Enhancing the integration of digital interfaces in outbound logistics

an exploratory case study in the Netherlands
Enhancing the integration of digital interfaces in outbound logistics

an exploratory case study in the Netherlands

by

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Executive summary

The advent of e-commerce has changed the composition of consumer buying behaviour. While consumers spend more and more of their money online, logistics providers are facing challenges as expectations rise about seamless online experiences, competitive pricing and instant delivery. Meanwhile existing limitations to incumbent integration mechanisms in outbound logistics have led to operational re-work and delayed deliveries. This then has extended impact on customer satisfaction and costs, as support teams at the retailers and logistics service providers receive more calls from consumers. Therefore, shipping Application Programming Interfaces (APIs) have recently witnessed increasing attention from practitioners, because they allow for real-time validation of data and improve data quality in comparison to older technology counterparts. However, implementing such web integration technologies to enable data sharing involves various stakeholders and separate IT systems, typically resulting in slow adoption.

Because APIs are affected by various stakeholders and the technical tools alone are inadequate for promoting API adoption, more research is needed to identify factors affecting API adoption. Previous information systems research on adoption predominantly focused on cloud computing, while Shipping API adoption remains under addressed. Given the potential of Shipping APIs to improve logistics performance and data sharing quality, it is important to understand how companies integrate to share data with logistics providers and explore what factors influence this practice in order to enhance it. Against the above mentioned backdrop, the main research question in this thesis is:

*What are the adoption barriers of web integration technologies in third-party outbound logistics and how can they be overcome?*

The objective of this study is to explore the factors influencing web integration technology in third-party outbound logistics, by identifying and analysing the barriers posed by logistics buyers regarding the adoption of APIs to enable the sharing of logistics data.

Six relevant stakeholders were identified: logistics providers, integrators, logistics buyers, fulfilment companies, integrators, recipients, and authorities. Only the first four are directly involved with the usage of Shipping APIs, either by using it to exchange logistics data themselves or by implementing it for another stakeholder. Based on this, they can be distinguished between the API demand and API supply side (Figure below).

Additionally, three logistics processes when logistics data is exchanged were identified (order booking, order picking and order tracing) and five integration technologies (a desktop application, FTP, web portal, Shipping APIs and Plugins). The focus of this thesis is on custom integration design meaning FTP and Shipping APIs were most relevant to this research.
With the aim of understanding and overcoming barriers to Shipping API adoption, this study adopts an embedded case study design surrounding logistics provider PostNL, involving both interview and focus group data collection techniques. Nine interviews with logistics buyers, integrators and fulfilment companies were conducted, after which one focus group with industry experts was held to validate interview findings. It allowed for the identification of subjective experiences, interpretation of motivations, and building an understanding contextual factors that influence the adoption process. The TOE framework was found to be most applicable to use as an analytical tool to explore adoption barriers. Multiple factors were brought forward that influence the Shipping API adoption by logistics buyers.

First of all, it was argued that a solid business case is necessary in order to even consider adoption a new technology like Shipping APIs. Key challenges in Shipping API adoption were found to be mainly technological. The relative advantage is often unclear, and the technological status quo of a logistics buyers’ logistics process may influence the adoption greatly. In addition, the risk of potential API downtime was pointed out to be an important barrier to adoption. Furthermore, among organizational factors, available resources were identified to play a moderate role in the adoption of Shipping APIs. Regarding environmental factors, the lack of marketing efforts was argued to be of marginal impact, as well as the lack of success stories about the use of APIs within the Dutch logistics industry.

Recommendations were provided for API suppliers in order to overcome barriers to Shipping API adoption. First, it is recommended to increase marketing efforts, by means of expanding the IT support department to proactively consult to customers. Second, findings suggest that availability of the Shipping API is paramount to its adoption, and hence it is recommended to develop a fall back solution. Third, it is recommended to strengthen partnerships, as interdependence among the stakeholders is clear and requires strategies on how to adapt to others in order delivery chain. Fourth, it is recommended to retrieve insights on functionality requirements from both API and non-API users and continue to gradually develop functionality. Finally, because of the existence of the status quo, it is recommended to create urgency in order to promote Shipping API adoption, while also considering that enough time, IT support, a fall back to critical processes, and reasoning need to be given. The recommendations also underscore the importance of actively explaining the commercial benefit to logistics buyers, as findings indicate the relative advantage and the lack of demand make it difficult to justify switching to an API.
Previous research within the realm of supply chains has mostly drawn data from top management at logistics buyers (i.e. executive board) and neglected other members, for instance developers, or other parties such as integrators and fulfilment companies. This study is the first to explore Shipping API adoption from a unique viewpoint (e.g. logistics provider, integrator, fulfilment company and logistics buyer). The findings help relevant stakeholders in enhancing the integration of digital interfaces by standardizing data flows and being more adaptable to changes. The insights gained from this research can help API suppliers to promote API adoption and better formulate implementation strategies, in an industry that is adapting to a new composition of consumer buying behaviour. The findings are not only relevant to the case study company, but also to other actors within the supply chain network as it enriches the understanding of the emerging API paradigm in supply chain integration.
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I would like to express my great appreciation to my graduation committee whose assistance was invaluable in this project. Dr. A. Ding was instrumental in shaping my research project, and provided many constructive recommendations throughout the research process. I also wish to thank Dr. R. Verburg for his empathetic attitude, motivation and enthusiasm. I am extremely grateful to both of them. Also, I wish to show gratitude to my external supervisors at PostNL, M. Bokhove and N. Pullens, for sharing their knowledge on the topic and their continuous support.

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I hope you will enjoy reading this report,

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Leiden
January 2020
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List of abbreviations

3PL  Third Party Logistics
LP   Logistics Provider
CC   Cloud Computing
IT   Information Technology
IS   Information Systems
MS   Management System
SCMI Supply Chain Management Integration
Introduction

The advent of e-commerce has changed the composition of consumer buying behaviour. While consumers spend more and more of their money online, expectations about seamless online experiences, competitive pricing and instant delivery are growing. Investments in sorting centres can hardly keep up with the exponentially growing shipment volume. Additionally, logistics service providers are facing technological challenges to accommodate an increase in last-mile delivery. Existing incumbent system integrations have shown to lead to more delayed deliveries, in comparison to modern technologies. There exists a pressing need to expand digitalization and improve digital integration in outbound logistics. To this end, logistics providers advocate the use of Application Programming Interfaces (APIs) to integrate logistics systems within the supply chain network. Though, its adoption has lagged behind and the cause of this remains unresolved.

A supply chain can be defined as a set of three or more organizations directly linked by the flows of products, services and information from a source to a customer (Mentzer et al., 2001). The goal of supply chain management (SCM) is to collaborate as a synergistic process to increase the competitive advantage of the supply chain as a whole (ibid). To successfully execute their supply chain processes, supply chain members knit operations from separate members of the supply chain together, defined by researchers as supply chain integration (SCI). This has shown to increase operational excellence and customer satisfaction (Katiyar et al., 2018). For example, future sales can be better forecasted after sharing order information and warehouse space is saved due to better route management.

Each phase of production and distribution within the supply chain requires the most up-to-date information. Therefore, in order to increase the effectiveness of the whole supply chain, organizations should carefully consider how to adapt to others: they must be open to being aligned, joint structured, and partner interdependent (Irfan, 2014). The impact of SCI on a firm largely depends on how other supply chain members act and how strong their relationships are (Charan et al., 2008). E-commerce, the selling of physical products online, requires this cross-firm process integration (Iyer et al., 2009).
E-commerce is more than just filling orders - it is about constructing a network to efficiently and effectively meet customer requirements, while keeping costs at a minimum (Croxton et al., 2001). To handle the business’ online orders, it requires order fulfilment strategies, i.e. the process of storing, picking, packing and distributing the order to the consumer. Order fulfilment is challenging because it is composed of several processes that are heavily interdependent among the resources and agents involved (Goodman, 2005; Lin & Shaw, 1998). For example, an ever-growing inventory has to be efficiently managed, orders have to be delivered fast at a low cost while also considering the impact on urbanization. Outsourcing is therefore common practice in e-commerce.

Outsourcing outbound logistics has many advantages for e-commerce companies, including (staffing) flexibility, reduced (overhead) costs and allows them to focus on their core competencies. They can take advantage of the flexible networks of logistics providers in order to deal with changing demand while keeping supply chain infrastructure costs to a minimum. As a result, it creates opportunities for logistics providers because logistics is considered a critical success factor for retailers (Cho et al., 2008).

1.1 Research background

Among researchers broad consensus exists that information technology (IT) is like the nervous system of a supply chain. The integration of systems aids organizations in efficient information sharing and data exchange. This has shown to result in better organizational agility (Huan et al., 2012; Liu et al., 2018) and supply chain responsiveness (Giannakis et al., 2019). It is no surprise that interest in the digital integration mechanisms of supply chain operations, and the effect on performance has significantly proliferated in the past two decades (Novais et al., 2019).

Previous research suggests that supply chain practices such as supply chain integration and information sharing complicate the adoption of new information technologies (Wang & Yu, 2006; Olorunniwo & Li, 2010). The nature of supply chains is complex, characterized by the flow of goods, the flow of information and the involvement of many actors. Members of the supply chain rely on different systems with different characteristics to share information. Therefore, in many cases, the hardware was upgraded, but software remained the same. As Kanet (1998) put it “Old computers go into museums, but old software goes into production every night.”

IT in the supply chain context has undergone many changes. The file transfer protocol (FTP) allowed businesses to communicate and exchange documents electronically that were traditionally shared by email, thereby improving objectives such as service quality, processing speed and logistics efficiency (Klein, 2016). However, old studies report its use was limited due to barriers such as risk, lack of verified effectiveness, high development costs and low levels of flexibility in its operation (Frohlich, 2002; White & Zain; 2005; Sum et al., 2001).

More recent studies underscore the developments of IT in supply chains (see Delfmann et al., 2018). In recent years, advancements in processors, disk storage and web technology allowed businesses to move away from tightly coupled systems to a more loosely coupled implementation. This has been referred to as the next stage of e-business called dynamic e-business. It is concerned with the integration of digital systems across organizations and systems, in a dynamic fashion, such that existing systems are more adaptable and modification can be done quickly and easily when business processes require changes.
Web integration technologies hold the promise for this dynamic e-business movement. In this thesis this includes Web Services and its successor, Application Programming Interfaces (APIs). They are the interface: they act as the go-between and specify how data transmission can take place between software components. In non technical terms, APIs can be described as a contract between the service requester (client) and the provider of the service (server). Therefore, if the client makes a request in a specific format, it will always get a response in a specific format or trigger a defined operation (Braunstein, 2018). Consequently, the client can retrieve data without understanding the technical details of the server and the service provider retains control over data exchange.

Web integration technology offers many benefits in the supply chain compared to older FTP technology, such as real-time exchange and validation of data, reduced IT costs, flexibility and scalability (Gomez et al., 2015). They produce optimal efficiencies and interoperability for intra- and inter-enterprise computing. Indeed, they create an infrastructure for dynamic e-business (Keller et al., 2002). Chapter 2 goes into more detail about web integration technologies and how APIs allow communication between separate IT systems.

1.2 Research gap and research questions

Information systems (IS) research has predominantly focused on cloud computing - the on-demand availability of computer resources. It refers to sharing hardware components over the internet. Much of this has been motivated by early studies investigating cloud computing adoption at an organizational level (Bayramusta & Nasir, 2016), while the past lustrum has seen a growing number of studies focusing exclusively on specific contexts such as healthcare (Gao & Sunyaev, 2019), higher education (Ali et al., 2018; Njenga, 2019), the private sector (Alkhater et al., 2018) and developing countries (Sharma et al., 2016).

Cloud computing adoption refers to the partially or fully replacement of the incumbent system with the cloud environment. Adoption thus implies that firms should discontinue current, on-premise systems and shift to the cloud alternative (Fan et al., 2015). Similarly, in the context of sharing logistics data, web integration adoption implies that the act of sharing logistics data is done by using the web protocol (http). The body of research on cloud adoption in a logistics context remains scarce (Subramanian, & Abdulrahman; 2017). Furthermore, while there have been successful attempts to improve cloud computing adoption in different contexts, the adoption of web integration technologies such as APIs in supply chains have been under addressed. Since the adoption of APIs has proven to be difficult, more research is required on the specific barriers to API adoption.

It is widely known that technologies develop differently in different contexts, meaning that specific technological management is required (Bergek et al., 2015; Verburg et al., 2005; Zehner, 2000). Indeed, studies by Ciganek et al. (2006) and Oliveira (2011) concluded that web integration technology are context-dependent and differs per industry. A portion of the supply chain is outbound logistics: the movement of goods outside of the organization. It is a particularly interesting context because of the many stakeholders that are involved. Additionally, the logistics industry is adapting to new customer expectations.

The shift from retailers to e-commerce has increased the levels of IT complexity. As a result of newly introduced logistics services for instance evening delivery and delivery pick-up locations, more frequent data sharing is required to manage the delivery information chain. Though, service providers have traditionally acted as laggards in IT
innovation and industry standards have shown to be heterogeneous (Gomez et al., 2015) and rudimentary (Pham et al., 2019). Practitioners have accordingly confirmed that API adoption in a third-party logistics context has been slower than anticipated.

Previous studies suggest that understanding the adoption of web integration technology within organizations is non-trivial and far from straightforward (Kim & Olfman; 2011). McDonnell et al. (2013) quantified the co-evolution behaviour of APIs within the Android ecosystem using GitHub version history data. The authors found that client adoption is not keeping pace with API evolution. Because APIs are affected by various stakeholders and the technical tools alone are inadequate for promoting API adoption, the authors call for further research: “further studies are needed to identify factors affecting API adoption” and “we call for further studies on how to promote API adoption”.

When old incumbent technology is used to share logistics data, it is more likely to result in an increased amount of re-work during logistic operations, as they are more error-prone, ensuing delayed deliveries. It then has extended impact customer satisfaction and on support teams from retailers and from the logistics provider, receiving calls from consumers. The use of web integration technology has been shown to beinstrumental in ensuring that logistics data is shared in an efficient, accurate manner. It is often referred to as using a Shipping API. Though, its adoption has lagged behind. Addressing this problem will give logistic providers the insight to the effective design of digital integration technologies, improving information sharing along the delivery information chain, as well as contributing to a better understanding of the motivations of current strategies to SCI.

To the best of our knowledge, the factors affecting API adoption in the outbound logistics context have not been closely studied. Given the potential of Shipping APIs to improve data sharing quality, logistics performance and subsequent customer satisfaction, it is important to understand how companies share logistics data among partners and explore what factors influence this practice in order to enhance it. Against the above mentioned backdrop, the main research question in this thesis is:

| Main research question | What are the adoption barriers of web integration technologies in third-party outbound logistics and how can they be overcome? |

This study contributes to extant theory by identifying industry-specific factors influencing API adoption. This exploratory thesis contributes theoretical knowledge within the area of SCI by using insights from literature and practice and enriches the understanding of the emerging API design paradigm in supply chains.

1.3 Research objective and output

The objective of this master thesis project is to explore the factors influencing web integration technology in third-party outbound logistics, by identifying and analysing the barriers posed by logistics buyers regarding the adoption of Shipping APIs to enable the sharing of logistics data. The objectives can be divided into three sub objectives:

1. identify current state of integration technology in outbound logistics;
2. identify barriers to adopting web integration technology in literature;
3. explore barriers to adopting web integration technology in outbound logistics in practice;
Based on the objectives, the following sub-questions for this research are defined (Table 1.1).

**Table 1.1: sub research questions of this research.**

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This research aims to answer the research questions by means of an exploratory case study in the Netherlands at PostNL Digital Channels. It is a division of PostNL Parcels responsible for designing digital integration technologies, enabling order information sharing with customers and partners. Although PostNL is an advocate of their Shipping APIs, which enables the sharing of logistics data between PostNL and its customers, its adoption by customers has proven to be difficult. This thesis aims to explore this lack of adoption. Qualitative methods will be used to identify and interpret motivations for Shipping API adoption (see Chapter 3). Chapter 4 discusses logistics integration processes in detail and why logistic service providers advocate API usage, in comparison to technological counterparts.

1.4 Defining the scope

It is important to clearly define the characteristics and boundaries of the study. In this thesis deliberate choices are made on the study design that limit its scope. This enlightens core interest of this study and ensures “that the study’s aims and objectives do not become impossible to achieve” (Theofanidis & Fountouki, 2018).

The focus of this study is the digital integration that is required between e-commerce companies and logistics providers to fulfil customer orders. In particular, this study considers regular parcels in e-commerce, resulting in five important implications.

First, cargo, i.e. pallets or roll containers, is freight that is a collection of parcels and moved as a group. It results in contextual considerations, for instance the frequency of movement which means data is shared less often. Therefore, the requirements for system integration are different from regular parcels (for instance label printing speed or importance of address check) and are left out of scope for this thesis.

Second, emerging markets such as food or pharma are also out of scope. Although, data sharing should be comparable to regular parcels and information sharing therefore similar, the nature of these markets have implications for managing integration design. Specifically, the Goede Distributie Praktijken (GDP, Good Distribution Practices) law applies to pharma in Europe (RIVM, 2018); food has often to be delivered at a certain temperature, within a fixed timespan.
Third, platforms require niche-specific system integration with logistics providers because of its distributed nature. Multisided platforms such as Marktplaats or Bol.com connect different kinds of customers. The concept multi-sided platforms was defined by De Reuver et al. (2018) as “mediating different groups of users, such as buyers and sellers”. The first is mainly designed as a consumer-to-consumer platform and the latter business-to-consumer. Considering generalizability of results, platforms are left out of scope for this thesis.

Fourth, this study does not tackle aspects in relation to returns management. Companies have realized that an understanding on product returns can provide a competitive advantage, as well as act as a strategic tool to strengthen their brand. Returns logistics is beyond the scope of this thesis; literature on how it has become a field of importance are available elsewhere, however (e.g. Agrawal et al., 2015).

Lastly, an additional delimitation is related to shipment quantity. Companies that send a relatively small amount of items can manage shipments by using off-the-shelf software, for instance a local desktop application, a plugin or a web portal. Though this is common for companies with less than 1000 shipments per month, these standard interfaces are left out of scope. This thesis focuses on custom integration technologies built by the logistics buyer. Chapter 4 discusses digital integration processes and technologies. Chapter 6 goes into more detail on sampling decisions and the influence of shipment quantity on the selection of interview participants.

1.5 Report structure

Analogous to IMRAD (Introduction, Methods, Results and Discussion), a commonly adopted organizational format in scientific writing, this report consists of nine chapters (Figure 1.1):

- Chapter 2 introduces a relevant theoretical background and defines concepts, creating a foundation for advancing knowledge;
- Chapter 3 concerns the technical research design. The chapter presents a set of activities to achieve the research objectives;
- Chapter 4 describes the status quo of IT integration technology in third-party logistics. It also provides details on logistics process and stakeholders;
- Chapter 5 analyses relevant adoption factors. At the end of this chapter, a list of adoption barriers is presented to guide the interview process;
- Chapter 6 presents and discusses the results of the semi-structured interviews. In total nine interviews were conducted;
- Chapter 7 presents findings on the last data collection method, the focus group. Six industry experts discuss influencing factors to adoption, thereby validating interview findings;
- Chapter 8 discusses the study results. Implications and limitations are discussed, before describing directions for future research endeavors;
- Chapter 9 presents research conclusions. It states answers to the research questions, discusses contributions and reflects on decisions made on the research design and deployment.
Figure 1.1: report chapter structure.
Theoretical orientation

This chapter aims to provide a theoretical frame of reference, creating a foundation for advancing knowledge. Previous research suggests that supply chain practices such as supply chain integration and information sharing influence the adoption of new information technologies. Therefore, the objective of this chapter is to define concepts and place the subject of this thesis into literature.

Specifically, the first section defines the concepts of supply chain management and logistics. Then section 2.2 explains web integration technologies. Subsequently section 2.3 describes theory on technology adoption. Lastly the chapter ends with conclusions. The next chapter will introduce the technical research design.

2.1 Supply chain management and logistics

Logistics is a boundary-spanning discipline that has gradually changed beyond just the movement and storage of goods to a broader supply chain management (SCM) context. Early work has shown that logisticians have different perspectives on SCM versus logistics (Larson, 2007). Moreover, the interpretation of the term SCM varies across industries (Shukla et al., 2011). Some logisticians view logistics as a function or subset of SCM, while others re-label logistics to SCM. Therefore, recent studies in logistic-oriented journals use different definitions to SCM (Anca, 2019).

When defining SCM, some authors describe it as the planning and management of activities - a restricted view that SCM is concerned with delivering products and services to the market. For instance Waters (2009) who defined SCM as a “series of activities and organisations that materials move through on their journey from initial suppliers to final customers”. Others attempted to develop broader views. These views acknowledge that SCM is not just cross-functional, but also involves the coordination of inter-firm information flows. Maia & Cerra (2009) suggest SCM is “the integration of the main processes that manage materials and information flows”. Indeed, the flow of information is a key ingredient for any SCM system and its effectiveness in general (Li & Lin, 2006; Mobert et al., 2002).

A similar pattern can be observed with definitions to logistics. Logistics was often linked to warehouse management and transport. Ballou (1992) suggest logistics “is all about
guaranteeing that the right goods and services are delivered at the right time, at the right place, and in the right condition, and that, in making this happen, the company concerned should attain the highest possible yield”. Later, logistics had taken a more strategic role and included the flow of information, thereby entailing more than just transport. A definition by Christopher (2016) for example included “the coordination of information flows that extend from the marketplace, through the firm and its operations and beyond that to suppliers”. These developments cited in literature underscore the importance of information flows and integration practices discussed in this thesis. This thesis follows the broader, more recent definitions of logistics and SCM.

Since many other definitions to SCM and logistics have been put forward in extant literature, interpreting it differently, a summary on the main notions about the scope of logistics and SCM is provided below (consistent with the broader definitions mentioned above, and relevant to this research):

- SCM encompasses logistics. SCM represents the intersection of various disciplines, including strategic management, manufacturing, purchasing, fulfillment, IT, marketing, retail and indeed, logistics (Maslarić et al., 2016).
- Logistics is concerned with planning the flow of products and the information flows. SCM builds on this and seeks to create coordination between processes of all companies involved (Anca, 2019).
- The main difference between logistics and SCM is its end goal. Logistics ensures customer satisfaction, while SCM focuses on economic performance through collaborative efforts (Christopher, 2016).
- Transport is only part of logistics. Logistics also includes the coordination of service flow, information flow and warehouse management.
- Logistics can be divided into two parts: inbound and outbound logistics. Inbound refers internal focus of expediting and receiving goods, while outbound refers to goods going out of the organization, including customer service and management of (digital) distribution channels.

Supply chain integration

Current research about the supply chain is partly geared towards risk management and sustainability (Wilding et al., 2012; Giannakis & Papadopoulos, 2016; Squire, et al., 2006), but scholarly interest in the integration mechanisms of supply chain operations and the effect on performance has significantly proliferated in the past decade (Hulthen, 2016). This is often referred to as supply chain integration (SCI). Many studies have noted that a firm performance lies on integration, and thus “a good understanding of the integration process is a key aspect in SCM” (Shukla et al., 2011).

Internal integration across departments and external integration with other companies has become essential for organizational success. Internally, the goal of SCI to reduce cycle times and production costs. To this end, it fosters the ability to design products faster, with higher quality and lower costs (Ajmira & Cook, 2009; Gimenez & Ventura, 2005). However, businesses do not intend to do this at the expense of other members of the supply chain.

External collaboration among supply chain partners leads to reduction of lead-time and integration to enhanced effectiveness and efficiency across the supply chain (Sahay, 2003). After all, in order to achieve the integration between members of the supply chain, it must a collaborative action of all as a synergistic process (Hulthen, 2016). Literature therefore tends to take a system perspective, focusing on observing interactions between the participants of the supply chain.
Despite the discussed importance of SCI, a review by Näslund, & Hulthen (2012) concluded that there exists a lack of understanding on the notion of SCI. The following new definition to SCI is proposed: "SCI is the coordination and management of the upstream and downstream product, service, financial and information flows of the core business processes between a focal company and its key supplier and its key customer." This definition is adopted in this research, as it emphasises information flows.

**Information sharing in supply chains**

Sub-optimal supply chain integration has, in many cases, been the result of poor information sharing (Kapia, 2009). Information sharing acts as an enabler for SCI (Lotfi et al., 2013). It supports collaboration and consequent decision making in order to achieve enhanced overall business performance (Marinagi et al., 2015). Order information sharing is known to bring many benefits in particular, for instance tracking and tracing shipments and the optimization of delivery schedules (Pham et al., 2019).

The primary benefit of information sharing is reducing the “bullwhip effect” (Warburton, 2004; Jiang & Ke, 2019), a phenomenon that refers to increasing swings in inventory in response to shifts in consumer demand as one moves further up the supply chain. The volatility of consumer demand can result in under- or overbuying supplies, that in turn leads to excessive and costly inventory, or conversely, exhaustion of inventory. Customer satisfaction is then negatively impacted. Information sharing between supply chain members can reduce this effect. However, sharing more information is not always better.

The key to enhanced supply chain operations does not lie solely in efficient information sharing, but also in information timeliness and quality (Kehoe and Boughton, 2001; Kaipia, 2009). Authors Kumar and Pugazhendhi (2012) argue that the impact of information sharing depends on what information is shared, in what manner and with whom. It is argued that the level of information sharing should be adjusted according to the decision making situation. Consequently, since companies might not have perfect information about others, information sharing does not come without challenges.

First, considering that different parties obtain different returns from the practice of information sharing, it then becomes a strategic issue. Because of the uncertainties and risks that have to be managed in the supply chain, the impact of SCI on company performance largely depends on how other supply chain members act and how strong their relationships are (Charan et al., 2008). It is thus no wonder that soft behavioural attributes of integration such as trust and commitment have become a central issue to SCI to explain performance (e.g. Saleh & Roslim, 2015; Wu, 2004).

Secondly, businesses hesitate to extent coordination and integration beyond the dyadic level (i.e. beyond two). Literature provides little empirical evidence on this aspect (i.e. integration among three members or more), although a supply chain by definition means that it involves more than a dyadic relationship. Despite the fact that new technologies have enabled the ability to integrate several members of the supply chain (White & Zain; 2005), the dyadic integration is the most common in practice (Hulthen, 2016).

Many authors have attempted to identify dimensions of information sharing with the goal of defining SCI more clearly. Though no consensus exists. Seidmann & Sundararajan (1998) identified four levels of information sharing, namely 1) order information, 2) operational information, 3) strategic information, and 4) competitive information. Rai et al. (2006) argued that SCI can be achieved by integration of informational, physical and financial flows. Alfalla-Luque et al. (2015) took another approach and described three
other levels: relationship linkage, coordination and resource sharing, and information sharing.

More recently, researchers have argued that order information sharing is not true information sharing, because it is has no strategic intent (Pham et al., 2019). They argue that information sharing by definition refers specifically to sharing crucial, proprietary or strategic information among other supply chain members (Kumar et al., 2012). Similarly, SCI can also be distinguished at strategic and operational level (Hulthen, 2016).

**Defining the logistic network**

In general, organizations focus on specific roles within the supply chain network and rely on outsourcing (Pieters, 2016). Outsourcing can be defined as “a strategic decision to contract out one or more activities required by the organization to a third-party specialist.” (Hong et al., 2004). Therefore, in e-commerce a logistics network often consists of multiple layers. In literature, logistic service providers are often categorized into four levels of logistics (Hosie et al., 2007).

On the first level is the first-party logistics provider (1PL), an actor that does not outsource distribution or logistic activities (Appendix A). It can be a manufacturer that performs all logistics tasks in-house or a warehouse operator. A second-party logistics provider (2PL) owns the means of transportation. They own ships, airlines, trucks etc. They are transporters. A third-party logistics provider (3PL) is a logistic service provider in which case the cargo owner partly or sometimes fully outsources its transport and logistic activities to a third party, on contract. Lastly, a fourth-party logistics provider (4PL) is a non-asset based lead service provider that fully independently assembles and manages the integrated supply chain. It is highly information based, as it coordinates asset-based supply chain actors on behalf of clients (Van Hoek and Chong, 2001, p. 463).

A few studies have articulated the overlapping nature and ambiguity of the terms 3PL and 4PL. Selviaridis & Spring (2007) argued in their literature review on 3PL that the term fails to take into account shippers’ industry-specific characteristics, as different definitions in literature emphasize different aspects of outsourcing arrangements (duration, service offering, responsibility of logistics processes and role in the supply chain). A master research project by Miechels (2011) investigated the developments of the Dutch third-party logistics market and concluded that the differences between the terms are vague. Many logistic providers appeared to market themselves as more than they actually are. Furthermore, industry experts suggest that practitioners are unaware of the term 4PL. Therefore, for this thesis a different approach to the logistics network is defined.

Five separate actors can be identified and will be used in this thesis: the logistics buyer, the logistics provider, the fulfilment company, the integrator and the recipient (Table 2.1). Figure 2.1 visually summarizes the relationships among the members of the network. It is worth noting that outsourcing warehousing and IT integration is optional, although it is prevalent in e-commerce. The e-retailer may prefer to do it themselves. For this thesis, it is assumed that the e-retailer outsources the transport to the logistics provider, and therefore it is defined as a logistics buyer.
Table 2.1: definitions to the logistics network.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics buyer</td>
<td>a company that owns and sells cargo (business-to-consumer and/or business-to-business) and outsources transport to a third-party</td>
</tr>
<tr>
<td>Logistics provider</td>
<td>a company that manages the flow of goods from one location to another</td>
</tr>
<tr>
<td>Fulfilment company</td>
<td>a company that handles warehousing including inventory, order processing, and shipping functions for other businesses</td>
</tr>
<tr>
<td>Integrator</td>
<td>a SaaS-company (Software as a Service) that facilitates business-to-logistics provider communications, and logistics provider management, from online booking to delivery.</td>
</tr>
<tr>
<td>Recipient</td>
<td>a consumer or business that receives a parcel.</td>
</tr>
</tbody>
</table>

2.2 Web integration technology

In order to share information among the stakeholders, digital integration technologies are used. Research on software engineering considers that systems are part of an ecosystem, involving other systems, stakeholders and needs. No computer is on an island. Businesses rely on data from external parties to understand consumer trends and the market of tomorrow (Lyseggen, 2017). There is a shift of focus from internal data to real-time, external data, allowing companies to quickly anticipate changes in the industry and its organizational context. Though data is often siloed and not easily shared.

To grasp the evolution of IT that enabled data sharing, it is important to understand what protocols are used for uploads and downloads over the internet. Traditionally, businesses used the FTP (File Transport Protocol) technology to transfer files between computers. It was used to upload and download large files from a server. By design this was not a secure protocol. Roughly ten years later, the successor emerged: HTTP (Hyper Text Transfer Protocol).
HTTP is largely used to view websites and enables communication between a *webserver* and a *webclient*. It can be illustrated by the fact that the world wide web can be surfed using HTTP. Build on top of HTTP, business can build communication software, referred to as *Web Services*. A broad definition to Web Services is mentioned in a paper from Chen (2005):

> loosely coupled, reusable software components that semantically encapsulate discrete functionality and are distributed and programmatically accessible over standard Internet protocols.

In computing the term *loosely coupled* implies that a technology makes little use of other separate software components. FTP is tightly coupled because it requires direct control and data connections, whereas Web Services that use HTTP do not require knowledge of other components and are thus defined as loosely coupled. Businesses can agree on a set of reusable Web Services that can be consumed by composite business applications, and integrate functions for each step in a business process.

Web Services are often used interchangeably with Application Programming Interfaces (APIs). However, simply put, APIs are the successor to Web Services in the evolution of *web integration methodologies*. APIs can be defined as (Oxford Dictionary, 2019):

> a set of functions and procedures allowing the creation of applications that access the features or data of an operating system, application, or other service.

APIs are independent of any programming languages, providing interoperable software interaction between two machines over the internet. One could say APIs are even more dynamic or loosely coupled than Web Services are.

APIs offer the *interface* between two software components so they can exchange information (Figure 2.2). It specifies how the components should interact, i.e. it acts as the *go-between*. It is worth noting that the supplier defines the API specification, and therefore retains control over what data is shared and how. It may be any type of communication and does not always have to be web-based. An offline API may be used to interact with a printer. Conversely, Web Services are by definition web-based. Concluding, it can be said that all Web Services are APIs, but not all APIs are Web Services. This research focuses solely on APIs that are Web Services, referred to as Web APIs. Therefore, in the remaining parts of this thesis the term API refers to Web APIs.

![Figure 2.2: how an API works, adapted from Eising (2017).](image-url)
In practice, an API is a method by which a company can write software components that interface easily with other programs. An API exactly defines the methods for one software program to exchange information with the other (i.e. contract as mentioned in Chapter 1).

Nowadays, developers are looking to deeply integrate APIs into their own applications (Shi et al., 2011). For most e-commerce companies, APIs are not an afterthought - they are an important part of their strategy. Companies question investing resources into building functionality in-house that can easily be accessed from elsewhere. This allows them to focus on building a better service or product. Examples of companies that have the API-first mentality are Stripe, a payment software platform, and Messagebird, a cloud communications platform.

APIs have impact on many industries. Facebook users can login with their credentials in other communities and we can manage our bank accounts on our phones. Also, when searching for an address in Google Maps, an API helps to communicate with a map database to identify latitude and longitude. Then an API enables, amongst other things, showing the address on the map. An API also helps developers in creating services built around other companies data; for example real-time flight tickets comparison or connecting to large databases with weather forecasting data. Concluding, the API helps in exposing functionality of an application or service that exists elsewhere independently of the API. Hence it is referred to as an interface.

There exist technical and business-critical benefits to web integration technologies. It lowers the need for custom IT development and provides faster interoperability among systems. APIs allow for faster integration projects and easier integration with external (legacy) systems. In turn this leads to positive business outcomes, for instance lower software development costs and a faster time to market. Chen (2006) analysed all benefits from a technical perspective linked to a business benefit (Appendix B).

In this research project, the barriers to adoption of Shipping APIs, used to enable data sharing between logistics buyers and logistics providers, are analyzed. In general all large logistics providers offer this API as a service for logistics buyers, for example UPS, DHL, FedEx, DPD, GLS, and central in this thesis, PostNL (see Chapter 4). The Shipping API can be defined as:

\[
\text{Web integration technology that exposes shipping functionality aimed at supporting shipping processes in third-party logistics, from booking to delivery.}
\]

2.3 Innovation adoption

Innovation adoption has been studied in various disciplines (psychology, marketing, sociology, economics and engineering), at different stages of innovations (pre-adoption, adoption and post-adoption) and at different levels of analysis (i.e. individual, organizational, industrial, national) (Oliveira & Martins, 2011). This part of the literature is concerned with understanding how factors that facilitate or confront the adoption of emerging new processes or products within a population of potential adopters (Fichman, 2000). Innovation can also be viewed as a process as outlined by Crossan & Apaydin (2010), and can be distinguished in two types of innovative organizations - those that generate, and those that adopt.
From a manager perspective, the purpose of innovation is to introduce change into the organization, in order to create new opportunities (Drucker, 1985). In today’s rapidly changing market dynamics of technological substitutions, businesses must innovate in order to stay competitive, be effective, and even to survive (Damanpour & Wischnevsky, 2006). Managers are expected to facilitate this ideation process to generate new ideas. The emphasis on newness of innovations was first coined by Schumpeter (Scherer, 1986).

Web integration technology is a new driver for data-driven services in logistics, and therefore can be viewed as a novelty or something new. However, researchers have different views on the interpretation of web integration innovation. Some view it as a technological breakthrough, while others view them only as an advancement in the evolution of distributed computing (Chen, 2005; Hanna, 2003). Furthermore, from a user perspective, web integration technology may only be an enabler of innovation. This is often referred to as the "technology-push" characteristic of innovation. The term innovation, in relation to the Shipping API, is defined in this research as:

> Web integration technology that is perceived as new by an adopting logistics buyer, discontinuous with previous integration and which is intentionally introduced aimed at improving shipping results.

Similar to the term innovation, the adoption of innovation can also be viewed as an outcome or a process. Rogers (1995) described a five stage model through which an individual passes. It starts with 1) knowledge, when the individual is aware of the existence of the technology and 2) persuasion when the individual decides if it is favorable or unfavorable towards the technology. This is followed by 3) decision to adopt or not, 4) implementation stage and 5) confirmation, being that the individual seeks confirmation for its already made adoption decision (Figure 2.3).

Apart from the individual perspective, Rogers also described the organizational innovation adoption process, consisting of two main stages: initiation, and implementation. During initiation in the first stage, a problem may create a perceived need for an innovation (agenda setting) and then the problem is fitted with an innovation (matching). Then between the two subsequent stages, the adoption decision takes place. Stage two, the implementation, contains “all the events, actions, and decisions involved in putting the innovation to use” (Rogers, 1995, p. 421). The innovation is modified to fit organization (redefining), the relation between the organization and the innovation is defined more clearly (clarifying) and lastly, the innovation becomes part of the organization (routinization).

**Figure 2.3:** adoption as a process from a user perspective, adapted from Rogers (1995).
As indicated by the Rogers model in Figure 2.4, the adoption decision is usually the first step; afterwards a secondary adoption process starts when the technology also has to be accepted by the end users (Gallivan, 2001). However, for this research project, web integration technology does not distinguish between developer and end users and thus a secondary adoption process is beyond its scope. Models proposed by other authors are variations of the two stages identified by Rogers. An overview of these models can be found in a study by Faber (2014).

![Figure 2.4: adoption from an organizational perspective, adapted from Rogers (1995).](image)

**Theories on organizational technology adoption**

Various authors constructed models to understand adoption of technology. As indicated by Rogers, technology adoption can be assessed at the individual (user) level and at the firm level. At the individual level, most commonly used models in literature are Technology Acceptance Model (TAM) introduced by Davis (1986) and the Theory of Planned Behaviour (TBP) by Ajzen (1991). At the firm level, often mentioned models are Diffusion of Innovation model (DOI) presented by Rogers (1995) and the Technological, Organization and Environment factors (TOE) by Tornatzky and Fleischer (1990).

The TOE framework captures aspects, related to an enterprises' context, that influence the decision to adopt and implement a technological innovation (Figure 2.5). It provides a useful framework to study the adoption of different types of IT innovation, including infrastructure technologies, such as APIs. It is widely used in IT adoption literature and has a solid theoretical basis, supported by empirical studies (Oliveira et al., 2011). It was found to be better able to explain intra-firm innovation adoption, in comparison to adoption model counterparts as it includes the environmental context (Oliveira et al., 2011). Technology adoption does not only depend on the benefits – technologies are adopted differently in different contexts (i.e. all other structures and relevant factors outside of the company).
The TOE framework consists of three contexts. First, the technological context entails both the internal and external technologies used or related to the firm. Second, the organizational context describes organizational characteristics such as scope, size and managerial structure. Third, the environmental context is the external arena in which the organization does business, i.e. its industry, competitors and governmental supports (Tornatzky and Fleischer 1990).

The importance of knowing the context becomes apparent when assessing the adoption of new technologies in a supply chain context. Previous research suggests that supply chain practices such as supply chain integration and information sharing complicate the adoption of new information technologies (Olorunniwo & Li, 2010). Within a supply chain network members must collectively reach a decision about a new system, while considering existing systems. Members of the supply chain may rely on different systems with different characteristics to frequently share information.

2.4 Conclusions

This chapter defined concepts, related to the main research question. Logistics was defined as more than just transport, including the management of information flows. Therefore, SCM builds on logistics as it seeks to create coordination between processes of all companies involved. In order to achieve competitive advantage, it must a collaborative action of all as a synergistic process.

The current definitions to logistic networks are vague and overlapping. A difference approach to the logistics network is defined: the logistics provider, the logistics buyer, the
fulfilment company and the integrator. All these stakeholders have a vested interest in logistics integration technology. They share (order) information in order to fulfil customer orders. The practice of order information sharing was argued to be not true information sharing, although it is known as the most prominent benefit of information sharing by decreasing the bullwhip effect. Rather, information sharing denotes the act of sharing strategic information. Digital integration technologies enable this data exchange.

Next, web integration technology was discussed within a supply chain context, introducing both Web Services and APIs. It was noted that APIs are often confused with Web Services. Arguably because all Web Services are APIs, but not all APIs are Web Services. APIs are seen by scholars as the successor to Web Services: they offer more flexibility and act as an interface between applications using a set of rules. This study focuses on Shipping APIs in particular. A Shipping API was defined as: web integration technology that exposes shipping functionality aimed at supporting shipping processes in third-party logistics, from booking to delivery.

Last, regarding the adoption of innovation and technology, multiple adoption models were distinguished, both at an individual and at company level. The TOE framework by Tornatzky and Fleischer (1990) was found to be the most applicable for this research, using it as an analytical tool to explore adoption barriers for Shipping APIs (Chapter 5).
Scientific research pursues a logical, organized, rigorous step-by-step approach. The goal of this chapter is to describe an appropriate technical research design to match and obtain answers to the research questions formulated in Chapter 1. It is based on the inductive case study approach.

The first section justifies the single, embedded case study design. Then section 3.2 discusses the information required to answer the research questions and describes how to collect this data. Section 3.3 presents the research strategy - the total set of activities to realise the research objectives. The chapter ends with a discussion on the analysis of the data. Data collection will commence in the next chapter in which a desk research is used to describe the logistic processes, the required integration technologies and stakeholders.

3.1 Case study design

The research design provides a blueprint for the collection and analysis of data. The case study approach was chosen for this thesis to capture important contextual information regarding the studied digital integration. The case study design allows the study of contemporary real-life situations and the retrieval of depth of understanding of the integration practices. To answer the main research question, the objective is to identify subjective experiences, interpret motivations, and understand the barriers to API adoption, a phenomenon about which little is known. A case study design with qualitative research methods is conducive in meeting this research objective (Teegavarapu, 2008).

Logistics provider PostNL is an appropriate case study based on the research purpose to explore issues to API adoption in logistics, because it can be described as a critical one. Critical cases are those with strategic intent (Rolland & Herstad, 2000) and are for some reason, important in the scheme of things (Kembro & Selviaridis, 2015; Patton, 2002). The high market share of PostNL and its digital services make PostNL an interesting case for this research project. Furthermore, PostNL has been a long-established partner to a variety of logistic service buyers in the Netherlands. As Patton (2002) puts it: “if that group is having problems then we can be sure all the groups are having problems”. Therefore, the reality of PostNL is also relevant to other logistics firms.
A single, embedded case study design was adopted to investigate digital integration and related barriers (Yin, 2014). The term “embedded” refers to the interrelated relationships in the studied outbound logistics chain (e.g. logistics provider, first-tier customer, integrators and fulfilment companies, Figure 3.1). It gives room for a diversity of perspectives on a niche-specific problem. Also, it helps to analyse interconnections and interdependencies between stakeholders and see evidence to API adoption challenges across the outbound logistics chain through multiple perspectives.

![Embedded Case Study Design](image)

**Figure 3.1:** Embedded case study design.

The adopted design is in line with similar studies, for example Kembro & Selviaridis (2015) that studied information sharing in the extended supply chain. Another similar study is Chen (2003) that discussed the XML and Web Services technologies in the context of e-business systems through a literature review and case study design. Frankel et al. (2005) noted that when studying 3PL relationships a case study and qualitative methods are specifically preferred. Indeed, a case study typically combines various data collection methods, and data are collected from multiple sources (Williamson & Johanson, 2017).

### 3.2 Data collection methods

Based on the sub research questions described in Chapter 1, three pieces of information are required:

1. understanding of the current digital integration technology in outbound logistics (descriptive);
2. insights into barriers to web integration adoption and supply chain integration in literature (descriptive);
3. insights into barriers to web integration adoption in third party logistics context in practice (exploratory).

Four data collection methods can subsequently be derived that are used in this research: desk research, literature review, interviews and a focus group (Figure 3.2). The different data sources provide different vantage points. The practice of collecting data using more than one method on the same topic is called data triangulation. It is used in this thesis to ensure internal validity, adding credibility to the findings (Yin, 2018). In other words, it is used to cross-check consistency among findings in order to enhance its robustness.
(Wahyuni, 2012; Locke; 2000; Sekaran & Boogie; 2016). Authors Teegavarapu et al., (2008) note that it also helps in removing any biases that might have been caused by the researcher’s subjectivity.

The findings from the desk research and the literature review are triangulated with the findings in the interviews. Moreover, interview transcripts are validated by sending them to the interviewees. They are invited to share feedback to ensure the data was registered and interpreted correctly. An internal expert focus group is done at the case company to triangulate the findings from the interviews. The use of a variety of methods to collect data on the same topic forms the basis for this research. The next section discusses each of the data collection techniques in detail.

![Figure 3.2: data collection procedure in this study.](image)

3.2.1 Desk research

Against the theoretical background from Chapter 2, the research first requires an understanding of how the current integration of digital integration technology in outbound logistics is organized. It provides a first understanding of the problem, defines the scope of the study and guides further data collection. The desk research identifies relevant stakeholders and provides insight how current integration technologies are implemented. It serves as a knowledge base before moving on to the remainder three data collection procedures, and aids in answering sub research question 1 (see Chapter 4):

1. What integration technology is currently available in outbound logistics?

3.2.2 Literature review

This study starts with a theoretical perspective in mind by analysing influencing factors. Before performing exploratory research, previous knowledge must be scrutinized and critically analysed in order to produce new knowledge (Stebbins, 2001; Hussein et al., 2017). It provides the background required to enable historical interpretation of the research problem in this thesis. In addition, it creates better usable results, because it
allows for the placement of the topic in related literature (Strauss & Corbin, 1997; Dey, 2007). Specifically, barriers to web integration adoption are identified. The analysis aids in answering the sub research question 2 (see Chapter 5):

2. What factors influence the adoption of web integration technologies?

3.2.3 Interviews

Interviews are the first primary data collection method, i.e., the information on the area of interest is directly collected from the respondents (Sekaran & Bougie, 2016). The objective of the interviews to identify subjective experiences, interpret motivations, and understand contextual factors that challenge the adoption Shipping APIs. Semi-structured interviews are chosen to get in depth understanding of the ideas that stakeholders have. The interviews aid in answering sub research questions 3 (see Chapter 6):

3. What factors influence the adoption of web integration technologies by Dutch logistics buyers in practice?

The interviews are semi-structured. Guided by the previous steps of the data collection procedure (the desk research and literature review) an interview protocol is constructed. By keeping the interview topics relatively constant, the comparability between the interviews increases, meaning more robust conclusions can be drawn about the topics identified in the literature review (Sekaran & Bougie, 2016). All nine interviews were carried out in November and December 2019. All interviews except one were held face-to-face at the interviewees location within the Netherlands, as they build trust and allow for a more relaxed feeling by the participant when compared to telephone interviews. A single interview was conducted by telephone, because the respondent was situated outside of the Netherlands.

The interviews were conducted on a one-to-one basis to a point where no new information is collected, reaching the saturation point. This criterion for discontinuing data collection has attained widespread acceptance as a methodological principle in qualitative research (Saunders et al., 2018). It means that, on the basis of the data that has been collected, further data collection is unnecessary (ibid).

3.2.4 Focus group

The fourth and last data collection method is a focus group with industry experts in attendance. The experts are invited based on their expertise and experience regarding digital integration technology in third-party outbound logistics. The findings of the interviews were used as a guide to structuring this focus group. This allows for the comparison of external views to internal views. In the focus group, an open discussion on the barriers and its implications will take place among multiple experts in the field. Based on the findings of the focus group justified recommendations on how to overcome barriers to Shipping API adoption can be constructed.
3.3 Research strategy

Based on the four data collection methods, the overall research process can be described as follows (Figure 3.3):

1. The environment is observed to gain insight into preliminary information about the problem.
2. A desk research is performed to understand the current digital integration technology at PostNL;
3. An analysis is conducted on the issues to web integration technology adoption. Based on Chapter 2, decisions are made on what literature should be used and what factors to take into account.
4. Semi-structured interviews with decision-makers within the system integration are performed to validate and find barriers in practice. This is a practical perspective on the barriers. By coding and analysing the interviews, key factors are identified and analysed.
5. A focus group with industry experts validates findings from the interviews;
6. Conclusions and recommendations can then be drawn from the results of the data collection procedures. The main research question is answered: what are the adoption barriers of web integration technologies in third-party outbound logistics and how can they be overcome?

Figure 3.3: research flow diagram of this study.
3.4 Data analysis

After data collection, Sekaran & Bougie (2016, p. 334) describe *data analysis* and *data interpretation* as follow-up steps in order to draw valid conclusions. Similarly, Miles and Huberman (1994) suggest that the ladder of analytical abstraction consists of three phases: data reduction, data display, and conclusion drawing. These three steps are used in this research.

The first step, data reduction, can be referred to as *categorization*. With the goal of exploring barriers to Shipping API adoption, audio recordings of the interviews are transcribed and converted into writing. Then a coding procedure starts. Coding is an iterative process of labelling words, sentences or paragraphs to reduce and rearrange the data in a meaningful way (Campbell, et al., 2013). The literature review provided a list of codes set prior to the interviews. However, considering literature has predominantly focused on cloud computing and dyadic relationships, open coding was used. This refers to deriving codes from the transcribed interviews and categorizing them. The discussion of the focus group was transcribed into words and analysed.

The second step is *data display*, in which data is presented in an organized, condensed way (Miles and Huberman, 1994). Visual displays help in the presentation of conclusions and represent ways of organizing, summarizing and simplifying data (Verdinelli, & Scagnoli, 2013). This also includes the identification of trends, often referred to as axial coding.

In the final step of qualitative data analysis, namely *conclusion drawing*, identified patterns and explanations for observed patterns or relationships are presented. With the aim of answering the research questions, comparisons or contrasts are made between themes. Note that conclusions are partly verified as the data collection proceeds, parallel to step two data display. In this research insights from conducted interviews were subsequently raised in the remaining interviews. Qualitative data analysis process can hence be described as an iterative process where “*data coding may help you simultaneously to develop ideas on how the data may be displayed, as well as to draw some preliminary conclusions.*” (Sekaran & Bougie, 2016).

With the aim of addressing the research problem, the research strategy that was introduced in this chapter constitute the basis of the research. The next chapter presents findings on the first data collection method: a desk research.
Case study description

This chapter describes the first data collection technique in this study: a desk research. Available secondary information is collected and organized in order to understand IT integration technology in logistics, the case study company PostNL and its organizational context. The objective is to answer the first sub-question of this research:

| 1 | What integration technologies are currently available in outbound logistics? |

First, section 4.1 introduces the current situation and emerging trends in the Dutch logistics industry. Then section 4.2 examines stakeholders in outbound logistics. Section 4.3 features integration processes and subsequent integration technology, before ending the chapter in section 4.4 with conclusions. This chapter serves as a necessary preparation step before addressing the remaining three data collection methods in Chapter 5, 6 and 7.

4.1 Trends in the Dutch logistics industry

The Netherlands is a small country, but it is known for its open economy that is strongly leaning towards international trade. According to UNCTAD (2019, p. 7), Netherlands ranked highest in Europe for their readiness and capacity to support online trade in 2019. The biggest logistics provider in the Netherlands, PostNL according to its 60-65% market share in 2018 (ACM, 2018), has seen a 22% growth in parcel quantities in 2018. The surge in parcels was highlighted by the decision of PostNL to build three new distribution centres in 2019, bringing its total to 25 depots in the Netherlands (“Logistiek.nl”, 2018).

While this denotes business prosperity, a combination of increasing labour and infrastructure costs and staff shortage means that the Dutch logistics market is in a difficult situation: the anticipated revenue growth cannot offset the increasing costs. (“Minder groei, meer uitdaging in transport en logistiek”, 2019). In recent years multiple exemplary developments can be identified.
First, due to digitalization, citizens send out fewer letters than ever before, but meanwhile order more online. It is expected that parcel volume will continue to grow, while the volume ratio of mail declines (Ministerie van Economische Zaken, 2017). As a result, PostNL joined forces with postal company Sandd by combining their postal networks in order “to keep mail delivery affordable, available and reliable in a shrinking market” (“Fusie PostNL en Sandd gaat toch door”, 2019).

Second, logistics is confronted with fierce competition as new differentiated services are introduced. Some online retailers have developed their own logistic chains. For example, Coolblue personally delivers applications at every doorstep, including washing machines, and Amazon unveiled Delivery Service partners in 2018, a program designed to let entrepreneurs run their own local delivery networks. Similarly, crowdsourced companies have recently made moves to last mile delivery. Examples include ride-sharing company Uber and Homerr, an independent social network of private individuals and shops that receive parcels ready for pick-up.

Third, more shipment quantity results in more packaging and more waste. In a survey from McKinsey and Company, suppliers and business partners from PostNL have stated they find it important for PostNL to focus on carbon free delivery (Daleman, 2018; van Spronsen & Middelburg, 2018). The Dutch e-commerce sector has committed to develop an approach to eco-friendly delivery, as a response to lower European carbon reduction policy targets (Thuiswinkel.org, n.d.). Though, research has shown that the likelihood of end-to-end zero carbon transport is slim: “there are no readily available, low-cost, technological solutions to reduce carbon emissions.” (Wells, 2019).

Last, the logistics industry is expected to deliver a better service at an even lower price. Nowadays, both online shoppers and companies have become accustomed to fast delivery and demand more flexibility. E-commerce companies are optimizing customer journeys across digital channels and physical stores to build brand loyalty. Logistics plays a key role in optimizing this customer journey, for instance by offering the freedom of choice when and where the package is delivered (Thuiswinkel.org, 2018). Therefore, customers began to expect more of these new services during check-out. For instance, for PostNL these delivery options include:

- Evening delivery (6.00 pm to 10.00pm);
- Sunday delivery (ordered on Saturday, delivered on Sunday);
- Same day delivery (ordered before lunch, delivered during the evening);
- By appointment delivery; and
- Pick-up locations (consumer can pick one from a list of locations nearby).

Concluding, the logistics industry benefits from trends in e-commerce and vice versa, but it does not come without challenges. Recent developments in logistics services have not only affected operational processes, they changed requirements to system integration that affect all stakeholders. The above-mentioned new innovative delivery services have logistical constraints - not only do pick-up locations close or open throughout the year, some services can only be offered at certain addresses. They require dynamic and real-time data exchange between suppliers, webshops and logistic providers.

Real-time event driven design has therefore recently witnessed increasing attention from practitioners in the logistics industry, in contrast to the old batch driven approach to integration that involve downloading and uploading files to a server. Shipping APIs offer real-time data exchange, integration flexibility and supplier retains control over what data is shared and with whom. Old FTP technology does not offer this. Section 4.4 goes
into more detail about the difference between FTP and Shipping APIs. However, first the involved stakeholders are discussed.

4.2 Stakeholder analysis

Recent developments in delivery services affected multiple stakeholders within the supply chain. In the process of successfully delivering a parcel from a logistics buyer to a recipient, multiple data flows can occur. This thesis focuses on data flows via integration technology, Shipping APIs in particular. Therefore, six stakeholders can be identified (Table 4.1.); logistics providers, integrators, logistics buyers, fulfilment companies, recipients and authorities. These stakeholders include the actors in the logistics network as defined in Chapter 2, and are divided between stakeholders that are directly affected by the use of integration technology versus stakeholders that are indirectly affected. Direct stakeholders may either demand or supply integration technology.

In addition, it is worth noting that more actors are indirectly related with integration technology than mentioned in Table 4.1, namely CRM (Customer Relationship Management) and Webshop software developers, payment service providers and ERP (Enterprise Resource Planning) and OMS (Order Management System) providers. Since these actors only have a facilitating role regarding shipping integration technologies, they are not found relevant enough.

Table 4.1: stakeholders related to integration technology in outbound logistics

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td></td>
</tr>
<tr>
<td>Supply</td>
<td></td>
</tr>
<tr>
<td>Logistics provider</td>
<td>a company that manages the flow of goods from one location to another and offers integration technology to exchange logistics data.</td>
</tr>
<tr>
<td>Integrator</td>
<td>a SaaS-company (Software as a Service) that offers business-to-logistics provider communications, integration technology, and logistics provider management, from online booking to delivery.</td>
</tr>
<tr>
<td>Demand</td>
<td></td>
</tr>
<tr>
<td>Logistics buyer</td>
<td>a business that owns and sells cargo (business-to-consumer and/or business-to-business), outsources transport, and may demand integration technology to exchange logistics data.</td>
</tr>
<tr>
<td>Fulfilment company</td>
<td>a company that handles inventory, order processing, and shipping functions for logistics buyers, and may demand integration technology to exchange logistics data.</td>
</tr>
<tr>
<td>Indirect</td>
<td></td>
</tr>
<tr>
<td>Recipient</td>
<td>a person or business that receives a parcel.</td>
</tr>
<tr>
<td>Authorities</td>
<td>An authority that monitors one of more processes within the logistics chain. In The Netherlands these include:</td>
</tr>
<tr>
<td></td>
<td>○ Transport en Logistiek Nederland (TLN) and Evofenedex</td>
</tr>
<tr>
<td></td>
<td>○ Autoriteit Consument en Markt (ACM) &amp; Autoriteit Persoonsgegevens (AM)</td>
</tr>
<tr>
<td></td>
<td>○ Thuiswinkel.org related to e-commerce</td>
</tr>
</tbody>
</table>
Relevant to this study, Daleman (2018) studied stakeholders in the last mile (Appendix C). Daleman’s composition shows the process and actors involved within the delivery process. He identified three roles: the logistics provider, the logistics buyer and the recipient. After the order has been received, order picking and packaging starts. The logistics provider starts a sorting process once the order is received at the distribution centre. Then a delivery van delivers the shipment at the right address at the right time. However, Daleman’s composition does not show (digital) data flows and does not include all stakeholders connected to Shipping APIs, mentioned in Table 4.1. Therefore, an adapted version is used for this thesis (Figure 4.1). Daleman’s stakeholder map is rebuilt and combined with three digital integration processes: order booking, order picking and order tracking (Section 4.3).

The composition in Figure 4.1 below starts with a booking from the recipient. A webshop shows delivery options from the logistics provider at the check-out, exchanges data with a Payment Service Provider (PSP) once the booking is confirmed, and afterwards sends data to an Enterprise Resource Planning (ERP). The ERP often has modules for Warehouse Management Systems (WMS) or Order Management Systems (OMS). The difference between these two systems is their scope: WMS is designed to support and optimize warehouse functionality, while OMS can manage all processes related to orders and shipping.

In the warehouse a label is requested from the logistics provider. Three actors may then perform tasks: a fulfilment company, the logistics provider, and/or a subcontractor - a business or person carrying out work for the logistics provider. Once the logistics provider has sorted the shipment in its distribution centre, the location of the shipment can be tracked by the recipient (and the logistics buyer). Finally, the shipment is delivered to the recipient’s address.

Authorities oversee this whole logistic process. Transport en Logistiek (TLN) arranges terms and conditions of employment for goods transport in the Netherlands and Evofenedex is an association of undertakings that represents the interest of all transport companies with a logistical or international operation. The Dutch Authority for Consumer and Market (ACM) and the Authoriteit Personsgegevens (AP) are independent regulators that oversee competition, sector-specific regulation and enforce consumer protection laws. Thuiswinkel.org is known for its trustmark, that ensures safe and trustworthy shopping.
4.3 Integration processes and technology

Logistics providers and integrators offer integration technologies, including Shipping APIs, that are used to exchange logistics data to logistics buyer or a fulfilment company. The use of integration technologies is needed during the following logistics processes: order booking, order picking and order tracing. These processes are illustrated in Figure 4.2 on the next page.

Order booking
As the recipient accumulates a list of items for purchase, it is added to the shopping cart. At the check-out web page, a number of logistics related processes can be made possible with the use of digital integration. An overview of delivery options that can be presented in the check-out was shown in section 4.1. Additionally the logistics buyer may implement additional functionality; the address check and/or delivery date and time frame. By checking the addresses the logistics buyer can make sure the address is valid. The delivery date and time frame can be calculated and given as a choice to the recipient. This process requires data transmission with the logistics providers’ back-end (as it is based on postal code, date and delivery type). Once the booking is confirmed, the order fulfilment process starts in the warehouse, indicating that a picking, packing and distributing process starts to fulfil the order and deliver it to the recipient.
Order picking
Three processes within order picking may use integration technology: 1) create barcode, 2) create label, 3) send confirmation. First in step one a barcode is generated. A barcode is a method of representing data in a visual, machine-readable form. The barcode is a unique combination of letters and numbers (based on a company code) that is used to identify a shipment. Second, a label is created, printed and taped onto the shipment. This label contains shipment information, including name, address, and city (“NAW gegevens” in Dutch), the created barcode in step one and any other specified delivery information. An example of a label is shown in Appendix D. Then, the final step in the order picking process: a confirmation of the shipment is sent to the logistics provider, also referred to as pre-notification by Daleman (2018). The confirmation contains information about the sender and receiver, the barcode and any information about additional delivery services applicable. This step establishes a link between the recipient information and the barcode, in order to make track and trace status information of shipments possible.

Order tracking
Last, integration technology can be used during order tracking. The barcode, created during order picking, enables the tracking of parcels during transport. Once the shipment has arrived at the distribution centre and the barcode has been scanned the first time, tracking is possible. Every time the barcode on the label is scanned within the logistic operations, the track and trace status information is updated. If the email of the consumer was provided in the confirmation data, the recipient can also view shipping status in the mobile app of the logistics provider. It is worth noting that the barcode itself not hold any recipient information - the confirmation has linked the barcode to both logistics buyers and recipient data.

The order picking process is mandatory to ensure successful delivery (a confirmation has to be sent), the discussed order booking process is highly recommended, and order tracking is optional depending on what service is preferred by the logistics buyer.

![Figure 4.2: activities along the logistic journey that require data sharing.](image-url)
This thesis uses logistics provider PostNL as a case study. It offers logistics buyers integration technologies that can be implemented to establish a digital link to PostNL, manage shipments and therefore execute the three processes introduced in the previous section (Table 4.2). These technologies are free of charge. Although IT support is available, the IT implementation cost is at the expense of the logistics buyer.

Table 4.2: PostNL digital services for businesses to manage shipments.

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traditional systems</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parcelware</td>
<td>Off the shelf</td>
<td>A desktop application. This is software that usually runs on a computer in the warehouse (on-premise).</td>
</tr>
<tr>
<td>FTP</td>
<td>Custom</td>
<td>Based on documentation, businesses can create their own labels and implement FTP connections to transfer data to PostNL. It is generally used by companies with bigger shipment volume (when compared to businesses using Parcelware) that require integration tailored to their warehouse and order management systems. FTP can be used for order picking and order tracing processes; order booking requires APIs.</td>
</tr>
<tr>
<td><strong>Modern technologies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MijnPostNL (commercial use)</td>
<td>Off the shelf</td>
<td>A web portal where businesses can manage shipments. It is the successor to Parcelware. Everything is managed in an online interface. Note that every logistics buyer has access to this web portal to manage related information, such as contracts, but can also manually create shipments.</td>
</tr>
<tr>
<td>APIs</td>
<td>Custom</td>
<td>A communication interface for web-based systems to process data. It is the successor to FTP. Based on documentation on a developer portal, businesses can use API endpoints to leverage PostNL Web Services (Appendix E).</td>
</tr>
<tr>
<td>Plugins</td>
<td>Configurable</td>
<td>An add-on to webshop software that leverages API-connections. These plugins support for example WooCommerce, LightSpeed, CCV and Magento (Appendix F).</td>
</tr>
</tbody>
</table>

As discussed in section 4.1, the growth in e-commerce has put its strain on IT systems. The modern technologies namely MijnPostNL, Shipping APIs and Plugins are adaptable to overall changes in its organizational environment, while traditional systems namely Parcelware and FTP can be hard to maintain, improve, and expand. These traditional systems systems rely on tight point-to-point File Transfer Protocol (FTP) connections to send and retrieve data, making update management complex (see Chapter 2). If there is an update to a service, then the software rollout can be inefficient or may not even be possible at all.

Conversely, the modern technologies result in less overhead costs when an update is implemented. Most changes are implemented in the back-end, therefore update management requires little effort on the client side. Concluding, older technologies limit the ability to change or update integration with ease and speed, while modern technologies allow for simple, flexible and fast update management.

When it comes to customizability, it ranges from none to very customizable. Off-the-shelf technologies Parcelware and MijnPostNL offer no customization - they are packaged solutions. Conversely, the other technologies are commissioned to offer more custom-made or bespoke implementation. First, plugins can be configured, i.e. it can be
adapted to fit a specific purpose by modifying the settings of the plugin. An API offers more customizability, meaning that developers can write code for example tailored to WMS or OMS systems and their operational processes. The logistics provider still controls the specification of the API. Lastly, FTP offers the most customizability. This technology allows customers to create their own labels, based on (logistical) requirements specified by the logistics provider. As customizability increases, time and resources also increase (Figure 4.3). The specific implementation time varies per context and required functionality, but also depends on the coding knowledge of the developer.

![Diagram](image)

**Figure 4.3:** integration technologies displayed according to resources required and flexibility.

The focus of this thesis is on custom integration designed for a specific purpose, meaning FTP and APIs are most relevant to this research. The main difference between FTP and API are summarized in Table 4.3 below.

<table>
<thead>
<tr>
<th>Context</th>
<th>FTP</th>
<th>API</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documentation</td>
<td>PDF that specifies what a label should like</td>
<td>online developer webportal that outlines what APIs to use per use case</td>
</tr>
<tr>
<td>Data sharing</td>
<td>upload and download to FTP server</td>
<td>web service technology specified by the supplier</td>
</tr>
<tr>
<td>Implementation</td>
<td>separate system for each process, customized to logistical processes</td>
<td>service oriented design interacting between systems</td>
</tr>
<tr>
<td>Update management</td>
<td>based on the extent to which it is customized, can become cumbersome</td>
<td>almost no effort at supplier side (automatically)</td>
</tr>
<tr>
<td>Data validation</td>
<td>none (upload file based on specification)</td>
<td>directly done by back-end</td>
</tr>
<tr>
<td>Timeliness</td>
<td>processed in groups</td>
<td>real-time per event</td>
</tr>
<tr>
<td>Available logistics services</td>
<td>only back-end</td>
<td>all</td>
</tr>
</tbody>
</table>
While traditional systems still support the needs of today’s business, new logistics services, for example, evening delivery and delivery locations, require Shipping APIs. These services require real-time interaction and validation of data at check-out, because they depend on the recipient’s address. As mentioned before in this chapter, evening delivery is not available at every address, and delivery locations may be closed due to local holidays or events. Shipping APIs are thus required to enable real-time data exchange in order to implement these services.

Next to existing services that require real-time integration, it is also the way moving forward. When logistics providers introduce new services, they often require modern technology. To illustrate this, one could imagine the following scenario. Delivery locations are displayed in the check-out webpage, but sometimes a delivery location may not be able to accommodate any more shipments. In this case of insufficient storage space, one could stop showing this particular delivery location in all check-outs. It can be presented back online once there is enough space again. This example illustrates that logistics providers are moving towards Shipping APIs: profiting from new innovative data-driven innovations in the future, by using real-time data exchange.

Apart from the benefits of APIs to logistics buyers, it is worth noting that there exist benefits to logistics providers too. Shipping APIs allow for real-time validation of data to reduce the chances of human error. High data quality is paramount to ensure that logistic processes are moving smoothly. If a Shipping API is used, the input and response can be specified by the logistics provider. It then takes control over data flows, while also being more adaptable to changes in its operational context.

Notwithstanding, internal PostNL documents show that Shipping APIs lead to less operational re-work and consequently, less delayed deliveries. Additionally, when using FTP more IT support resources are required (manually exchanging datasets), whereas Shipping APIs are predominantly self-service, and therefore a sustainable solution. Table 4.4 summarizes why logistics providers are an advocate of Shipping APIs. Despite the benefits of Shipping APIs, many businesses have not yet adopted this technology. Logistics buyers often use different technologies in different contexts to integrate and manage shipments.

**Table 4.4: reasons why logistics providers are an advocate of APIs**

<table>
<thead>
<tr>
<th>Index</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Delivery options are only available on the API (they require dynamic integration)</td>
</tr>
<tr>
<td>2</td>
<td>Offer more implementation flexibility when introducing new services</td>
</tr>
</tbody>
</table>
| 3     | Offer more control on own processes:  
- real-time integration (changes to locations are directly implemented)  
- most changes and functionality is implemented in own back-end (e.g. Brexit) |
| 4     | FTP solution is more error-prone and offers customers to create their own labels;  
API is standardized based on own specification |
| 5     | Data validation improves data quality |
| 6     | More IT support resources required for FTP (manually exchanging datasets, old technology); API predominantly self service, sustainable solution |
Often businesses choose to outsource the implementation of the mentioned integration technologies. Generally two situations exist when outsourcing is applicable. First, the logistic needs may not be covered by only one logistics provider. Shipments may have to be sent to different countries, or a variety of logistic services are required. Digital integration management with multiple logistics providers can then be complex and therefore is often outsourced to integrators, or fulfilment companies in case they also outsource warehousing.

Second, a business may not have the development capacity or required technological knowledge in-house. Based on costs and time-to-market, outsourcing the integration may then be the best option. In these two cases, integrators offer a variety of ICT solutions to logistics buyers using FTP or API. Concluding, logistics providers offer a variety of digital integration technologies to their customers, that is supplemented by solutions of integrators (Figure 4.4)

![Figure 4.4: PostNL digital services. Adapted from internal documents (PostNL)](image)

4.4 Conclusions

This chapter described the first data collection technique in this thesis: a desk research. Available secondary information was collected and organized in order to understand the integration technologies in third-party outbound logistics. This chapter aimed to answer the following question:

| 1 | What integration technologies are currently available in outbound logistics? |

A number of trends shaping the Dutch logistics industry are identified: increased revenue cannot offset higher labour and infrastructure costs, more emphasis on environmental sustainability and Dutch citizens send out fewer letters. Meanwhile, recipients order more online, demand more flexibility, more delivery options are introduced, and expect their shipments at the right time at the right location. This has put an increasing strain on distribution centres. Furthermore, existing limitations to traditional incumbent integration technologies have led to more operational re-work and delayed deliveries at PostNL. As a result, these developments have not only affected operational processes in logistics, integration technologies in logistics have changed from a batch driven design to a real-time event driven design, affecting multiple stakeholders. This reality of PostNL is relevant to other logistics providers as they are adapting to the same changing customer expectations, operational processes and required system integration design.
Based on Chapter 2, six stakeholders, affected by integration technology, were identified: 1) logistics providers, 2) integrators, 3) fulfilment companies 4) logistics buyers, 5) recipients, 6) authorities. The first four are directly affected, where the latter two are indirectly affected by the use of integration technology. In this case study PostNL is identified as the logistics provider.

Three main integration processes are identified in the order fulfilment delivery chain: order booking, order picking and order tracing. Only the order picking process and its subsequent integration technology is mandatory for a successful package delivery. Accordingly, different digital integration technologies are used by logistics buyers during different logistics processes. Five main integration technologies are identified: a desktop application, FTP, web portal, Shipping APIs and Plugins. The focus of this thesis is on custom integration design (Chapter 1), meaning FTP and Shipping APIs are most relevant to this research.

Multiple benefits of Shipping APIs over FTP were identified, both for logistics buyers and logistics providers. Shipping APIs allow for real-time validation of data to reduce the chances of human error and increase data quality. In addition, Shipping APIs lead to less operational re-work and consequently, less delayed deliveries. They are more adaptable, easier to update, and require less IT resources than FTP. However, despite the benefits of Shipping APIs, many logistics buyers have not yet adopted this technology.

Last, many logistics buyers choose to outsource the implementation of integration technology to integrators or fulfilment companies. For instance when a logistics buyer works with multiple logistics providers, or does not have the required expertise to implement the integration technology themselves. Therefore, integrators and fulfilment companies have, similar to logistics buyers, a vested interest in the integration technology in third-party outbound logistics.

The knowledge gained throughout this chapter is used in guiding the analysis in Chapter 5 and used as input for the selection of participants for the semi-structured interviews with stakeholders in Chapter 6.
5

Analysis of influencing factors

The aim of Chapter 2 was to provide a theoretical background, whereas the objective of this chapter is to analyse influencing factors to the adoption of Shipping APIs using the TOE framework. It addresses the following sub research question:

| 2 | What factors influence the adoption of web integration technologies? |

Section 5.1 discusses the search description and explains inclusion and exclusion of studies for this literature review. Section 5.2 provides an introduction of literature about the adoption of web integration technologies, Shipping APIs in particular. Section 5.3 then presents the findings and describes commonalities and differences among studies in existing literature. Finally, the chapter concludes with a list of barriers that confront the adoption of Shipping APIs. These are subsequently used in guiding the empirical exploration in the semi-structured interviews (Chapter 6) and the focus group (Chapter 7).

5.1 Search description and selection criteria

The papers discussed in this chapter were identified as follows. ScienceDirect and Google Scholar were queried based on the following keywords: “web services”, “web integration technology”, “cloud computing”, “supply chain” or “logistics”, and “adoption”. Using the snowballing technique, references were checked. Then the articles that specifically focus on factors to the adoption were filtered out. The filtering processes consisted of reading the abstracts and conclusions. In the end ten papers from peer-reviewed journals and conferences were selected (Table 5.1).

Literature reviews that were found to be beyond the scope of this literature review include for instance a paper by Gao & Sunyaev (2019) that focuses solely on healthcare industry, research done by Akter (2019) that describes channel integration within the marketing discipline and lastly, papers by Ibrahim & Hemayed (2019) and Chiregi & Navimipour (2017) that discussed trust evaluation mechanisms and infrastructures.
Table 5.1: list of selected articles for analysis.

<table>
<thead>
<tr>
<th>Index</th>
<th>Authors (year)</th>
<th>Topic</th>
<th>Journal (citescore)</th>
</tr>
</thead>
</table>
Introduction

The study by McDonnel (2013) that proposed further research in API adoption, beyond just technical tools, can be seen as the starting point of this research. Because APIs are affected by various stakeholders and the technical tools alone are inadequate for promoting API adoption, the authors call for further research: “further studies are needed to identify factors affecting API adoption”. This research project focuses on Shipping APIs in particular, which were defined in Chapter 2 as: web integration technology that exposes shipping functionality aimed at supporting shipping processes in third-party logistics, from booking to delivery.

Literature about the adoption of web integration technologies, including APIs, is scarce. APIs are a relatively new phenomenon. While there is some work done in the adoption of Web Services, this was done many years ago and factors vary over time. Most literature related to APIs consider the evolution, while they devote little or no time to investigate the adoption. Conversely, there has been much research geared towards identifying factors to cloud computing adoption. Meanwhile an API is one of the main elements of cloud services; APIs make the cloud extensible and allow for interoperability between cloud services. Therefore, this chapter analyses factors to adoption found in literature regarding Web Services, API and cloud computing to guide the interviewing process.

The evolution of cloud computing adoption has developed broadly. Businesses have shifted to a Software-as-a-Service segment, and it has become common to have applications running in the cloud. A survey by IDG in 2018 quantified cloud computing patterns. It found that 73% of organizations have adopted cloud computing for some portion of its applications or infrastructure (IDG, 2018). It is no surprise that a large body of research focused on cloud computing adoption exists. This was confirmed by Bayramusta & Nasir in 2016 that investigated 236 articles on cloud computing between 2009-2016. The authors found that the majority was done on cloud computing adoption, namely 19%. The TOE framework by Tornatzky and Fleischer (1990) was identified as a popular analytical tool to explore adoption factors of cloud computing (for instance Borgman, et al. 2013; Nkhoma et al., 2013; Hsu et al., 2014), that is also adopted in this study (see Chapter 2). The framework argues that technological as well as organizational and environmental factors act as obstacles to successfully adopting and deploying technologies. This chapter adopts the TOE framework to explore adoption barriers of Shipping APIs, within existing literature.

As a result of this popular discourse, the emergence of cloud computing has also led to the increased importance of integration technologies like APIs. However, literature on APIs is predominantly focused on the evolution, how APIs are updated and how these updates are managed by developers, instead of its adoption. Hora et al. investigated how developers react to API evolution. The authors summarized patterns and characteristics to API evolution. Other investigations on API evolution were done by for example Dig & Johnson (2006), Hora et al. (2015) and Sohan et al. (2015).

Previous studies suggest that understanding the adoption of web integration technology within organizations is non-trivial and far from straightforward (Kim & Olfman; 2011). APIs are the successor to Web Services, on which more literature can be found, although most studies were written more than years ago. For example, Ciganek (2006) found that Web Services are context dependent, there exist industry-specific factors that can inhibit or promote its adoption. This is consistent with this study’s research strategy, the technology adoption is studied in a specific context. Though, the study only investigated the current experiences of eight companies, and the factors may vary over time. Five years later Kim & Olfman (2011) note that Web Services are still in its early stages.
Literature suggests that while considering the adoption of Web Services, businesses may be concerned about the risks and consequences of moving business-critical applications online (El-Gazzar, 2016). For instance, technological factors such as security, privacy and availability concerns may outweigh the perceived benefits. (Kshetri, 2013).

5.2 Findings: issues to adoption

This section discusses factors influencing the adoption of technologies found in literature about cloud computing, Web Services and APIs. However, for the sake of this thesis, it is assumed that all factors might be applicable on the adoption of Shipping APIs. The factors are grouped with the use of the TOE framework.

5.3.1 Technological factors

The technological context entails both the internal and external technologies used or related to the firm. The most significant factors stem from the technological context: relative advantage, security and privacy and interoperability were found to be popular factors supported by literature. They were found to play a significant role in the adoption decision. The following technological factors were found.

Relative advantage

A relative advantage is a central indicator for adoption in Rogers’ Diffusion Of Innovations (DOI) theory (Alshamaila, et al., 2013; Oliverira et al., 2014). It is defined as “the degree to which an innovation is perceived as being better than the idea it supersedes” (Rogers, 2003). In business, most decisions have an alternative. Alternative technologies therefore challenge the adoption of new technologies. As discussed in Chapter 4, the Shipping API offers many advantages related to data quality and flexibility. However, security concerns may diminish the relative advantage of the innovation adoption.

Security

In Information Systems (IS) research on adoption security has always been a topic of discussion (Subashini and Kavitha, 2011). For the processing of personal information outside of the organization, safeguards have to be taken to ensure the data is not shared with anyone without permission (i.e data leakage). Phaphoom et al. (2012) found security to be the most critical factor to adoption or non-adoption of a technology, while Oliveria et al. (2014) found security not to be significant. Nonetheless, it also draws attention to trust in the provider, which is discussed later.

Reliability and availability

Because customer data is shared in combination with the flow of physical goods, integration mechanisms influence the whole supply chain (Gupta et al., 2013). Reliability is an important aspect of availability, and hence they were grouped. Any errors or delays that affect uptime of a technology, can have a negative impact on the whole fulfilment process. Reliability and availability are thus important features that partners expect once they have adopted the technology (Nkhoma et al., 2013). Consequently concerns to service availability can pose as an issue to adoption.

Interoperability

It is essential to integrate with existing applications that may be resident on either a separate cloud or traditional system (Avram, 2014). Rogers defined compatibility as “the degree to which an innovation is perceived as consistent with the existing values, past
experiences, and needs of potential adopters." Supply chains are characterized by a complex network of systems. This means that data integration is not straightforward, interoperability is a key issue and low technological compatibility can hinder adoption (Wang et al., 2015; Alshamaila, et al., 2013). If there exists no industry standard, this may require separate integration technology for each user. This can become complex. Furthermore, a vendor lock-in may occur, a situation in which a company becomes dependent on the vendor, facing substantial switching costs. This has been identified as a key issue to cloud adoption in literature. (Armbrust et al., 2010; Wang et al., 2015; Majid Al-Ruithe et al., 2018).

5.3.2 Organizational factors

The organizational context describes organizational characteristics such as scope, size and managerial structure, and may refer to the resources and characteristics of the logistics buyer. Within the organizational context, resources and top management supports were frequently mentioned.

Financial and technological resources
Companies may not have the required knowledge, or financial resources, that is required to innovate and digitally transform integration practices. This concept is often used in organizational change and information systems, but it has become common in e-commerce literature too (e.g. Rahayu & Day, 2015, Bakker et al, 2008). For example, the lack of qualified IT personnel can inhibit the adoption process. In addition, Schneider & Sunyaev underscored the importance of technological knowledge by considering the degree of IT personnel within the industry (environmental factor). Chen et al. (2011) suggest that the IT competency of workers and IT management maturity affect the adoption and diffusion for e-business systems.

Top management support
The final decision to adopt a technology is made by top management, strongly influencing IT implementation (Chen et al., 2006; Wilson et al., 2008; Oliveira et al., 2014). The attitude towards change from top management can influence the adoption decision (Alshamaila, et al., 2013; Lee & Kim, 2007; Wang et al., 2010; Low et al., 2011). It is known to be the most essential factor for a project’s success (Young & Jordan 2008).

Company size
Generally speaking, large firms have an advantage over smaller firms, as they have more resources and can take more risks (Oliveira et al., 2014; Alshamaila, et al. (2013). Though, Schneider & Sunyaev note that larger enterprises tend to have highly specific IT processes in place that require fragmented IT infrastructure; thus they may be slower to adopt new technologies compared to smaller firms that may be more flexible. This is also related to absorptive capacity (ACAP) - the company’s ability to recognize and acquire useful new knowledge from its external environment (Cohen & Levinthal, 1990).

5.3.3 Environmental factors

The environmental context is the external arena in which the organization does business, i.e. its industry, competitors and governmental supports. Environmental factors appear to play a role in a lesser extent than the other two: not all researchers found environmental factors to be of influence.
Competitive pressure

Competitive pressure was defined by Zhu & Kraemer (2005) as ‘the degree of pressure that the company feels from competitors within the industry’. The pressure from external parties can motivate the firms’ decision to adopt an innovation or not (Haug, et al., 2011). Studies seem to contradict in this regard; some found direct impact (Ifinedo, 2011; Low et al., 2011), but others found no evidence that it impact the adoption process (Alshamaila & Papagiannidis, 2012).

Industry fragmentation

The acceptance IS innovation can depend on the industry it is introduced to (Alshamaila & Papagiannidis, 2012; Levenburg et al., 2006). Many studies on cloud service adoption have shown that there exist industry specific factors, for instance technology intensiveness of the sector (Kula & Tatoglu, 2003). Some industries have been laggards, while others are quick to adopt.

Supplier efforts and support

Marketing and communication activities by the technology supplier can influence the adoption decision (Alshamaila et al., 2013). By promoting the service, the awareness factor is increased (found to be relevant to adoption by El-Gazzar et al., 2016). Schneider & Sunyaev and El-Gazzar et al. (2016) also note that service Level Agreements (SLA), can act as an issue. An SLA ensures a minimum level of service maintained by the technology provider. However, they may not be perceived as sufficient, transparent about data storage or security. After the adoption, disaster recovery is the responsibility of the provider (Raut et al, 2017).

Trust in provider

Apart from viewing new technologies from an innovation perspective, Schneider & Sunyaev (2016) argued we can also view cloud computing from an outsourcing perspective. It can be seen as an outsourcing decision, because it means the sharing of computing resources (i.e. multi tenancy). This outsourcing decision implies that apart from the already mentioned loss of control and security concerns, lack of trust can be an obstacle to adoption.

5.4 Conclusions

The aim of this chapter was to understand and provide factors influencing web integration adoption found in literature. It aids in answering the following question:

| 2 | What factors influence the adoption of web integration technologies? |

First, it was determined that research on the adoption of APIs is scarce. Therefore, studies about similar technologies, cloud computing and Web Services, were also used to find factors that influence the adoption of Shipping APIs. The factors that were found in literature were grouped according to the TOE framework (technological, organizational and environmental factors), and are compiled in Table 5.2.
Table 5.2: list of adoption factors.

<table>
<thead>
<tr>
<th>Factors</th>
<th>References</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative advantage</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security &amp; privacy</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability and availability</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controllability</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial and technological resources</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top management support</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Company size</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry fragmentation</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplier support and effort</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Trust in supplier</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As illustrated by Table 5.3, the most significant factors to the adoption of Shipping APIs stem from the technological context. Almost all authors agree that especially relative advantage has a strong impact on the adoption decision of the mentioned technologies. Oliveira et al., (2014) noted that the relative advantage of cloud computing is not conclusive across industries (manufacturing and services). Phaphoom et al. (2015) confirms the criticality of the security concern (Alexander and Thomas, 2011; Gupta et al., 2013; Lian et al., 2014). The authors also found low influence in availability, which is quite surprising compared to other studies that did mention this key concern. Interoperability was also found to be a universal theme among the literature - the technology is compared and needs to be consistent with existing technological architecture (Gangwar et al., 2015; Oliveira et al., 2014).

Within the organizational context, resources (especially technological) and top management support were mentioned often. Kim & Olfman (2011) found that the age of the firm determined the adoption likelihood, which was not mentioned in other
IS-studies in this review. The findings of these authors did not support findings by many other studies that show that firm size is a significant factor regarding adoption (e.g. Oliveira et al., 2014 and Phaphoom et al., 2015).

Overall environmental factors seem to be of lesser importance to the adoption decision, and furthermore not all researchers found environmental factors to be of influence at all. However, in studies by Priyadarshinee et al. (2017) and Kim & Olfman (2011) trust was found to have a significant direct impact on CC adoption as it is the first most important predictor. While Alshamaila (2013) did not find enough evidence that competitive pressure was a significant determinant of cloud computing adoption, El-Gazzar et al. (2016) and Gangwar et al. (2015) did find competitive pressure and trading partner pressure to directly affecting adoption.

In conclusion, the factors that are found to be influencing the adoption of technologies similar to Shipping APIs (cloud computing and Web Services), will be used as a starting point for the interview questions (Chapter 6).
Interview results

This chapter presents findings on the third data collection method: semi-structured interviews. The objective of the interviews is to identify subjective experiences, interpret motivations, and understand contextual factors that challenge the adoption of Shipping APIs in outbound logistics. The aim is to understand the interview participants’ motivations to the Shipping API adoption decision in particular. The units of analysis are defined as “the integration practices of companies adapting to Shipping APIs, in order to share logistics data”. Therefore participants include companies with some level of integration to a third-party logistics provider, both API and non-API (i.e. FTP). Based on the literature review, this chapter aims to answer the third sub-question in this research:

| 3 | What factors influence the adoption of web integration technologies by Dutch logistics buyers in practice? |

Section 6.1 provides details on the participants and case selection to ensure transferability of results. Section 6.2 outlines the interview protocol that was followed. Then the findings are presented in section 6.3. Lastly, the chapter ends with conclusions. The findings of this chapter are then validated with industry experts by means of a focus group in Chapter 7, the last research method in this thesis.

6.1 Participants

In qualitative research it is usually not possible to collect data on the entire population of stakeholders. For this reason, a sampling method is adopted, as proposed by Robinson (2014) in which a number of observations or cases are selected from the larger population. In this thesis, careful attention is paid in selecting participants that relevantly reflect the total population of stakeholders (Sekaran & Bougie, 2016). These categories are exemplary of the trade-offs that are expected to be present among the total population.

Sample universe and Sample Strategy

In the selection of interview participants, the stakeholders as defined in Chapter 4, are considered. Logistics buyers, integrators and fulfilment companies are interviewed,
because they are stakeholders directly related to Shipping API adoption in outbound logistics (Figure 6.1). As described in Chapter 4, the stakeholders can be distinguished between the supply and demand side related to Shipping APIs. The logistics buyers and fulfilment companies demand integration technology. Conversely, the integrators supply Shipping APIs.

![Figure 6.1 integration stakeholders.](image)

Because of the qualitative nature of this case study, the selection of the interview participants is guided by the judgement as to which interviewees are likely to provide the most diverse and complete information (Kumar, 2019). In this research judgemental sampling was used (also known as purposive sampling), a non-probability sampling technique where ‘information rich’ respondents are picked on purpose, based on the researcher’s knowledge and the information required for the research (Bernard, 2002; Lewis & Sheppard, 2006). Judgemental sampling is for certain studies the only meaningful way to investigate a specific phenomenon - other probability or nonprobability sampling techniques are not suitable (Tongco, 2007).

The first and main participant type, regarding the unit of analysis, is the logistics buyer. In this research, there exists only a restricted number of logistics buyers in the total population who have a large enough parcel quantity to make them adequate candidates for the use of APIs. Additionally we want to make sure both API and non API users are among the participant population in order to analyze API adoption from different technological starting points. It also helps in identifying any problems that still remain after API adoption. Therefore, participants were purposively selected that were presumed to be able to provide the most meaningful insights. Analogous to Tongco (2007), this preparation step was done based on experience from industry experts.

Industry experts argue that based on the parcel quantity, processes and functional requirements change. While for some smaller logistics buyers a webportal may be appropriate to meet their needs, and an API is not necessary, logistics buyers with a high parcel quantity require extensive integration systems to process the daily amount of parcels. Hence, in order to understand integration processes, and make an informed selection of participants, it is important to know what parcel quantity logistics buyers are sending. Unfortunately, sales data is not freely available and retrieving this from the logistics buyer themselves is not feasible given the time constraints of this project. Therefore, a PostNL database with the parcel quantities of their customers (logistics buyers) is used as a first basis for selecting logistics buyers for the interviews.
In order to address all factors influencing the adoption of APIs by logistics buyers, all stakeholders must be included in the interviews. Subsequently, a second and third participant type were interviewed, namely integrators and fulfilment companies, for a different perspective. Since the number of integrators and fulfilment companies in The Netherlands is a lot smaller and less varied than logistics buyers, the advice and connections of industry experts were decisive for the selection. Careful attention is paid to select participants with different expertises, for instance an integrator with a focus on front-end integration (webshop) versus one who focussed more on back-end integration (warehousing).

The selection of participants is summarized in a matrix (Table 6.1), illustrating both the participant type and the integration technologies that were currently practiced.

**Table 6.1: participant selection matrix.**

<table>
<thead>
<tr>
<th>Participant type</th>
<th>Logistics buyer</th>
<th>Integrator</th>
<th>Fulfilment companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT integration</td>
<td>API</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>FTP</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Two additional remarks on the participant selection must be made. First, one cell in the matrix is partially filled (e.g. API, Fulfilment). It is caused by the fact that only two fulfilment companies were among the participants: the first implemented FTP and the second outsources its integration with logistics providers to an integrator. However, in the case of this second fulfilment company, the integrator uses API as integration technology. Furthermore, the participant of this second fulfilment company possessed a good understanding of its implications and related considerations. Second, one logistics buyer outsourced part of its logistics integration to integrators, but was considering switching to direct Shipping API integration with the logistics provider.

In these two cases it was not necessary to deviate from the interview protocol and in the end, these perspectives led to new insights. In fact, it meant that all possible routes of integration practices from Figure 6.1 were present among the sample, i.e.

- logistics buyer → logistics provider;
- logistics buyer → integrator → logistics provider;
- logistics buyer → fulfilment company → integrator → logistics provider.

**Sourcing Sample and Sample Size**

Subsequent to informing the sales department and receiving approval, the participants were called by telephone and invited to participate. Out of the possible candidates that were contacted about 20% agreed to participate. The other 80% were not found to be interested in participating for various reasons: lack of time, the person did not have a sufficient understanding of the IT in a logistics context, appropriate person was not reachable, IT integration was outsourced or the company used an off-the-shelf integration technology stack.
In the end, nine participants were found and interviewed. Among the participants were (product) owners or IT executives who possessed a good understanding of the integration practices and requirements for shipping functionality. In some cases two participants were present during the interview. Analogous to Ciganek et al. (2006), one individual had technical expertise with respect to implementing APIs, and the other had managerial responsibility and a broader business perspective.

To summarize, the approach to sampling is shown in Table 6.2, as proposed by Robinson (2014). Table 6.3 shows the final list of interview participants.

**Table 6.2:** sampling considerations.

<table>
<thead>
<tr>
<th>Point of concern</th>
<th>Description</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample universe</td>
<td>integration stakeholders</td>
<td>Inclusion: companies using FTP or APIs for shipping functionality (direct customers, integrators and fulfilment companies) Exclusion: companies using off-the-shelf technology (i.e. not customized, but standard software)</td>
</tr>
<tr>
<td>Sample size</td>
<td>number of individual observations</td>
<td>9 (5 logistics buyers, 2 fulfilment companies, 2 integrators).</td>
</tr>
<tr>
<td>Sample strategy</td>
<td>selection method</td>
<td>Purposive sampling. Companies were selected based on the technology currently used and the experience of industry experts</td>
</tr>
<tr>
<td>Sourcing sample</td>
<td>hands-on sourcing</td>
<td>Account managers and consultants are informed. If permissioned to interview the company, the company is called by telephone, inviting them to participate in the research.</td>
</tr>
</tbody>
</table>
### Table 6.3: list of participants in the interviews.

<table>
<thead>
<tr>
<th>Index</th>
<th>Company type</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>Logistics buyer E-commerce</td>
<td>Owner</td>
</tr>
<tr>
<td></td>
<td>(electronics)</td>
<td></td>
</tr>
<tr>
<td>L2</td>
<td>Logistics buyer E-commerce</td>
<td>Product Owner</td>
</tr>
<tr>
<td></td>
<td>(electronics)</td>
<td></td>
</tr>
<tr>
<td>L3</td>
<td>Logistics buyer E-commerce</td>
<td>Owner</td>
</tr>
<tr>
<td></td>
<td>(fashion)</td>
<td>Developer</td>
</tr>
<tr>
<td>L4</td>
<td>Logistics buyer E-commerce</td>
<td>IT Director</td>
</tr>
<tr>
<td></td>
<td>(fashion)</td>
<td></td>
</tr>
<tr>
<td>L5</td>
<td>Logistics buyer E-commerce</td>
<td>IT manager</td>
</tr>
<tr>
<td></td>
<td>(fashion)</td>
<td></td>
</tr>
<tr>
<td>I6</td>
<td>Integrator</td>
<td>Owner</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Product Owner</td>
</tr>
<tr>
<td>I7</td>
<td>Integrator</td>
<td>Director</td>
</tr>
<tr>
<td>F8</td>
<td>Fulfilment company</td>
<td>Manager Solutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Developer</td>
</tr>
<tr>
<td>F9</td>
<td>Fulfilment company</td>
<td>IT Director</td>
</tr>
</tbody>
</table>

#### 6.2 Interview protocol

The structure of interviews can span a wide spectrum, from standardized to flexible. In this study, the interviews are of the type semi-structured. By keeping the interview topics relatively constant, the comparability between the interviews increases, meaning more robust conclusions can be drawn about the topics identified in the literature review (Sekaran & Bougie, 2016). A variety of topics for discussion were selected beforehand, while maintaining the flexibility to diverge into related topics that are important to the interviewees (Sekaran & Bougie, 2016).

Appendix G presents the interview protocol, i.e. the structure of the interviews, and topics to be discussed. After a brief introduction and context description, the interview starts with open questions regarding barriers to API adoption perceived by the participant to avoid bias introduced by the interviewer (Meijer et al., 2019). Questions informed by the literature review are then subsequently raised about API adoption barriers. Finally, the interview ends with an open question so that the participant can add anything that he or she assumes to be relevant, or wanted to address regarding the dialogue throughout the interview.

It is worth noting that interview questions slightly differ per interview category. As described, the interview participants have different roles in the supply chain. The logistics buyers and fulfilment companies were asked about their own motivations to adopt a Shipping API. Conversely, the integrators were asked about the motivations of their customers (i.e. logistics buyers or fulfilment companies) to adopt or reject Shipping APIs; their own motivations were not discussed.
In order to support transparency in research and to increase re-usability potential of research outputs, research data should be made as open as possible. However, when sharing information about humans, their privacy and rights have to be taken into account as defined in GDPR. Therefore, in this study participants gave written consent for the way in which their personal information is processed. The TU Delft (2018) provided a template for the consent form and guidelines for an accompanying information sheet. These were adapted to this study and can be found in Appendix H and Appendix I, respectively. After the research was done, the audio recordings from the interviews were deleted in order to comply with new GDPR regulations (Kormelink, 2018).

6.3 Findings

Based on the analysis of the interviews, a number of factors can be identified that explain logistics buyers reasoning in regards to the decision to adopt Shipping APIs. As a result of the interviews, it was found that only after justifying a business case, logistics buyers may decide adoption an API. Once the business case is clear, logistics buyers consider what integration technology is needed (API/FTP). Both the business case and the adoption decision, including factors influencing API adoption by logistics buyers, are discussed in detail next. However, first the participants’ current attitude towards APIs is discussed.

Current attitude

It is observed that all participants agree that APIs are the way moving forward. Especially integrators are in favor. The main reason for this is that FTP connections demands more resources to update when a process requires change.

Since I am here I’m trying to make it clear to colleagues that self-implementation cost a lot of developer resources. (..) We intent to get rid of self implementation because it results in more overhead. - I6

Fulfilment companies agree: separate FTP connections at different locations are hard to maintain. They thus prefer to centralize software rollout and APIs help them being more dynamic. They point out that the e-commerce market is growing so fast, that they have to use modern technology in order to not get ‘left behind’. F9 pointed out they are currently building a new, better and easier process to integrate logistics providers at clients, because it currently takes a lot of effort and time.

When I look at the market and other carriers, API is from my point of view that is what every large carrier is switching to (..). And my feeling is that API communication is currently state of the art. - F8

L1, L3, L4 and L5 point out that they do not have a dismissive attitude towards the API, but they just see it as a enabler in offering services to their customers.

In the end the benefits the API offers translate into the front-end. So for us it is not so much about a great API endpoint, but the more that we can provide value to our customers. If API is required for that, then that is how we implement it. - L5

L2’s vision is to work with APIs. Almost their entire technology stack is based on APIs. Therefore the participant said that if they are looking to integrate with a logistics provider using API, and for some reason the logistics provider does not provide API integration, then this is a reason to look for another logistics provider.
Concluding, overall, the current attitude towards Shipping APIs is positive; many non-adopter see it as a possibility for the future. Logistics buyers are a bit more reserved than integrators and fulfilment companies. It was often mentioned to act as an enabler to translate benefits from the front-end into functionality. The current technology stack used by logistics buyers was shown to act as an anchor to future adoption decision.

6.3.1 Business case and status quo

How do logistics buyers decide when to implement a new integration technology, like Shipping APIs? Participants agreed that this decision first and foremost starts with a business case; a switch to a new technology needs to make sense financially. This means that logistics buyers must justify a proposed integration project in regards to its expected commercial benefit. Logistics buyers were found to only consider implementing Shipping APIs if the expected outcome was in support of a specific business need. The API is then merely an enabler.

*In the end for us it is all about what can we do with it. API is the enabler. If you do on paper, by email, or through an FTP server, or Web Service. Well that is just the technology - for us it is more about what can we achieve with it?* - L3

If a switch to a new integration technology is expected to have profitable results, for instance high customer satisfaction or more sales, then participants considered adopting another integration technology if this is required to enable the business need. However, findings indicate that the proposed project is compared to existing and other projects on the roadmap. The status quo was therefore also found to act as an anchor to future decisions. Participants thus argued that when considering a business case, they expect it to be both a Return On Investment (ROI) and an improvement on the current situation. L5 and I9 argued:

*We do not make the decision to use API vs FTP- rather, we look at the business case.* - L5

*Everything is dependent on resources and business cases. Are you going to put effort into it? That applies to integration technology too.* - I9

Recognizing the commercial benefits of a Shipping API is prone to a status quo bias as current systems act as an anchor to future decisions. Without the prospect of improving the status quo, logistics buyers struggle to even consider using a new technology for their business. Participants mentioned this relative advantage as an influencing factor regarding the business case and thus the following decision to adopt a Shipping API. This was illustrated by L1 and L4:

*If everything works fine, why would you change it? There is no need to change it. (...) At this moment no (I do not see the relative advantage). But that is because it is going well. So it is not really on the agenda. If it is not needed, why would you do it? At least if you do not see the benefits of it. Maybe you can explain (the benefits)* - L1

*This works. It does not bother us. There is no urge to innovate at this moment.* - L4

However, if a business case is clear, multiple participants expressed to be positive toward the API technology (as mentioned in the previous section). Integrators and fulfilment
companies agreed as well. They offer a variety of services and are well-informed on all the advantages of the Shipping API.

*It is not so much that I have to be convinced of PostNL APIs. We know that it is very good and has been frequently updated in recent years.* - L3

Four separate reasonings for a *business case* including Shipping APIs came forward during the interviews. First, participants suggested there may be a market or technical need that requires *urgent* action to adopt the API. From a *market* perspective, a business may have to switch to an API in order to efficiently manage warehouse operations. For instance as a result of increasing shipment volume or merge with another company that uses different integration technology. From a *technical* perspective, the support of an old technology may come to an end. In that case a decision is imposed on the logistics buyer to switch integration technologies. L4 and L5 said:

*If the support stops (on old technology), then you set priorities. Then they will naturally go to a new integration technology. That is not rocket science.* - L4

*In the end you want to sum up the benefits to the customer. But you also want to create some kind of urgency - something like you have until 31 december 2020. You want to be able to explain why you are stopping support, because it is old technology and frankly costs unnecessary amount of time.* - L5

Second, new recipient expectations may result in new business cases. As the e-commerce marketplace steadily grows and adapts to new emerging customer requirements, a business may develop new strategies to bring more value to customers. For instance, recent research by Kieskierug.nl showed that 39% of online shoppers prefer evening delivery (Oosterhout, 2019). There thus exists an external market need to offer evening delivery, a service that is solely offered via a Shipping API.

Third, the current logistical process was found to influence the business case. In many cases, besides the shipping label, other labels may have to be put on the box as well. For instance, additional instructions to explain how to return the product if the consumer was not satisfied with the product. Thus, when considering Shipping APIs, logistics buyers might demand the ability to customize the label best fit to their logistic process. This can result in a higher warehouse throughput rate - the number of processed units given a timespan - saving time and costs.

Fourth, a logistics provider may promote commercial benefits of using Shipping APIs. The sales department or the IT support may have suggested a business case that can be implemented by a switch in integration technology. This reasoning may convince the logistics buyer to adopt a Shipping API. Conversely, if a logistics provider does not communicate the possibilities of APIs to logistics buyers, they may not see the commercial benefits, and a business case is never formed. L1 and L2 pointed out they are ill-informed on the benefits and possibilities of APIs:

*No one told me that this option was available. (timeframes)* - L1

*Does PostNL also offer the ability to create labels? No right? Oh okay... haha.* - L3

*To be honest I did not know you had an API in place.* - F9
Concluding, a business case including Shipping APIs may stem from an urgency to act on a proposed project, demands from the recipient, wants within a logistics buyers logistic processes, or advice from the logistics provider. However, a business case is prone to a status quo bias as current systems acts as an anchor to future decisions. After a business case is clear and justified, the logistics buyer decides on a technology to adopt, in order to achieve the desired result. In other words, which technology is the best fit to implement the business case?

It is worth noting that the case evidence suggest that the API adoption decision is evaluated per business process and subsequent business case. A set of Shipping APIs are offered that each enable different functionality, and because of its flexible and dynamic nature, they can be implemented separately. Hence logistics buyers may choose to use a combination of integration technologies for their delivery information chain, from booking to delivery. As L5 said:

_Let’s say we want to build pick up locations. Okay how can we achieve this? Okay we need to connect with the API, but that does not mean that everything has to be implemented using the API. If we do not need an API in some other cases, then that is also okay._ - L5

In order to discuss the factors that influence Shipping API adoption by logistics buyers, they are categorized based on the three components of the TOE framework: _technological, organizational_ and _environmental factors_.

### 6.3.2 Technological factors

Three technological factors were discussed during the interviews: _relative advantage, availability and security_.

**Relative advantage**

The technological relative advantage of Shipping APIs were found to influence the chosen integration technology. As described in Chapter 4, Shipping APIs offer logistics buyers, integrators and fulfilment companies a quick, almost real-time, way to communicate logistics data with their logistics provider. Speeding up order booking, order picking and order tracking by means of APIs, can be beneficial for the logistics buyers’ internal logistics processes, and may result in satisfied recipients who received their package fast. Furthermore, Shipping APIs offer a flexible way of communicating with the logistics provider, suitable in the fast-changing logistics industry nowadays.

The extent to which these technical advantages appeal to logistics buyers, is again influenced by the status quo. The context in what manner an API in general is currently used or not used, is important in understanding Shipping API adoption. A logistics buyer’s current use of integration technology may or may not allow them to switch to APIs easily, and plays an important role in deciding which technology to use. Both the front-end and back-end operations, for instance webshop software, ERP, OMS and WMS, all influence how logistics buyers view Shipping API. Do these systems support web integration technology? How difficult is software implementation?

In addition, logistics buyers may have certain demands when considering Shipping APIs, for instance a customizable label or full control of a process, that Shipping APIs cannot offer. In the event an API does not meet the logistics buyers demands (yet), self-implementation (FTP) is generally the only other option.
A key advantage of self-implementation when compared to Shipping API is the ability to customize labels (as pointed out by L7). Some businesses require this for their operational processes. APIs offers little room for customizability - users can customize it to the extent that they can configure what data or services to include. With FTP however, businesses can create their own label, and put for instance their own logo on it (argued by L2 but remained inconclusive about its influence). Also the size of the label received in response was seen as a limiting factor to Shipping APIs, because the printers may not support it.

Some of our clients want to customize the label. I see this often that big retailers that want to add instructions to the label. This advantage in terms of the labeling process then outweighs them. - L7

L2 used the Labelling Web Service via the Shipping API and pointed out that 'a standard' API can be hard to deal with:

I do all kinds of magic with ImageMagick. I put an invoice number over it with international labels. I rotate the German labels once. No, the Dutch ones. I put the German one upright. Would be cool if I could specify rotation parameters (.). And we have no problem doing this, but others may run into problems. - L2

Furthermore, participants suggested that Shipping APIs are likely considered when logistics buyers are planning to rebuild existing systems. APIs may bring technological benefits for Order Management Systems (OMS) or Warehouse Management System (WMS). For instance, if the new OMS is built in the cloud, the link to a third-party logistics provider can be integrated faster and at a lower cost using the API, in comparison to FTP. L5 illustrated this by pointing out that they recently decided to rebuild their OMS systems from scratch, but now build in the cloud. As a result they decided to reconsider logistics integration technology and decided API technology was the best option.

Lastly, the Shipping API may simply be the only technology available to enable a certain service, making API adoption inevitable in order to implement a business case and achieve the desired commercial benefit. Chapter 4 outlines which services require an API, for example evening delivery and pick up locations.

Availability
Most participants pointed out that availability of Shipping APIs is paramount to its adoption. Uptime has to be safeguarded, since just the slightest glitch can possibly have a big impact in a logistics buyer’s logistics processes. Therefore, the possibility of downtime was mentioned by most of the participants as a concern when considering the adoption of APIs.

No I do not see any chance for improvement. 10/10 score. Except if the API is down. - F9

Some considerations have to be made regarding availability. First, we can distinguish APIs that are customer facing (i.e. check-out) and APIs that facilitate back-end operations (warehousing). Participants had conflicting views related to these two levels, depending on their business priorities.

(,)In which case the customer facing is the most important in my opinion. Unless I'm missing something. - L3
Other participants pointed out that if the Shipping API is down in check-out, they engineered a default option so the check-out process does not come to a standstill. When the Address Check API or Delivery Points API do not work, they leave those fields blank allowing the customer to continue its purchase. They thus suggested although downtime on the front-end can have negative consequences, it can be overcome and does not challenge the adoption of the technology.

On the back-end however, downtime on the Labelling Web Service for instance leads to delays in warehouse operations. The extent of the negative effects then depend on the shipment volume and warehouse throughput. For bigger businesses this can result in employees doing nothing and delayed deliveries, with lower customer satisfaction and costs as a result. Concluding, most participants agreed that downtime is a bigger issue in the back-end than in the front-end. They shared interesting insights on how they approached this issue.

Considering the back-end, L2 and L4 pointed out that best practice is to perform the API call to the Labelling Web Service right after the order has been placed on the webshop, and then store it in a database. When picking and packing procedure commences in the warehouse, the label can then be retrieved from the database immediately. This thus leads to a time window by which companies are able to counter any downtime or lag in the API and continue its supply chain processes. Though, this was argued to be not a foolproof fall back solution. For instance, when downtime occurs close to the cut-off time - the time at which the logistics provider picks up the packages - this presumably still leads to delayed shipments.

The integrators also agreed that availability, whether it is a fall back solution or just a 100% guarantee, plays a key role for them in case a switch from FTP to API needs to be made. Integrators wish to remove any liability from of the supply chain (and want to be a back-up solution to their customers). This can thus be a competitive advantage for an integrator.

Yeah I think it would (convince people to switch to API). It is an extra incentive to switch. They are already missing some services they cannot use. And that is hurting them - but I may be too sales oriented for that. - 18

On the other hand, fulfilment companies were less concerned with downtime. They pointed out their ability to switch logistics providers when a Shipping API is down. If the Shipping API is not working, packages are rerouted to another logistics provider in The Netherlands. In contrast I8 pointed out that switching logistics providers is not a suitable solution in the long run - and, in many cases, not possible. Fulfilment companies may have multiple logistics provider coming in every day, but for most businesses this is not the case which makes switching logistics providers not possible. F8 did have back-up solutions in place for every logistics provider, while F9 outsourced integration and did not have fallback solutions in place apart from switching logistics providers.

However, no strong consensus among logistics buyers was found on the importance of availability and a possible fallback solution. Although L3 argued that availability is very important, the participant pointed out that availability is not something they based their adoption decision on, as they argued that downtime can only be experienced after implementation.
For two other participants downtime was not an issue (L2 and L4). L2 found Shipping APIs to be stable and L4 pointed out that they did not worry about uptime and considered an uptime guarantee to be obvious. In contrast L1 pointed out that availability is seen as a challenge because in case of downtime “then there are people doing nothing in the warehouse. With their arms crossed.” L5 expressed the importance of availability, but did not consider a fallback necessary: "A fallback is not really necessary in my opinion, but a reliable API is. In the end, offering a fallback might actually be a weakness.”

Security
Participants did not express security or privacy concerns when it comes to Shipping API adoption. L3 mentioned that security is simply part of the deal when using technology. After all the difference between FTP and API in terms of security was found to not pose a challenge to API adoption.

It is just something that comes along with it. You just take care of it. So that is not a challenge. - L3

Just think about it well beforehand - and then it is very doable. -C2

![Figure 6.2: influencing technological factors (mentioned by %participants).](image)

6.3.3. Organizational factors

Two organizational factors were discussed during the interviews: controllability and resources.

Controllability
When comparing FTP to APIs, it was assumed that APIs could be seen as an outsourcing decision (Chapter 5). By using APIs, logistics buyers would ‘lose control’ and therefore be hesitant to adopt where as FTP allows logistics buyers to perform tasks themselves and then just upload the data. However, none of the participants see controllability as an issue to the adoption of APIs., L1 and F8 underlined this by saying:

Well that would not matter to me (dependency risk). You just have to have a working system. - L1
We are working in a partnership (...). So I am not worried we lose control. - F8

In fact, participants pointed out that they experience “more control” when using the API. 18 the most important reason to adopt APIs is being flexible and being able to quickly switch. L2 agreed:

Difficult to debug (FTP). You just want to do it with an API. Because then it’s just the 1 on 1. Yes or no. We like working with that. - L2

**Resources**

When a logistics buyer is considering whether or not they should use APIs, their available resources play a big part in the decision. Does a logistics buyer have the required funds, technical expertise, and time to implement APIs? Most participants pointed out that especially a lack of time was challenging the adoption of APIs.

Our problem is a capacity issue. We have too many projects and too few developers. And that means that we have priorities. - L4

It is partly a time issue. We need to make a choice and commit to it. It is indeed my wish to use the same API for the whole cycle. (...) Yeah I had no time to.. it is on the list. - L2

We have postponed this project (...). The fact that we do not use it is just that we have not had time for it yet. - L3

All of the participants agreed that technical expertise does not pose as a challenge. Most of the companies had the expertise available or were confident they could acquire it when needed. The switch from old technology to API can be made as soon as it was desired.

Well we can make anything. It depends on the API. In the end everything is possible. - L1

Integrators and fulfilment companies have technical expertise by definition. It is after all their business to integrate logistics buyers with logistics providers. Therefore, both have mentioned technical expertise not to be an issue regarding what integration technology to use. How much money it costs for a logistics buyer to adopt the API depends on a variety of factors, including the status quo, the desired functionality and the talent of the developer. Hence a business case is not always clear.

![Figure 6.3: influencing organizational factors(mentioned by %participants).](image-url)
6.3.4. Environmental factors

Two organizational factors were discussed during the interviews: vendor support and past experience.

Vendor efforts and support
It was found that based on the advice or actions of the logistics provider or an integrator the logistics buyer may choose to go for the API. I9 mentioned that all of their new customers (logistics buyers) use the API, as I9 thinks it is the way moving forward. F10 said that the logistics buyers do not always decide what technology is used. For example, one participant merged with another logistics buyer, but did not have enough warehouse space to accommodate all items. The logistics buyer therefore used two separate technologies that were not chosen by themselves, but by the fulfilment company they were outsourcing their fulfilment to.

Participants emphasized the importance of documentation and online testing environments when considering adoption a new technology like APIs. In the case of PostNL, the documentation was positively reviewed by participants and the testing environment is available, so this should not be an issue. However, a few participants mentioned the lack of clear communication about API updates (sidenote: it was found that most logistics providers send a technical newsletter to inform customers, and PostNL has also done so recently).

Yeah these updates. We often miss them. Sometimes it suddenly appears in the documentation. - L2

The API onboarding was half a year ago little bit difficult. It was not really clear what was on and off. And what you are communicating about. Or for which things you need to make a contract for example, back then it was not really clear to me. - L3

F8 also pointed out that API adoption is not a problem on a technical basis. Rather, the participant thought the communication could be improved. I8 also underscored that it would be beneficial to all parties if there was result demonstrability of a logistics buyer using APIs.

When you see it on the email yeah, it is very hard to read and the latest status of that. Maybe a ticket tool or something like that could be a better process, where a customer would post every piece of information that you need and you provide us with all the information that you have. The current process for client integration is very painful from my point of view. - F8

Past experience
Some participants have argued that past experiences influenced API adoption, in a positive but also negative way. C1 had a few issues with an API from another logistics provider, whereas C3 had a bad experience with an API from accounting software. F9 confirmed this by saying:

Yeah they have experience with an API. In some way. Or heard about it.(..) If we offer a particular carrier and they say no we do not want that one because we have had a bad experience with them then it is their own experience right. - F9
6.4 Conclusions

Nine interviews were conducted to identify subjective experiences, interpret motivations, and understand contextual factors that challenge the adoption of APIs by logistics buyers. On average the interviews took 65 minutes. This chapter aims to understand the adoption decision. Among the participants were logistics buyers using FTP or APIs, integrators and fulfilment companies.

The sub-question in this chapter was defined as:

| 3 | What factors influence the adoption of web integration technologies by Dutch logistics buyers in practice? |

First, after analyzing the interview results it became clear a business case is essential for logistics buyers when considering to adopt Shipping APIs. A business case may stem from an urgency to act on a proposed project, demands from the recipient, wants within a logistics buyers logistic processes, or advice from logistics providers, and is influenced by a status quo bias. After a business case is clear and justified, the logistics buyer decides on a technology to adopt, in order to achieve the desired result. In other words, are APIs the best fit to implement the business case?

This adoption decision is influenced by multiple factors. An overview of all influencing factors as indicated by each participant is shown in Table 6.4. The influencing factors are divided in three categories using the TOE framework as discussed in Chapter 2. The participants were labeled, where L stands for logistics buyer, I stands for Integrator and F for Fulfilment company. Furthermore, a “+” implies that the participant suggested that it was indeed a factor they considered to be a challenge in API adoption. In contrast a “-” implies that it was not considered to be relevant or a challenge. A blank indicates that the factor was not addressed by the participant and an “o” that the participant was inconclusive about the factor’s influence.

Figure 6.4: influencing environmental factors (mentioned by % participants).
Table 6.4: cross-factor overview among participants (based on findings from Chapter 5).

<table>
<thead>
<tr>
<th></th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>L4</th>
<th>L5</th>
<th>I6</th>
<th>I7</th>
<th>F8</th>
<th>F9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technological</strong></td>
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<td></td>
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<td></td>
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<tr>
<td>Relative advantage</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>O</td>
</tr>
<tr>
<td>Security and privacy</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>O</td>
</tr>
<tr>
<td>Reliability and availability</td>
<td>+</td>
<td>-</td>
<td>O</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Controllability</td>
<td>O</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>O</td>
</tr>
<tr>
<td><strong>Organizational</strong></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Financial resources</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>O</td>
</tr>
<tr>
<td>Top management support</td>
<td>O</td>
<td>O</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>Company size</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry fragmentation</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>O</td>
<td>-</td>
<td>O</td>
<td>-</td>
</tr>
<tr>
<td>Supplier communication and support</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Trust in supplier</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Past experience</td>
<td>+</td>
<td>O</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>O</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>

**Technological factors**
A key problem was the business case, i.e. the participants argued that there exists a lack of justification for the proposed project on the basis of the expected commercial benefit. Findings suggest that the Shipping API as an innovation does not pose a challenge. The switch from old technology to API can be made as soon as it was desired. However, there were concerns about the availability. Participants indicated that downtime is viewed as an important barrier to adoption, although there was no strong consensus among logistics buyers. In this regard, downtime was more important in the context of back-end APIs that form the infrastructure in the supply chain, in comparison to front-end APIs that do not cause the whole process to come to a standstill in case of failure. It was argued that a back-up solution would provide a means to improve chances of participants switching. In general security was not found to be a concern; participants trusted that data sent through the API would be safe, as described in the guidelines of General Data Protection Regulation (GDPR). Overall challenges related to the technological innovation appear to play a significant role.

**Organizational factors**
Participants brought important factors forward at the organizational level. Findings suggest that financial resources plays a significant role as API implementation requires
time and resources. Given the status quo, participants stated that resources were a major obstacle to API adoption, especially if the logistics buyer does not have development resources in-house. In addition, controllability also did not seem to be an issue. Overall, the organizational factors were found to play a moderate role.

Environmental factors
The lack of a logistics industry standard has resulted in a scattered landscape with different APIs that are offered by different logistics service providers. After all, this is why integrators have business: the hassle of implementing different APIs means that logistics buyers decide to outsource IT integration. Not all APIs meet the standard that users expect, and so the case evidence shows that this experience influences the adoption decision. The lack of result demonstrability has also shown to be of influence. The main environmental factor influencing the adoption of APIs was identified as vendor support. Findings suggest a lack of awareness; communication and advice from the logistics provider about the relative advantage of APIs was not present or was lacking. The participants underscored that the specification and testing tools should be well-documented. Overall, environmental factors were found to be of marginal impact.

Concluding, one of the key challenges in Shipping API adoption is the lack of demand and awareness at logistics buyers, in combination with the availability of alternative technologies that are already implemented. In addition to a perceived risk of downtime for APIs, this makes it hard to justify the investment in order to switch integration technologies. The next chapter will validate these factors with industry experts at PostNL, to ensure justified recommendations can be made towards enhancing integration.
Focus group results

This chapter presents findings on the fourth, and last, data collection method: a focus group. A focus group is chosen, because the research is conducted while within the organizational boundaries of PostNL, connecting to a variety of industry experts having knowledge about the problem at hand. The objective of this focus group is to retrieve views from industry experts about the adoption of APIs by logistics buyers, compare them to the interview results from Chapter 6, and discuss possible solutions for these barriers. This chapter results from Chapter 6, and discuss possible solutions for these barriers. This chapter aids in, again, answering the third sub-question in this research:

| 3 | What factors influence the adoption of web integration technologies by Dutch logistics buyers in practice? |

Section 7.1 starts off with describing the participants that took part in the focus group, after which section 7.2 contains the script that was followed. Then section 7.3 outlines data analysis and the findings. The chapter ends with a factor validation from the interviews in comparison to the opinions of industry experts. A discussion on all data collection methods and the findings is presented in Chapter 8.

7.1 Participants

The participants were purposely selected on the basis of their familiarity with the digital integration with customers and partners (Table 7.1). According to Kitzinger (1995) the ideal size of a focus group is four to eight people. If more participants are present during the group session, then controlling the focus group can become difficult and limits the ability for each person to share their opinions and insights. Barnett (2002) points out that the session ideally lasts at maximum 90 minutes. If it takes longer, participants start to exhibit signs of boredom. In this focus group, six experts were able to be present out of the nine experts that were invited (Table 7.1). The focus group took 84 minutes in total.
Table 7.1: industry experts present during the focus group.

<table>
<thead>
<tr>
<th>Index</th>
<th>Job function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Manager</td>
<td>manages products owners; acts as contact person to Sales &amp; IT support departments</td>
</tr>
<tr>
<td>P2</td>
<td>Product owner</td>
<td>member of the agile team; responsible for managing one product in the integration technology portfolio</td>
</tr>
<tr>
<td>P3</td>
<td>Consultant</td>
<td>delivery options expert; regularly visits customers onsite</td>
</tr>
<tr>
<td>P4</td>
<td>Partner manager</td>
<td>contact person for partnerships, including integrators, fulfilment companies and platforms</td>
</tr>
<tr>
<td>P5</td>
<td>Consultant</td>
<td>information technology expert; connects business requirements to IT implementations</td>
</tr>
<tr>
<td>P6</td>
<td>IT support</td>
<td>technical support to customers and partners; responsible for key accounts</td>
</tr>
</tbody>
</table>

7.2 Script

The findings of the interviews were used as a guideline for a discussion script. The script was followed to structure the group discussion (Table 7.2), and contained four components.

First, the context, the goal and structure of the focus group were explained to the participants. The focus group used the same consent form and data privacy procedure that was used during the interviews. After the participants gave their written consent, the audio recording started.

Second, the participants were asked to share insights on their current option on barriers to API adoption by logistics buyers, and possible solutions to these barriers. A discussion among the industry experts started. In order to avoid bias imposed by the researcher, these questions were raised prior to revealing the interview results.

Third, the interview results were presented (see Chapter 6) by the researcher. The following discussion allowed a comparison of the opinions expressed by the focus group participants versus the opinions of the interview participants.

Last, the participants were asked to draw conclusions about the discussions conducted in the focus group. Finally, a number of ideas about factors that influence API adoption by logistics buyers came forward. For each factor, the results and analysis are presented next. Note that the findings of this focus group are an aggregate of the opinions of individual industry experts, and not the opinion of the company PostNL.
Table 7.2: script of focus group

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to the focus group + written consent</td>
</tr>
<tr>
<td>2</td>
<td>Discussion about current ideas and possible solutions to barriers of API adoption</td>
</tr>
<tr>
<td>3</td>
<td>Discussion about interview results</td>
</tr>
<tr>
<td>4</td>
<td>Conclusions</td>
</tr>
</tbody>
</table>

7.3 Findings

In order to discuss the factors which were found to influence API adoption during the focus group, the factors are grouped based on the three components of the TOE framework: technological, organizational and environmental factors.

7.3.1 Technological factors

A number of factors were related to the technological characteristics of APIs. It was argued that characteristics were not up to the standards logistics buyers expected. This was noted by experts as the relative advantage of the API, as well as the availability guarantee. These technological factors are discussed next.

Relative advantage
A participant argued that API response time acts as a barrier to adoption. This refers to the amount of time the system takes to respond to a request. In some cases, the API may not meet the speed logistics buyers demand or may be slower than an alternative solution, and therefore is lacking a relative advantage.

For certain market segments the performance demand is higher than we can now offer.  
- P4

It was argued that logistics buyers are constantly looking to improve the speed of the webpages in their webshop, including the check-out webpage. In this regard, implementing an API adds up to the total time it takes to load the webpage. A participant argued that because an API leads to a slower webpage, a worse consumer experience may occur. Therefore, a logistics buyer may look for an alternative technology. For instance, retrieving data from a privately owned database is typically faster than performing API calls to retrieve data from third parties.

The industry experts argued that the currently used technology also plays a role in the relative advantage. Many logistics buyers historically implemented FTP solutions, because in previous times FTP was the standard. The current integration involves tight point-to-point FTP connections. This means that changing one part of the total system integration, affects the system as a whole. It is difficult to change and would often require high development investment costs. Industry experts mentioned that FTP is based on batch processing, where a collection of events is processed. In contrast, API is based on event driven design, meaning that the receiving application is triggered based on individual events. For instance a confirmation process: with FTP confirmations are processed in batch by uploading a text file to an FTP server, whereas the API confirms each order individually.
The API is based on a transactional basis, event driven. And so I think that it could be difficult to switch when your entire system is not based on event driven design. And then the cost can suddenly be much higher. - P5

Subsequently, industry experts suspected that if FTP integration works well, then the incentive to switch to an API may be very limited. Since the currently used technology already works, and is probably deeply integrated into the logistics buyers’ systems, the relative advantage may not be clear. Again, a status quo bias is identified, though one expert mentioned that differs per logistics buyer depending on how it perceives the API implementation complexity.

What you often hear, or what I often heard in the past, is that they often say yes it works already. So why should we change. It is completely integrated into all our systems. It just works. That’s one reason not to adopt the API. - P3

Lastly, the focus group participants discussed a possible way to create a relative advantage for logistics buyers, when using APIs. They suggested the possibility of a lower cost policy for API versus FTP technology. The experts agreed that although it may stimulate logistics buyers to switch, this cost policy does come without implications. The experts agreed that it seems illogical to ‘force’ logistics buyers to use only one technology (the API), while there exists an availability issue and is thus less safe option than the current one (FTP).

**Availability**

Focus group participants considered the availability of APIs to be an issue for API adoption. Notably, an availability issue occurred a few years ago when a part of the API platform (and subsequent services) was offline. This happened during the peak season in December (Van der Velden, 2016). As illustrated by this event, since then it became clear that it is important to monitor API uptime to be able to take care of hosting issues in case of emergency.

Four aspects of availability were mentioned during the focus group. First, an industry expert said that one should distinguish between complete outage of the API and a slow response time. When is an API considered to be up or down? It became clear there was not a clear definition to *downtime*.

Second, the possibility of a *fall back* solution was argued to be a way to overcome the availability barrier. If logistic buyers are using the API, they are using a *monolithic* application, in the sense that they rely on a single technology only, and cannot easily switch to a technological counterpart. As a result of using only one technology without a *fall back*, experts argued that logistics buyers may currently be hesitant to adopt.

Using a fall back prevents the total failure of the supply chain in the event the API is down. This means that a separate solution is implemented, in conjunction with the API. The fall back is (automatically or manually) activated when it is needed and deactivated once the normal operation is resumed. A fall back solution typically has limited or reduced functionality, but it is still capable of facilitating the operations for a certain period.

A participant suggested that logistics buyers that have already implemented FTP solutions, can use FTP as a back up when they switch to an API. This then acts as a fall back in the event the API is down. However, due to the time consuming implementation
of FTP, it cannot reasonably act as a fall back scenario for logistics buyers that do not have it implemented already because of its high costs.

In addition, participants pointed out that a logistics provider will have to consider if it is desirable to have many offline implementations running at logistics buyers warehouses. In that case a logistics provider has little control over update management and its usage in such cases, possibly resulting in flaws in the logistics process.

Let’s say you configure an offline solution at the client. If you do that at 10, then you will have to maintain 10. - P6

Yes but uhh.. if you have 600 pick up locations, and if a normal label is printed then it goes wrong (in case of a fall back solution). Because then the primary process continues, but within logistics we get into trouble. We need to really think this through then. - P5

Furthermore, who would be responsible for the fall back solution? For a logistics buyer implementing a fall back solution leads to more development time and costs, and is therefore not considered to be the best way to overcome availability issues. Participants subsequently argued that logistics providers could build a fall back to facilitate a back up process.

I think we should do everything we can to facilitate this yes (a fall back). And if in the end this costs hundreds of thousands of euros then maybe we need to reconsider - but frankly we are not thinking about it enough. - P5

And then the question is how are you going to set that up. We could also say we have 2 APIs. The possibility that they are both down is small. But then you have to set that up. And we are then the initiator for such a fall back solution. (...) I do not know if we want to do this, but it does provide the logistics buyer with a sense of safety. - P5

On the other hand, one expert raised the question if a fall back is even necessary if an API performs well in regards to availability.

If the performance is good then in principle you do not need a fall back. (...) If the API is never down, then why would you have a fall back implemented? - P5

Processes in the front-end such as Address check and Pick-up locations are not necessary in the sense that if it is not working, a consumer can still continue the process. In back-end operations, a confirmation is necessary and a label is too, making a fall back much more important.

For every process you have to consider: let’s say it is down, can the process still continue? You should always build it so that this process as a whole cannot break and continues in case a piece fails. - P5

But for locations and timeframes this is much easier to implement such solutions, in comparison to a sendservice or barcode services. Or confirmation service. Let’s say it is down, then what do you do as back up? - P5

Third, experts questioned if a 100% availability guarantee is really what logistics buyers want. It was argued that a guarantee means little if it does not have consequences attached to it. This means that in the event the API is down, typically the Service Level Agreement (SLA) specifies what monetary compensation is paid for lost business (as a
consequence). Nonetheless, it became clear that it is difficult to convince logistics buyers about the API uptime guarantee if the API was down just a few days ago. Concluding, the term guarantee does not mean much when there are no consequences linked to it.

Fourth, the uptime demand depends on the contextual factors of the logistics buyer. The internal warehousing processes of logistics buyers, for instance picking and packing, and how this is currently integrated with logistics providers influences the degree as to how much uptime is demanded. Additionally, higher warehouse throughput means that shipments need to be fulfilled faster, resulting in less room for downtime. Some logistics buyers may thus be able to handle API downtime better, in comparison to others that require real-time fulfilment.

“There are different levels of demanded uptime for the customer. Some may find it okay to get labels and confirm them later on. Others prefer to confirm them immediately.” - P5

“So I think that they will stay on FTP to be able to print labels all the time, just in case (when it is down). Or keep using FTP for all the things, but then use the API for confirmation… Yes that does not have the time pressure.” - P6

7.3.2 Organizational factors

Organizational factors refer to the resources and characteristics of the logistics buyer. Two organizational factors came forward during the focus group: controllability and resources.

Controllability

Based on the availability barrier, it is concluded that availability is strongly tied to controllability. Two aspects of controllability were discussed during the focus group. On the one hand, it was suggested that logistics buyers do not want to rely on a third party when its service and support may sometimes fail. Logistics buyers might find the risk of being too dependent on a third-party to high.

“I think customers just want a flawless shipping experience - and by using the API you are dependent on the carrier. With FTP this is much less the case. So you are creating a link to a carrier - and if the API is down, then you suffer from that. They do not want the dependency. In their critical processes in the supply chain.” - P1

On the other hand, by using a Shipping API, the logistics buyer is unable to control the output of the API. In the case of the Labelling API, this means that it is not possible for a logistics buyer to customize a label completely. The customizability within APIs is limited, whereas the customizability with the FTP implementation is extensive. This limits both the controllability for a logistics buyers, as decreases the relative advantage of APIs over FTP.

“Yeah and if you look at the labelling in particular - you get a label and you will have to deal with that. Indeed - you can in fact do magic on that - but you do not have control over the output of the API.” - P2

Resources

During the focus group participants concluded that it requires a specific IT skill set to implement an API. Experts suspected that logistics buyers might lack the technical expertise to switch to APIs, causing a barrier for its adoption. Logistics buyers either
need to have a developer in house or need to hire one, resulting in higher development costs.

You have all kinds of people in the organization that need to invent the wheel again. You will have to have a developer in house or you need to hire one externally. That could be a barrier to adoption. -P2

7.3.3 Environmental factors

The macroeconomic context, competitors, industry characteristics and the regulatory environment are categorized as environmental factors. Two factors came forward in the focus group: Industry standards and Vendor communication and support.

Past experience

Industry experts argued that the API is not yet state-of-the-art. In other words, the API is not a well-established technology in the transport market (yet), and logistics buyers might not have any experience with this technology. Furthermore, although many logistics providers are developing APIs, not all APIs meet the industry expectations and demands for functionality, reliability, performance, security and support. This means that logistics buyers might be hesitant to adopt this new technology in general.

In the event we argue that we have an API, then partners are like ‘... we are familiar with the APIs from other carriers but we are not really happy with them’. So there exists a bad image about the APIs from carriers in general. -P6

Vendor communication and support

Participants suspected that poor sales efforts and support by PostN, might be a reason why logistics buyers are not seeing the (commercial) benefits of APIs. First, industry experts argued that not all logistics sales agents may have the required IT knowledge. Traditionally, the core business of logistics providers is a logistics service, meaning the sales agents may not be aware of the details on IT integration services, or may not be able to explain why an API might be the best integration technology in certain cases.

Furthermore, often when promoting the logistics services among logistics buyers, sales agents only speak to logistics managers. Very rarely an IT manager is involved. One participant argued that it can be difficult to get in touch with the IT person responsible for the IT integration with the logistics provider, as company structures differ. Add to that, one expert argued that employee shortage can explain that IT managers of logistics buyers are not well-informed. Concluding, although it is difficult to reach the right person, sales knowledge may act as a barrier to adoption.

Yeah well I don’t think they know exactly what it is (the API). Because it is like magic - everything is possible via the API. - P3

Second, experts questioned if the API is marketed and communicated well enough. The participant did not provide any specific details, but referred to how the API is communicated to customers. Currently there exists a newsletter for developers and an online developer portal, but perhaps the overall marketing of the API could be improved. One expert mentioned that the FTP documentation was easier to read and understand in comparison to the API developer portal. Although the API specification was argued to be thorough, the details can steer away from the most important aspects. After all, the API
can do offers more services than FTP does, and in combination with a list of different use cases, becomes complex to understand.

And yeah I think there is just a lot of information available. A lot of specifications on the API. They can’t see the Wood for the Trees. (...) I think in the communication to customers we can pick low-hanging fruit. - P6

Third, support refers to the technical help offered by the logistics provider to those logistics buyers who need it. Usually support is offered to help solve a specific integration issue a logistics buyer is facing. Industry experts argued that a logistics buyer may demand immediate support and explained that a status page is highly desirable. This page communicates downtime issues to keep customers posted 24/7. Concluding, logistics buyers may be hesitant to adopt the API if no sufficient support is offered.

On the other hand, it was suggested that discontinuing support on old technologies like FTP may act as an incentive for logistics buyers to switch to APIs:

No but look if we say we stop with the support... formally speaking. (...) And then we could say that we discontinue FTP connections, that could be a reason for a lot of logistics buyers to go to API. - P2

7.3 Conclusions

A focus group was held with six industry experts. The focus group lasted 84 minutes. The objective of this focus group was to retrieve views from industry experts about the adoption of APIs by logistics buyers, validate interview findings from Chapter 6, and potentially discuss possible solutions for these barriers. The sub-question in this chapter was the same as in Chapter 6:

| 3 | What factors influence the adoption of web integration technologies by Dutch logistics buyers in practice? |

After analyzing the focus group results, multiple factors were suspected to influence the adoption of APIs by logistics buyers, according to industry experts. The influencing factors are again grouped in three categories using the TOE framework as discussed in Chapter 2, and demonstrated in Table 7.3.
Table 7.3: suspected barriers to API adoption

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
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</table>
| Relative advantage              | - APIs speed might not meet market demands.  
- Currently used technology by logistics buyers may complicate switching to APIs over using an alternative. Both in regards of (development) time and costs.  
- If currently used technology is working well a relative advantage might be lacking. |
| Availability                    | - The possibility of API downtime. Its influence may differ in the front-end and back-end, and depends on the specific process used by a logistics buyer.  
- A logistics provider may not guarantee 100% uptime.  
- If no fall back solution is available, or implementing one would be expensive. |
| Controllability                 | - Dependability on logistics provider while their APIs might fail (downtime) sometimes.  
- Limited controllability of the API output; limited customizability. |
| Resources                       | - the lack of technical expertise to implement an API.                                                                                     |
| Past experience                 | - API technology is not (yet) universally used, and logistics buyers may not have experienced its benefits.                                 |
| Supplier communication and support | - Sales agents of the logistics provider may have insufficient knowledge of APIs in order to promote its benefits among logistics buyers.  
- APIs may not be marketed and communicated well enough through digital channels and by sales agents. |

**Technological factors**
The industry experts suspected the technological factors to be the biggest barriers to API adoption. They extensively discussed the technical relative advantage. Especially the performance speed of APIs and the currently used technology by logistics buyers were mentioned in regards to the relative advantage of APIs. In addition, they suspected the perceived risk of downtime of Shipping APIs - or the lack of a fall back solution - to be a significant barrier to its adoption.

**Organizational factors**
As organizational factors, the controllability and customizability of APIs was suggested to be of influence for logistics buyers when considering APIs. It was argued logistics buyers do not want to be dependent on the logistics provider, in regard to such an important IT solution as their logistics process, and the limited customizability of APIs.
might not meet demands. Furthermore, industry experts suspected logistics buyers to have insufficient technical expertise to implement APIs, resulting in a barrier to its adoption.

**Environmental factors**

Lastly, regarding environmental factors, mainly the vendor communication and support by the logistics provider were argued to cause a barrier to Shipping API adoption. If logistics buyers are not aware of the existence or benefits of APIs, they will not switch to APIs. Industry experts pointed out that both the lack of API knowledge by sales agents, and insufficient marketing and communication about Shipping APIs via digital channels, preventing logistics buyers to adopt Shipping APIs. Furthermore, the lack of 24/7 support and experience with APIs within the logistics industry were mentioned to be of potential influence.

In addition to barriers, during the focus group participants a few possible solutions emerged to overcome the discussed barriers (Table 7.4).

<table>
<thead>
<tr>
<th>Table 7.4: suggested solutions to overcome barriers to API adoption</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor</strong></td>
</tr>
<tr>
<td>Technological</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Environmental</td>
</tr>
</tbody>
</table>

First, industry experts suggested a financial advantage for logistics buyers when using APIs over old technology like FTP, as a way to create a relative advantage for APIs. However, industry experts questioned the feasibility of this solution, because of the argued monolithic nature of APIs and the lack of a fall back solution in the event of downtime. It seems illogical to force customers to use APIs by charging them costs for using technological counterparts (that are arguably more reliable), when there is no fall back offered by the logistics provider.

Second, a solid fall back solution was suggested to overcome availability as a barrier to API adoption, build by the API supplier or by logistics buyers themselves. Though, industry experts also mentioned building a fall back solution might demand too much (development) time or costs, and might not be equally necessary for every API. Third, the option of discontinuing support of old technologies was suggested. This might act as an incentive for logistics buyers to switch to APIs.

In the next chapter, in Chapter 6 and 7 found barriers, and solutions to overcome these barriers, to API adoption are compared and discussed in light of previous studies (Chapter 5). Recommendations are then constructed.
Discussion

This chapter delves into the meaning and significance of the results presented in Chapter 5, 6 and 7. The research findings are interpreted and related to previous studies. Additionally, it is important to examine the appropriateness of the research design and critically reflect on its limitations.

The first section discusses the importance of the different factors that were identified. Next, section 8.2 describes findings in light of what was already known about the research problem. Practical implications for managers are derived in section 8.3, after which the chapter ends by pointing out limitations and future research avenues. The next chapter will conclude this thesis by stating answers to the research questions and reflecting on the research experience.

8.1 Factor importance

As pointed out by Priyadarshinee et al. (2017), adoption factors should be ranked before making any important adoption decision. The inevitable trade-off of factors has to be made during the adoption process. This section combines and synthesizes noteworthy findings from the interviews and focus group. The factors are discussed in the three broad categories of the TOE-framework: technological, organizational and environmental. For each group of challenges, an assessment on its importance in influencing the adoption decision is provided.

Business case

A key problem that came forward during the interviews was the business case, i.e. there exists a lack of justification for the proposed project on the basis of the expected commercial benefit. It became clear that it is often difficult to establish a link between Shipping APIs and the business benefit. The focus group findings do not specifically show that the business case was unclear, however participants did emphasize the costs as a barrier for API adoption. This can be explained by the fact that the focus group participants were more knowledgeable on the benefits of the API, in comparison to the interview participants that were less informed about Shipping APIs benefits. Notwithstanding, the focus group results confirm that more effort needs to be made in
communicating the API. Results show it is a complex infrastructure technology, that is difficult to translate to business benefit.

**Technological factors**

Interview findings suggest that Shipping APIs can be implemented as soon as their desired. However, there were clearly concerns about the relative advantage, availability and controllability, among interview participants. In addition, the focus group participants mentioned API performance as an adoption barrier, which was not explicitly found in the interviews. All findings underscore the importance of considering the status quo. The lack of an advantage relative to the technical status quo was put forward in both data collection methods as a significant determinant for Shipping API rejection.

Furthermore, both the interview and focus group findings indicated that downtime is viewed as an important technological barrier to adoption and a fall back solution should be considered. In this regard, downtime appeared to be more important in the context of back-end APIs that form the infrastructure in the supply chain, in comparison to front-end APIs that do not cause the whole process to come to a standstill in case of failure. Additionally, back-end APIs are more obscure to recipients, and therefore it is difficult to link back-end APIs to a business outcome or objective. It was argued, by both integrators and focus group participants, that a back-up solution would provide a means to improve chances of participants switching.

Security was not found to be a concern; interviewees trusted that data sent through the API would be safe and the focus group did not mention it at all. Furthermore, interview findings stress the customizability benefit of FTP, whereas similarly, the focus group findings underscore controllability of the output of the API. This implies that focus group participants point to the technological nature of the API, whereas the interviewees compared it to the status quo functionality. One interviewee concluded that the functionality of the FTP today, is the API of tomorrow. Overall, challenges related to the technological innovation appear to play a significant role in the adoption of Shipping APIs by logistics buyers.

**Organizational factors**

Both interview and focus group participants brought important organizational factors forward. Interviewees pointed out that resource capacity plays a significant role as Shipping API implementation requires time and resources. Similarly, the focus group concluded that resources were a major obstacle to Shipping API adoption, especially if the logistics buyer does not have development resources in-house. In addition, the current implementation was argued to act as an anchor to API adoption. Overall, the organizational factors were found to play a moderate role in the adoption of Shipping APIs by logistics buyers.

**Environmental factors**

It was found that various logistics buyers were not aware of the (the advantages of) Shipping API. Supplier and marketing efforts were a key barrier to Shipping API adoption found in the interviews. This was confirmed during the focus group. The focus group findings imply that trust and IT support can be a barrier to adoption. This was not mentioned by interview participants. This can be explained that the focus group participants were discussing trust in relation to IT support, through the lens of downtime risks. Documentation was mentioned as conducive by the interviewees; the focus group concluded that API documentation is more difficult to grasp than FTP documentation. Overall, environmental factors were found to play a marginal role.
To conclude, Table 8.1 shows the comparison between the findings of the interviews and the focus group.

**Table 8.1: comparison of key findings in interviews and focus group**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Interviews</th>
<th>Focus group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative advantage</td>
<td>- often not clear</td>
<td>- performance</td>
</tr>
<tr>
<td></td>
<td>- combination of status quo alternative and no urgency to act</td>
<td></td>
</tr>
<tr>
<td>Security</td>
<td>- no issue, see trust in provider</td>
<td>- not mentioned</td>
</tr>
<tr>
<td>Reliability and Availability</td>
<td>- downtime</td>
<td>- fallback</td>
</tr>
<tr>
<td>Controllability</td>
<td>- lack of customizability</td>
<td>- lack of control on output API</td>
</tr>
<tr>
<td></td>
<td>- FTP more control than API</td>
<td>- lack of control in case of downtime</td>
</tr>
<tr>
<td>Financial and technological resources</td>
<td>- too many projects on the roadmap, no time</td>
<td>- batch driven vs event driven</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- API requires developers in-house</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- cost depend on talent of developer</td>
</tr>
<tr>
<td>Top management support</td>
<td>- no issue</td>
<td>- logistics manager vs IT manager</td>
</tr>
<tr>
<td>Company size</td>
<td>- no relation</td>
<td>- larger company more resources in house</td>
</tr>
<tr>
<td>Industry fragmentation</td>
<td>- no issue</td>
<td>- other carriers experience</td>
</tr>
<tr>
<td>Supplier communication and support</td>
<td>- participants not aware of (the benefits of) shipping API;</td>
<td>- not being able to reach the right person;</td>
</tr>
<tr>
<td></td>
<td>- communication in implementation process could be improved through ticketing</td>
<td>- questioned if marketing efforts are done the right way</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- API developer portal more difficult to read than FTP documentation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- no 24/7 IT support</td>
</tr>
<tr>
<td>Trust in supplier</td>
<td>- no issue</td>
<td>- related to support</td>
</tr>
<tr>
<td>Past experience</td>
<td>- previous experience with other suppliers</td>
<td>- not mentioned</td>
</tr>
</tbody>
</table>
8.2 Academic implications

This research has implications for IS-research and the logistics field. The results of this study are consistent with previous research presented in Chapter 5, but differ in some ways.

Consistent with previous research (Oliveira et al., 2014), the case evidence suggest that relative advantage is a key issue in adoption infrastructure information technologies. The API was often not found to have a relative advantage over FTP, the technology that it supersedes (in line with Rogers’ DOI theory). The status quo was also found to be a strong motivator to inhibit API adoption. Many other studies argued that new technologies are expected to bring value well beyond that the current status quo (Alshamaila et al., 2012). The investments on existing systems impede an organization to chase for new IT innovations, and cause them to behave conservatively (Shim et al., 2009). This study underscores other studies that argued that the status quo should be included in order to assist in a better understanding of IT adoption (Salimonu et al., 2013; Lucia-Palacios et al., 2016; Wu, 2016). It was also found that an understanding of the relative advantages is important to the adoption decision, which draws attention to marketing efforts towards raising awareness of the APIs, as also proposed by Alshamaila et al. (2013).

The findings regarding availability and interoperability are also key themes in extant research; availability needs to be safeguarded and the technology is compared and needs to be consistent with existing technological architecture (Gangwar et al., 2015; Oliveira et al., 2014). However, findings suggest a new perspective: distinguish between back-end and front-end Shipping APIs. For instance, availability and resources were found to differ between the two categories. Complexity was found to be no issue: it was seen as just another technology and was not perceived as complex, similar to findings from for example Ciganek et al. (2014).

Conversely, some findings differ from previous studies. Extant literature points out that the size of the firm can be a determinant for adoption or non-adoption (Raut et al., 2017; Oliveira et al., 2014; Phaphoom et al., 2015). A larger firm has more resources and can take greater risks. However, the findings suggest that the size has no impact on the Shipping API adoption, although resource capacity was found to be influential. One interviewee, the founder of the company, pointed out that he had implemented new technologies himself. Thus, although technological knowledge is required to implement Shipping APIs, the size of the company is of no influence.

Furthermore, in previous research security has been noted as a key determinant for adoption (Phaphoom et al., 2015; Alexander and Thomas, 2011; Gupta et al., 2013; Lian et al., 2014). In this study this was not found to be a factor of importance. This can be explained by to what extent sensitive data is shared. As mentioned in Chapter 1, order information sharing was not found to be true information sharing as it does not involve crucial, proprietary or strategic information (Pham et al., 2019; Kumar et al., 2012). Security is thus also found to be a less critical concern. It also draws attention to trust in the provider.

In studies by Priyadarshinee et al. (2017) and Kim & Olfman (2011) trust in the technology provider was found to have a significant direct impact on CC adoption as it is the first most important predictor. These findings contradict with this study, where trust in the provider was found to be no determinant for Shipping API adoption.
While Alshamaila (2013) did not find enough evidence that competitive pressure was a significant determinant of cloud computing adoption, El-Gazzar et al. (2016) and Gangwar et al. (2015) did find competitive pressure and trading partner pressure to be directly affecting adoption. In the case of Shipping API adoption, the above-mentioned environmental factors were not mentioned as influencing factors. One integrator argued during the interview that because some services are only offered by using the API and therefore promotes logistics buyers to switch integration. Though, no evidence was found in literature or case evidence to support this claim.

**Understanding the adoption process**
The results of the semi-structured interviews and the focus group can be structured and interpreted by using the Rogers’ (1995) five stage innovation model, that was discussed in Chapter 2. This has been done in other studies; see for instance a study by Spiller et al. (2013) that used Roger’s model to structure interviews with raw water quality and catchment management personnel, thereby describing the process of adopting source control interventions by water and sewerage companies. Rogers’ model is used because it is simple and represents the main process stage that many other organizational innovation adoption models have. Consistent to the findings of this study, an adapted version of this adoption process is made (Figure 8.1). Through the process multiple steps can be identified.

First and foremost, the findings suggest that four factors determine if the Shipping API ends up on the agenda. First, there may be urgency to switch, because of the end of support or limitations to existing systems, for instance FTP support may be cancelled by a stakeholder. Second, an external market need may also lead logistics buyers to consider Shipping APIs, for instance the market may demand specific delivery options that are only available on the API. Third, there may be an internal need or want to use APIs. For instance, a decision to rebuild the order management system can consequently promote API adoption. Last, a logistics buyer may consider Shipping APIs based on advice from a Shipping API supplier.

**Agenda setting**
In this step the logistics buyers evaluate the business case including Shipping APIs by comparing it to the status quo. If it is considered to be beyond the benefits of the status quo, a justification for its adoption can be made, while comparing it to other projects on the roadmap. If adopting a Shipping API is considered less critical than other projects, then the adoption may be postponed. Findings suggest that, in some cases, as a result of
the comparison with the status quo, urgency has to be present in order to convince the switch to Shipping APIs.

**Matching**
Based on the business need or defined problem, logistics buyers try to find a matching technology. In that case alternative technologies are compared to the Shipping API. Logistics buyers may consider Shipping APIs if the API is the only technology option. In addition, the integrator or logistics provider may advice in using the API, or the benefits of the API may meet business demands the best, such as flexibility and customizability in its implementation. The technological characteristics such as availability of a Shipping API is also considered at this stage. At the end of this stage a decision is made whether to adopt the Shipping API or not. This is the transition from the initiation stage, to implementation.

**Redefining**
The characteristics of the Shipping API are altered to the organizational needs. In coordination with the logistics provider the logistics buyer implements the API in a way that matches its existing systems and operational processes.

**Clarifying**
The process by which the Shipping API spreads through the organization. Based on the experience of this API, other API functionalities may be added. A logistics buyer may start by implementing Confirmation APIs, and afterwards continue with for instance Labelling and Tracing API.

### 8.3 Managerial implications

The interview and focus group findings have a number of implications for practice. As mentioned in Chapter 4, stakeholders can be divided into a demand and a supply side. Based on the case evidence, recommendations can be provided to the supply side on how to overcome barriers and promote Shipping API adoption. The research objective is then met to overcome these barriers. They are ranked on level of importance based on the findings.

**Increase marketing efforts**
As found in the interviews, various logistics buyers were not aware of the Shipping APIs. They lacked not only knowledge of the existence of Shipping APIs and its benefits, but also of the business-critical differences between the different integration technologies. Findings also suggest that the relative advantage was not clear and there was a lack of result demonstrability. The findings from the focus group suggest that it can be difficult to market APIs to the right person. Account managers predominantly talk to logistics managers at the logistics buyers, and rarely meet IT managers.

Considering these results, it is recommended to outline commercial benefits for each Shipping API. An emphasis needs to be on the back-end APIs as these benefits are not easily understood. For instance, how does using the Labelling API translate to commercial benefits? In times of change, the commercial context is often the first filter to evaluate the adoption. It is preferred to back these benefits up with data to demonstrate results. But next, how can logistics providers communicate these benefits in the most efficient way?
It is recommended to expand the IT support department rather than the sales department. Pedroso & Nakano (2009) suggest to find engineers in charge of sales, often referred to as technical sales. The job function involves delivering the IT support, but also contracting and actively presenting solutions to decision makers. This study partially shares this view as API adoption is found to be too complex to make it a sales responsibility; rather, results suggest IT support can promote adoption in a more efficient manner. IT support can directly analyse the technological status quo of a logistics buyer, interact with the right IT person, and provide meaningful advice and nuances on integration technology. A more proactive customer-facing role is required, rather than the reactive approach that is often practiced.

Also, it is recommended to share analysis on shipping results with logistics buyers. Any negative consequences such as re-work that are a result of poor IT integration are, in many cases, not shared with the logistics buyer, and are therefore unknown. By sharing these insights, API adoption is promoted. The sales department is also encouraged to work strongly together with IT support in ensuring logistics buyer satisfaction.

**Develop a fall back solution**

Case evidence has shown that there were concerns about the availability of the Shipping API. Although there was no strong consensus among logistics buyers, integrators found availability issues to be the most significant barrier. The focus group underscored these findings. It is thus recommended to investigate a possible fall-back solution, in partnership with integrators (discussed next), in case a Shipping API is down. It is worth noting, again, that downtime was more important in the context of back-end APIs, that form the infrastructure in the supply chain, in comparison to front-end APIs that do not cause the whole process to come to a standstill in case of failure. Concluding, it draws attention to a fall back solution for the Labelling service in particular.

A fall back solution could help persuade integrators to switch their customers (logistics buyers) to Shipping APIs, and strengthens the overall business case for Shipping APIs. Furthermore, it is recommended to design this fall back as a packaged solution, in line with other integration technologies, offering implementation and update management at the expense of the logistics buyer.

**Strengthen partnerships (with integrators)**

As the e-commerce has grown, the importance of partnerships has also become more important. Logistics providers are, among other members of the supply chain, strongly dependent on integrators. In many cases, logistics buyers that outsource integration to integrators, can easily switch from FTP to API, in comparison to logistics buyers that do not outsource integration. It provides an opportunity for logistics providers. It is recommended to not only develop a fall back solution together, but also to actively work together in marketing the Shipping API. Marketing efforts could be streamlined and result demonstrability could be shared. The integrators could also help in developing a roadmap for future functionality of the Shipping API, which is discussed next.

**Functionality of FTP today, is the API of tomorrow**

Results suggest that the status quo, including FTP, influence the adoption decision. FTP was found to offer more flexibility and customizability in comparison to the Shipping API. For instance, logistics buyers are able to put a logo on the label. Additionally, it was found that current API users still have to perform additional actions like resizing and rotating the label to conform operational needs (for instance, a label printer cannot print the size). It is thus recommended to retrieve insights on functionality requirements from both API and non-API users and continue to gradually upgrade functionality.
Create urgency
During the interviews it became clear that some logistics buyers require urgency to discontinue current implementation. There was no reason to change the current implementation, because it is working (and sunk costs were made by implementing the current integration). It is thus recommended to create urgency in order to promote Shipping API adoption, while also considering that enough time, IT support, a fall back to critical processes, and reasoning need to be given. Urgency can be created by communicating a date, from which old technology will not be supported and FTP servers will be taken offline. However, this can only be reasonably done if a small portion, for instance five percent, of the total of logistics buyers are affected. Otherwise this can lead to difficult and unforeseeable consequences, for instance pressure on IT support.

Additionally, interview participants shared thoughts on the onboarding process. It was found that although the current set-up was conducive in meeting logistics buyer’s requests, a ticketing procedure instead of email could make onboarding faster and more efficient. Nevertheless, new logistics buyers are, needless to say, encouraged to directly adopt the Shipping APIs. If the logistics buyer is hesitant, it is recommended to encourage adoption of simpler Shipping APIs as a first step (for instance a Confirmation API or Address Check), before implementing APIs that have more impact on the operational process (for instance a Labelling API). Result demonstrability can also help in that case.

8.4 Limitations
Like any study, this research study also has its limitations. The decisions made in this design process ultimately affect the confidence level readers can place in the conclusions drawn from the study (Bono & Mcnamara, 2011). A discussion on why the case methodology was deemed appropriate was provided in Chapter 3. This section focuses on additional constraints to the study design that influence the interpretation of the findings. In qualitative research, there exist three “gold” criteria to assess its quality (Sekaran & Bougie; 2016; Leung, 2015).

Validity
Validity refers to the appropriate use of tools, process and data. The study design is qualitative and exploratory in nature to gain additional insight in a relatively unknown phenomenon (Sekaran & Bougie, 2016). Data triangulation was used to ensure internal validity. To answer the main research question, the objective is to identify subjective experiences, interpret motivations, and explore the barriers to adoption about a phenomenon where little is known. A case study design with qualitative research methods is appropriate in meeting the research objective.

Generalizability
Generalizability refers to the extension of findings to a wider population or different context. When comparing qualitative to quantitative studies, quantitative research selects a sample based on the study population (predetermined), is more reliable and therefore more generalizable to a wider population. However, in natural settings it can be tricky to quantify findings in numbers. The findings of qualitative studies, for instance case studies, are harder to generalize, but provide a richer understanding of the situation at hand. A drawback of the study design used in this thesis is that the ability to generalize its findings is limited.
Reliability
Reliability (or dependability) is the replicability of processes and results. In qualitative research this can be difficult and is sometimes referred to as epistemologically counter-intuitive (Leung, 2015). The nature of qualitative research inherently means that the context and research settings are ever changing. Therefore, first, it is important to document all aspects of any changes or unexpected occurrences. This report describes all procedures done to meet this requirement to further explain the findings (for example case selection). Secondly, as explained in section 3.2, data triangulation was done to enhance reliability and reduce researcher subjectivity.

Additional considerations that are worth noting are the following. First, this research only reflects the current state, i.e. taking the current technology into consideration and interpreting current motivations to Shipping API adoption. Other factors that either promote or inhibit adoption may surface in the future. Most research questions in management implicitly address issues of change (Bono & McNamara, 2011). After all a case study is only a preliminary research method and can not be used to describe or test propositions. But this was not the goal of this research - the goal was to explore and understand motivations to adoption of Shipping APIs, a phenomenon about which little is known.

Second, it is acknowledged that the recommendations were not validated by practitioners. In order to close an evaluation loop, it is preferred to validate findings and recommendations from the exploratory research methods, thereby adding credibility to the findings. However, within the short timespan of this research, the focus was on finding relevant problems to the issue. Significant improvements can be made based on the findings of this research, that was based on a unique view from multiple perspectives within the supply chain network.

Third, the results are dependent on the case study. However, we argue that the results can be generalized to a wider population, namely API suppliers within the supply chain network. PostNL is the biggest third-party logistics provider in the Netherlands and the case can be described as a critical one (see Chapter 3). The reality of PostNL is also relevant to other logistics firms, as integration technologies are very similarly based on operational processes. Though, it should be considered that results indicate that technological aspects of the API play a significant role in its adoption. Some APIs may have important technological shortcomings or advantages compared to others (i.e. downtime, response rate, size of label etc). The participants in this study do predominantly business in the Benelux region; is is expected the nature of competition differs per country, thereby influencing integration practices.

Fourth, due to the limited timespan, this study has chosen semi-structured interviews to get a wide overview of the ideas that stakeholders have. The delphi method that aims to get consensus using multiple rounds in a group, was not considered to be suitable within the short timeframe of this project. Although survey research is dominant in logistics research and proven to be useful for identifying trends (Selviaridis & Spring, 2005), this data collection technique was not chosen for this thesis. Surveys are less effective when studying inter-firm relationships, because they are often “based on mismatched service provider-user pairs” (Murphy & Poist, 2000).

Fifth, a focus group was chosen, because the research is conducted within the organizational boundaries of PostNL, connecting to a variety of industry experts having knowledge about the problem at hand. A more systematic approach to the focus group could have produced different results on how to best design the integration solution to
the problem. However, this was not the main goal of the focus group - the goal was to start a discussion on understanding barriers to Shipping API adoption, as a basis for constructing recommendations and further scientific research. In that case “focus groups serve an important function.” (Sekaran & Bougie, 2016).

8.5 Future research avenues

Based on the limitations, various directions for future research are proposed. First, as the study only reflects the current state, a longitudinal approach can be applied to look at adoption motivations over a longer period of time. Although this study included both API and non-API logistics buyers, it is recommended to further investigate API adoption at different times of adoption. For instance, two data collection times, before and after API adoption in order to compare the two.

Second, the findings of this study were not statistically validated. The small sample size of this study may not generalize the findings on a larger scale, thus subsequent studies should conduct quantitative surveys to validate the findings and establish an adoption framework for better replication in different markets. A statistical study with a qualitative study design can be integrated to gain deeper variance explanation across members of the supply chain.

Third, the research strategy was to perform a case study on one logistics provider, namely PostNL. Our findings suggest that previous technological experience with other Shipping APIs can influence the adoption decision. Future studies could investigate difference between integration technology of logistics providers in order to retrieve additional insights and improve the understanding of Shipping API adoption. It is recommended to perform this study from an integrator perspective, as it allows for independent comparison of a variety of Shipping API’s of different logistics providers.

Fourth, the statement made by experts influence the answers from other experts during the focus group. Hence there exists an opportunity to organise different focus groups with different participants. In that case bias imposed by other participants is reduced and recommendations are validated. As Bono & Mcnamara (2011) pointed out, the best approach to strong research design lies in conducting a series of studies, where each will have its own flaws, but together the result in more generalizable results than any single study on its own would.

Fifth, digital platforms are transforming every industry, and logistics is no exception. Digital platform was defined by Tiwana et al. (2010) as “software-based external platforms consisting of the extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they interoperate”. Within the Netherlands before-mentioned platforms Bol.com, Coolblue and Marktplaats are well established and expanding at a rapid rate. The rise of platforms provides an opportunity for IS-research to investigate how these developments impact integration technologies and what (digital) role logistics buyers can play in the customer journey. Additionally, in the future it seems that a logistics trading or comparison platform is a next step in the realm of logistics integration technology. This platform could allow the logistics buyers real-time comparison of shipping rates and CO2 emission. Design science research is required in constructing this new reality.
Conclusions

“Do not call me Chief Information Officer, but Chief Integration Officer.”
- Ragowsky et al. (2014)

This last chapter presents the conclusions of this research study. It provides answers to the research questions as proposed in Chapter 1, discusses contributions, reflects upon the research process and aligns the study with the author’s study curriculum.

9.1 Answers to research questions

As introduced in Chapter 1, the e-commerce industry is evolving and growing fast. In order to manage growing shipping quantities, a new integration technology is offered by logistics providers to share logistics data quicker and more accurately: Shipping APIs. Although logistics buyers outsource and partner up with a logistics provider, Shipping API adoption has proven to be difficult. Therefore, in this thesis, an empirical study was conducted on the adoption these barriers in a third-party logistics context.

The main research question of this study was sparked by the lack of knowledge and empirical evidence in existing literature, regarding factors that promote or inhibit the adoption of Shipping APIs. The main question is: What are the adoption barriers of web integration technologies in outbound logistics and how can they be overcome? It was argued that addressing these barriers gives logistic providers the insight to the effective design of digital integration interfaces, including Shipping APIs, improving information sharing along the supply chain, as well as contributing to a better understanding of the motivations of current integration strategies within the supply chain network. Against the above mentioned backdrop, several sub-questions were developed, presented in Table 9.1. Note that all research questions were explored and answered in the light of a case study conducted at logistics provider PostNL, and will be discussed next.
Table 9.1: research questions of this research.

<table>
<thead>
<tr>
<th>Type</th>
<th>Research question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main</td>
<td>What are the adoption barriers of web integration technologies in outbound logistics and how can they be overcome?</td>
</tr>
<tr>
<td>Sub 1</td>
<td>What integration technologies are currently available in outbound logistics?</td>
</tr>
<tr>
<td>Sub 2</td>
<td>What factors that influence the adoption of web integration technologies?</td>
</tr>
<tr>
<td>Sub 3</td>
<td>What factors influence the adoption of web integration technologies by Dutch logistics buyers in practice?</td>
</tr>
</tbody>
</table>

As a result of a desk research, developments in the Dutch logistics industry were found to be a motivation for the development of Shipping APIs by logistics providers. Real-time data sharing by means of APIs has recently witnessed increasing attention from logistics providers, as new services were introduced and integration practices became an apparent issue due to increasing shipment quantities.

However, in order to use Shipping APIs for the exchange of logistics data, multiple stakeholders must be willing to adopt this new integration technology. Six stakeholders were identified: logistics providers, integrators, logistics buyers, fulfilment companies, recipients, and authorities. The first four are directly involved with the use of Shipping APIs, either by using it to exchange logistics data themselves or by implementing it for another stakeholder, where the latter two are indirectly affected.

After collecting insights about the Dutch logistics industry, and the involved stakeholders, an answer was found to the first sub-question: What integration technologies are currently available in outbound logistics? During three logistics processes integration technologies are used to exchange logistics data: order booking, order picking and order tracing. While Shipping APIs are offered that enable data exchange, in practice different technologies are used among logistics buyers. In total, five integration technologies were identified: a desktop application, FTP, a web portal, APIs and plugins. Beside APIs, FTP technology was found to be the most relevant for this study as this research studies custom integration design, and leaves standardized software out of scope. Furthermore, integrators and fulfilment companies indeed appeared to be relevant stakeholders, because outsourcing is common within outbound logistics.

Next, by means of an analysis of extant literature the second sub-question was answered: What factors influence the adoption of web integration technologies? Literature on web integration technology was analyzed but found to be scarce, though, a large body of literature investigated cloud computing adoption. As APIs are one of the main elements in cloud services, the analysis included papers from the cloud computing research field. The found factors were sorted with the use of the TOE framework and subsequently used in guiding the interview process.

The found factors were: relative advantage, security & privacy, reliability and availability, interoperability, financial and technology resources, top management support, company, size, competitive pressure, industry fragmentation, trust in supplier and lastly, supplier support and effort. In the end the technological factors appeared to be the most significant for the adoption of Shipping APIs, followed by the organizational and lastly the environmental factors. The found factors were used as a guideline for the interview and focus group protocol.
After conducting nine interviews and one focus group, the third sub-question was answered: What factors influence the adoption of web integration technologies by Dutch logistics buyers in practice? First of all, it was argued that a solid business case is necessary for logistics buyers in order to even consider adoption a new technology like Shipping APIs. Key challenges in Shipping API adoption were found to be mainly technological. The relative advantage of Shipping APIs is often unclear, and the technological status quo of a logistics buyers’ logistics process may influence the adoption greatly. In addition, API downtime was pointed out to be an important barrier to adoption. Furthermore, among organizational factors, available resources were identified to play a moderate role in the adoption of Shipping APIs. Regarding environmental factors, the lack of marketing efforts by logistics providers surrounding Shipping APIs was argued to be of marginal impact, as well as the lack of success stories about the use of APIs within the Dutch logistics industry.

In conclusion, the main research question can be answered. What are the adoption barriers of web integration technologies in outbound logistics and how can they be overcome? The adoption barriers were described above by means of the sub-questions. These results are consistent with previous research, but are also found to differ in some ways. Consistent with previous research, relative advantage, status quo, availability and interoperability were found to be significant barriers to adoption. Conversely, the company size, security and privacy, trust in supplier and competitive pressure were not found to be barriers to Shipping API adoption, which differs from findings in previous research.

However, in order to answer this question completely, the research results were analysed so recommendations could be made for API suppliers about how the found barriers can be overcome. First, it is recommended to increase marketing efforts, by means of expanding the IT support department to interact with the right IT person at the logistics buyer and provide meaningful feedback and nuances on integration technology. It requires a more proactive approach to IT support, rather than the reactive approach that is often practiced. Second, findings suggest that availability of the Shipping API is paramount to its adoption, and hence it is recommended to develop a fall back solution. More specifically, a fall back solution for the labelling service during the order picking process is expected to promote exiting FTP users to switch to API. It is recommended to encourage adoption of simpler Shipping APIs as a first step, before suggesting APIs that have more impact on the operational process (for instance a Labelling API). Third, it is recommended to strengthen partnerships, as interdependence among the stakeholders is clear and requires strategies on how to adapt to others in the order delivery chain. Fourth, it is recommended to retrieve insights on functionality requirements from both API and non-API users and continue to gradually develop functionality. Finally, because of the existence of the status quo, it is recommended to create urgency in order to promote Shipping API adoption, while also considering that enough time, IT support, a fall back to critical processes, and reasoning need to be given.

9.2 Contributions

This exploratory thesis contributes theoretical knowledge within the area of SCI by using insights from literature and practice. Recent research has called to investigate IT adoption from multiple perspectives, as decision making within supply chain is influenced by stakeholders inside and outside the organization (Schneider & Sunyaev, 2016; Hulthen, 2016). Previous research has only drawn data from top management (i.e. executive board) and neglected other members, for instance developer or IT managers (Schneider & Sunyaev, 2016). This study is the first to try to understand Shipping API
adoption from a unique viewpoint, by including multiple stakeholders in the outbound logistics chain.

With the aim of understanding and overcoming barriers to API adoption in outbound logistics, all relevant stakeholders were interviewed. The insights gained from this research can help API suppliers in promoting Shipping APIs. It can help them to better formulate implementation strategies concerning the integration of digital interfaces in an industry that is adapting to new composition of consumer buying behaviour. The findings are also relevant to other actors within the supply chain network, as it enriches the understanding of the emerging API paradigm in SCI. In particular, they increase our limited knowledge on factors influencing Shipping APIs adoption and its implementation.

9.3 Reflection

This section reflects on societal and managerial relevance and ends with a discussion of the research strategy, process and learnings.

Societal relevance
Societal relevance was defined by Van Drooge (2010) as: “the degree to which research contributes to and creates an understanding of the development of societal sectors and practice (such as industry, education, policymaking, health care)”. Prior to this study little was known about API adoption. This research project contributes to a better understanding of how several factors interact and influence the extent to which web integration technology is adopted in an third-party logistics context.

On one hand it improves efficiency and costs in the logistical processes, on the other hand it also improves consumer satisfaction by meeting delivery expectations. Integration affects all stakeholders in the delivery information chain, including logistics buyers and providers, integrators, fulfilment companies, the recipient and authorities.

Additionally, as noted in Chapter 4, the e-commerce industry aims to reduce its carbon footprint. Earlier this year a calculation tool was announced that shows the amount of CO2 that is used to deliver a package at the check-out webpage to the consumer (Terra, 2019). Web integration technology facilitates this sustainable trend by enabling the real-time data exchange.

Furthermore, Shipping APIs help in standardizing integration. They provide structure, improves data quality, enhances performance but also help in regulating and controlling information flows. Any step forward in improving logistics efficiency, improving customer satisfaction, reducing the carbon footprint and standardization is of societal relevance. Shipping APIs hold the promise for these improvements.

Managerial relevance
Shipping API adoption in outbound logistics is relevant to many stakeholders. Apart from being able to offer the latest delivery services (that are only offered by using the API), benefits exist to each stakeholder. For logistics providers, high data quality when exchanging data with partners is paramount make sure operational processes are running smoothly. For integrators, API adoption results in lower overhead costs in comparison to older technological counterparts such as FTP. For fulfilment companies, it allows them to offer more logistical service to their clientele. And lastly, for logistics buyers, API adoption improves customer satisfaction, as they prevent errors in data sharing.
Recommendations were provided for API suppliers in order to promote Shipping API adoption. They are encouraged to consider their interdependence among members of the supply chain, and exchange knowledge to improve current integration practices. The recommendations also underscore the importance of actively explaining the commercial benefit to logistics buyers, as findings indicate the relative advantage and the lack of demand make it difficult to justify switching to an API. These recommendations help in enhancing the integration of digital interfaces in outbound logistics by standardizing data flows and being more adaptable to changes.

Reflection on the research process

Early on in the research process, finding participants for the interviews was found to be difficult. Participants in this research are customers and partners of PostNL, and the data collection was done in the fall, the busiest time of the year for the e-commerce industry, meaning that shipping quantities were high and participants were often occupied. Before inviting participants, a selection had to be made based on internal documentation and an approval had to be given from an account manager before invitations could be sent out. Participants were invited by telephone, which took a lot of time and presented challenges accordingly (as described in Chapter 6). One interview was done through Skype as the participant was situated in Germany. In this interview, it was more difficult to connect with the participant on a deeper level to truly understand the motivations relating integration technology.

The exploratory nature of this research project made it possible to fully immerse into the problems the logistics buyers are facing. It was found that many contextual considerations have to be made, that cannot be easily captured in a survey. A survey would have provided less understanding on the reasoning behind Shipping APIs adoption, meaning that drawing conclusions and giving recommendations would have been more difficult. The skills learned in the MOT curriculum helped in this regard.

9.4 Relevance to MOT curriculum

The author’s study curriculum, Management of Technology (MOT), is designed on the basis that today’s engineers need knowledge in both technology and management (Verburg et al., 2005). Rooted in an engineering discipline, students learn how to analyse and implement technologies in an organizational context. As different contexts apply to technology, specific technological management is required (Zehner, 2000). Consequently, technology can be described as a corporate resource that can be utilised to gain competitive advantage (Verburg et al., 2005).

In this scientific study web integration technology is analysed in the context of third-party logistics. The work shows an understanding of technology as a corporate resource by covering IT integration services in third-party logistics and its managerial aspects. The end result of enhancing the digital integration is value for the customer, while the digital processes also become more adaptable to overall changes in its organizational environment. Based on the understanding of the underlying problem and the data collected, insights are generated that are valuable to both theory and practice. The study exemplifies the type of research skills a MOT alum should exhibit.

Fundamental course material of the master curriculum was used during the research process. Within the first year several courses have found to be relevant. For instance, the course Research Methods was used in constructing the research design. Additional courses that were found useful are Technology, Strategy and Entrepreneurship and Business Process
Management. In these courses students learn to align strategy and technology, and analyse business processes executed by digital technology.

Furthermore, the authors technological specialisation of choice in the second year, Information and Communications Technology (ICT) Management and Design, has proven to be useful in this research project. The knowledge gained in these courses - I&C Service Design, in particular - helped in reviewing extant literature on service innovation, learning about the design of (digital) services and interpreting the research results.
References


Fichman, R. G. (2000). The diffusion and assimilation of information technology innovations. Framing the domains of IT management: Projecting the future through the past, 105127, 105-128.


Theofanidis, D., & Fountouki, A. LIMITATIONS AND DELIMITATIONS IN THE RESEARCH PROCESS.


Appendices
Appendix A: logistics outsourcing network

Source: adapted from Norall (2013).
Appendix B: web services benefit analysis model

Source: adapted from Chen (2005).
Appendix C: last mile delivery process

Source: adapted from Daleman (2018).
Appendix D: Example label

Source: PostNL.
Appendix E: PostNL API platform and web services

<table>
<thead>
<tr>
<th>Index</th>
<th>Name API</th>
<th>Web Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Address check</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Domestic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- International</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Geo coordinates</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Send and track</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Barcode</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Labelling</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Confirming</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Shipping Status</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Delivery options*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Delivery date</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Location</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Timeframe</td>
<td></td>
</tr>
</tbody>
</table>

*PostNL also offers a CheckoutAPI that combines the 3 Web Services into 1.
Appendix F: how plugins are used
## Appendix G: Interview protocol

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
<th>Starting question</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Opening the interview</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>About</td>
<td>Researcher and participants introduce themselves</td>
<td>Could you explain what your job description is at company X?</td>
</tr>
<tr>
<td>Informed consent &amp; audio rec.</td>
<td>See Appendix H</td>
<td>-</td>
</tr>
<tr>
<td>Context research</td>
<td>Current situation is explained</td>
<td>-</td>
</tr>
<tr>
<td>Research objective</td>
<td>Goal of the research is explained</td>
<td>-</td>
</tr>
<tr>
<td><strong>Current operational process (short)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warehouse management</td>
<td></td>
<td>Do you have inventory stock? How do you manage inventory? Is this coupled to outgoing orders?</td>
</tr>
<tr>
<td>Printing labels</td>
<td></td>
<td>Do you print labels at the end of each day or after every order?</td>
</tr>
<tr>
<td>Order picking</td>
<td></td>
<td>What does your order picking process look like? Do you use voice picking?</td>
</tr>
<tr>
<td><strong>Current integration (main questions)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Order process</td>
<td>Front-end</td>
<td>Are you using any specific webshop software? If so, are you updating this regularly? Is this coupled to an ERP system? Can you change this in an easy way? Do you have delivery options integrated?</td>
</tr>
<tr>
<td>Order picking process</td>
<td>Back-end</td>
<td>What software for the order picking process are you using? How is this currently linked to PostNL?</td>
</tr>
<tr>
<td>Track &amp; trace process</td>
<td>Back-end</td>
<td>Are you sending notifications to customers, and if so, how do you do this?</td>
</tr>
<tr>
<td><strong>Factors influencing web integration</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opening</td>
<td></td>
<td>What is important to consider in a migration process to cloud computing in logistics?</td>
</tr>
<tr>
<td>Perceived value</td>
<td>cost-benefit</td>
<td></td>
</tr>
<tr>
<td>Relative advantage</td>
<td>status quo bias and lack of functionality</td>
<td></td>
</tr>
<tr>
<td>Absorptive capacity</td>
<td>to what extent the business takes advantage of opportunities</td>
<td></td>
</tr>
<tr>
<td>Technological compatibility</td>
<td>compatible with tightly coupled or</td>
<td></td>
</tr>
<tr>
<td>and interoperability</td>
<td>existing legacy systems</td>
<td></td>
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<tr>
<td>----------------------</td>
<td>-------------------------</td>
<td></td>
</tr>
<tr>
<td>Reliability and availability</td>
<td>uptime of APIs</td>
<td></td>
</tr>
<tr>
<td>Portability and lack of industry standards</td>
<td>integration compatibility with others, such as DHL or integrators</td>
<td></td>
</tr>
<tr>
<td>Security and privacy</td>
<td>regulatory compliance and control to protect privacy</td>
<td></td>
</tr>
<tr>
<td>Perceived risk and trust</td>
<td>to what extent PostNL is perceived as trustworthy</td>
<td></td>
</tr>
<tr>
<td>Migration process</td>
<td>to what extent they see the process of moving as an issue</td>
<td></td>
</tr>
</tbody>
</table>

**Closing the interview**

<table>
<thead>
<tr>
<th>Prioritization of factors</th>
<th>What do you think are the most important hindering factors to API adoption?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missed factors</td>
<td>Did we miss any topics that you think might be relevant?</td>
</tr>
<tr>
<td>Comments</td>
<td>Anything that has been left out or they would like to say</td>
</tr>
<tr>
<td></td>
<td>Do you have any final thoughts or suggestions?</td>
</tr>
</tbody>
</table>

**End of interview**
Appendix H: Informed consent form

Study consent form:
Enhancing the integration of digital interfaces in outbound logistics

Please tick the appropriate boxes

Taking part in the study I have read and understood the study information dated [DD/MM/YYYY], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.

I voluntarily give consent to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.

I understand that taking part in the study involves participation in an audio-recorded interview that will be transcribed as text. The audio recording will be destroyed after transcribing.

Use of the information in the study

I understand that the information I provide will be used for the researcher’s master thesis, (scientific) publications or other educational purposes.

I understand that personal information collected about me that can identify me, such as my name or where I work, will not be shared beyond the study team.

I agree that my anonymized information can be quoted in research outputs, after I have been sent a full transcript of the interview.

Signatures

_______________________  __________________________  ____________
Name of participant        Signature                      Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands what they are freely consenting.

Kevin Oost

_______________________  __________________________  ____________
Researcher name          Signature                      Date

Researcher: Kevin Oost  Telephone: 06-  E-mail:
Appendix I: Information sheet

Purpose of the study
The objective of this study is to provide insights into the factors influencing the adoption decision of web integration in the context of outbound logistics. Specifically, the focus will be on third-party logistics provider PostNL and its integration practices with buyers of logistics services. Part of the research includes data collection by means of semi-structured interviews. This research project is part of a master thesis, in partial fulfilment of the requirements for the degree of Master of Science, at the TU Delft.

Rights of participants
Participants can refuse to answer questions and can withdraw from the study at any time, by notifying the researcher, without having to give a reason. Participants have the right to request access to any personal data collected without undue delay and obtain rectification of inaccurate personal data concerning him or her. Complaints can be filed by contacting the data protection officer of the TU Delft.

Personal information processing
The interviews will be audio recorded and transcribed to meet scientific standards. The data will be stored by using trusted software and repositories. Any personal data, including audio recording, is destroyed once the research has finished. Personal information collected that can identify a participant, such as name or where the participant works, will not be shared beyond the study team. Information gathered during the interviews can be used for the researcher’s master thesis, by means of anonymized quotes.

Contact details and affiliated institutions
Researcher: Kevin Oost
Telephone:
E-mail:
Affiliated research institute: Delft University of Technology
Contact details of the data protection officer: privacy-tud@tudelft.nl
Affiliated company: this project is conducted as part of an internship at PostNL