Delft University of Technology

FACULTY MECHANICAL, MARITIME AND MATERIALS ENGINEERING
Department Marine and Transport Technology

Mekelweg 2
2628 CD Delft
the Netherlands
Phone +31 (0)15-2782889
Fax +31 (0)15-2781397
www.mtt.tudelft.nl

Specialization:	Transport Engineering and Logistics
Report number:	2016.TEL.8057
Title:	**Impact of RFID technologies on the supply chain of Heineken Nederland Supply**
Author:	H.A. (Jasper) Roosendaal

Impact van RFID technologieën op de supply chain van Heineken Nederland Supply

Assignment:	Research Assignment - Internship
Confidential:	yes
Initiator (university):	Dr. W.W.A. Beelaerts van Blokland
Initiator (company):	ir. J. Kuilboer
Supervisor:	ir. G. Versantvoort
Date:	July 1, 2016

Delft University of Technology

FACULTY MECHANICAL, MARITIME AND MATERIALS ENGINEERING
Department Marine and Transport Technology

Mekelweg 2
2628 CD Delft
the Netherlands
Phone +31 (0)15-2782889
Fax +31 (0)15-2781397
www.mtt.tudelft.nl

Student:	H.A. (Jasper) Roosendaal	Assignment type:	Research Assignment - Internship
Supervisor (TUD):	W.W.A. Beelaerts van Blokland	Creditpoints (EC):	15
Supervisor (Company):	G. Versantvoort	Specialization	TEL
Initiator (company):	J. Kuilboer		
		Report number:	2016.TEL.8057
		Confidential:	Yes

Subject: **Impact of RFID technology on the supply chain of Heineken Nederland Supply**

The research assignment will take place at the Customer Service Export & Customs department (CSE&C), part of Heineken Netherlands Supply. This department of Heineken exports a volume of approximately 80,000 containers to 160 countries per year. CSE&C is responsible for the order management also named order to cash.

The department CSE&C is having problems with serving their clients. This problem is multifaceted: there is a lot of rework in documentation flow, CSE&C has no clear tracking system on their deliveries/containers, deliveries are not on time (OT) and there is no room for improvement in innovation. Despite recent attempts to research the current documentation flow, no improvements have been made.

The objective for this assignment is to make recommendations to CSE&C about the technical innovations that can reduce their rework. By achieving transparency in rework the impact could be measured and compared with the RFID technology.

The report is complied with the guidelines of the section.

The professor,

Dr. W.W.A. Beelaerts van Blokland

Impact of RFID technology on the supply chain of Heineken Nederland Supply

Research Assignment

ME2130 – Research Assignment

Jasper Roosendaal (1508792)

Supervisor Heineken: Guus Versandvoort
Initiatior Heineken: Jos Kuilboer
Supervisor TU Delft: Wouter Beelaerts van Blokland

Date: 9 september 2016

HEINEKEN

TU Delft

Technische Universiteit Delft

This page is left blank intentionally

Preface

This research assignment is one of the finals steps in obtaining my MSc degree at the TU Delft, after 4 months internship and one full-time month working. In January 2016 I set up the contact with Jos Kuilboer (Manager Customer Service Export & Customs) and not more than two weeks later, the 1rst of February 1 I entranced the building of the Brewery in Zoeterwoude for my first internship day.

During the MSc program I have seen different parts of the transport and logistic sector. Additionally to the MSc program my visits to various companies such as Pon, Philips, SEW Eurodrive, APM Terminals etc. helped me to overcome the challenge I had to deal with during my internship.

I realize that conducting a research assignment would have never been possible without support. Therefore, I would like to thank Jos Kuilboer for giving me the chance to experience what it is to be part of Heineken for five months. Thereby the support and supervision of Guus Versantvoort helped me to develop a tool which contributes to the vision of the department CSE&C. Not only the successful completion of the tool, I would like to thank Guus also for taking the time to discuss the project and the interesting conversations we had. As an extra component the feedback on regular basis was helpful to develop myself personally and it also improved the level of the project. I would like to thank Wouter Beelaerts van Blokland, for his supportive feedback and giving me new inspiring insights throughout this research assignment.

Delft, September 1th 2016

Jasper Roosendaal - 1508792

Table of Contents

List of Figures

List of Tables

List of definitions and abbreviations

ASN – Advance Shipping Notice
BCT – Hinterland terminal Den Bosch
CSE – Customer Service Export
CSD – Customer Service Domestic
CSO – Customer Sales Organisation
EIS – Enterprise Information System
EPC – Electronic Product Code
ERP – Enterprise Resource Planning
E-SCM – Electronic Supply Chain Management
HNS – Heineken Nederland Supply
ILT – Item Level Tagging
IOS – Inter Organisational Systems
MDM – Market Demand Management
MSO – Market sales organization
MTO – Make to order
MTS – Make to stock
NPI – New Product Introduction
OPI – Operation performance indicator
OS – Operational scheduling
OTA – Hinterland terminal Alpherium (Alpen aan den Rijn)
PA – Product availability on time to be loaded
PCO – Perfect Customer Order
RFI – Request for inspection
SKU – Stock Keeping Unit (aka: SPC, Material, Fert, GPC)
SPC – Special product code (aka: SKU)
TPM – Total Productive Management
TSCP – tactical supply chain planning
VSM – Value Stream Map

1 General introduction

This chapter contains a brief summary about the Heineken Group. Additionally a more detailed description about Heineken Netherlands (HNL) in paragraph 1.2 and Heineken Netherlands Supply (HNS) in paragraph 1.3 is given. The research about implementation of RFID in Heineken is carried out at the department Customer Service Export & Customs at HNS Zoeterwoude, a description about this department is given in paragraph 1.3.1.

1.1 Heineken Group

Heineken is established in 1864 by the Heineken family and the different brands from Heineken are currently sold in 178 countries around the world. In 2015 the revenue of Heineken was 20.5 billion euro with a net profit of 2 billion euro. The operations are spread within over 70 countries with a team of over 85,000 employees. Today, Heineken is the number one brewer in Europe and the number three brewer by volume in the world (number two if and when a merge between AB-Inbev and SABMiller will be approved). The Heineken portfolio contains more than 250 brands, which are sold internationally, regionally and locally. Heineken Premium Pils is the flagship brand and is world's largest international premium beer. The aim of Heineken is to be a leading brewer in all of the markets where they operate and to have the world's most prominent brand portfolio (Heineken, 2016).

1.2 Heineken Netherlands

Heineken Netherlands is an exceptional operation within the Heineken Group. The Heineken brewery in Zoeterwoude is the largest brewery in Europe and the largest within Heineken worldwide. Besides the brewery in Zoeterwoude there are two more in the Netherlands, one in 's-Hertogenbosch and one in Wijlre. Besides breweries Heineken owns the soft drink producer Vrumona which is located in Bunnik. In the Netherlands, yearly about 16.5 million hectolitres is produced from which about 30% is designated for the Netherlands, 30 % for the USA and the rest is exported to more than 150 countries all over the world. Heineken Netherlands consists of four divisions divided in Heineken Netherlands Supply (HNS), Commerce, Vrumona and Business support (Heineken Nederland, 2016).

1.3 Heineken Netherlands Supply

Heineken Netherlands Supply (HNS) is the division of Heineken Netherlands which is responsible for the production of beers and ciders for both the domestic and the export market. Production takes place in the breweries in Zoeterwoude,'s-Hertogenbosch and Wijlre. The most important products are Heineken, Amstel and Brand, furthermore many innovative products like Jillz, Amstel Radler, Wieckse Rosé and different draft kegs are made in the HNS breweries.

1.3.1 CSE&C

The research assignment will take place at the Customer Service Export & Customs department (CSE&C), part of Heineken Netherlands Supply. This department of Heineken exports a volume of approximately 80,000 containers to 160 countries per year. CSE&C is responsible for the order management also named order to cash. Furthermore this department is responsible for the organisation and management of the worldwide transport per train, truck, deep sea vessel, barges and air transport, including all the documentation needed for transport and clearance.

The department CSE&C has several missions:

- An accurate and On Time (OT) delivery of an order, including the necessary documentation for clearance (depending on transportation conditions)

- In case of singularities in an order, proactive communication towards the customer crucial actions need to be taken directly
- Advising clients in logistics (export knowledge combined with customer and market knowledge)
- Being a central contact point for all export order related questions and information
- Being in control of information flow and create 100% transparency
- Being "First Time Right" (FTR) for x% of the orders (target FTR not defined yet)

1.4 Research Assignment

At this moment the main objective in the strategy of CSE&C is to create '100% transparency'. This objective must result in a distinct operational performance overview of the department. One of the responsibilities of the Customer Service Export & Customs department is the order management (order to cash). Within handling order management the department struggles with so-called "rework", which is the extra work done by an employee when an order is not FTR. This rework does not add value to the customer and frustrates employees, and therefore should be solved/minimized. To deduct a research question from the industrial setting I used the books "Designing a research project" by (Verschuren & Doorewaard) and "Technical Communication" by (Raman & Sharma).

1.4.1 Reason for the assignment

The department CSE&C is having problems with serving their clients. This problem is multifaceted: there is a lot of rework in documentation flow, CSE&C has no clear tracking system on their deliveries/containers, deliveries are not on time (OT) and there is no room for improvement in innovation. Despite recent attempts to research the current documentation flow, no improvements have been made. It is not clear where the rework problems stem from and it is caused by several incidents which are not yet defined and structured.

1.4.2 Aim of this assignment

The objective for this assignment is to make recommendations to CSE&C about the technical innovations that can reduce their rework. By achieving transparency in rework the impact could be measured and compared with the RFID technology.

- ✓ Micro level – RFID tagged
- ✓ Producer, shipper, carrier level – including qualification, handling and routing
- ✓ Freight corridor level – represented by authority and infrastructure services including authorization, security and safety control.

This will be the thread of this research assignment. By achieving the reduction of rework, the employees of the CSE&C department can invest more time in the customer service to increase the customer satisfaction.

1.4.3 Approach

1. Identifying the current state of information flow of HNS
2. Basic of RFID technology architecture
3. Study trends in upcoming technology around tracking transport, for example RFID technology implementation on transport (Zara, Walmart, other retailers).
4. Study trends in other similar technology, as NFC or other examples.
    a. Track and Trace
    b. Inventory levels, replenishment, forecasting
    c. Repetitive tasks – place and pick. Minimize expediting tasks and buffer stocks
    d. Managing the capacity, staging and # of pieces. Time consuming manual tasks

e. Real time graphical overview to show -> hot orders, economic reordering, performance metrics

5. Business Case – Potential for implementation
6. Building a conceptual model
7. Impact of conceptual model on information flow from a CSE&C perspective
8. Analysis of the results

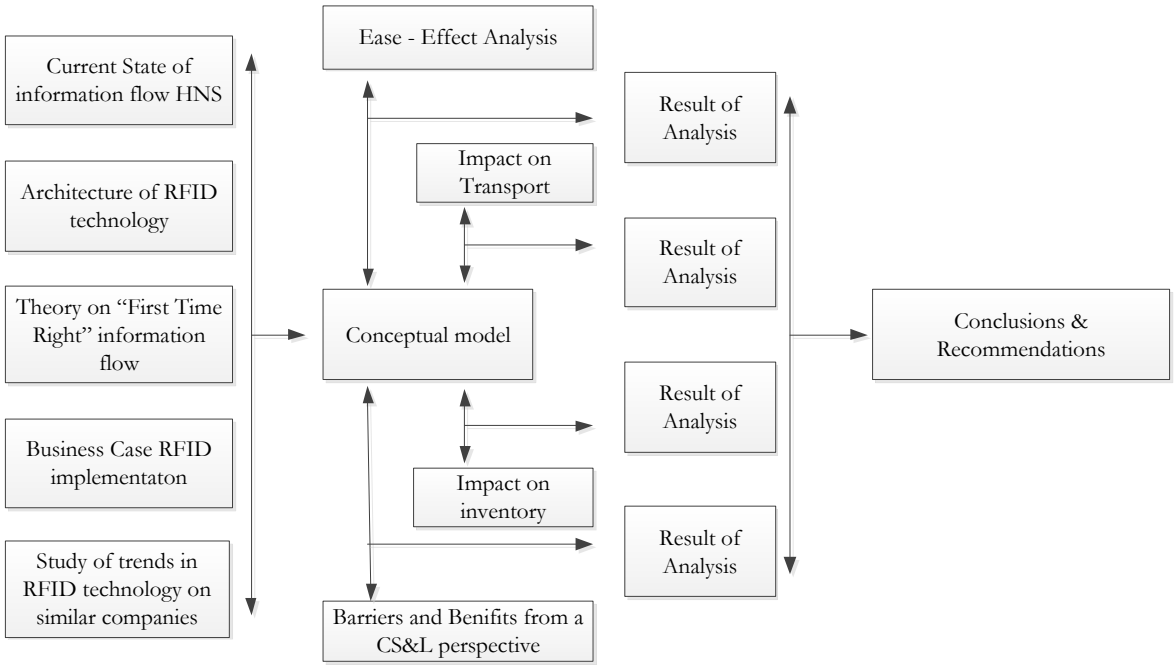


Figure 1: Research Framework

The structure of the research is given in Figure 1: Research Framework. This research explores how implementable the RFID technology is in the Heinekens' supply chain and thereby what are the benefits for Heineken in different perspectives. This research will examine the grade of implementation on different operational capabilities: Quality (is one of the main objectives of Heineken), speed, flexibility & costs. This is done by creating an in depth literature research of RFID technology which is used to enhance various aspects of service deliveries. Parallel on that the architecture of RFID in tracking & tracing transport has been studied. Besides this research a business case and a study of trends in RFID technology on similar companies as Heineken has been done in a general way. After completion of this literature research a conceptual model of the implementation of RFID has been made. This model has impact on different elements in the supply chain, which will be explained later on. The results of the conceptual model will be analysed and finally conclusions and recommendations are presented.

2 Current State of Information Flow HNS

This section explains how the information flow in HNS is structured. The information flow will be explained from a CSE perspective. The documentation flow is integrated within the information flow, and is an important part of the current state. In this section the potential of RFID on the documentation flow will be described.

2.1 Supply Chain HNS

First of all the Order to Cash process will be introduced from a CSE perspective, how this is executed in the current state. Before going into further detail about the Order to Cash process, an introduction about the structure of the department which affected the information flow is given;

Figure 2: Departments CS&L

Market Business Partners (MBP)

The main responsibility of MPBis to be the link for the markets and Heineken Netherlands Supply. In addition, they are trying to gain more insight in the market developments. These market developments includes: volume, (new) products, Supply Chain setup. Furthermore, the main outputs they deliver can be split up in four categories; Developing business plans, build innovation plan, long-term demand forecast and finally reporting to and from the customer. *(Source: Hylke Steiginga, Market Business Partner).*

Customer Service Export & Customs (CSE&C)

On a higher level CSE&C is already introduced. In this section a brief explanation of the responsibilities of this department is given. The responsibilities can be summarised in two task; Order to Cash management (which includes transportation) and customer service. The component Order to Cash contains the transport, the shipments and deliveries that are created. The order coordinators adjusts the real start shipment to a trucking- or a shipping company. All the paper/documentation is also covered by the CSE&C department. For example the Certificates of Origin, Invoices, Bill of lading etc. *(Source: Guus Versantvoort, Supervisor CSE&C)*

Tactical Planning (TP)

TP is responsible for the planning from 1 to 13 weeks. TP analyses the capacities of machines, material and people internally. This includes the following responsibilities: packaging planning, replenishment planning, material planning and brewing plan. The output that is generated every week covers the tactical supply chain planning, and a weekly schedule sent forward to Operational Planning. *(Source: Arjen van Diepen, Supply Chain Planner).*

Operational planning (OS)

As mentioned in previous section the weekly schedule is forwarded to OS. They are responsible for short-term planning (1-2 weeks planning). OS schedules what has to be produced per day. Hereby a five

different schedules will be produced to bring the process in the right direction. This involves the following plans: packaging plan, material plan, brew plan, filtration plan, and the loading plan. *(Source: Darcy Bosman, Operational Scheduler)*

Logistic Support (LS)
LS starts when the beer leaves the production lines. They are responsible for a smooth continuous flow into the containers. This process includes the addressing of the containers at the inland terminal, assign containers to the appropriate dock, the physical loading of the containers, cross docking and managing the stock levels in the warehouse. *(Source: Jacco Schreuder, Coordinator Logistic Support)*

Contract Managers
They are the persons who are responsible for the contracts with the third parties where mainly CSE&C deals with on daily basis. These third parties can be divided into two types; Namely, first the suppliers of semi-finished products. Secondly, the carriers, which can be divided into two different groups; the truck-transport and shipping-transport (inland and deep sea). (Source: Anette van Baal, Contract Manager Sea Freight)

Customs
The export of the Heineken products flow all through the ports of Rotterdam and Antwerp. The Customs procedure for the export of beer seems quite complicated, so this procedure will not be explained here, but the bottom line is that it is essential for customs and other inspections autorities that there is proof of export for the beer. Many of these certificates are paper documents that needs to be sent by the exporting company for all kinds of different government agencies. In case Heineken and its chain partners want to send a container from the Netherlands to America, Heineken exports must send data to different government systems as the Export Control System (ECS), a VAT and excise systems, and additional paperwork for example a retour document from the Chamber of Commerce. Also other statistical data from the CBS is required.

2.2 Information flow

As mentioned in the previous section all the export orders are funnelled through the department CSE. In this section the information between all department is explained. This is relevant information because how every product reaches the right destination error sensitive flows are involved in the supply chain.

2.2.1 Replenishment vs Make To Order

Before continuing the information flow more information about two order models is defined. HNS applies two different order models; Replenishment and MTO. The main difference is between these models is that within the replenishment model HNS manages the inventory levels of the customer themselves. A big advantage of this model is the ownership over the production quantities. When HNS foresees a lack of material in the next weeks, they can easily decrease the production to a lower level than the forecast suggest. In the MTO model HNS is totally dependent of the order quantity of the customer. However also in the MTO model the forecast gives an indication of the expected demand in a specific week.

2.2.2 Order process current state

CSE receives orders from two different organisations. Respectively the Customer Sales Organisation or the Market Sales Organisation. The main difference between the organisations is that HNS receives the order from the CSO directly into their order management software. The order coordinator has to manually process the order for the MSO. Those both types of order are collected in a certain environment in SAP (Software HNS uses for order management).

Once the order are received the order coordinator creates deliveries and shipment. This means that the order gets his actual delivery. Without a delivery and shipment no action on HNS's side are taken. Parallel on the coordinators of CSE, TP starts with the planning of the resources, material and the beer planning for the specific orders. When the resources are planned a planning analyst provides a list with capacity shortages and the impacted on the specific product codes. Depending on the shortages the demand managers identifies the SPCs with the orders and asks the customer (CSO or MSO) to reduce their orders. In the replenishment model this won't be a problem, because HNS can manage the production levels themselves. At the moment TP is adjusting the resource plan, OS creates the operational plan. The detail planning and the material call-offs are made. In a meanwhile CSE is developing the shipment plan bases on all adjustments and the rescheduled deliveries. Finally the product will be produced and LS carries the responsibility for the further shipment.

A RFID integrated "Order-to-Cash" flow

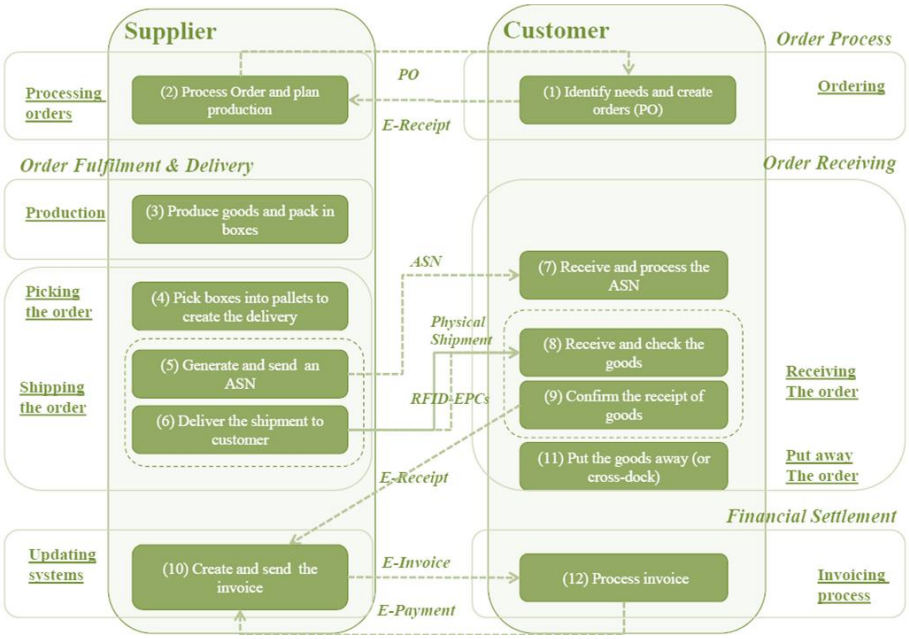


Figure 3: Order to Cash process RFID

In Figure 3 is the potential of RFID technology already composed in a e-SCM. This flow diagram involves some integrated steps of the RFID technology in the order process between customer and HNS. Each number of communication and transaction will be discussed below. The ordering process starts when needs are identified and Purchase Orders are created (1). For instance, if RFID cabinets integrated with the EIS are used at the point of consumption, this infrastructure helps organizations control inventories and keep products in continuous stock - i.e. records each transaction such as what RFID Electronic Product Code number was removed and when. Based on this real-time data capture a PO containing all the EPCs can be automatically generated in the ERP and sent to a preferred supplier through EDI. This EDI connection is for a couple of customers and carriers already integrated with. Upon automated receipt, the supplier can process the order and plan its production accordingly (2). This would be helpful for the markets that are fully replenished by HNS (for example HUSA and Taiwan). As it is explained through this scenario, the RFID system automates a limited portion of the ordering process, but its ability to automatically capture data in real time is making the level of supply chain visibility. Order fulfilment & delivery processes Once Heineken's order entry system receives the PO and updates its ERP system, specific order fulfilment & deliveries order are generated. The production line starts to fill the bottles with beer and the bottles are packed in boxes (3). At this step, an EPC number is encoded on a RFID smart label, and applied at item (bottle), case or even pallet-level based on

process/product requirements. While most of current RFID projects focus on case/pallet level tagging, as later will be mentioned in chapter RFID, some Item-Level Tagging (ILT) initiatives in apparel and footwear are being deployed very rapidly with companies such as Wal-Mart. Boxes are then picked onto pallets to create the delivery (4). The next logical steps (5&6) consist of delivering the physical shipment to customer while automatically sending an ASN, which is an e-document relating to the original PO that details the goods EPCs numbers that have been automatically captured by the RFID portals installed at the shipping doors of the supplier. Automatically linking EPC's with logistics units allow to synchronise the physical and the information flow, which in turn can be verified against shipping order in the ERP. Beside increasing the visibility of the shipment status and reducing delivery errors such RFID enabled processes can also provide real time inventory update. Finally, the use of the ASN sent through an IOS constitutes an essential document to improve the (automated) goods receiving process at the client site where all received goods will be matched with the ASN and the original PO. While simple, the shipping process is a great example to demonstrate how RFID technologies need to be integrated to ERP/WMS systems and connected through IOS to realise the full potential intra and inter organisational process improvement. Order receiving process The order receiving process starts, in fact, when the customer receives the ASN through an EDI connection (7) to be automatically processed and checked against original PO (in the ERP) and to detect any discrepancies. The ASN also constitutes the comparison basis for the receiving process of physical goods (8). Basically, at this step, as goods are removed from the truck and entered through the receiving dock, RFID/EPCs are automatically captured (using the RFID infrastructure) rooted to specific EIS module (using the RFID Middleware infrastructure) and matched against the ASN to automatically confirm the receipt of goods in the ERP (9). Alike for any automated operations, the importance of properly configuring event based business rules to support RFID enabled processes is critical since the human intervention is replaced with computing business logic. An EDI e-receipt message is then automatically sent to the supplier to acknowledge that the transaction has been completed so the supplier can create and send the related invoice (10). To complete the internal receiving process, a put away order is then automatically generated by the ERP and transmitted to warehouse clerks (11) – generally through the warehouse WLAN connection. Upon receipt, the put away process (or cross docked in the case of direct delivery scenario) can be supported using RFID vehicle mounted applications similar to the ones used in the delivery process (described in 4). As the goods are put away, the inventory is then automatically updated in the ERP since pallet/boxes EPCs are read and associated with the tagged floor/shelves EPCs locations. (Bendavid, 2016)

Financial Settlement process Finally, once the invoice is generated in the supplier ERP and sent through EDI (10) it is processed by the client's system (12). Therefore, this portion of the process is not different from the one handled with existing EISs and IOSs. (Bendavid, 2016)

Figure 4: A six step order-to-cash process

Concluding; RFID data used to optimise order-to-cash can also improve related processes like replenishment planning and demand forecasting. Last two mentioned are applicable to Customer Service department within Heineken. Finally, RFID workgroups must identify discrete improvements to woo each stakeholder. One of the biggest promises of RFID is the cross enterprise visibility, however most intermediaries will not have technical platforms or spending much support RFID-based visibility for the foreseeable future.

3 RFID Technology

The aim of this assignment is to create transparency by RFID technology. Therefore this section provides a brief introduction in the technology. RFID technology works with a reader and a tag. A reader transmits radio signal which is then received by a tag. The tags antenna receives the signal and then either by its own power or power received from the signal the tag will send a radio signal back. This radio signal is then received by the reader which it can translate into a data signal. This data signal can envelop all types of measurement data i.e. time stamp, temperature reading, article number, etc.

3.1 RFID Technology

RFID is used to identify, read and communicate wirelessly between so called 'tags' over a distance with a 'reader'. This technique is already used in industry for different purposes (Baum, Niemann, & Abelbeck, 2007). It can be used in warehouses or sorting centres where stock gets an RFID tag so it can be easily identified from a distance even without a visible sight. Other applications are in production processes where the different components get tags in order to be followed and controlled during the process. Since RFID technology is being used in more and more applications the production costs of reader and tags are decreasing, an expectation for the future is that grocery stores can use it on all their products (Lodewijks, Veeke, & Lopez, 2006). This will give an easy overview of what articles are in the shelves and scanning the groceries at the counters will be a split second affair. There are different kinds of tags, readers and radio frequency possibility's to use. These will be explained in the next sections.

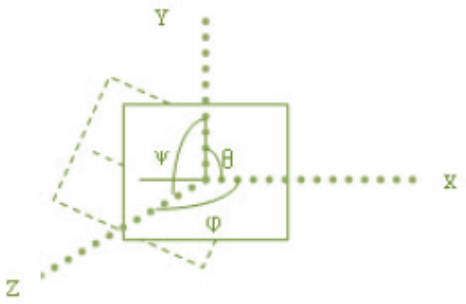
3.1.1 Radio Frequency

The communication between the reader and tag is at a certain frequency. Different levels of frequencies are possible, which have different characteristics. The higher the frequency the more data can be transmitted at a higher speed and the further the communication. A higher frequency also brings in more expensive equipment. Lower frequencies penetrate other mediums making it more suitable for dense area. Since the RFID signal has problems with steel contact it's best to shield the reader from a heavy steel construction (Baum, Niemann, & Abelbeck, 2007).

Low Frequency (LF) 125 kHz or 134 kHz worldwide	Short read range, Low reading speed, Can read through liquids, Inexpensive
High Frequency (HF) 13.56MHz worldwide	Short to medium read range, medium reading speed, reads through liquids, moderate expensive
Ultra-high frequency (UHF) 850-950 MHz Regional	Long read range, high data rates, reduced signal collision, cannot read through liquids, relatively expensive
Microwave 2.4GHz	Similar to UHF, faster read rates, expensive

Table 1: Frequency ranges

3.1.2 Tag Offset



Antenna tag orientation has a large influence on the readability of the signal. The orientation of the tag's antenna with respect to the reader has influence on signal strength. Therefore attention should be put to the placing of the tags and readers. Tests have shown that the area of readability can drop by 25% as an effect of different angles of antenna orientation as in Figure 5: Antenna orientation. (Lodewijks, Veeke, & Lopez, 2006)

Figure 5: Antenna orientation adapted from (Lodewijks, Veeke, & Lopez, 2006)

3.1.3 RFID Tags

The RFID tag has two main parts: an antenna and internal hardware. The hardware inside the chip translates the received radio signal into useable data. Depending on the type and class of the RFID tag the RFID can store this information on its memory and send information back. This information will then be transformed to a radio signal again and will then be transmitted by the antenna. The power supply of the RFID tag can differ. The power supply of the tag can either come from an own power supply, active, or the power of the radio signal can be transformed into electric energy in order to power the tag, passive.

Type of Tags

Active tags: Active tags are equipped with their own power supply and actively broadcast a radio signal containing their ID at periodic intervals. Due to their own power supply they are capable of broadcasting out a strong signal which can be detected up to 100 meters. Due to their own power supply these type of tags are quite a bit more expensive than the passive ones. Mostly they are powered by a battery which will run out of power eventually. (Pang, 2015)

Passive tags: Passive tags power themselves by the radio signal they receive from the reader. The reader will broadcast a signal. The coil form of the antenna of the passive tag can act as a coil and receive the energy of the radio signal. This energy can be used to power the tag. The tag will power up and use the energy to broadcast a radio signal containing it's ID. The radio signal can reach up to 10 meters but a range of 2 meters it's more stable in practice. Due to the simplicity of a tag they are cheap to produce and tags will last for years. Since they don't have their own power supply which can run out but use the power of the radio signal received from the reader they will work until they break down.

Semi-active tags: The Semi-active tag is a combination of the passive and the active tag. These types of tags don't broadcast their radio signal periodically. The tag waits for a signal to be received. When it receives a signal the tag will become active and use its internal power supply in order to broadcast a strong signal. These types of tags will therefore have a larger reach than passive tags but they will also eventually run out of battery. Since they are in standby for most of the time this period will be a little longer than with the active tag. (Baum, Niemann, & Abelbeck, 2007)

Memory Tag Classification

Tags have an internal memory with their ID but it depends on the type of tag whether it's possible to change this type of information and how much information can be stored on to the memory. The data stored on these kind of chips is pre-written during production and cannot be changed. A more advanced type of tag is the write once/read many type of tag. The data can be added onto the tag by the user once and thereafter it's unchangeable. The maximum data storage is around 4kb. The read/write tags are the most advanced, these can be written and read as many times as needed. (Pang, 2015)

Class 0	**Read only passive identity tags:** Product code is programmed by the manufacturer.
Class 1	**Write once / read many passive tags:** Tags are manufactured without product code. Tags are programmed by the user. Data cannot be changed once written to the tag.
Class 2	**Read/write passive tags**: Tags have larger memory with additional functionality like encryption and authenticated access control.
Class 3	**Semi-passive tags:** Tags have increased communication range and advanced functionality like sensing capability.
Class 4	**Active tags:** Tags are capable of broad-band communication with other active tags and with readers. Tags can be integrated with sensors with or without data logging.
Class 5	**Essential readers:** Tags can power other tags of Class 0, 1, 2 and communicate with tags of Class 3, 4 and other readers.

Table 2: Tag Classification (Pang, 2015)

3.1.4 RFID Readers

The RFID reader is the eventual receiving part of the system. The reader consists of three main parts: the high frequency interface, the control unit and an antenna explained in **Fout! Verwijzingsbron niet gevonden.**. Readers are usually connected to other pc systems that can analyses the data and act accordingly. This is called the control system.

High Frequency Interface	The high frequency interface generates the high frequency transmission power to activate the tags, it also modulates the transmission signal to send data to the tags and it demodulates the receiving signal coming from the tags.
Control Unit	The Control unit is the brain of the reader. The unit is in charge of the communication with the tags, performs the signal coding and decoding and communicates the data to the rest of the system.
The Antenna	The antenna broadcasts the radio signal generated by the high frequency interface. It receives the signal being send back by the tag. The performance of the antenna is affected by its size. There are different types of radio frequencies possible to use for RF communication. Different types of frequencies require different types of antennas.

Table 3: RFID reader parts

3.2 Uses of RFID

Today RFID technology is already widely used in different parts of the industry. It is a proven technical system which can give several different solutions for the identification. Identification by RFID technology today is even used as a payment solution. Modern payment cards are equipped with a tag which can be read by the reader in payment machines. A few examples where RFID is used:

Warehouses: In warehouses goods can be labelled with tags. Tags have an advantage over barcode scanners to find products since RFID technology doesn't require a straight line of sight and it even has the possibility of adding information to the tag.
Production: During production processes parts and components can be equipped with a tag. This makes it easy to track a component trough production and add valued information about the component to the tag.

A study recently conducted by the Computing Technology Industry Association says that the 29.2% of the participants indicated that their primary reason for mandating RFID was to improve visibility. Other benefits included improved collaboration with partners (cited by 11.9% of respondents). Although mass merchants and grocers do not provide an incentive for mandating RFID labelling, suppliers will benefit by being better organized and more responsive. **(Selwyn Piramuthu, 2016)**
RFID can be applied in various locations across the retail supply chain including warehouses, transportation (either retail and/or supply), distribution centres, and retail stores (Yin, Tserng, Wang, & Tsai, 2009). The benefits of using RFID in warehouse management derive from the advantages in inventory management by reducing optimum stock levels and eliminating inventory inaccuracies.

3.3 Trends & Development

Despite of the fact that the marketable applications of RFID date back to the 1970s, the use of RFID in the SCM is to some extent quite new. Around 2003 the world's largest retailing companies, including the Metro Group in Germany and Wal-Mart in the United States, started with the implementation of the RFID technology in the supply chain. Wal-Mart expected to save $ 8 billion by the introduction of RFID and the EPC global network in their operation. About 80% of the reduction should come from human actions which are still needed for scanning barcodes. Other 7,5% could gained by reducing the empty shelves (in other words out of stock). Thereby the risk in errors and fraud can be reduced by 7,5% as well. Finally, the ultimate goals must be to increase the customer focus to the provided products. In terms of

RFID forecasts a recent global RFID market forecast indicates that, despite the 2009 economic difficulties, RFID industry has witnessed a significant growth in almost each sector in the recent years.

3.4 Potential Benefits

In this section the benefits of RFID applications are discussed focused on the Heineken's supply chain. The advantages of RFID will be treated by each activity and location. This creates the overall impression of possible applications and benefits for Heineken in the future. These advantages can be achieved both at operational and strategic level.

Due to the simplicity of the technique and the ability to identify one unique object, the applications are very diverse and numerous. As a result, various benefits of the RFID technique from the literature are listed, all of which can be reached in the ideal situation.

- Pointing different activities in logistical processes RFID technology can assist in the execution in movements or proceedings. Errors can be reduced and the processes can be executed faster. The main advantage is related to the identification during arrival and departure of trucks from the breweries to the hinterland terminals. The potential mistakes during the loading of pallets in the container can be controlled easily. Two production lines brewery are using cross docking stations. By effortless identification there is an improvement possible in the logistic chain.
- RFID technology can provide HNS 100% transparency in the stock level along the full supply chain. It can increase the level of Track & Traceability. Both the 100% transparency and the track & traceability are one of the several objectives of the department CSE&C. By using the RFID technology on item level the warehouses can be labelled as smart. It provides real time data of the inventory. Consequently, the annual inventory count has not longer to be done. Besides the benefits of transparency of stock, also the efficiency of the set up can be optimized.
- Heineken pretends to achieve the best freshness of their products. Freshness is also one of the mission that CS&L has as a whole. By labelling items on a certain level, say boxes or pallets, the time to consumer can be measured easily. Also by registering best before date of the beer in the system will respond to a better respond anticipation on the throughput times.
- Finally, it could lead to an improvement in customer service. Heineken could be able to show their customers where their order is in the supply chain at any time.

3.5 Barriers on the Road

Obviously there are not only benefits of the RFID technology. The following are three frequently cited barriers for widespread adoption of RFID: a lack of return on investment (ROI), technical risks, the popularity of bar codes.

- Lack of ROI: For most initial adopters, mandated compliance was the reason for their adoption of RFID . Moreover, as previously discussed, many consider the unit cost of tags still too high. RFID implementation may also incur hidden costs, for example, the need to revamp material handling equipment.
- Technical risks: Unreliable performance has been an ongoing issue for RFID. The proportion of defective tags and false reads, which in some pilot projects has been as high as 20–50%, is still not acceptable.
- Popularity of bar codes: Entrenched business practices can significantly hinder the spread of a new technology. Between 5 and 10 trillion bar codes are printed every year. Barcodes are inexpensive, standardised, and, in some cases, are already achieving a satisfactory performance levels,

4 Conceptual model

To verify and identify if a possible integration of RFID technology it is interesting for HNS to build a conceptual model. The outcomes of this conceptual model brings insight in the benefits and challenges when HNS chooses to integrate RFID in the supply chain. This section sets out a strategy to overcome a couple of challenges and reveals the challenges have to be made. Clearly in this conceptual model no types of tags or readers will be picked. This chapter gives more an indication of the steps that all need to be taken. A particular case is selected to generate a quick overview of the situation.

When designing a conceptual model a case study is done. The primary purpose of this study was to evaluate the impact of the RFID technology on the supply chain of HNS. The examination of different aspects related to the supply chain of HNS. In this paragraph an introduction of the conceptual model is given. To provide a good insight in the supply chain the product flow to Miami (HUSA) is given. This case is ideal because of its great export volumes.

In a simple process, a raw material is processed into a product, and this is then transported to and sold to a customer. In this case the raw material is the beer, glass, cap, labels and cardboard. In Figure 6 is shown the simplified supply chain of HNS for one product. The various stakeholder in the supply chain are identified here , the supplier, manufacturer, transporter, inland terminal, deep sea vessel, deep sea terminal and distributor. In a perfect setting of the supply chain management the information is shared between all stakeholders. At the moment the information shared between these parties is on the minimum level. The figure is completed with the cash flow. However, this is out of scope and will not be a part of the business case later clarified in this chapter.

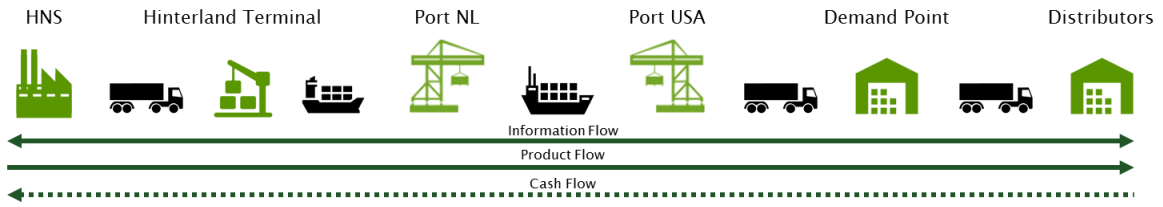


Figure 6: Simplified Supply Chain

4.1 Design Location

Probably one of most challenging obstacles become the definite placement of the readers at all stakeholders. The Design location is categorised in two parts. The first part of the design location is the placement of readers at the stakeholders. The traceability of the containers or pallets depends on the amount of readers along the supply chain. The second part of the design location is about; Where to place the takes to provide the traceability needed? The tags can be positioned on different items, for example bottle (which is not very likely), every SKU (Stock Keeping Unit), every pallet, or just outside the container or may a combination of these positions.

4.1.1 Location on stakeholders

More than 95% of all containers that passes the hinterland terminal in Alphen aan de Rijn and Den Bosch (OTA and BCT) are Heineken's. The influence on the hinterland terminals of Heineken is substantial because of its export volume. Through this it must be likely that Heineken could place RFID readers at the port of the hinterland terminals. During my internship I visited both hinterland terminals and spoke to the terminal manager (Ivo Hilhorst) of the OTA. He was very interested in the RFID technology and willing for implementation in the near future. Besides the influences on the hinterland terminal, the percentage of export volume related to the total outgoing containers in Antwerp and Rotterdam is a relevant number. What I experienced during my internship is that Heineken has direct impact on the

parties in and around the Port of Rotterdam. Although it is too easy to proclaim that Heineken can provide all container terminals with RFID readers on their preferred location.

In Table 4 below provides a quick overview where it could be feasible to locate readers on a short term.

Stakeholder	Degree of Feasibility Easy (1-5) Tough	Note
HNS	1	Easy for implementing (at least a pilot)
Hinterland Terminal	2	Pretty easy for implementation, depends only on investing costs. (who's going to pay for the readers and installation?)
Port NL	4	Quite hard to implement. Where to place and why would terminals invest without barely creating benefits.
Port USA (or elsewhere overseas)	5	Almost impossible. Passive action.
Demand Point	3	Reasonable for implementation. With the help of Heineken's operated companies.
Distributors	4	Quite hard for implementation, because already don't want to share their sales number and it is not a Heineken entity.

Table 4: Degree of feasibility of stakeholders

The contract managers for transport have noticed a lack of information in the beginning of their supply chain. The lack of information in traceability and the degree of implementation possibilities at the stakeholders at the start of the supply chain is a desired outcome. The fulfilment can be labelled as successful by the time HNS succeeded to install RFD readers at the end of the supply chain. The ideal situation would be the consumer, because that closes the information loop from the beginning until the end.

4.1.2 Location on Unit

This section threats the advantages of using RFID over the current system of identification, namely barcodes. Currently the barcodes are placed on two sides of a pallet. Table 5 shows the differences between barcoding and RFID displayed. The RFID application is the one that has more advantages above the barcoding. Although the fact that the criteria are not weighted. Obviously, the investing costs and the operating cost are for a company the ones with the most importance. In addition to the comparison with de barcodes there will be proposed on which preferred place the tag should be placed.

The main question in replacing the barcodes is whether the additional cost for the RFID is valued above the technical improvements. The barcode technique has its limitations, although it is arguable whether RFID is the right solution. Due to the relative high cost of RFID and some technical limitations they expect that the share of barcoding identification still remains large.

At the moment the strategic department of HNS is developing an extra production line. One of the developers told me during an interview that the investment cost of a rotating machine for a pallet costs about €150,000. By rotating the pallet it can be labelled two 2 sides. The implementation of RFID can contribute to the reduction of waste of this machine. This line will be built within a year. My proposal could potential lead to implementation of the RFID technology.

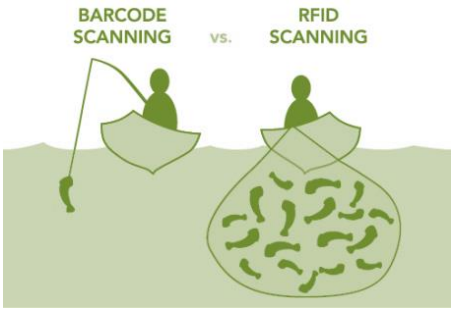


Figure 7: Visual of barcode vs RFID

Read Rate	High throughput. Multiple (>100) tags can be read simultaneously.	Very low throughput. Tags can only be read manually, one at a time.

Line of Sights	Not required. Item can be oriented in any direction. As long as it is in the read range, and not influenced by materials.	Definitely required. Scanner must physically see each item directly to scan, and items must be oriented in a very specific manner
Human Capital	Virtually none. Once up and running, the system is completely automated.	Larger requirements. Labourers must scan each tag.
Read/Write Capability	More than just reading. Ability to read, write, modify, and update.	Read only. Ability to read items and nothing else.
Durability	High. Much better protected, and can even be internally attached, so it can be read in very harsh environments.	Low. Easily damaged or removed; cannot be read if dirty or greasy.
Security	High. Difficult to replicate. Data can be encrypted, password protected, or include a "kill" feature to remove data permanently, so information stored is much more secure.	Low. Much easier to reproduce or counterfeit.
Event Triggering	Capable. Can be used to trigger certain events (like door openings, alarms, etc.).	Not capable. Cannot be used to trigger events.

Table 5: Comparison RFID vs Barcode

The main advantages of using RFID technology in the operations are: faster identification, better control, preventing counting errors and the loss of some actions.

The RFID tag can be attached to different kind of units. It can be attached in the label of the bottle to just one active tag on the outside of the container. It simple to conclude it is might not realistic to put a tag on every bottle, because the costs will explode in that case. Thereby, once the only unit that is tagged is the container Heineken will lose the traceability when the pallets are outside the containers.

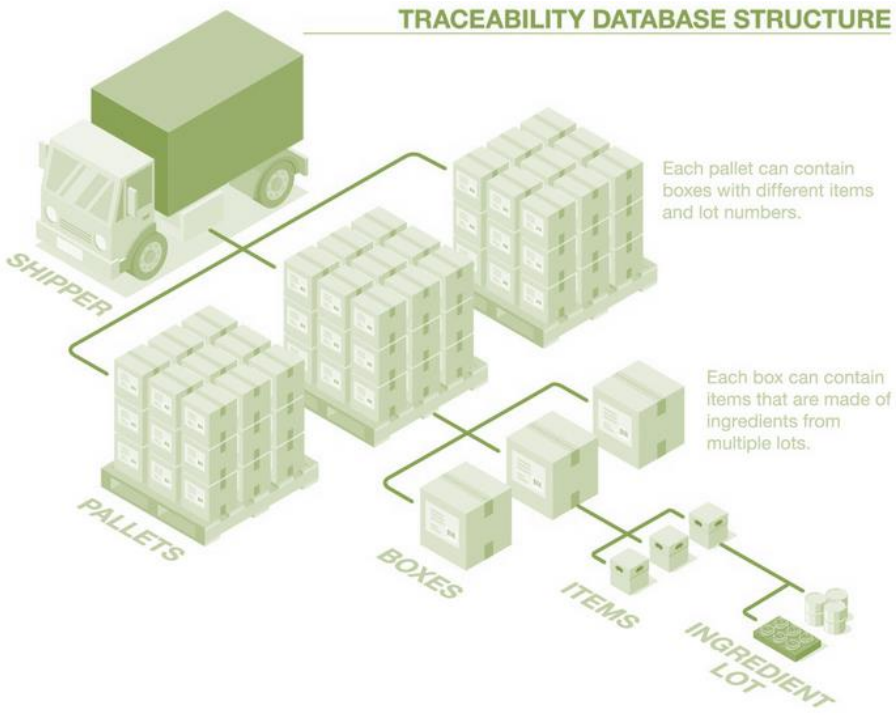


Figure 8: Traceability on different units

4.2 Case

In this section of the report an analysis is conducted to establish the cost, timescale, and the risks. This analysis should eventually lead to a solid judgement whether RFID technology has an added value to the supply chain or not. The business case is applied on the production flow from HNS to Miami. The data generated from this case are used in the feedback to Heineken and presented in the conclusions and recommendations. Based on the insights on the components and mechanisms of RFID used, a deeper understanding of the barriers can now also be gained by the business case.

4.2.1 Costs

As described in Chapter 3, there are a lot of different RFID components with different applications available. The costs of the components are also dependent on the applications that it has to perform with the end-user. As versions with additional sensors are more expensive than models without applications, the average cost of the parts will be displayed in this section together with the quantities that needs to be repurchased.

The cost of the RFID tag for a profitable business case for every company and every situation is different. The research that producers that are relatively sell product for higher prices, have a higher critical cost of the RFID tag. This makes the use of RFID for these companies more profitable and achieved additional profits through the use of RFID higher at low cost of the RFID tag. This will also be applicable for Heineken, because the selling price per pallet beer is on a higher level as well.

4.2.1 Risk prevention

RFID in the supply chain can provide many benefits. One of the positive result is the prevention of the bullwhip effect. The transparency and data gained by using the RFID technology could be helpful to prevent the risk of a bullwhip effect. In this section of the conceptual model a short introduction of the bullwhip is given and how the conceptual model can possibly prevent this with this adverse effect of a supply chain.

Bullwhip effect

The bullwhip effect can be approached in several directions. The bullwhip effect is an important phenomenon in supply chain management that has been studied for years. The variation in demand of the customer become increasingly large when they diffuse backwards through the chain. Resulting in a fluctuation and amplification of demand from the downstream to the upstream of the supply chain. Consequently, there can be stated that the variance of the customer demand increases at each step of the supply chain (customer, retailer, distributor, producer and supplier). Furthermore, the main cause of this amplification is the difficulties in the information sharing between each actor of the supply chain. RFID technology can prevent a supply chain against the bullwhip effect, because it creates a close loop.

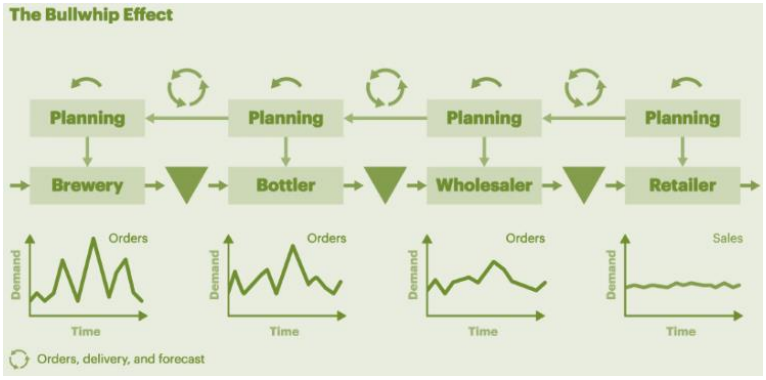


Figure 9: Bullwhip effect Beer distribution Game (AT Kearney, 2015)

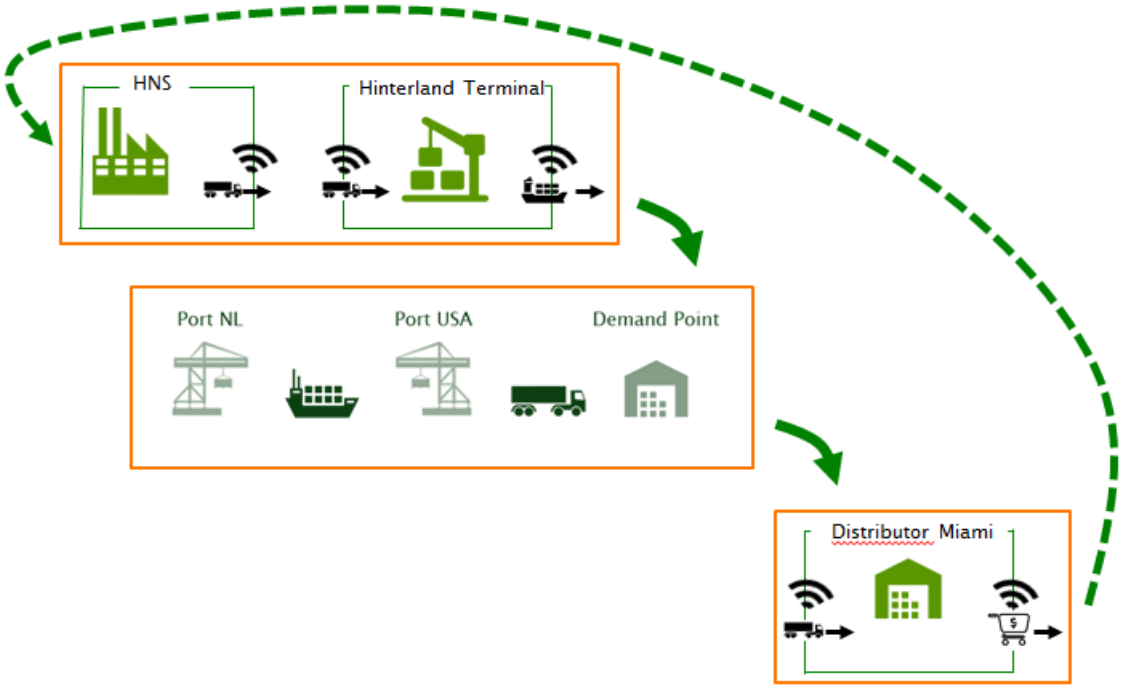


Figure 10: Visualisation of the closed loop

Figure 10 above shows a representation of the supply chain integrated with a simplification of the RFID readers in the conceptual model. (From brewery to the distributor in Miami). There is generated a continuous signal which is send to the "cloud" software centre.

5 Research Conclusions

In this part of the report the conclusions are presented and recommendations for further research are shown. Finally, a personal reflection has been done.

5.1 General conclusions

As mentioned in the previous sections still several obstacles and constraints must be overcome in order to ensure profitable RFID technology fit. Due to the large profits earned may be using RFID at the product level will in all likelihood pressure arise for solutions to the disadvantages. A profitable use of RFID include logistical benefits will be implemented on a short term. Especially, that the critical cost of the RFID tag is higher than the price that is mentioned in the literature. The system is therefore more profitable than was thought earlier. There will need to be done much research to resolve obstacles and dangers for the future and also many expected technological breakthroughs for a rapid decline in the cost. Assuming that this factors will soon be achieved, the way is open for large-scale deployment for HNS.

Overall the degree of adoption of RFID by HNS largely depends on the unit price, as well as their adoption by the rest of the supply chain. Mark that the breweries and the inland terminals as an easy location to implement the hardware such as readers, but implement readers on the Terminals in the Port of Rotterdam and Port of Antwerp will be harder. It will be even harder to implement the readers in other Ports around the world. Although implement the readers in the bigger Heineken Operating Companies or other subsequent distributors seems to be reasonable.

Results found that the implementation of RFID practices significantly affect the supply chain performance in the following areas: supplier, inventory, distribution, plan, sales, and forecasting.

5.2 Recommendations

This section lists the recommendations for HNS, other opportunities are given and more explicit recommendations for stakeholders to develop in the implementation of RFID in a supply chain.

Steps for realisation

It seems not realistic to integrate the RFID technology in the short term in the supply chain. As mention before in the business case the investment of the equipment can be expensive. Thereby there must be done a pilot to show the practical execution of the RFID technology. For example, it coulde be a good moment to do a pilot when HNS builds a new production line. Besides the regular label machine the production line could get a RFID tagger.

Do research in other technologies

In this research I focussed on the RFID technology as a potential technique to create track- & traceability in the supply chain. Obviously there are different technologies with mostly same characteristics as RFID technology. Another option which has even more traceability than RFID is GPS. Although this can be an expensive alternative, it provides detailed information.

Elaborated business case required

During my internship I have seen how decisions were taken within HNS. They demonstrate me that a very descent business case is required before the decision makers go to the table.

Outsourcing

Rather than investing in tags and putting a lot of effort in placing reader through all stakeholder in the supply chain HNS has options in outsourcing the tracking & tracing facilities. There is a upcoming market in potential suppliers who build hard- and software for tracking and tracing in containers. Probably outsourcing can be more expensive, but there are no investment risks at all.

5.3 Personal reflection

My internship at Heineken turned out to be stimulating and I enriched myself with extra practical knowledge in the Transport & Logistics sector. I have tested my analytical skills acquired over the year, build a model and a tool for a department and learned how to implement your finding of a project project in a department. Obviously, I had the chance to experience how is to be part of a company such as Heineken, which has with its export volume big influences on their stakeholders, for example the Port of Rotterdam.

For me it is important that the output of my internship at Heineken can be used even when I am not longer working for Heineken. On that purpose I had built up my schedule. I took 25% of time during my internship, mainly the last month, for implementing my results of the tool and model. Because of my tight schedule the people in the department could get access to my outcomes quickly. When your colleagues see the result of what you're doing it eases the extraction of information and knowledge of them. As a result they involved me in meetings and negotiations with suppliers. As well as my colleagues the suppliers, in this case a company that builds software that gives transparency in Heineken's container float, were positively surprised by my input during these meetings.

Another point of personal reflection, is that my start of a thorough analysis of the current situation threatened my process as a whole. I noticed that is important to write down your findings, especially during the analysis phases. This not only saves a lot of time writing afterwards, but it also leads to a more consistent and descent process. Lastly, an external research brings the challenge to align the research goals from the company and from the TU Delft. Not only the aligning of the objectives, but also managing the expectations of both stakeholders brings an interesting point of attention. Naturally, the

company just prefers a good working tool, but the university elevates scientific approach and method. I experienced this as a major challenge, nearly even big as the whole research assignment itself.

However the theory on supply chain in combination with the application of RFID technology formed an interesting research internship. For me the application of RFID technology was not new, in contrast to the theory on supply chain. I had to develop myself to feel comfortable with this theory, and finally implement the potential application of RFID technology in the supply chain. I am convinced that my report as well as my time at Heineken contributes to a more 'sophisticated' and smoother supply chain, which generates more transparency and service to their customers.

6 Bibliography

Baum, M., Niemann, B., & Abelbeck, F. (2007). Qualification Tests of HF RFID Foil Transponders for a Vehicle. *Intelligent Transportation Systems Conference*, 950-955.

Bendavid, Y. (2016, August 8). *Assessing the Potential of RFID Technology in e-supply Chains: An "Order-to-Cash" Business Process Persepective.* Retrieved from wbiconpro: http://wbiconpro.com/418-Bendavid.pdf

Giannapoulos, G. A. (2009). Towards a European ITS for freight transport and logistics: results of current EU funded reseach and prospects for the future. *springerlink.com*, 15.

Jovix Atlas RFID Solutions. (n.d.). Retrieved 08 10, 2016, from http://www.atlasrfid.com/jovix-education/auto-id-basics/rfid-vs-barcode/

Kok, A. d. (2008). *A break-even analysis of RFID technology for inventory sensitive to shrinkage.* International Journal of Production Economics, Vol. 112(2008), No. 2, p. 521-531.

Lean Enterprise Institution. (2000-2015). *What is Lean?* Retrieved May 8, 2015, from http://www.lean.org/WhatsLean/

LeanSixSigma. (2015). *LeanSixSigma.* Retrieved from http://www.sixsigma.nl/artikelen/poka-yoke

Lodewijks, G., Veeke, H., & Lopez, A. (2006). Reliability of RFID in Logistic Systems. 971-976.

Negenborn, R., & Hellendoorn, H. (2010). *Intelligent Infrastructures.* Dordrecht: Springer.

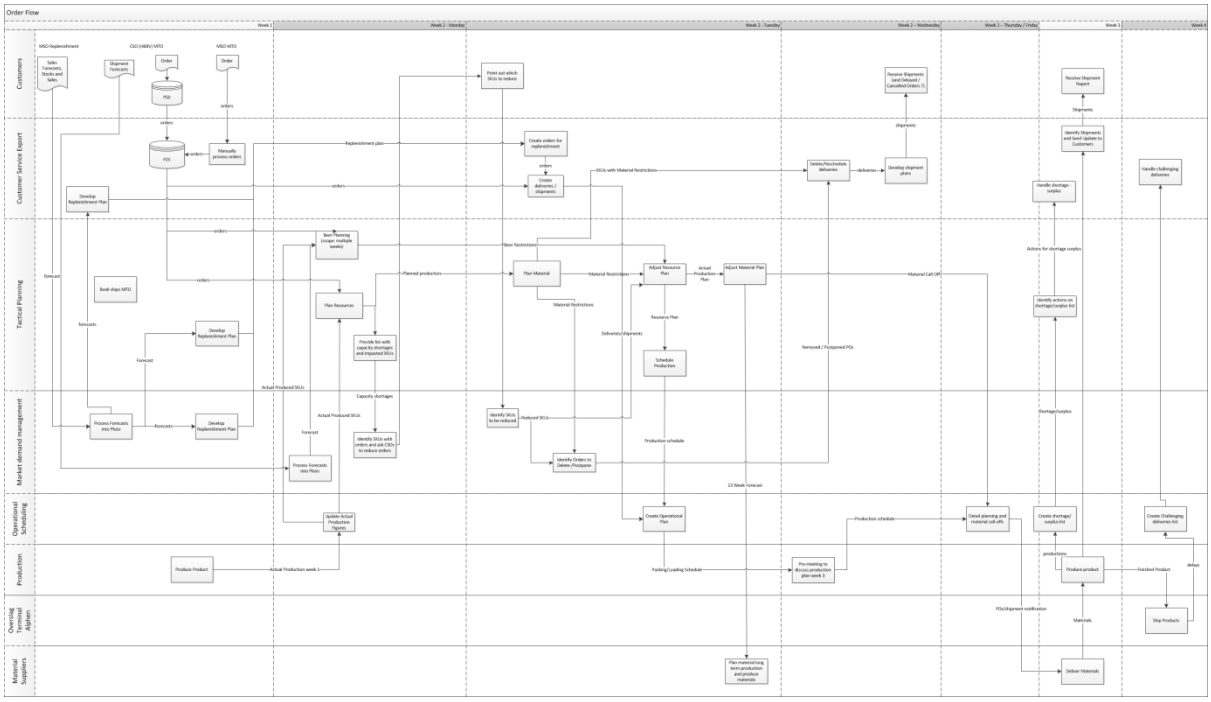
Overby, C. S. (2016). How RFID improves the order-to-cash process. *Forrester Research*, 4.

Pang, Y. (2015). RFID . *Lecture Notes Automation of Transport Systems.* Delft : Delft University of Technology.

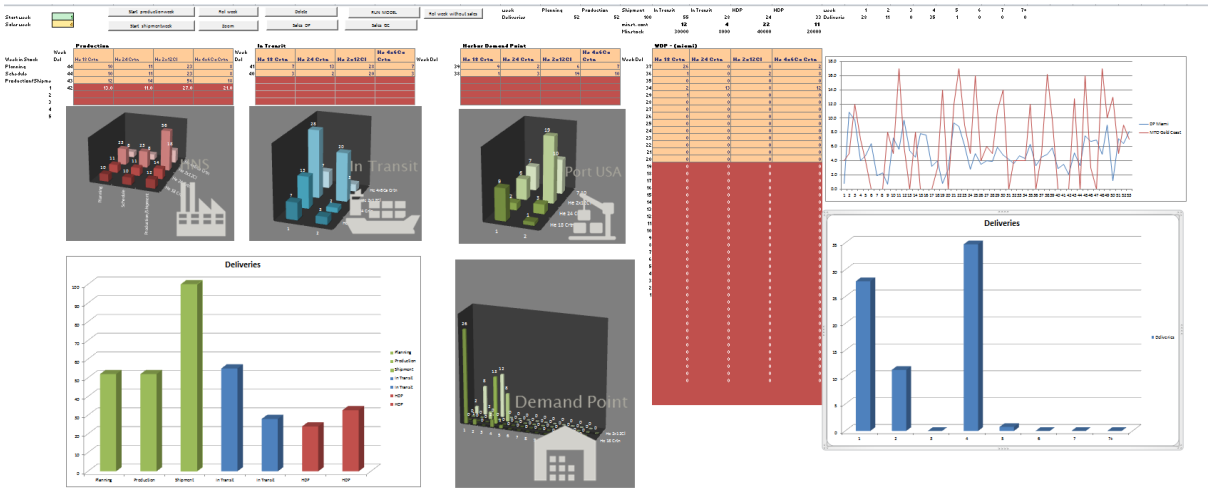
Selwyn Piramuthu, W. Z. (2016). *RFID and Sensor Network Automation in the Food.* John Wiley & Sons.

will, T. (2009). *RFID in Maritime Container Logistics.* Hamburg: Hamburger Logistik Instituts.

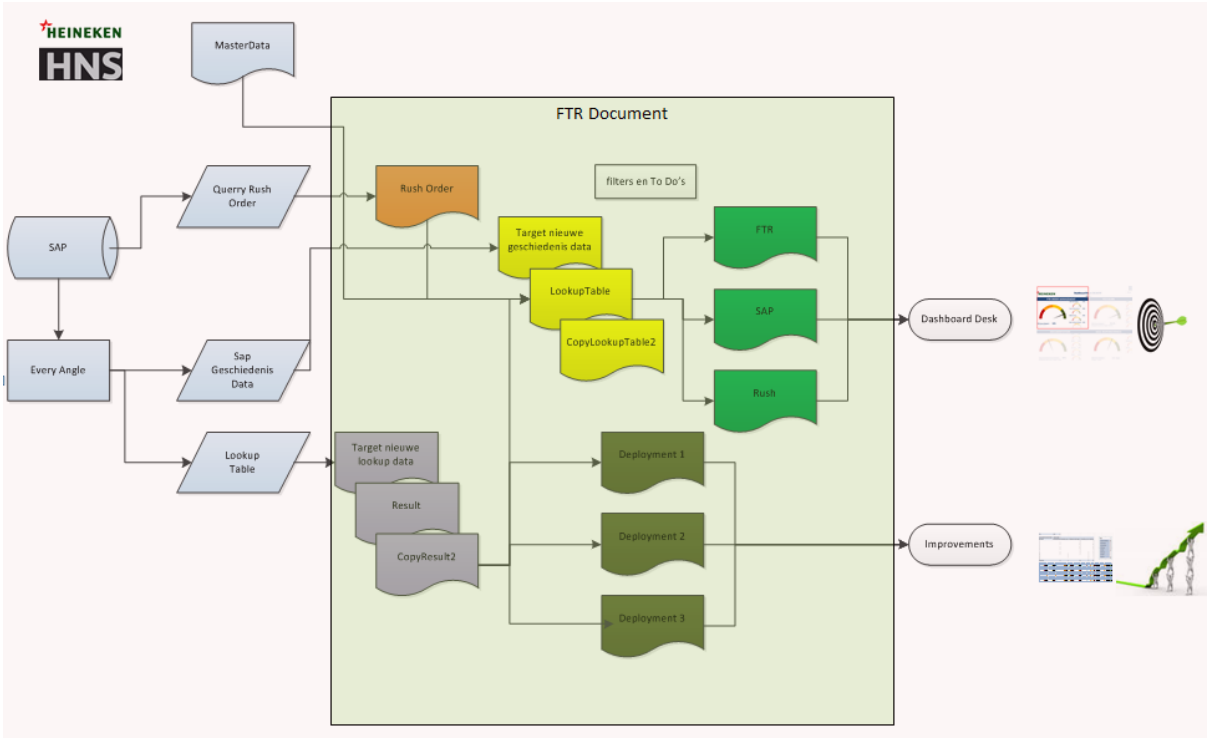
Appendix A



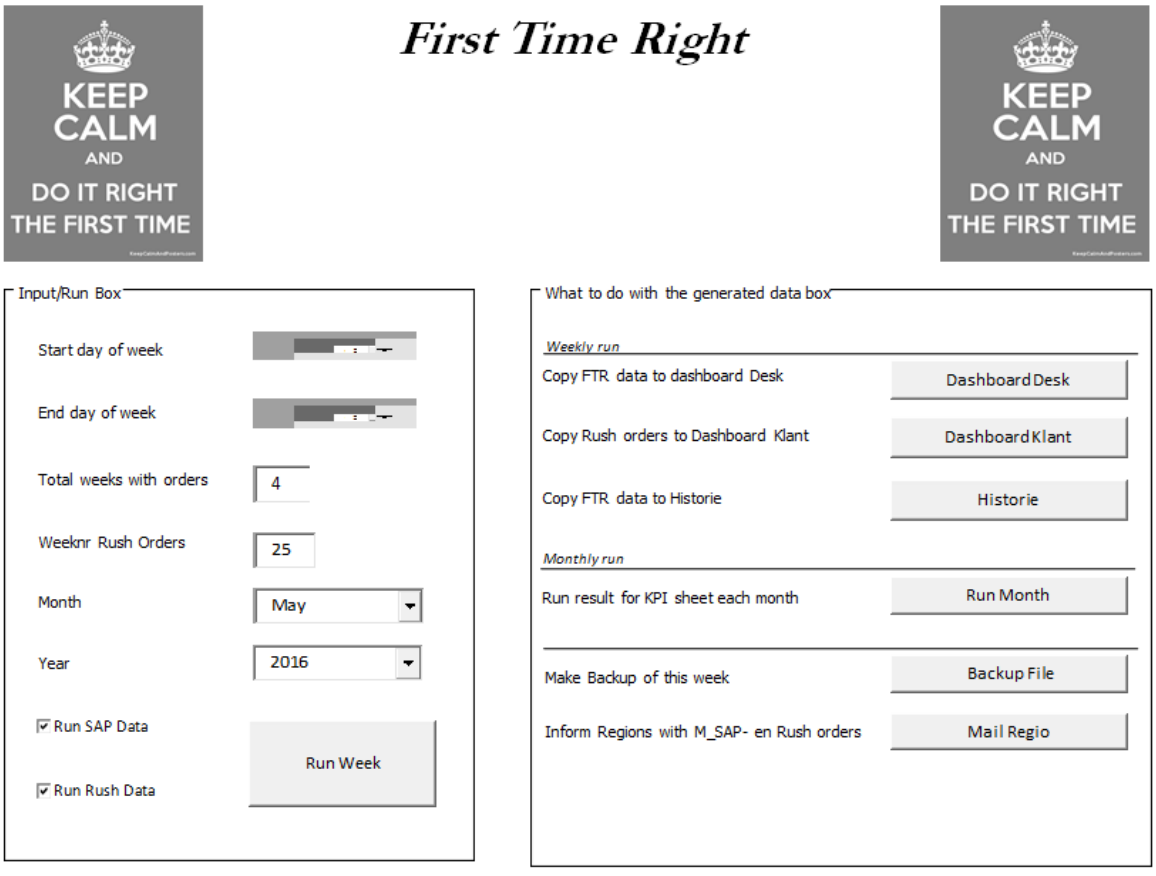
Information flow diagram



Conceptual model Case Miami



Structure of FTR Tool



InterFace FTR Tool

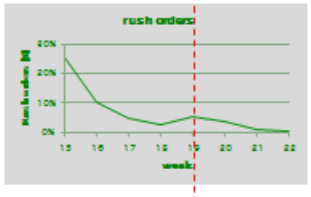
Appendix B

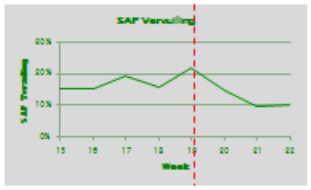
Presentation of First Time Right Tool

Hoe werkt het?

6 HEINEKEN

Het resultaat van de FTR order tool is dat de rush orders significant afneemt



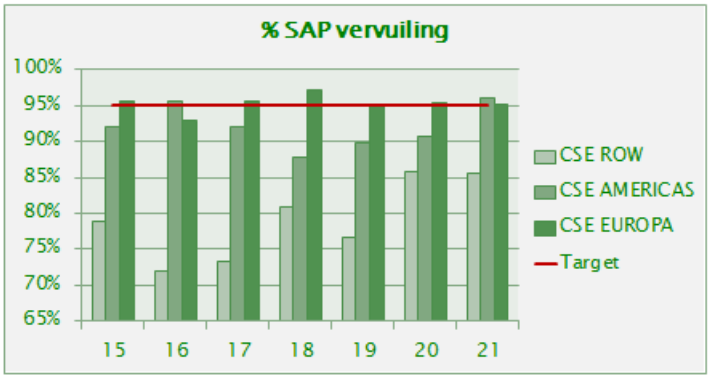


1. Communicatie Customer

2. Feedback

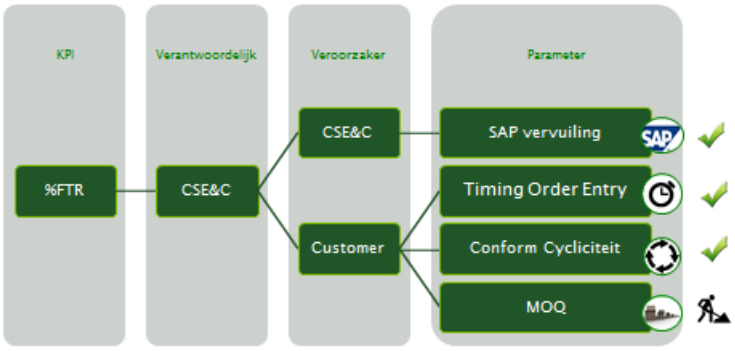
7 HEINEKEN

Resultaat kwantitatief – targets 95%



8 HEINEKEN

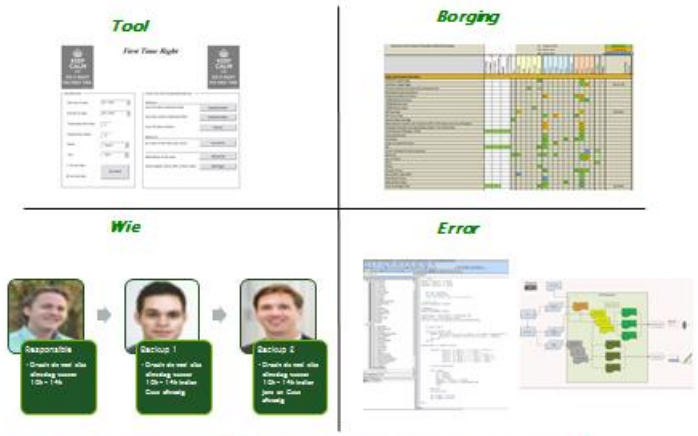
Vervolg



9

HEINEKEN

Deliverables

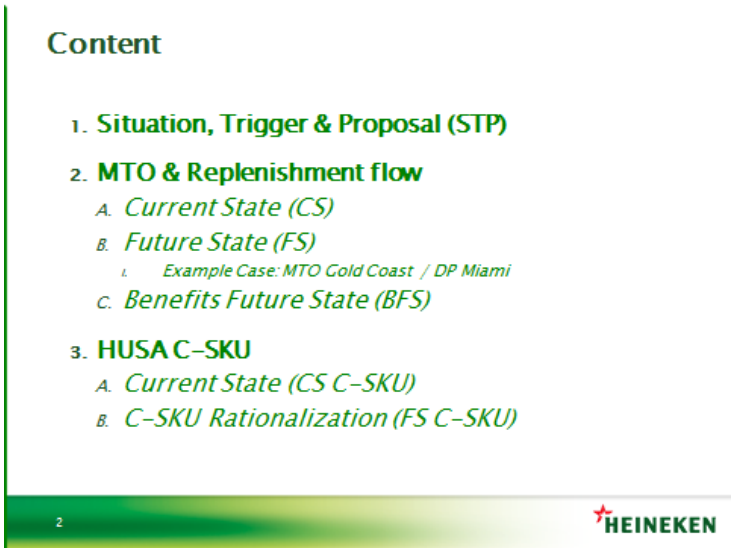


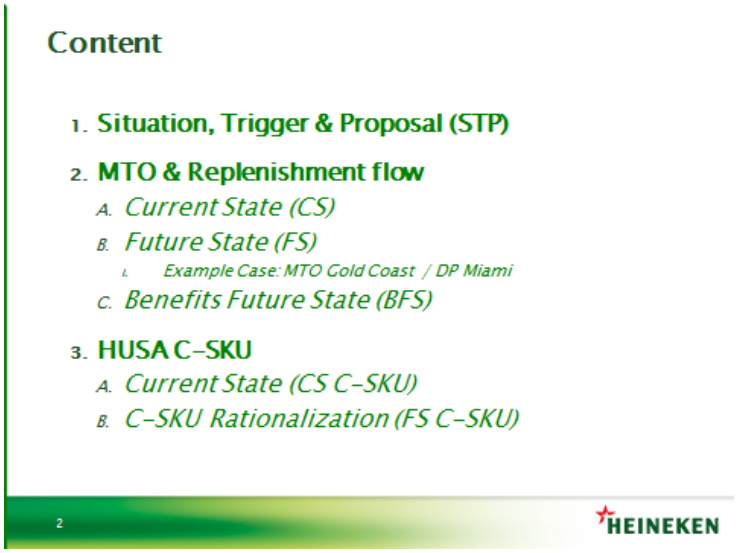
10

HEINEKEN

Appendix C

A contributed research for replenishment flow vs MTO





Why are we here?

Situation

- Volume MTO flow is increasing over the past five years. Up to ~20% of the total volume of HUSA.

Trigger

- HNS noticed an opportunity in improving the service level to HUSA and further stabilize its supply.
- HUSA has $767K Inter Demand Point (IDP) transportation cost.

Proposal

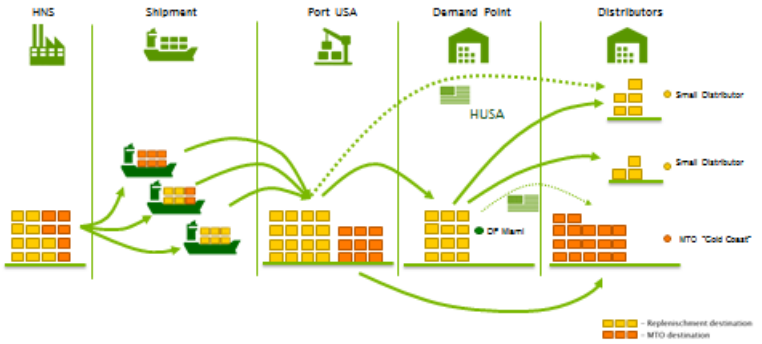
- 100% Replenishment flow through Dynamic Allocation from US Ports.
- Potential reduction for HUSA in IDP transportation cost by C-SKU rationalization.

3

HEINEKEN

Current State – Delivery has a specific destination at HNS (MTO or Replenishment)

Mixing Replenishment model with MTO flow

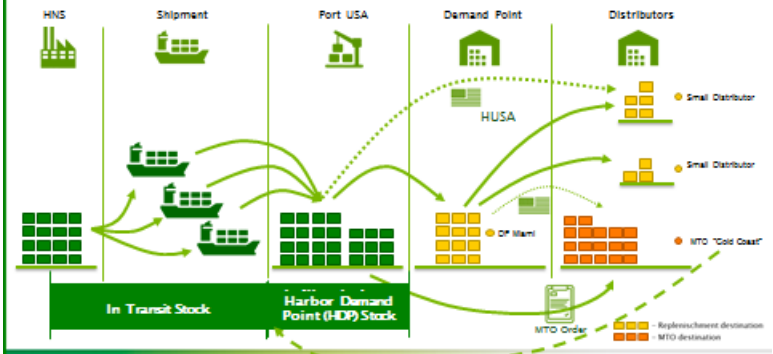


5

HEINEKEN

Future State – Delivery assigned to destination in the Virtual Demand Point (Port USA)

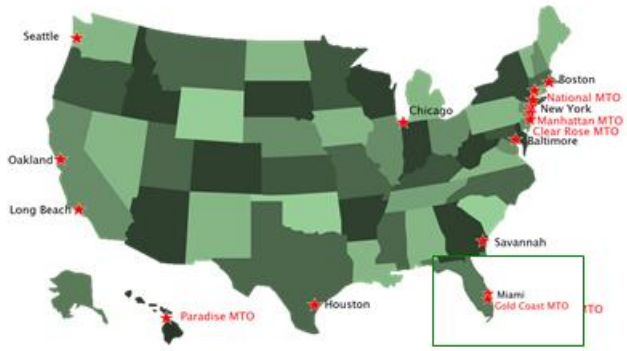
Using Harbor Demand Points in US Ports



6

HEINEKEN

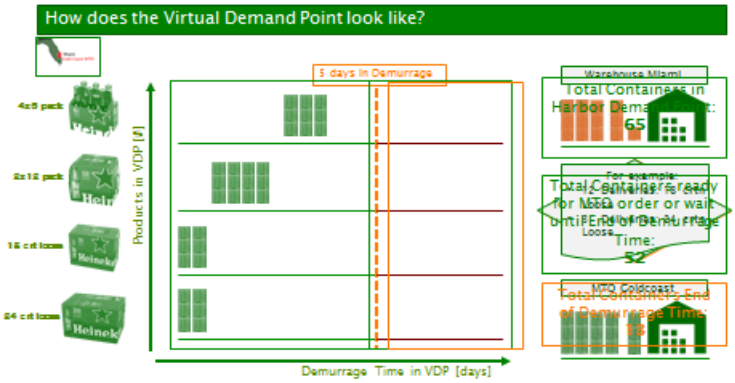
On the basis of the case Miami/Gold Coast the utilization of the VDP will be illustrated



7

HEINEKEN

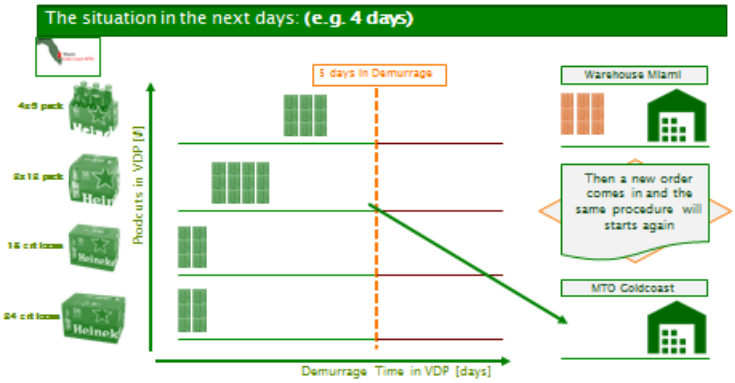
This animation explains how the Virtual Demand Point allocation works



8

HEINEKEN

This is a repeated process and will continue over time



9

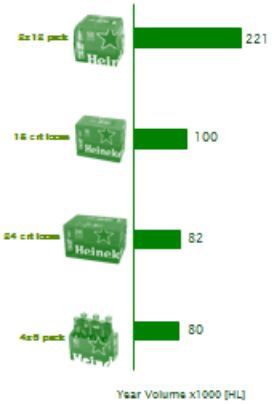
HEINEKEN

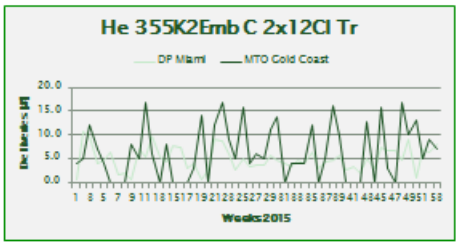
For a better view of the case Miami/Gold Coast some information is given

		DP Miami	MTO Gold Coast
Focusing on the four SKU's (65% of total volume to DP Miami & MTO Gold Coast)			
Total types of SKU's	[#]	26	4
Sales Volume mutual SKU's x1000	[HL]	213	270
Order Lead Time (Shipment end - Creation o	[Days]	36	45

HEINEKEN

The MTO delivery pattern fluctuates heavily and effects the Replenishment flow

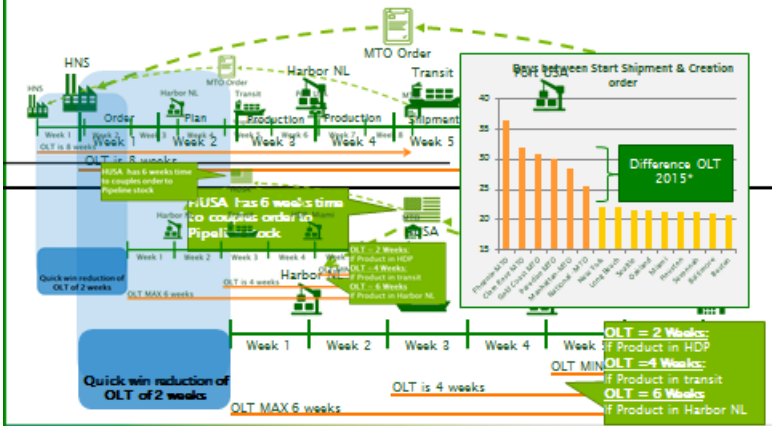




- Track & Trace challenges tactical planning
- SOP-link to sailings
- Delay in replenishment order
- Capacity challenges with carriers

HEINEKEN

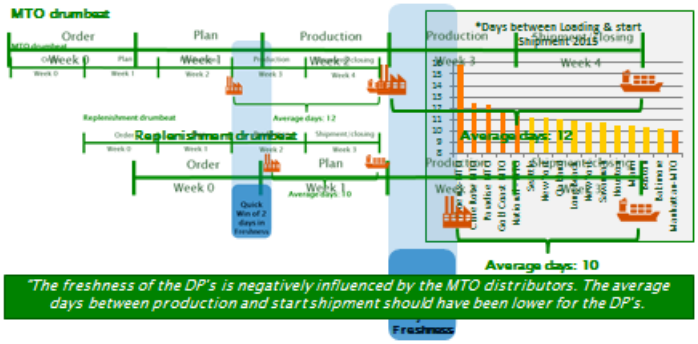
The 100% replenishment model provides a reduction in OLT by at least 2 weeks



HEINEKEN

The expected reduction in freshness is by the 100% replenishment model is ~5days

Freshness (in this case) = Date of production HNS - Start Shipment



"The freshness of the DP's is negatively influenced by the MTO distributors. The average days between production and start shipment should have been lower for the DP's.

16

HEINEKEN

Time line of the development of the slow mover strategy in HUSA

Since 1988
Direct delivery of SKU from HNS to USADP for Fast movers & Slow movers

2010
Over $1M cost for obsolete slow movers

2011
Introduction C-SKU concept for slow movers by IDP transport

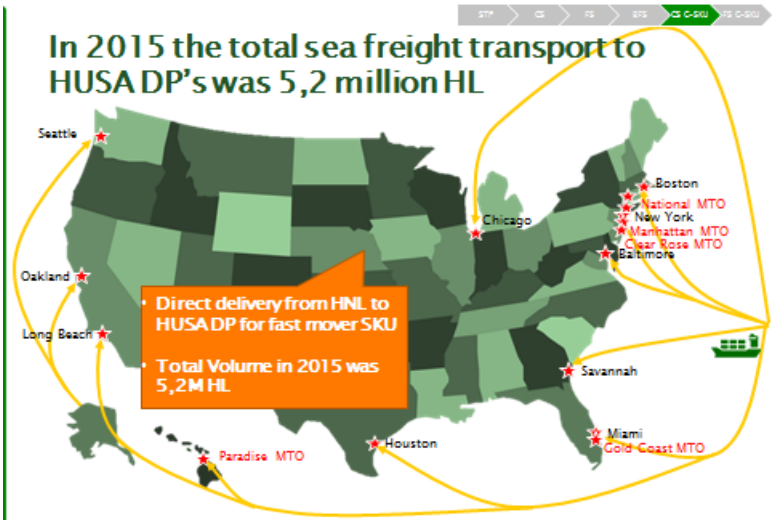
2012
High costs for inter DP truck transport for C-SKU estimated cost of $780K for HUSA in 2014

2016 → Future
Decrease transport cost by C-SKU portfolio rationalization

18

HEINEKEN

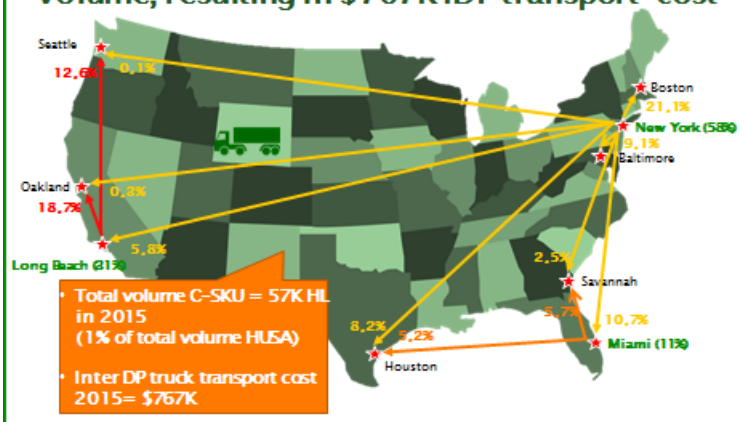
In 2015 the total sea freight transport to HUSA DP's was 5,2 million HL



20

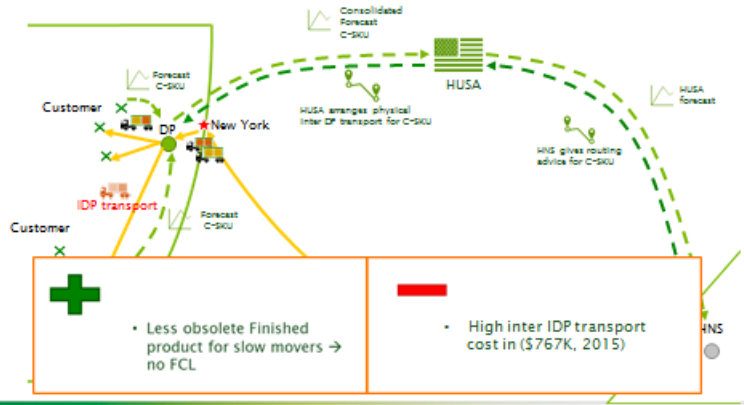
HEINEKEN

In 2015 the total C-SKU volume was 1% of HUSA volume, resulting in $767K IDP transport cost



HEINEKEN

Animation of the current C-SKU concept for slow movers HUSA with IDP tansport



HEINEKEN

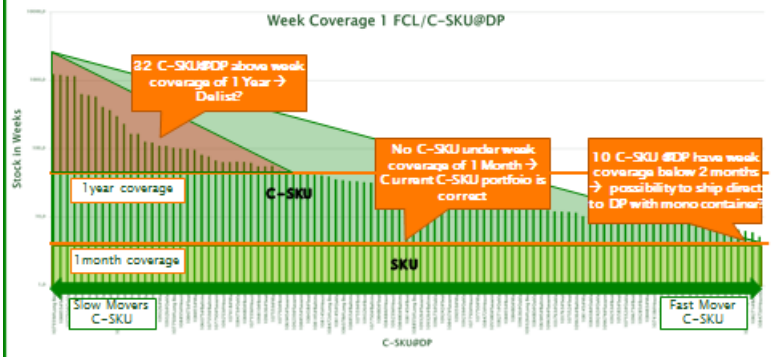
What is the week coverage per C-SKU@DP for 1 FCL based on the actual sales of 2016

Definition

Week coverage = The amount of weeks covered to sale 1 FCL of a certain C-SKU at a DP

HEINEKEN

What is the week coverage per C-SKU@DP for 1 FCL based on the actual sales of 2016



HEINEKEN

A shift of 4 weeks gives a saving of$196K of IDP transport cost

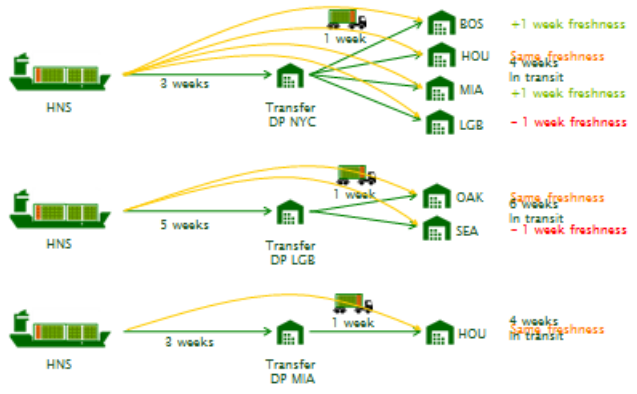
Savings overview per Boundary shift + Delist of C-SKU with week coverage above 1 year

	Current State	Shifting Boundary for C-SKU			
	4 week coverage	6 week coverage	7 week coverage	8 week coverage	Delist C-SKU week coverage>1 year
HUSA IDPtransport cost	-$767K	-$736K	-$658K	-$522K	-$721K
HUSA Storage cost		- $1K	-$3,8K	-$16,4K	+$6k
Cost of Capital (WACC= 6%/Year)		-$3K	-$12K	-$33K	+$2K
% C-SKU in portfolio	19,2 %	19% (-1 C-SKU@DP)	18,4% (-4 C-SKU@DP)	17,3 % (-10 C-SKU@DP)	13,3 % (-21 C-SKU@DP)
Savings		+$27K	+$93K	+$196K	+$54K

26

HEINEKEN

The freshness for 10 C-SKU@DP will change because of direct shipment to DP



27

HEINEKEN

In the future stat 5,5% of total container per year will be mixed

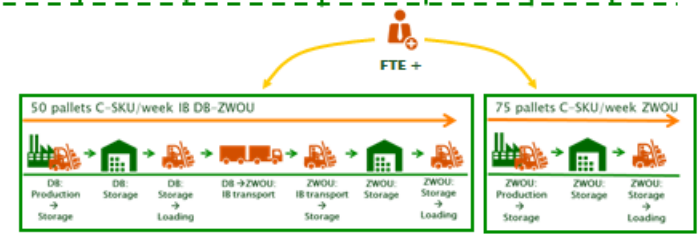
Future state 5,5% of total containers per year is mix container

Production Location	# C-SKU Pallets/week
Den Bosch	50
Zoeterwoude	75
Total	125

HEINEKEN

What are the cost for the implementation of the new mix container concept

	IDP transport USA	IB transport cost NL	Handling cost NL	Storage Cost NL	FTE +	Total Saving
$/year	+$767K	-$19K	-$33K	-$9K	-$100K	+$606K



HEINEKEN

Recap: The benefits for both HUSA & HNS seem substantial and valuable

Benefits

- Stable Supply Chain
- Cost saving by C-SKU Rationalization
- Reduction in Order lead time
- Reduction in Freshness
- Potential increase in PCO (perfect customer order)

Challenges

- IT Adjustments
- HDP & VDP depends on Demurrage & Detention Time

HEINEKEN