered company addresses?

Data completeness is "the degree to which all required information is present in a particular dataset" (Batini & Scannapieco, 2016, p. 130). The implications of data completeness are that businesses must provide complete information to Customs based on Customs regulations. For example, Customs asks businesses to provide their complete addresses, including street and

postcode. Thus, for the the data to be considered as complete, businesses must provide street and postcode when they submit address information.

Last but not least, data timeliness is “when the information was entered in the sources and/or the data warehouse”(Batini et al., 2009, p. 8). The implication of data timeliness relates to regulations that require businesses to submit information prior to shipment. For example, ENS must be submitted 24 hours before loading a container onto the vessel at the port of departure.

## *2. What does the current information sharing process look like and what are the issues with the quality of the data shared?*

After researching the working procedure from a previous study on information sharing in supply chains and my own interviews, it was found that that small and medium sized companies mostly hired freight forwarders —third party subcontractors— to transport goods to a port of entry, to load/unload goods, and to deal with Customs procedures in both the import and export of goods. The main medium of data exchange between businesses, in this case, buyers, sellers or product manufactures, and freight forwarders was email. The documents were submitted between the various parties by email. If hard copy documents were needed, the documents were sent by post or courier. EDI also played a role in information sharing as a platform for businesses to exchange data with shipping agents or with Customs. However, email was still used to speedily confirmation information such as ship bookings and for requests for further information by Customs. The demand by Customs for hard copy documents and the inconsistency of Customs' requests for information were problems that businesses find disconcerting with the current import procedure processes. But businesses are reluctant to adopt a new technology and prefer to continue using the traditional methods of data exchange, such as email, postal mail and couriers, which affects data timeliness for the entire process.

## *3. What does the information sharing process look like for businesses when applying the context-aware architecture?*

The biggest change to the current process, once the context-aware architecture is applied to the current information sharing process, is that the information flow planner takes control of information sharing based on the context information stored in a repository. Sellers only share the data and context information and then the information flow planner will manage the rest of information exchange (see figure 8 in chapter 5). Businesses must own data routers that share information according to an information flow proposed by the information flow planner. Moreover, businesses can choose the conditions under which to share data, for example, when the information flow planner is advised that a condition to share is that data needs to be encrypted. Then it must first manage the information by sending the data to be encrypted by an encryption component before sharing it with other parties. Customs can also easily access the various businesses' information because every party uses the same platform—the context aware architecture.

## *4. What are differences between a context-aware architecture and the current system in encouraging businesses to share higher quality of data?*

After analysing the data quality dimensions from interviews, the result was that data accuracy, data completeness, and data timeliness impacted information sharing between Customs and businesses in the container shipping domain. It was found that the context aware architecture could improve data accuracy and data timeliness. The data accuracy can be improved by the ability to sense and adapt to the context. Businesses would feel more secure because they can choose what they want to share with other businesses so that businesses are comfortable with revealing more information.

As for data timeliness, the ability to sense and adapt to the context would support businesses in sharing information because the context aware architecture automates part of the decision-making concerning with whom to share and when, and then it automatically shares the data appropriately. However, data completeness would not be impacted by the context aware architecture as the businesses claimed that they were already providing sufficient data to Customs.

To sum up, regarding the main research question, data accuracy, data completeness, and data timeliness in the data quality dimension are impacted by the information sharing systems used in the container shipping domain. Based on my assessment, data accuracy and data timeliness would be improved by using context aware architecture.

## 8.2 Recommendations

Although the context aware architecture might improve data quality, I would recommend waiting for other government ICT systems to be installed first and government regulations to be made more explicit so that businesses will have a clearer understanding about what Customs wants from them. The context aware architecture is designed based on the assumption that information is digitized, but the ICT infrastructure in the supply chain field seems to be technologically immature and technology adoption is slow. Besides data exchange systems, such as context aware architecture, other systems should be developed to digitize the supply chain and make the supply chain information more accessible. Although businesses may share more information in context aware architecture, if businesses share superfluous information in the system, the unnecessary information would more likely just waste time for Customs officials who are looking for particular useful information.

In addition, in the opinion of those interviewed for this study, before implementing the context aware architecture, Customs must resolve some issues.

The first recommendation is that Customs should not demand hardcopy documents from businesses. Rather a system for E-certificates should be implemented through which all certificates can be issued online, and then businesses can share these electronic certificates with Customs. This will assist Customs, not only by reducing paper work-generally, but also government officials would save time in the overall process by minimizing the need for printing and then sending certificates to businesses by postal mail or courier.

The second recommendation is that the Customs regulations should be made more explicit, and the Customs officers themselves must be more precise and consistent when verifying documents. In the opinion of those businesses interviewed for this study, they are willing to share information; however, Customs must provide more details on what they expect from businesses. Businesses will then be clear about exactly what types of information they need to provide to Customs. Moreover, the standardization of the document checking should be improved. Even businesses that have received AEO status must still present documents to Customs [2:9].

## 8.3 Limitations and further research

The data collection process had its limitations. The results may be biased due to several issues. The first bias is due to the complexity of the technology. Most interviewees did not completely understand the process of the technology, although, they claimed that they appreciated the concepts of the context aware and the associated technology. Some interviewees even claimed that they were too old to learn to adopt the context-aware architecture. The results from the interviews may come from the fact that the context-aware architecture sounds too innovative to them. The second bias is that the current information sharing system has not reached the necessary

digitalization levels. Businesses still use email as the principal system to share documents and other information with other parties. Context-aware architecture was designed based on the assumption that businesses and government were sharing information through digitized platforms. Therefore, the feedbacks from the interviewed respondents partly came from their understanding that the context-aware architecture will digitize the entire information sharing system in the supply chain and that Customs would not require them to send hardcopy documents.

Another limitation to the study was that all of the interviewees worked at small-or medium-sized companies. Future research should be conducted and can use the same process and the same interview protocol, but the sampling group should be expanded to large-sized companies or high-technology logistics companies such as *Maersk*, *DHL* and *Royal FloraHolland*. We assume that the large-sized companies might have already developed innovative data exchange systems which digitize data and automatically share data with other parties. Moreover, as they are technologically more mature companies, we expect that they would provide information that could assist in better evaluating the context aware architecture.

## 8.4 Reflection

Nowadays, many system architectures have been developed to improve the data exchange process and the visibility of the supply chain. To know exactly what is inside a container, Customs must inspect it (Hesketh, 2010). However, the number of containers often is so high that it is impossible for Customs to open each of them (Hesketh, 2010). Therefore, they need high quality information to perform risk assessment and target high risk containers for inspection (Hesketh, 2010). Not only should more information be acquired for this, but also the shared information must be of high quality. Accurate, complete, and timely data would facilitate Customs processing by forcing businesses to be compliant with regulations, allowing Customs to be able to identify and inspect the highest risk containers for illegal items and to appropriately punish either importers or exporters who try to illegally smuggle goods via sea containers. As the ability of Customs to enforce regulations improves, misbehaving businesses have a higher chance of being caught, so businesses would be less likely to risk engaging in illegal behaviour, resulting in improving a level of compliance in the container shipping domain.

Considering the context aware architecture as a solution, this architecture was designed to support businesses in sharing more high-quality information by using context awareness to detect the context of the shared information and then adapt. The concept of the context-aware architecture is sound, and I believe that the context aware architecture is an appealing architecture for businesses who need to share more high-quality information. However, if I were looking to invest in an innovative architecture to improve information sharing in the supply chain, I would not invest in this architecture at this time. I would prefer to be able to evaluate more tangible aspects related to this architecture, such as the interface and the hardware that would be necessary to implement this architecture. While I believe that the concept of the context aware architecture has the potential to encourage businesses in sharing more helpful information with Customs resulting in improving compliance, but it is too early to make a decision to invest based on only an abstract concept.

As a Management of Technology (MOT) student, the courses from this program helped me to understand how technology can be designed, developed, and adopted at the corporate level. These following courses from Management of Technology curriculum help me doing this thesis:

- **Business Process Management and Technology** for introducing concepts where ICT meets with businesses and concepts of business-to-government information sharing architecture. Furthermore, this class taught me how to draw BPMN diagrams.

- **Technology, Strategy and Entrepreneurship** for understanding the technology adoption model which reflected on the interviewee feedback during the interviews. Although TAM model was not mentioned in the thesis, TAM model guided me in providing recommendations to architecture designers.
- **Inter- and Intra- organization Decision Making** for understanding about the trust and willingness of businesses to reveal insights or to comply with rules, which is similar to a command and control relationship.
- **Research Methods** for introducing how to conduct a research with business and building upon the concept of qualitative research.
- **Preparation for Master Thesis** for guiding me to search for a thesis topic, to research for a main research question and to choose a thesis methodology by writing a thesis proposal.

The most challenging part of conducting the research for this thesis was that this research was my first qualitative research project and my first research on an ICT topic. Qualitative research differs from quantitative research in terms of collecting data and interpreting results from the collected data. The data collection was conducted during summer in the Netherlands in the midst of a holiday period. It took much effort to find appropriate interview candidates to complete this research. Moreover, interpretation of the interviews was even more challenging. The precise wording and tones of the interviewees can have indirect meaning to analysing the content of the interview, which differs from quantitative research where numbers speak for everything. For example, if an interviewee answered the interview question promptly, it can be interpreted that he either understands the content clearly, or perhaps did not understand it at all. To prepare for conducting good qualitative research, a lot of training is needed to get the most meaningful insights from interviewees. Afterwards, transcribing interviews is a hard and time-consuming process. Unfortunately, I did not include my interview transcripts in the Annex, as this aspect of my research consumed a disproportionate amount of time in translating the interviews from Thai to English. As this was my first thesis related to ICT, I have learned a lot while conducting this thesis research, such as evaluating software architecture, blockchain, information exchange systems, and so on. It was a challenge to learn these aspects by myself, but I appreciate the knowledge gained from what I have done to fulfil this research.

For answering the main research question, I reviewed many papers related to ICT and the supply chain management. I read several research reports from the EU-funded projects to improve the visibility of the supply chain, which I have discovered that the data quality is an issue in the exchanging data system. From reviewing data quality's literature by *Batini* and *Scannapieca*, and the EU regulations, I found that data accuracy, data complete and data timeliness are applicable for measuring the improvement of the data quality in the container-shipping domain. For improving these data quality dimensions, the potential technology must be able to assess the accuracy, the completeness and the timestamp of the information. Although the context-aware architecture does improve the data quality, the next challenges for system designers are data privacy, the identification of data and cybersecurity. First, when businesses share more data, how Customs authorities can ensure business about the privacy of data's owners? Second, as all documents will be digitized, without signature how Customs authorities can ensure that documents are not forgery? Lastly, as the information flow planner control the flow of the information, the information flow planner is prone to be hacked. Therefore, the cybersecurity will be an essential issue for the context-aware architecture because data must be protected.



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## 10. Annex

### Annex 1: Asking permission to interview letter

#### In English

To whom it may concern

My name is Tanya Tapaneya-Olarn. I am a 2nd year MSc student at TU Delft, the Netherlands. I am conducting research for my MSc thesis related to the information sharing system between Customs and businesses. The research objective is to validate a new software architecture--the context-aware architecture. The context-aware architecture is a conceptual model which a PhD candidate had developed to facilitate trades and to become more digitalized; it is aimed to be applied in the process of importing goods by sea containers from Non-EU country to Europe in order to improve data quality of information sharing. In this interview, the definition of the information sharing is to provide shipping documents such as a commercial invoice and Entry Summary Declaration (ENS) to other parties such as businesses and Customs. The next step is to validate the conceptual model.

This letter, therefore, is an inquiry to interview your personnel who are involved in the process of sharing information with either businesses or EU Customs. A prospective interviewee can be working in the role of an importer, a carrier or a freight forwarder. This interview focuses on the export from Non-EU and the import into Europe in the containerized shipping domain.

This interview consists of three parts:

1. Background information of the company and the interviewee
2. The current importing processes
3. Validation on the conceptual. (Pictures of the process, the use scenarios will be shown to the interviewee during the interview.)

Duration of the interview: around 30 to 40 minutes.

Arrangement of the interview: the interview can be conducted via either face-to-face or phone interview.

If there are any of the specified personnel functioning at your company, I would like to ask for a permission for an interview. This interview would contribute to my learning on the current and actual importing process and help me gain insights to improve the context-aware architecture.

Looking forward to hearing from you.

Kind regards,

Tanya Tapaneya-Olarn

## In Thai

เรียน ผู้ที่เกี่ยวข้อง

ดิฉันชื่อธัญญา ตปNEYโอพาร(วัน) กำลังศึกษาปริญญาโทที่มหาวิทยาลัย TU Delft ประเทศเนเธอร์แลนด์ ตอนนี้ดิฉันกำลังทำวิจัยหัวข้อเรื่อง ผลกระทบของ The context-aware architecture ซึ่งเป็นระบบใหม่ที่ถูกพัฒนาขึ้นมาโดยการสนับสนุนของ EU commission ในกระบวนการนำสินค้าด้วยตู้คอนเทนเนอร์ทางเรือจากเข้ามายังสหภาพยุโรป ระบบใหม่ถูกออกแบบมาเพื่อปรับปรุงคุณภาพข้อมูลที่แชร์ระหว่างธุรกิจต่าง ๆ เช่น สายเรือ , Freight forwarder กับศุลกากร ตัวอย่างของการใช้งานคือ การส่งเอกสาร Commercial invoice, Packing list ไปยังศุลกากร เป็นต้น เนื่องจากระบบนี้ยังเป็น Conceptual model สิ่งที่เป็นเนื้อหาในการวิจัยคือการศึกษาผลกระทบที่อาจจะเกิดขึ้นเมื่อมีการใช้ระบบ

### การสัมภาษณ์

ผู้ถูกสัมภาษณ์ : ผู้ส่งออก , freight forwarder หรือ สายเรือ

เนื้อหาของการสัมภาษณ์ : กระบวนการนำสินค้าด้วยตู้คอนเทนเนอร์ทางเรือจากเข้ามายังสหภาพยุโรป

### ขั้นตอนการสัมภาษณ์

1. สอบถามรายละเอียดทั่วไปของผู้ถูกสัมภาษณ์
2. สอบถามกระบวนการทำงานของผู้ถูกสัมภาษณ์โดยภาพรวม
3. ประเมินระบบ Context-aware โดยการอธิบายกระบวนการส่งออกโดยใช้ Context-aware แล้วสอบถามความคิดเห็น

ระยะเวลาในการสัมภาษณ์ : 30 นาที ถึง 1 ชั่วโมง

รูปแบบการสัมภาษณ์ : สัมภาษณ์ทางโทรศัพท์ผ่าน Skype , Line call หรือ Facebook Messenger

จึงเรียนมาเพื่อขออนุญาตสัมภาษณ์ หรือ แนะนำบุคคลที่เกี่ยวข้องเพื่อนำข้อมูลไปในการทำวิทยานิพนธ์และนำไปปรับระบบ Context-aware

เรียนมาเพื่อทราบ

ธัญญา ตปNEYโอพาร



## Annex 2: Interview protocol

### Introduction

First of all, before we start, I would like to ask for a permission to record this interview. I am a 2year master student from TPM, TU Delft. Currently, I am doing my thesis about an impact of the context-aware architect regarding increasing a level of compliance. This record will be used to understand and analyze a current process of submitting information between Customs and businesses in which Customs will use particular information to perform risk assessment and Customs declaration.

To perform risk assessment, carriers are required to submit ENS to Customs so that the Customs can perform risk analysis and decide to accept this cargo before loading to a ship. However, when cargoes arrive in Europe, some cargoes will be inspected by Customs again. When a ship arrives at the port, goods will be unloaded and go through Customs declaration. If these goods meet all compliance and are paid for duties, the goods are released for free circulation. Some goods might be detained for further inspection. These decisions depend on Customs' analysis. To improve this process, the context-aware architecture is created to support businesses to share more information so that businesses would be more compliance to the regulations and reduce the number of inspecting cargoes.

The objective of this interview is to understand the current process of information sharing system between Customs and businesses, and to ask for opinions to improve the architecture.

### Question

#### 1.Introduction

##### Opening

1. Name
2. Company
3. Position
4. Responsibility
5. How long have you been working for this company?

##### How is information currently shared?

1. What is the current information sharing process to Customs?
  - a. What parties are involved in the information sharing process?
  - b. What systems are involved in the information sharing process?
  - c. What software do you use for sharing information to businesses and Customs?
  - d. What is a benefit of using this system?

#### 2.Transition questions

(If the company use the simple information sharing system)

2. What do you think is a problem while sharing information to Customs?
  - a. Do you have any difficulty in providing enough detail to Customs? (data accuracy)
  - b. How about a problem in providing more information regarding the shipment? (data completeness)
  - c. How about a problem related to information's currency?

(If the company use the digitalization platform to share information)

2. What would you like to improve for this current system to share information with Customs?

- How about providing enough detail to Customs? (data accuracy)
- How about providing more information regarding to the shipment? (data completeness)
- How about the currency of shared information?

### 3. Research question

#### Scenario of the current system

This current process by BPMN is adapted from Yantian - Felixstrowe trade lane, a trade lane between China seller and UK retailer in Free on Board term, from CASSANDRA project. The parties in this trade lane are China seller, a freight forwarder in China, Shipper agent, a freight forwarder in UK, UK Customs, and UK retailer. The INCOTERM is Free On Board (FOB), a term of agreement that a seller is responsible for in term of risk a good when it is loaded on a ship. The information sharing systems in this trade lane depended on each company's system. It can be email or Electronic Data Interchange (EDI) but the main idea is that each stakeholder push information into the system. The flow of information is explained in the figure 1.

Information sharing between businesses and EU customs for importing by sea from Non-EU country based on FOB term

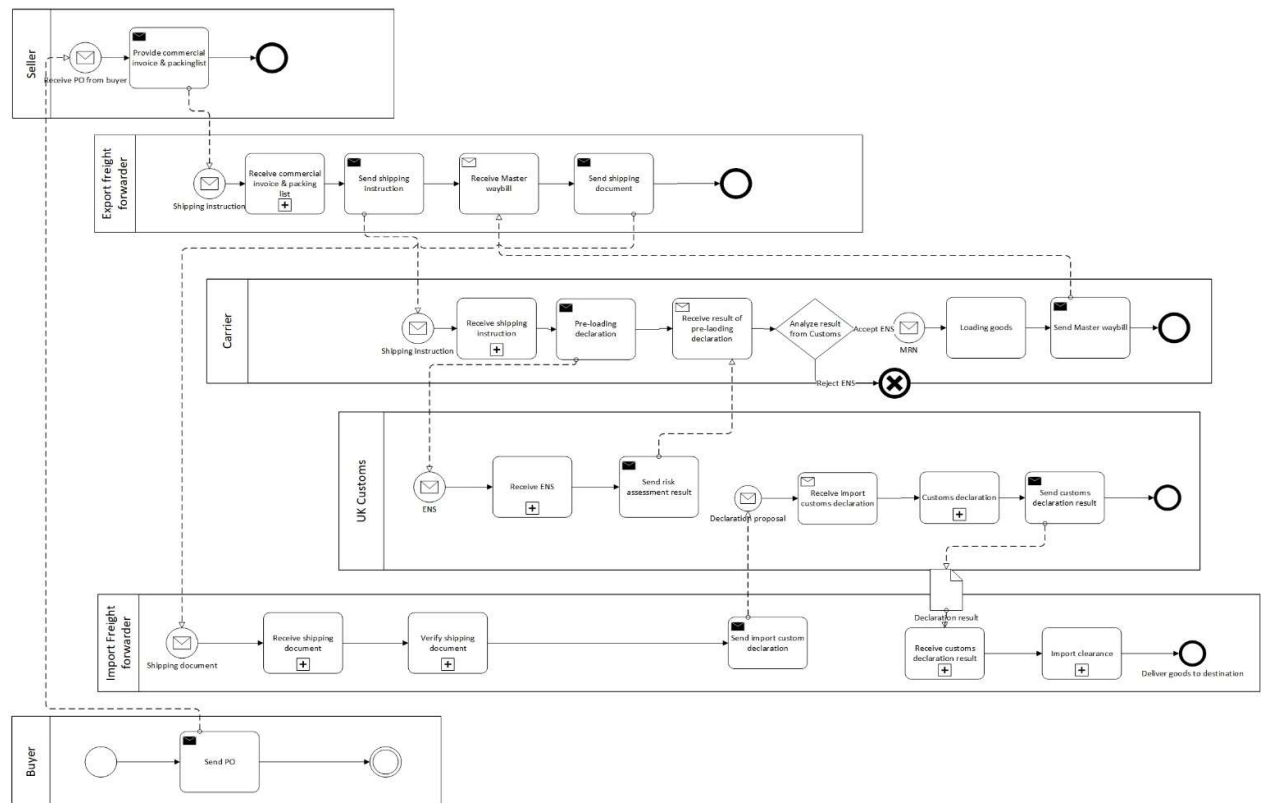


Figure 12 current scenario in FOB term

- Do you agree with this current situation that I propose to you?
- Do you have any question about it?

### **Process with the context-aware architecture**

This is a picture of information sharing process adopting a context-aware architecture. A context-awareness is to be able to sense and adapt to context. In the other words, the context-awareness is an ability to sense and adapt to context. The context-aware architecture supports on lawfulness and willingness to share information in the containerized shipping domain. The lawfulness is to obligate with laws such as data protection law, competition law and IP law. Willingness is that businesses is willing to share information, and Customs would receive more information so that they can perform risk analysis. The overall architecture consists of sensors, repository, decision component and adaptors.

- Sensors provide context information that is stored in blockchain. Sensors can detect certain context of information whether information can be shared to certain parties.
- Repository is to store information. In this case, blockchain is used for storing information.
- Decision component is to plan where information should flow.
- Adaptor is to share data to the proposed flow and to receive access requirement from other parties. In this system, we will use data router which is a specific used router tailored for sharing data. Moreover, router can operate some actions on data. For example, it can send data to encryption component.

In this case, the concept is applied to the container shipping domain. Referred to the previous scenario in the figure 1, the figure 2 shows how the context-awareness applies.

When businesses share information, data will be sent by data router. The data router will send a request to an information flow planner. The information flow planner will check the context information which the business as a user stored in the repository. Then, the information flow planner proposes the flow to the data router and the data will be sent to the right parties. For example, a seller shares a commercial invoice and a packing list to the trusted a freight forwarder and a shipping agent. Because the documents are set by the business either to share or to not share to the particular freight forwarder and carrier, the information flow planner detected these criteria and proposed information flows based on the criteria. In this case, the business chooses to reveal the document to only trusted parties. Thus, the documents are assigned by the information flow planner to the encryption component to encrypt the document with a key. The encryption component will send the key to the trusted parties, in this case the freight forwarder, to unencrypt data and they can access to data. In addition to, Customs will pull information from this system. Customs will send a request to access to businesses via data router and the information flow planner will propose the flow of data to the request. Mandatory information requested by customs will be inspected, but businesses can choose to provide key to the Customs. Moreover, because history is stored in the repository, the Customs can check the information from the history. Based on the figure 2, the Customs has to send the requirement via a data router to the information flow planner to get access to ENS and declaration forms.

Information sharing between businesses and EU customs for importing by sea from Non-EU country with an implementation of the context-aware architecture

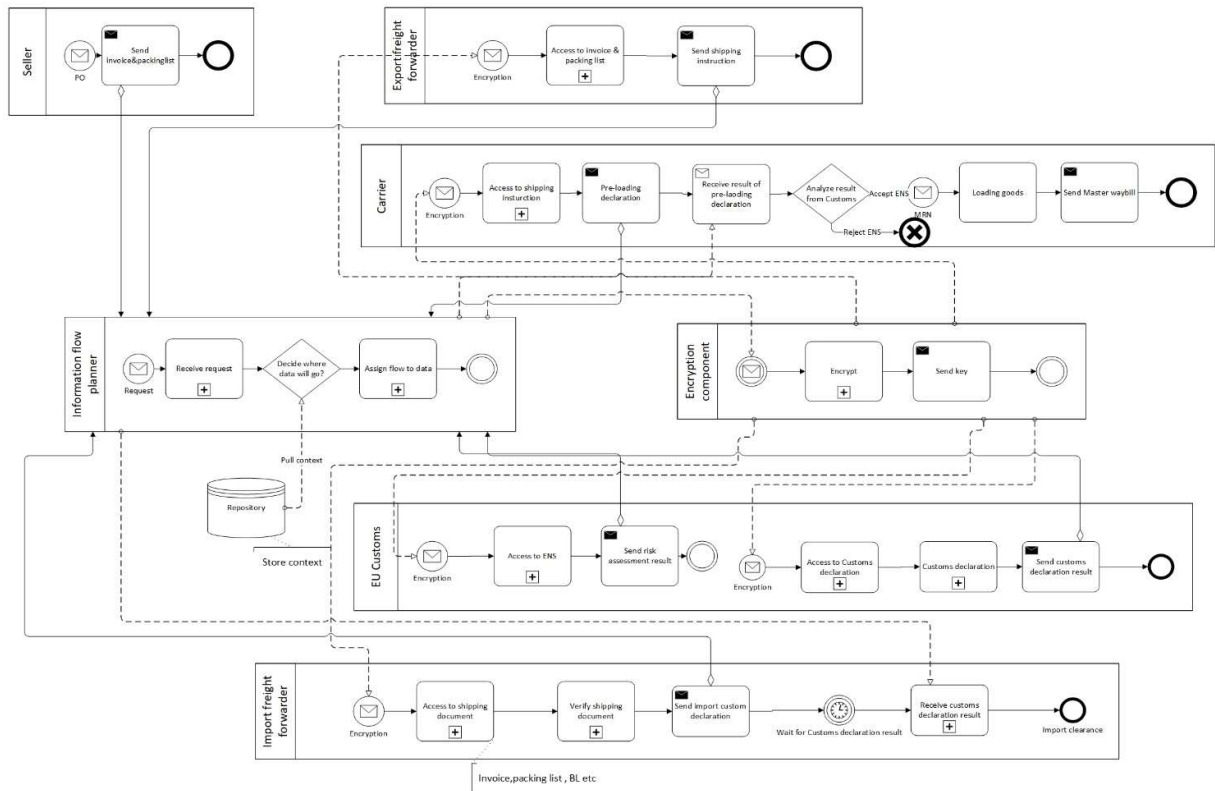


Figure 13 Scenario with applying the context-awareness

According to the mentioned scenario, if you have to use this system:

1. How do you like this new process?

a. Will you share more detail about the shipment while using this system?

Why?

b. Will you share more information regarding the shipment while using this system?

Why?

c. Will you share information on time while using this system?

Why?

2. How can we do to improve the willingness to provide more information?

3. In the future, Customs is considered rewarding businesses such as providing privilege trade lane with less inspection or give you an AEO status. According the Customs reward, the context-aware architecture is the architecture that supports them. What do you think about sharing more information to Customs?

4. Closing

1. Do you have any suggestions or feedback concerning our research?

2. Could you suggest other people that are interesting for us to interview to evaluate the architecture?

3. Would you like to be kept up-to-date on the progress of this research?

### Annex 3: Interview codes related to the current import process

Table 7: Current process

Code	Respondents	Source	Dialogue
"Current Process"	Interviewee 1	Transcription	<p>"They own the website. They will give us like account, password, login and we send instruction booking by website..EDI." [1:9]</p> <p>"Normally, for the customs clearance, everything is in the EDI system. We put every information like HS code, bill of lading, and filling in EDI and send. Normally, everything is ok. It is fine. But sometimes, they are asking for complete document or please send more detail for these goods or send photos of these goods. In that case, they will send an email." [1:10]</p> <p>"So, we reply one by one for each. For example, we are importing a lot car's auto parts because many of our customers work for the car industries like Toyota, Honda and supply their group company. Customs will ask which kind of auto part it is? It made by steel or aluminum or plastic. They ask for some kind of special. So, we reply them one by one." [1:11]</p> <p>"By the system, mostly update maybe. For example, now shipping liner by customers. Tracking system. We just access website and fill in container's number and then it shows where the container is now. Yesterday, visiting Singapore or landing at Antwerp. It is a real-time updated. I think always it is automatically updated. So, always updated system gives us useful information." [1:12]</p> <p>"I email in English. They reply in Dutch. It depends on person. Yes. Some officers is ok and very kind and reply me in English but some officers reply in Dutch." [1:14]</p> <p>"We do have this kind of system and customers will send us a password and a kind of link of the website and fill the password and we can receive or download the packing list." [1:24]</p> <p>"One more thing...they will request... the original document or by paper... or hard copy. Important documents. For example, we import a lot of food stuffs. The food stuff is very complicate. We need to send them the health certificate and we need to include with paper and it is hard for human to prove so we have to prove them by document. It says the health certificate, but it is not by PDF. It is only in the original and we receive by courier from Japan and also bring to the Customs officer by hand." [1:25]</p>
	Interviewee 2	Transcription	<p>"We use email for communication and at the present we use Group Line. It is very speedy. For important issues we will use email for confirmation." [2:1]</p> <p>"We still use original paper documents most of the time even though there is LPI from FDA (Food and Drug Administration). The importer/representative still</p>

			need to bring the original documents to submit to FDA.”[2:2]
	<b>Interviewee 3</b>	Note	<p>“To arrange the shipment, she books a vessel to load crude oils, prepares documents for customs declarations and co-ordinates with an operation team to unload crude oil into the tank. She said that the documents should be carefully prepared. For example, Pro Forma invoice must indicate crude oil’s description, a price referred to Brent crude oil price on that certain month, a vessel number, a port of loading, a port of unloading, American Petroleum Institute gravity (API gravity), INCOTERM, and a volume of crude oil. She also drafts the Single Administrative Document (SAD) and send to her managers to approve and to inform a financial department to pay supplier and tax duties. After the documents are checked and approved by managers, she contacts a Customs brokerage to do Customs clearance for company 3. During the Customs clearance due to the specific procedure of Customs clearance for crude oil, Customs officers go to the port of unloading to check and then give permission to release goods. The officers check the current Brent crude oil price and API gravity value. Due to a special API gravity of particular crude oil, the company hires the third-party specialist to cross check with the Customs officers. After inspecting the imported crude oil, company 3 pays the tax duties of crude oil by hand cheque. Then, Customs release goods which a Customs broker transports crude oil to particular destinations.”[3:1]</p> <p>“She must carefully verify Pro Forma Invoice, insurance and the SAD because the Customs were strict with these details:”[3:11]</p> <p>“Custom broker supported her work by sending email to inform the status of her work.”[3:12]</p>
	<b>Interviewee 4</b>	Note	<p>“To either import or export, the interviewee used freight forwarders to work for the company. The documents were sent by email. For the importance case, he would call the freight forwarders or the suppliers to track the orders or the shipment.”[4:4]</p> <p>“Moreover, he asked the international suppliers to get the bill of lading in form of Surrender B/L or Telex-release B/L because the customs clearance will be done without using the original document. There was a case that one of his colleagues lost the original house sea way bill. They had to report to the police about losing an original bill of lading and showed Customs the police notice to release the goods.” [4:5]</p> <p>“He asked international suppliers to send commercial invoices and packing lists by email.”[4:6]</p>

			<p>“the company thoroughly and repeatedly checked the documents.”[4:11]</p> <p>“Documents and data presented to Customs are thoroughly verified by officers several times before submitting to Customs or sending freight forwarders”[4:12]</p>
	<b>Interviewee 5</b>	Note	<p>“According to the interview, company 5 is responsible in manufacturing and shipping customers’ orders to a sea port. The goods are delivered by a freight forward arranged by the seller from the factory to the vessel. When the goods arrive at the sea port, the freight forwarder places goods at a certain carrier to which a buyer has assigned. The buyer chooses carriers based on sea freight prices that they offer so a carrier for each delivery will change, and company 5 will be informed about in-charged carriers. Company 5 receives the vessel’s name and carrier’s phone number from the buyer and assigns the forwarder to transport the orders to the vessels. The rest processes of shipping the orders are the client’s responsibility. Shipping documents that company 5 provide to the seller consist of commercial invoices, packing lists, bills of lading and certificates of origin. The communication between company and its stakeholders are done by email and telephone. The documents are mainly shared by email and sometimes by post. The interviewee has a positive feedback toward sharing documents by email. She claimed that sharing documents by email saves costs because sending documents by post, especially by courier is costly. Moreover, she emphasized that digitalized document format saves her cost of sending documents by courier. Although the seller’s responsibility ends at loading the order on board, the seller still has to send bills of lading, issued by carriers, to the buyer. The bills of lading that can be sent by email are Surrender bills of lading. The buyers need Surrender bills of lading from the sellers to confirm that the orders are loaded on vessels successfully.” [5:1]</p> <p>“The interviewee confirmed that completeness of documents is done by reviewing documents by both buyer and seller. The documents are revising until the acceptance by the buyer. After that, the shipping documents are shared to other stakeholders such as freight forwarders, carriers and Customs.” [5:2]</p>
	<b>Interviewee 6</b>	Transcription	<p>“For dealing with customers, there are many types of customers. Sometimes, we can sell freight services to them, but they have their own freight forwarders. We will coordinate with customers’ freight forwarders. If they use all of our service, I will send a team to wait at the port of loading for receiving <i>Shipping instruction</i></p>



		<p>and prepare to perform exporting Customs declaration.” [6:1]</p> <p>“Dealing with ship agents, each ship agent has different system. Some of them request me to send emails directly and their customer service officers will follow up data from customers for me. Some of them request us to register in their system and then I will receive confirmations from them by email.” [6:2]</p> <p>“For example, for Hyundai, I have to book in its system and Hyundai will confirm the booking which it manages everything for me. What I have to do is to inform the date I plan to return a container and to stuff goods into the container. Hyundai will put the requirement in the system, send confirmation email to me, and print and give the shipping instruction to a vessel operator. In case that we need Master B/L and customers do not want to pay for service, which costs 1,200 baht, I can issue Master B/L in Hyundai’s system by myself. To do so, I have to log into Hyundai’s system, fill information and print B/L from the system. If customers need original B/L, I can ask the ship agent to prepare documents.” [6:3]</p> <p>“they have their own system. They do not receive my phone call for booking vessels, but they will send us Website links to register in their system and wait for them to confirm our registration with username and password.” [6:8]</p> <p>“It is slow in responding a booking confirmation back which I need this booking confirmation for my customers so that they can plan with their factories and whatever. Sometimes, I have to call their sale representatives to hasten them to push their Customer Service to send emails to her because of late confirmations. For example, for Hyundai system, I booked the vessel at 9 am. I would receive the fastest confirmation at 11 am.” [6:13]</p> <p>“it is not final confirmation. I have to wait for the email from them for the confirmation.” [6:14]</p> <p>“I called the sale person to accelerate the process.” [6:15]</p> <p>“we have to carefully check the detail again before submitting information, but for the time-related problems, it is limited” [6:16]</p> <p>“Similar to China Customs” [6:29]</p>
	<p><b>Interviewee 7</b></p>	<p>Transcription</p> <p>“the actual clearing and the contacts with the customs are we have an agent. That's we don't do that ourselves.” [16:3]</p> <p>“We send the purchase order to the suppliers. And in this case, Unicord. Once the goods are produced and loaded in a container and that container is on board of the vessel and the bill of lading is drafted and issued as</p>

		<p>you know. So once the B/L is back at the supplier. We get a copy of the documents. We get a copy of the invoice, a copy of packing list and a copy of bill of lading. For us, this is also the point that we take the goods from stock because we buy them free on board. The goods are on board so we are responsible to stockholders in that case.” [16:4]</p> <p>“we get the full set of documents which usually take one and a half weeks. Before arrival we get the original sets of documents and that we hand over to our agents and they give the documents to the customs and the Health authorities. And the thing is it is tuna. It is a veterinary product so it needs to be subjected to a health inspection. And for this the authorities need original paper, hardcopy documents.” [16:5]</p> <p>“we give the documents to our agents and they take care of get the contact with the customs and with the health authorities. So they hand over the documents to the customs so the health authority.” [16:11]</p> <p>“They have to be subjected to veterinarian inspection and this can only take place based on original hard copy documents.” [16:12]</p> <p>“They’re not only our customs agents but they are actually also freight forwarders. So they are like a double role. They arranged the transport. They take also the container from the terminal after the authorities released everything. And they also transport the container to our warehouse, but this is not necessarily the same party that this could be two or three parties would be involved.” [16:13]</p> <p>“Well the thing is we cannot do it only by e-mail because the documents have to be original hard copy documents so that we can send them copies scanned copies by e-mail. Just notify them. Okay this container is coming. Prepared. Maybe you can already fill in some systems to prepare everything but that is a real process only starts once we receive the original documents from Thailand and then we have to physically hand over the original documents that can be issued to the Customs.” [16:20]</p> <p>“Well, we need to issue for them to release the goods are invoice, packing list with lot codes, a certificate of origin, a health certificate and catching certificate.” [16:23]</p> <p>“In that case the other documents that are more related to the veterinary inspection, health certificates and catching certificates. We get later because they are not issued by the Department of Thai fishing immediately. It takes some time.” [16:28]</p>
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Table 8: Current information sharing system

Code	Respondents	Source	Dialogue
Current Information sharing system	Interviewee 1	Transcription	<p>“email”[1:1]                      “email”[1:3]                      “But some shipping line. They also use like a..EDI this day. They own the website. They will give us like account, password, login and we send instruction booking by website..EDI.”[1:4]                      “Difficult. They are working with several like eight or ten shipping liner. And EDI of shipping liner are different. Some companies are ok with EDI.” [1:5]                      “Some companies prefer email.”[1:6]                      “Some companies ask in fill in their website”[1:7]                      “Normally, we use one of the shipping that EDI system.”[1:8]                      “I email in English. They reply in Dutch.”[1:15]                      “,for the customs clearance, everything is in the EDI system.”[1:16]                      “please send more detail for these goods or send photos of these goods. In that case, they will send an email.” [1:19]</p>
	Interviewee 2	Transcription	<p>“email” [2:3]                      “Group Line” [2:4]</p>
	Interviewee 3	Note	<p>“Dealing every party in this process, she uses phone call and email to communicate among parties.”[3:2]                      “She mentioned that only submitting the SAD is used a special software created by Thai Customs, but this process is done by a third-party Customs broker.”[3:3]                      “sending email to inform the status of her work.”[3:13]</p>
	Interviewee 4	Note	<p>“The documents were sent by email.”[4:2]                      “For the importance case, he would call the freight forwarders or the suppliers to track the orders or the shipment”[4:3]                      “send commercial invoices and packing lists by email.” [4:7]</p>
	Interviewee 5	Note	<p>“email”[5:5]                      “telephone” [5:6]                      “sometimes by post.” [5:7]                      “The documents are mainly shared by email” [5:8]</p>
	Interviewee 6	Transcription	<p>“Some of them request me to send emails directly and their customer service officers will follow up data from customers for me.”[6:4]</p>

			<p>“Some of them request us to register in their system and then I will receive confirmations from them by email.” [6:5]</p> <p>“They do not receive my phone call for booking vessels, but they will send us Website links to register in their system and wait for them to confirm our registration with username and password.”[6:9]</p> <p>“website.”[6:10]</p> <p>“I do not book Maersk, but I will book Maerk’s subsidiary company like MCC which I book a vessel in their system”[6:11]</p> <p>“booking a vessel in their EDI”[6:12]</p> <p>“I used email.”[6:20]</p> <p>“I have to wait for the email”[6:23]</p>
	<b>Interviewee 7</b>	Transcription	<p>“Email”[16:9]</p> <p>“telephone”[16:10]</p>

Table 9: Stakeholders

Code	Respondents	Source	Dialogue
"Stakeholder"	<b>Interviewee 1</b>	Transcription	<p>“customers, shipping liners...and Customs sometimes Customs, trucking company”[1:2]</p> <p>“some shipping line”[1:17]</p>
	<b>Interviewee 2</b>	Transcription	<p>“Customs, Department of International Trade Promotion, Ministry of Commerce, Royal Forest Department, Department of Fisheries, Department of Industrial Works”[2:5]</p> <p>“FDA”[2:7]</p>
	<b>Interviewee 3</b>	Note	<p>“a third-party Customs broker.”[3:4]</p> <p>“Customs broker”[3:5]</p> <p>“a Customs brokerage to do Customs clearance for my company.”[3:6]</p> <p>“Custom broker”[3:14]</p>
	<b>Interviewee 4</b>	Note	<p>“freight forwarders”[4:1]</p> <p>“freight forwarders”[4:8]</p>
	<b>Interviewee 5</b>	Note	<p>“freight forwarder”[5:3]</p> <p>“a certain carrier”[5:4]</p>
	<b>Interviewee 6</b>	Transcription	<p>“ship agents”[6:6]</p> <p>“customer service officers”[6:7]</p> <p>“customers” [6:17]</p> <p>“ship agents”[6:18]</p> <p>“freight forwarders.”[6:19]</p> <p>“sale representatives”[6:21]</p>
	<b>Interviewee 7</b>	Transcription	<p>“importer”[16:1]</p> <p>“an agent”[16:2]</p> <p>“NVWA –Netherlands Food and Consumer Product Safety Authority”[16:6]</p> <p>“Customs—Health authorities”[16:7]</p> <p>“agents”[16:8]</p>

			"Department of Thai fishing immediately."[16:14]
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Table 10: Other findings

Code	Dialogue
"Cost"	"cost of delivery" [2:8] "storage charges" [2:9] "demurrage" [2:10] "additional warrant money." [2:11] "The delay in the unloading goods led to pay demurrage fee"[3:17] "As a result, the Customs fined company 4."[4:10] "pay a demurrage cost"[4:14] "demurrage charges"[4:15] "especially by courier is costly"[5:9] "Free of demurrage."[16:26] "we have to pay extra to the carrier. That is the concern."[16:27]
"Incomplete data"	"insufficient document issues"[2:12] "It turned out...that...a system of <i>Department of International Trade Promotion</i> does not provide enough space to include every detail in the Form E compared to B/L."[6:26]
"Inconsistency"	"why this time they ask and last time, they did not ask".[1:21] "sometimes, they are asking for complete document"[1:22] "The Customs officer claimed that the company declared one item with wrong HS code"[4:9]
"Language issue"	"some officers reply in Dutch"[1:18]
"Original paper documents"	"original paper documents"[2:6] "hard copy of documents,"[3:7] "original sets of documents"[16:16] "need original paper, hardcopy documents"[16:17] "this can only take place based on original hard copy document"[16:18] "the documents have to be original hard copy documents"[16:19] "original documents with all the stamps and all the seals from the Thai authorities."[16:21] "physically hand over the original documents"[16:22]
"repetitive work"	"We have to ask customers and of course customers have to prepare document."[1:20] "They ask for some kind of special. So,we reply them one by one."[1:23] "I submitted Form E 5 times, and the Chinese Customs rejected all of them and explained reasons why they rejected the application."[6:28]
"Timeliness"	"related to time"[3:8] "it took 2 to 3 days by courier"[3:10] "it took some time to communicate among parties"[3:16] "but when a plenty of emails were sent to his email, he could not manage all of them causing the delay of order processing."[4:13] "The interviewee claimed that she did not have any problem with data timeliness because it took three or four weeks for goods to arrive at Italy."[5:11] "I booked the vessel at 9 am. I would receive the fastest confirmation at 11 am."[6:22]

	<p>"I have to wait for the email from them for the confirmation." [6:24]</p> <p>"This is the majority of problems because customers cannot provide the detail on time." [6:25]</p> <p>"We get later because they are not issued by the Department of Thai fishing immediately. It takes some time." [16:15]</p> <p>"Because it sometimes happens that we get the documents not in time because usually the Customs and health authority need maybe for four to five working days." [16:24]</p> <p>"The release of the documents might be after the free time we receive from the carrier because normally with the container we use to ship canned tunas. we can have five to seven working days." [16:25]</p>
"Compliance"	<p>"Because company 4 is a leading corporate in Thailand and a public limited company, the company is targeted by the Customs for paying correct amount of duties and complying with regulations" [4:16]</p>

Annex 4: List of examples of acceptable and unacceptable descriptions of goods

**List of examples of acceptable and unacceptable descriptions of goods**

Unacceptable	Acceptable	
Agricultural products	Oranges, Fish, Rice, Bread	
Aid consignments	Blankets, Medications	
Animals	Horse, Poultry, Bovine	
Apparel	Men's Shirts, Lingerie, Girls' Vests, Boys', Jackets	
Appliances	Refrigerator, Stove, Microwave Oven, Coffee Machines	
Auto Parts	Automobile Brakes, Windshield Glass for Automobiles	
Caps	Plastic Caps	
Chemicals, hazardous	Actual Chemical Name (not brand name)	
Chemicals, non-hazardous	Actual Chemical Name (not brand name)	
Cleaning products	Alcohol, Detergents	
Consolidated	(See other specific examples in the table)	
Didactic articles	Pencils, Smart boards, Books	
Electronics	Computers, televisions, CD Players, Walkmans, Tape Recorders, Mobile phones, Monitors, Printers	
Equipment	Oil Well Equipment, Poultry Equipment	
FAK Freight All Kinds	(See other specific examples in the table)	
Foodstuffs	Beverages, (See other examples for "Agricultural products")	
General Cargo	(See other specific examples in the table)	
Gifts	Dolls, Remote Control Cars	
Household goods	Plates, Dishes, Tableware (See also examples for "appliances")	
Industrial products	(See examples for "Electronics")	
Iron and Steel	Iron Pipes, Steel Pipes, Iron Building Material, Steel Building Material	
I.T. goods	(See examples for "Electronics")	
Leather Articles	Saddles, Leather Handbags, Leather Jackets	
Machine parts	Pumps, Seals, Engines	

Figure 14 Lists of examples of acceptable and unacceptable description of goods 1(EUROPEAN COMMISSION, 2016b, p. 3)

Unacceptable	Acceptable	
Machinery	Metal Working Machinery, Cigarette Making Machinery, Sewing Machines, Printing Machines	
Machines	(See examples for "Machinery")	
Oil	Mineral oil, Plant oil	
Ore	Iron ore, Copper ore	
Parts	(See examples for "Machine parts")	
Personal effects	(See other specific examples in the table)	
Pipes	Plastic Pipes, Steel Pipes, Copper Pipes	
Plants	Tulips	
Plastic Goods	Plastic Kitchenware, Plastic House ware	
Polyurethane	Polyurethane Threads, Polyurethane Medical Gloves	
Propellant	(See examples for "chemicals")	
Rubber Articles	Rubber Hoses, Rubber Conveyor Belts	
Rod	Welding Rod, Fuel rod, Copper rod	
Said to Contain	(See other specific examples in the table)	
Sanitary goods	Towels, Buckets, Detergents, Tooth brushes	
Scrap	Plastic Scrap, Foam Scrap, Iron Scrap	
Spare parts	(See examples for "Machine parts")	
Textiles	Linen fabric, T-shirts, (See also examples for "Apparel")	
Tools	Hand tools, Electric tools	
Toys	(See examples for "gifts")	
Various products	(See other specific examples in the table)	
Vehicles	Boats, Cars, Bicycles	
Weapons	Daggers, Machine guns	
Wires	Iron and Steel Wire, Copper Wires	
Wooden articles	Wooden furniture, Wooden kitchen utensils	

Figure 15 Lists of examples of acceptable and unacceptable description of goods 2 (EUROPEAN COMMISSION, 2016b, p. 4)



## Annex 5: Interview codes related to data quality dimensions

Table 11: Data accuracy

Code	Respondents	Source	Dialogues
Data accuracy	Interviewee 1	Transcription	“Yeah I think so. For some information, it is very very top secret for business and special technique or special things. So... If we can lock, it will more close for businesses.” [1:27]
	Interviewee 2	Transcription	“Sharing information on time is dependent on human feeding the system not the system by itself but the context aware system should be able to check the correctness, the completeness of the sending information otherwise information in the flow system will be inaccurate and take more time in searching and checking.” [2:5] “The context aware should be able to detect if the information is true or inaccurate otherwise the sharing information will be considered junk information and affect the system” [2:6] “We are OK with using blockchain.” [2:9] “Custom Tariff of the exactly the same goods, same material, same properties are different in each country's This different in opinion and tariff's caused delay in releasing the goods resulting in increased cost in storage, demurrage/detention etc. The importer has to put adequate tax guarantee before getting the goods.” [2:11]
	Interviewee 3	Note	“She agreed that the context-aware architecture would improve the quality of data accuracy because when she dealt with a ship agent, sometimes she had to combine her orders with other oil dealers. It is unavoidable for her to revealed information to other oil refinery companies anyway.” [3:9]
	Interviewee 4	Note	“If he had to use the context-aware architecture, he said that he would provide more detail to Customs. He said that it was unavoidable to co-operate with Customs and thereby he would compliance with Customs regulations no matter” [4:9]
	Interviewee 5	Note	She said that she would not provide more accurate information in the shipping documents. She claimed that she already provided as much information as she can in the shipping documents. She also resisted to provide more information beyond the description on purchase orders. [5:4]
	Interviewee 6	Transcription	“I have to ask Customs what kind of information they prefer from businesses. For example, if it is information about cost of production and raw material, mostly, importers and exporters do not want to share because .... I will give you an example. For Colgate, I had a difficulty with FDA.

			<p>For Dispose Green—chemical name--, why this officer accepted the proposal and other one did not accept it? And FDA officer asked to see detail of raw material, chemical composition, production process of the chemical. So, I had to discuss this issue with the client which he said it was a big issue for them because the company cannot reveal a production process to anybody.” [6:18]</p> <p>“I think it is fine. Besides raw material or production process, it is common information that Customs usually requests. However, what I want for the system is security.” [6:21]</p> <p>“For example, Cream, the system already enforced clients to declare with a certain HS code. If you meet skillful freight forwarders, they can help businesses evading tax duties.” [6:29]</p>
	Interviewee 7	Transcription	<p>“Well I don't think it will affect the accuracy as such but it will probably reduce the workload involved to share the information” [16:19]</p> <p>“But the thing is for the Customs and for the authorities, it is more or less all data that this all the commercial data are involved in packing list, bill of lading, certificate of origin, health certificate and catch certificates. This is almost this is like 90 percent of all the info we receive from our suppliers. But that is because this is information that is required in order to import. So it will be the same amount if we'll use this system or if we don't use the system because this is the information that they require. And that is the information we provide.” [16:17]</p>

Table 12: Data completeness

Code	Respondents	Source	Dialogues
Data completeness	Interviewee 1	Transcription	“Yeah yeah yeah yeah yeah yeah. Of course,if Customs will follow our...the system. ... One more thing...they will request... the original document or by paper... or hard copy. Important documents.” [1:26]
	Interviewee 2	Transcription	“There should be more sharing information with faster speed like current social system. The context aware should be able to detect if the information is true or inaccurate otherwise the sharing information will be considered junk information and affect the system.” [2:8]
	Interviewee 3	Note	“She said that the system would help her sharing more complete data than the current system which relied mainly human based data checking” [3:10]
	Interviewee 4	Note	“He would share more information to meet with Customs requirements because he

			believed that it would help him work easily for either importing or exporting goods.” [4:12]
	Interviewee 5	Note	“She would provide the same amount of information to other stakeholders. She will follow the requirements from her customers and will not share more information beyond the requirements.” [5:5]
	Interviewee 6	Transcription	“I think it is 50/50. It depends on individual’s opinion, or the program forces users to fill information. ...I am not confident.” [6:20]
	Interviewee 7	Transcription	“But the thing is for the Customs and for the authorities, it is more or less all data that this all the commercial data are involved.in packing list, bill of lading, certificate of origin, health certificate and catch certificates. This is almost this is like 90 percent of all the info we receive from our suppliers. But that is because this is information that is required in order to import. So, it will be the same amount if we’ll use this system or if we don’t use the system because this is the information that they require. And that is the information we provide.” [16:17]

Table 13: Data timeliness

Code	Respondents	Source	Dialogues
Data timeliness	Interviewee 1	Transcription	“Because and why. Because we can receive information by ourselves. We do not need to ask from other to Please send it Please it.” [1:13]
	Interviewee 2	Transcription	“Sharing information on time is dependent on human feeding the system not the system” [2:3]
	Interviewee 3	Note	“She said that she appreciated any system that can shorten waiting times during the process.” [3:8] “She totally agreed that the context-aware would significantly improve the timeliness of data shared among businesses. She said that the system would save her time working on the data and data transferring time.” [3:11]
	Interviewee 4	Note	“He believed that the system would improve the data timeliness. He said that technology in the context-aware architecture should improve the entire information sharing system.” [4:13]
	Interviewee 5	Note	“She did not think that the context-aware architecture would improve timeliness of the information sharing. She claimed that sharing information by email was already sufficient for her because the documents arrive to her customers before the vessel arrives and making shipping documents digitize saves cost from sending documents by post.” [5:6]

	Interviewee 6	Transcription	<p>“I think it should be improved. If it is not faster, we have to push like before.” [6:22]</p> <p>“It seems that we do not have to repetitively work. When we provide our clients detail or clients provide us detail, each party will individually work like accessing to system to retrieve information. Nowadays, I have to get receive information from clients and then forward the information to ship agents so, the context-aware system should reduce some working processes.” [6:23]</p> <p>“Well,...when I listened to the system, I have to wait. It seems that people have their own issue. People have to fill information but waiting for 2 hours is not fine. It should be faster if everything is fine and complete.” [6:24]</p>
	Interviewee 7	Transcription	<p>“Yeah. Definitely. It's a very time consuming to do to check the documents, to sort them and to distribute them because it is a lot of paperwork and a system can do this much faster than that person and once the system is like error resistant it will do it much faster and with much less mistakes.” [16:18]</p>

Table 14: Willingness to share information

Code	Respondents	Source	Dialogues
Willingness to share information	Interviewee 1	Transcription	<p>“But for the Customs, I think I do not know yet. But they...are government. They are government workers. So, I think it is difficult to ask for something or to do something to do I mean what they say is always right.”[1:28]</p> <p>“Yeah. Like everywhere Customs is in the... everywhere but like a police. Also, officer in the commune. Err... Everybody. It is difficult to work... And normally, they... do like this...So, the customers of the system should be separate. ...I suppose so I do not know. I suppose? But if it is possible, I think it's very, very useful. ... If the Customs is okay, if they have good additional document, they have to download and log in to the system and download by themselves. I think it will be useful that we do not have always to send them by email.” [1:25]</p>
	Interviewee 2	Transcription	<p>“We are OK with using block chain.” [2:9]</p> <p>“From previous working experience getting gold card will help some but it is not enough. Entrepreneur requires</p> <ol style="list-style-type: none"> <li>1. Speed. How to get the context aware system be accepted giving the right of the importer ,exporter or shipping of AEO level gain access to use export information , check</li> </ol>

			<p>the goods from original country's with reliability's and acceptable at AEO level and have been checked and approved from customs' on both ends and custom fee can be paid and release the goods without going through custom again .This will answer our needs.</p> <p>2.Custom Tariff of the exactly the same goods, same material, same properties are different in each country's This different in opinion and tariff's caused delay in releasing the goods resulting in increased cost in storage, demurrage/detention etc. The importer has to put adequate tax guarantee before getting the goods.</p> <p>How can context aware system and block chain have a sharing system that can be checked for custom tariff and be acceptable worldwide or approved by WCO</p> <p>That is if context aware system can answer the above issues this will speed up the importing process and the checking process.” [2:13]</p>
	Interviewee 3	Note	<p>“She agreed that her company would be more complied. Customs would constantly check the information anyway. Thus, the context-aware architecture would support both businesses and Customs.” [3:12]</p> <p>“She said that the Customs had to verify information anyway.” [3:13]</p> <p>“She added it was also unavoidable for other oil refinery companies to co-operate with the other.” [3:14]</p>
	Interviewee 4	Note	<p>“he said that he would provide more detail to Customs. He said that it was unavoidable to co-operate with Customs and thereby he would compliance with Customs regulations no matter what.” [4:10]</p> <p>“SCG Packaging has no reason to not being compliance with laws. The company itself is willing to conform with laws and regulations.” [4:14]</p>
	Interviewee 6	Transcription	<p>“I have to ask Customs what kind of information they prefer from businesses. For example, if it is information about cost of production and raw material, mostly, importers and exporters do not want to share because .... I will give you an example. For Colgate, I had a difficulty with FDA. For Dispose Green—chemical name--, why this officer accepted the proposal and other one did not accept it? And FDA officer asked to see</p>

			<p>detail of raw material, chemical composition, production process of the chemical. So, I had to discuss this issue with the client which he said it was a big issue for them because the company cannot reveal a production process to anybody." [6:19]</p> <p>"I think businesses would share more. I think if Customs worked faster and do not ask so many questions, businesses would well co-operate with Customs. Businesses are willing to co-operate with Customs." [6:25]</p> <p>"Please consider sincere clients. They are willing to work with Customs." [6:26]</p> <p>"If you meet skillful freight forwarders, they can help businesses evade tax duties. So, I am curious why there is a system. Sometimes, the system is down entire day, or some people can evade tax duties. So, the system can only block particular parties." [6:30]</p>
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