Sharing essential information in the Rofra | Home supply chain

Improving supply chain transparency and structuring information flows

UNIVERSITEIT TWENTE.

BACHELOR OPDRACHT

SHARING ESSENTIAL INFORMATION IN THE ROFRA | HOME SUPPLY CHAIN

Improving supply chain transparency and structuring information flows

L.P. Kerver

MANAGEMENT EN BESTUUR
INDUSTRIAL ENGINEERING AND BUSINESS INFORMATION SYSTEMS

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24 JANUARY 2012

PREFACE

At this moment you will start reading the report of my bachelor thesis. This thesis was written to finish my Bachelor of business administration at the University of Twente. Several months I have been writing these thesis, performing research and above all, gaining a lot of practical experience on the research subject that this thesis has been written about, supply chain integration and the development of interorganisational information systems to support supply chain integration. Besides that, I have been given a wonderful insight in the dynamic world of the furniture branch by the Rofra | Home company. With 25 own retail shop, an own upholstery, an own furniture factory and supplier from all over the world, the Rofra | Home company can be classified as an unique company in the furniture business.

One of the greatest challenges in writing this thesis was my own planning and discipline from time to time. I stated with the internship at the Rofra | Home company even before I had formulated a clear thesis proposal. The aim was to finish this thesis at the end of the summer of 2012, unfortunately I had to conclude that now is January 24, the year 2013. The process of writing took longer than I thought it would, but I'm proud of end result, this bachelor thesis.

At all this time I was doing research and writing my thesis, there were several people who supported and coached me through the process. Therefore I would like to thank these people. The first person I would like to thank is Mister Frans Schimmel, the owner of the Rofra | Home company, for giving me the opportunity to perform my research at his company, and giving me a wonderful insight in the dynamic world of the furniture industry. The person closely related to Mister Frans Schimmel is Mister Frank Slot, the managing director of the Rofra | Home company. Mister Frank Slot became a very special person for me, who coached my through the process of developing a usable solution for the Rofra | Home company and challenged me to think outside the theoretical box. Therefore I would like to thank you Frank.

Another word of appreciation is for the two supervisors of my thesis, Dr. Fons Wijnhoven and Maria Iacob. Both have given me the structure for this thesis which I could not figure out by myself, provided a great inspiration for new ideas and have introduced me to a , for me new, exciting world of information management and business process modelling.

As end of this preface I would like to my dear girlfriend, Jalisa Rozendal, for the support she gave me when writing this thesis.

Enschede, 24 Jan. 13

Léon Kerver

MANAGEMENT SUMMARY

This thesis focusses on the research to develop and build a prototype of the Rofra | Home supplier portal for sharing essential information throughout the supply chain, in order to resolve the "red rule problem". The performed research is based on a six design science research methodology. The design research on the Rofra | Home supplier portal was conducted by following a problem centered approach.

The specific research problem was defined as the accuracy of the expected delivery dates of ordered goods from external supplier, which was indicated as the cause for the “red rule” problem at the Rofra | Home company. Specific solution objectives were defined for the solution. The goal of the solution was to integrate and manage critical business links in the supply chain as managed process links. The solution objectives were defined as structure objectives for the artifact and functional objectives for the artifact. These defined objectives served as a blueprint for the development of the artifact.

The desired functionality and the architecture of the artifact were designed and modelled. Based on the model and analysis of the current situation, ass also on the determined solution objectives, the desired functionality and the architecture of the new artifact were designed and modelled into a new purchasing and delivery process. Based on the new model a demonstration version of the artifact was developed.

The demonstration version of the artifact was used for a simulation of the newly designed process. Based on this simulation the developed artifact was evaluated. For the evaluation of the artifact, the developed solution objectives were transferred into evaluation criteria, and structured in an evaluation scheme.

Based on the evaluation results we concluded that the evaluation criteria of the developed artifact which were rated as good, contribute to the integration of critical business links in the supply chain, in order to enhance the accuracy of the expected delivery dates for goods ordered from ordered external suppliers. We recommended that in order to enhance the two way information flow, which was evaluated as moderate, the integration of the not available functionalities into the developed artifact should happen.

Overall the thesis concluded that the developed artifact did contribute at resolving the “red rule” problem, but that the missing functionalities in the developed demonstration version of the artifact could enhance the integration of critical business links in the supply chain, in order to improve the accuracy of the expected delivery dates for goods ordered from ordered external suppliers, which will resolve the “red rule” problem.

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1 INTRODUCTION

1.1 THE COMPANY

The company of Rofra | Home was founded in 1980 by Frans Schimmel. Extensive research revealed a nice in the furniture market. The results of the research showed that the majority of mass-produced furniture was failing to meet the needs of customers valuing individuality and creativity. The company of Rofra | Home was founded to meet those needs.

At this moment Rofra | Home has over 25 stores in the Netherlands, as well as in foreign countries. The main office is established in Vaassen, and the company also owns its own carpentry factory in Tubbergen and its own upholstery in Dreumel.

The products that are sold in the Rofra | Home stores are made in their own factories, as well as purchased from suppliers all over the world. Both completely finished products as intermediates are bought from the external suppliers and delivered to the main office in Vaassen. The already finished products are ready to deliver to the customers, and the intermediates will be finished by the intern production department in Vaassen.

The final transportation of the goods to the customers is also managed by Rofra | Home itself. Every day more than 8 trucks deliver to over a 100 customers their new furniture.

1.2 PROBLEM OUTLINE

The Rofra | Home company delivers many customers each day. The most of them will evolve in to happy customers, some of them however are not satisfied with their (planned) delivery. In order to solve these problems, the Rofra | Home company set up a research to identify the causes of the unsatisfied customers.

During 10 weeks all the complaints of the unsatisfied customers were assigned to a pre-defined list of causes, which was separated into “Internal Causes” and “External Causes”. By assigning the complaints to the pre-defined list of causes, the company of Rofra | Home gained a better structural insight in the causes of the complaints, in order to eventually resolve the issues. A list of the pre-defined causes is displayed below in table 1.

Internal Causes	External Causes
Code 1: Transport damage	Code 2: Nobody home / not picked up
Code 3: Set up fault	Code 5: Cancelled via Planning department
Code 4: Production fault	Code 6: Supplier fault
Code 7: Inventory fault	Code 10: Does not fit in the house
Code 8: Order fault	Code 11: Red rule / not pressent yet
Code 9: Planning fault	
Code 11: Red rule / not pressent yet	

Table 1: Pre-defined causes

The result of the research was clear after the 10 weeks of investigation. There was one cause in the pre-defined list which seemed to be the main cause of unsatisfied customers, “code 11: Red rule / Not present yet”. The results are of the research on the internal causes can be found in appendix I, table 5 and graph 1. The results of the research on the external causes can be found in appendix II, table 6 and graph 2.

When looking at the outcome of the research there are several things that are notable. At first the main cause of the unsatisfied customers, code 11, is listed as internal cause, as well as external cause. To explain why this is done so, the cause should be clarified some more. The “Red rule” part refers to the software that is used by the Rofra | Home company. When an article, or multiple articles are not present yet, the order rule in the program stays red, instead of green. This means that the product was expected to be present at the main warehouse in Vaassen at the time of planned delivery to the customer, but it was not present. Why the product was not present at that time could both have an internal cause, as well as an external cause. But the fact that it was not there at the time that it should have been there, remains.

The second thing which is notable when looking at the outcome of the research, is that the main cause, code 11, exceeds the other causes by far. In almost 30% of the unsatisfied customer cases, the dissatisfaction is caused by the fact that the article, or multiple articles, are not present at the main warehouse in Vaassen, and therefore these customers cannot be delivered at the pre-arranged date.

In order to improve the customer satisfaction the issue of “Red Rules” should be resolved.

1.3 RESEARCH GOAL

In order to resolve the problem as presented in the problem description, the Rofra | Home company came up with a solution. The Rofra | Home company wanted to gain more insight and more transparency in the supply chain, especially in when the ordered goods from their suppliers are actually delivered. In order to get this insight and transparency, more essential information should be shared throughout the supply chain regarding actual delivery dates and actual delivery quantities. For sharing this information the Rofra | Home company asked for the development of a supplier portal.

The aim of this research is to develop and build a prototype of the Rofra | Home supplier portal for sharing essential information throughout the supply chain, in order to resolve the "red rule problem".

1.4 RESEARCH QUESTION

Based on the research goal the following research question is formulated:

How should the Rofra | Home supplier portal be designed, for sharing essential information throughout their supply chain, in order to resolve the "red rule" problem?

In order to structure the research and selecting the right methodology for the research, a set of sub questions are formulated based on the problem outline, research goal and the main research question. These sub questions serve as a guideline for selecting the appropriate methodology for the research, and are mentioned below.

1. **What is the cause of the "red rule" problem?**
   What does the Rofra | Home business process looks like?
   What does the Rofra | Home supply chain looks like?
   What is the "red rule" problem?

2. **What is required to solve the "red rule" problem?**
   What is causing the "red rule" problem?
   What is required for solving the "red rule" problem?
   What are the implications for Rofra | Home?
   What are the implications for the supply chain?

3. **How should the Supplier Portal be designed?**
   What are the requirements for the supplier portal?
   What are the variables and attributes for the prototype of the supplier portal?
   What does the data model looks like for the prototype of the supplier portal?
   Which business rules should be integrated in the prototype of the supplier portal?

4. **How should the Supplier Portal be used?**
   How will the essential information be delivered in the portal?
   How can the portal be accessed and controlled?
   Who can do what in the portal?
   What are the safety requirements for the portal?

1.5 RESEARCH METHODOLOGY

In order to develop and build a useful prototype of the Rofra | Home supplier portal, the design science research methodology developed by Peffers, Tuunanen, Rothenberger, and Chatterjee (2007) is used. This methodology provides a specific framework for conducting design science research in information systems and the development of an artifact as a solution (Peffers et al., 2007). The methodology developed by Peffers et al. (2007) consists of several process elements, which are graphically represented below in figure 1, the DSRM process model (Peffers et al., 2007).

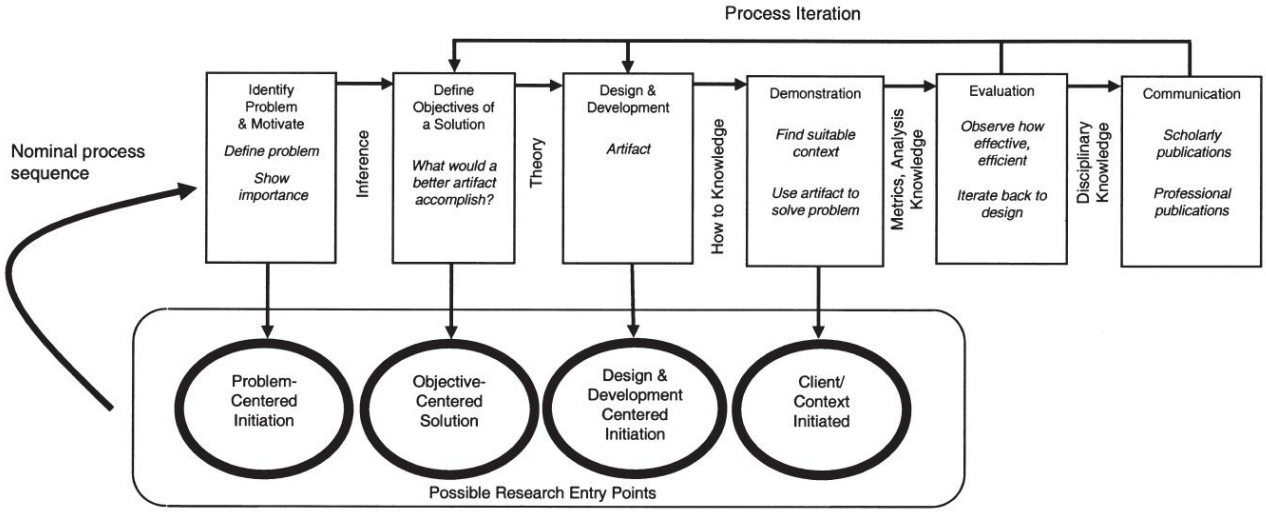

Figure 1: The DSRM process model (Peffers et al., 2007)

The sequence of the process elements in the methodology is not always the same and is determined by the four "Possible Research Entry Points" (Peffers et al., 2007). For this research a "Problem centered approach" is uses, described by Peffers et al. (2007) as the basis of the nominal sequence, starting the design science research with activity one. The problem centered approach is used by researchers in situations where the idea for the research resulted from an observation of the problem, according to Peffers et al. (2007) and therefore the problem centered approach is chosen for this research.

The design research on the Rofra | Home supplier portal will be conducted by following the process steps based on the problem centered approach. A brief overview of these process steps, the sequence of the process steps and the interpretation of these process steps for the design research on the Rofra | Home supplier portal can be found below, and is based on the methodology developed by Peffers et al. (2007).

<u>Process Step 1: Problem identification and motivation</u>
In the first process step of the research is that the specific research problem will be defined and the value of a solution for the research problem will be motivated. For the definition of the specific research problem, the current business process at the Rofra | Home company is described and the problems in the business current business process will be identified at first. Based on this process description and the problem identification the specific research problem will be defined and the value for a solution will be motivated.

Process Step 2: Defining objectives of a solution
The second process step of the research will focus on defining objectives for the solution. These objectives are derived from the problem definition, as well as from a constructed theoretical framework. The defined objectives serve as a blueprint for the development of the artifact, the Rofra | Home supplier portal in the next process step. The defined objectives will also serve as evaluation criteria for the evaluation of the developed artifact, the Rofra | Home supplier portal.

Process Step 3: Design and Development
The third process step focusses on the design and development of the artifact, the Rofra | Home supplier portal. At this process step the desired functionality and the architecture of the artifact are determined and modelled. For modelling the desired functionality and architecture, the modelling language BPMN 2.0 is used. Based on this model, a demonstration version of the artifact, the Rofra | Home supplier portal, is created.

For building the actual demonstration version of the artifact, a computer program called Bizagi will be used. Bizagi is a business process modeling program that is based on the BPMN 2.0 standard notations. The program uses a model driven approach which is consistent which the chosen research methodology, and therefore chosen for the development of a prototype of the Rofra | Home supplier portal.

Process Step 4: Demonstration
In this fourth process step the developed artifact will be demonstrated. The demonstration of the artifact, the Rofra | Home supplier portal, focusses on the usage of the artifact to solve the problem.

Process Step 5: Evaluation
The last process step of the research focusses on the evaluation of the developed artifact. The goal of this process step is to evaluate how well the developed artifact supports a solution to the problem. Therefore the developed artifact will be compared to the solution objectives, which were formulated in the second process step. The practical- and theoretical implications of the developed artifact and the performed research are also discussed in this process step.

The last process step that Peffers et al. (2007) describe is “Communication”. Peffers et al. (2007) state that “communicating the problem and its importance, the artifact, its utility and novelty, the rigor of its design, and its effectiveness to researchers and other relevant audiences such as practicing professionals” is the last process step. The process step of communication will be performed by means of this written bachelor thesis and the publication of this written bachelor thesis on the website of the University of Twente. The publication of the developed artifact is not possible at this moment yet.

2 PROBLEM IDENTIFICATION AND MOTIVATION

The aim of this chapter is to define the specific research problem and to motivate the value of a solution for the problem.

For the definition of the specific research problem, the current business process at the Rofra | Home company is described at first. The problems in the current business process are identified as the next step. Based on this process description and the problem identification the specific research problem is defined and the value for a solution is motivated.

2.1 THE BUSINESS PROCESS

2.1.1 INTRODUCTION

The company of Rofra | Home is active in the furniture branch, delivering furniture to consumers and to business customers. With more than 25 own stores the company delivers more than a 100 customers a day. Most of the business process is in own management, for example the own stores, the finishing of the intermediate products, providing service to the sold furniture and the daily delivery's to the customers.

The main office is situated in Vaassen, which is also the main, and only, warehouse of the company. In Vaassen arrives all the furniture which was purchased from external suppliers. Rofra | Home works with several external suppliers, from all over the world, which deliver standard collection furniture, as well as custom made furniture and intermediate products. The contact with, and the purchases from the external suppliers is done by one central purchasing department, which is also situated at the main office in Vaassen.

The Rofra | Home business process consists of several process steps, which can generally be divided into four sub processes. These four sub processes are related to each other and between the sub processes there is a form of interaction. The four sub processes are mentioned below and each sub process will be described in the next section.

The four sub processes at the Rofra | Home company are:

- The customer ordering process
- The purchase process
- The supplier delivery process
- The customer delivery process

2.1.2 THE CUSTOMER ORDERING PROCESS

When a customer wants to order furniture at the Rofra | Home company, the process starts at one of the Rofra | Home stores, were the customer can place its order. The order intake will be done by one the Rofra | Home store employees, which will create a customer order, directly in the Logic4 ERP system. The customer order exists of several parts, starting with the order head. This is the part of the customer order were all the customer information is filled in. The second part of the order are the order rows. Every product that the customer wants to order, gets his own order row in the order. The quantity of the product that the customer wants to order is also a part of the order row. Finally the customer receives an expected delivery date, based on the free available stock of the demanded products and several other aspects.

When customers orders furniture in one of the Rofra | Home stores, not every customers wants to get the furniture as soon as possible delivered. Some customers are waiting for the finishing of their new house, or there can be other reasons why the customer does not want their ordered furniture delivered as soon as possible. When the expected delivery date is too early in time for the customer, the delivery date can be moved to a later date.

2.1.3 THE PURCHASE PROCES

Every week the purchase department in Vaassen creates a purchase list of what needs to be ordered that week from the various external suppliers. These list are generated by the purchase advise manager function of the Logic4 ERP system that the company of Rofra | Home uses.

When these lists are generated, the purchase advice manager function takes a few things into account. At first, does the company needs to order stock items? And at second, does the company needs to order custom made items? When looking at the stock items purchase, the ERP systems bases its purchase advice on the following items:

- Available stock of the product
- Free available stock of the product
- Minimum stock of the product
- Reserved stock of the product

The available stock of the product is the quantity of the product that is currently present in the warehouse in Vaassen. The existing order rows of the customer orders reserve a certain quantity of the available stock of the product, which is called the reserved stock of the product. These reserved stock for customer orders have an expected/desired delivery date, based on the order rows in the customer orders. The available stock minus the reserved stock is the free available stock. When the quantity reserved by the customer orders is larger than the available stock, the free available stock quantity will turn into a negative number, there are not enough products available to deliver the existing orders. The minimum stock of the product is a pre-defined minimum free available stock quantity for the product. These minimum stock quantities are set by the Rofra | Home management, based on their forecasting for the sales of the product.

There are several scenario's in the purchase advice management function. These are mentioned below in table 2, and explained under the table.

Purchase Scenarios Stock Products:	Order products?
1: Free available stock > Minimum Stock	No
2: Free available stock < Minimum Stock, and Reserved stock is needed	Yes
3: Free available stock < Minimum Stock, and Reserved stock is not needed yet	Yes / No

Table 2: Purchase scenario's for stock products

In the first scenario the free available stock is greater than the minimum stock that has been set for the product. In this case, there is enough stock of the product to deliver the existing customer orders, the reserved stock, and the remaining stock of the product, the free available stock, is greater than the minimum stock that has been set for the product. In this scenario, the purchase advice manager function will advise not to purchase any more stock of that product.

In second scenario the free available stock of the product is less than the minimum stock that has been set for the product. Also the reserved stock by the customer orders is needed, which means that the expected/desired delivery date of the customer orders requires that these products are ordered at this moment. Therefore the purchase advice management function will advise to purchase these products, in order to have the goods in time for the delivery to the customers and get the inventory level back to the minimum stock level of the product.

The third scenario is a more complex situation. The free available stock is less than the minimum stock that has been set for the product, the same scenario as in the second scenario. But in this case, not all, or maybe even no goods at all, have to be ordered yet for the reserved stock, the quantity needed for the customer orders. This scenario happens when a customer orders a product, the delivery time of the product is for example one month, and the customer wants to get the product delivered several months later. In this case the free available stock is below the minimum stock, the available stock is still above the minimum stock and the customer does not needs its products yet. In order to prevent huge stock levels at the Rofra | Home warehouse in Vaassen, the products will only be ordered at the moment that the customer orders need them. Therefore in this situation, the purchase advice manager function will advise not to order the products (yet).

When dealing with more than one customer order for a specific product, the third scenario consist of several considerations, whether to purchase the product for that specific customer order at that moment already, or to purchase the product for that specific customer order at a later moment in time. This results in a set of considerations, for each customer order of that product. Therefore this is the most common scenario in the purchase process at the Rofra | Home company purchase department, in which all the considerations are done by the purchase advice manager function of the Logic4 ERP software.

For the purchase of custom made products, the expected/desired delivery date of the custom order is the indicator for when the purchase department orders the products. When the products are needed as soon as possible, they will be ordered the same week that the customer order is placed in the Rofra | Home store by the customer. When a customer wants to get the products delivered at a later moment in time, the purchase of the products will be postponed until the products are needed. In this way Rofra | Home wants to prevent a high stock level in their own warehouse in Vaassen.

After the purchase advice is generated by the purchase advice manager function, this advice is exported to a Microsoft Excel file and emailed to the supplier. Based on the pre-defined delivery time of the supplier, an expected delivery date for the ordered goods is generated. The expected delivery date is also linked to the order rows in the customer orders. So if the purchase department of Rofra | Home orders a product too late, the expected delivery date of the goods in the customer order can be recalculated.

2.1.4 THE SUPPLIER DELIVERY PROCES

When the goods are ready for delivery from the supplier to the Rofra | Home company, the purchase department of Rofra | Home receives an email from the supplier with the delivery information. The delivery information is usually also send in an Microsoft Excel file or an Adobe PDF file. The information contains the different products and in which quantities they will be delivered. This delivery information is manually added in the generated purchase order by the purchase department, and from there on the expected delivery date in the custom order rows is automatically updated.

Together with the delivery information the supplier usually sends the transport information of the goods that will be delivered. Most of the goods from the Eastern Block are delivered by trucks and most of the goods from Asia and the United Stated are delivered in containers by cargo ships. As these cargo ships arrive in the port of Rotterdam, a local Dutch freighter picks up the containers and deliver them at the Rofra | Home warehouse in Vaassen. On average the trucks from the Eastern Block need one week to arrive and deliver the goods in Vaassen. The ships from the United States and Asia sail usually need one month to arrive in the port of Rotterdam, from where it takes on average one or two days to get the containers with the goods in Vaassen.

The transport information is administered in a Microsoft Excel sheet at this moment. The legal documents, invoices and shipment papers are also linked to this Excel sheet. There is no link between the delivery information and the Logic4 ERP software. Also the transport information is not linked to the Logic4 ERP software. All the delivery and transport information needs to be entered manually into the software, in order to recalculate the expected delivery dates in the customer orders.
When the goods finally arrive at the Rofra | Home warehouse in Vaassen, the goods must be booked to the inventory. The first step in this process is done by the purchasing department at Rofra | Home. Based on the delivery information about the product items and the quantities they create a purchase delivery order. In this purchase delivery order all the products that will be delivered and their quantities are filled in. When the truck or container arrives at the Rofra | Home warehouse in Vaassen the inventory chief opens the purchase delivery order, prints the product labels and checks the delivered quantities.

When the inventory chief has made the required changes, he processes the purchase delivery order and the goods are booked to the warehouse inventory. At that same moment, the Logic4 ERP software automatically deducts the quantities of the delivered goods, from the quantities in the original purchase order. The software thereby searches for the oldest order rows in the purchase orders, and then deducts the delivered quantities from those purchase order rows. Another thing that happens at the same time, is that the order rows in the customer orders change color, the red rules, which indicate that at the moment there is no available stock at the Rofra | Home warehouse for that order row, turns into green, indicating that there are products available for that order row, and that the products are present at the Rofra | Home warehouse in Vaassen. Below the process of a delivery of purchased goods is shown schematically, in figure 2.

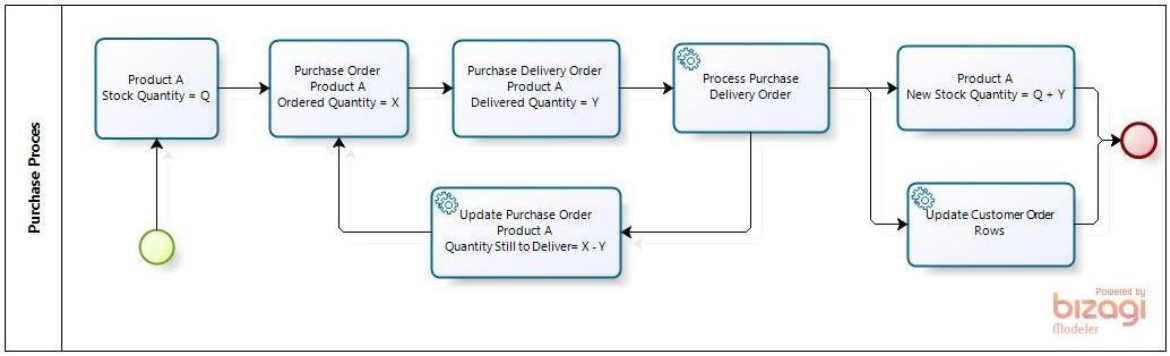

Figure 2: The process of a delivery of purchased goods

2.1.5 THE CUSTOMER DELIVERY PROCES

The Rofra | Home company has many processes in own management. The final delivery to the customers in one of those processes. On average every day more than a hundred customers get their orders delivered by one of the Rofra | Home trucks.

In order to inform the customers on their upcoming delivery, the Rofra | Home company strives to inform their customers about their delivery at least a three weeks in advance of the delivery date. This in order to prevent that their drivers encounter closed doors and customers who are at home at the time of the delivery of their order. In the past the company experimented with shorter notice times, but from those experiences the company concluded that the customers should be informed at least three weeks in advance of the planned delivery date.

The customer delivery schedules are made by the Rofra | Home planning department. When planning the customer order there are two scenario's. The first scenario is that all the products of the customer order are in stock. In that scenario the delivery date is usually not very difficult to determine, it could be at any moment from now and the Rofra | Home company strives to deliver the ordered goods as soon as possible.
The second scenario at the planning department is that the ordered products, or not all of the ordered products, are in stock yet. They are ordered at external supplier by the purchase department. Because the Rofra | Home company strives to keep its own stock levels as low as possible, the goods should be delivered to the customer as soon as possible after the goods have arrived in the warehouse in Vaassen. In this scenario the planning department rely on the expected delivery dates in the customer orders. The expected delivery date indicates when all the goods are ready for delivery. Because the Rofra | Home company wants to deliver the goods as soon as possible when the goods have arrived in the warehouse in Vaassen, the planning department already plans deliveries for goods that are not present yet at the warehouse in Vaassen. They plan "red rules", based on the expected delivery date of the goods.

In the last scenario is happens quite often that at the day the goods should be delivered to the customer, the goods are not even present at the warehouse in Vaassen. This situation is referred to as the red rule problem, and results in unsatisfied customers as shown in table three and four, which can be found in Appendix I and II.

2.2 RESEARCH PROBLEM IDENTIFICATION AND MOTIVATION

2.2.1 INTRODUCTION

The business process description above gives a clear inside in the Rofra | Home business process, which actors are involved in the business process and what their roles are in the process. The description of the business process also provides a clear description for the “red rule” problem, causing the customer dissatisfaction. The “red rule” problem can be defined as:

“At the moment that goods are planned to deliver to the customer, the goods are not present yet in the Rofra | Home warehouse, which results in a non-complete delivery to customers or no delivery at all to the customers at that moment.”

The aim of the chapter is to define the specific research problem and motivate the value of a solution for the problem. For the definition of the specific research problem, the cause of the research problem is identified first, in order to define the specific research problem. For the motivation of the value of a solution for the research problem, the process which is related to the problem cause is described to indicate the value of a solution for the research problem.

2.2.2 RESEARCH PROBLEM IDENTIFICATION

In order to identify the cause of the problem, we start at the end of the Rofra | Home business process, at the moment that the “red rule” problem shows up. That moment is when the customer is informed about the planned delivery date for their ordered goods and that someone at the Rofra | Home company noticed that the goods are not in the warehouse yet, or will arrive in the warehouse too late to realize the planned delivery date.

The word “someone” in the last sentence has been chosen on purpose. There is not one person or department single responsible for checking if all the purchased goods from external suppliers meet their expected delivery date. Both the planning department and the purchase department can signal the problem in advance. The last department to signal the problem is the inventory staff, who need to prepare the goods for the delivery transport. When there is concluded that the goods are not there, or not there in time, to realize the planned delivery date, the planning department contacts the customer to inform them about a partial delivery or no delivery at all at the planned delivery date.

When we look back at the Rofra | Home business process description, the problem could be caused by two reasons. The planning department planned the delivery to the customer to early, or the goods have arrived too late. Before a direct cause of the problem can be identified, both scenarios should be investigated more closely.

The first scenario that could cause the problem, is when the planning department plans a delivery to the customer to early. When we look at the Rofra | Home business process we see that there are two scenarios in planning the deliveries to the customer. The first scenario is that all the goods are already in the warehouse, which means that in this scenario the “red rule” problem could not occur. The second scenario at the planning department is that not all, or none of the goods, are in the Rofra | Home warehouse yet. In that scenario they base their delivery date, on the expected delivery date of the goods. In that scenario the “red rule” problem could occur. If the expected delivery date of the goods at the warehouse, is not accurate, meaning that the goods are not delivered at the expected delivery date, the “red rule” problem could occur. Therefore we can conclude that if the goods arrive later than the expected delivery date, the “red rule” problem could occur.

Another possibility in this scenario is that the planning department plans a delivery date to the customer, before the expected delivery date of the goods. We can rule out this scenario as a cause of the problem, because we can see in Appendix I, and in table 1, that such situations are marked as “Planning fault”,

code 9 in the pre-defined causes table, and that therefore this scenario does not add on to the “red rule” problem.

The second scenario that was pointed out above, was that the goods were delivered too late. When we look at the Rofra | Home business process we can define the part “too late” as later than the expected delivery date of the goods. When this happens, two scenarios could have been the causing this situation. In the first scenario the expected delivery date of the goods was not set right by the Rofra | Home purchase department. This could result in goods that are delivered at a different time than that the expected delivery date of the goods would indicate, the goods will be delivered too early, but it is also possible that the goods will be delivered too late. When this happens, it will result in the problem described as the “red rule” problem. Therefore we can conclude that this described scenario could be marked as a possible cause of the “red rule” problem.

The second scenario when goods were delivered too late is that that the expected delivery date is set right by the Rofra | Home purchasing department, based on the delivery information received from the supplier, but that the supplier itself fails to meet the expected delivery date. This scenario also results in the situation were goods are delivered too late, and therefore the customer delivery is not, or only partially possible. Based on this scenario and the situation it is resulting in, we can conclude that this could also be a possible cause of the “red rule” problem.

When we look back at the initial two scenario distinction between the causes of the “red rule” problem, the delivery planned to early, or the goods arrived too late, we see in the elaboration of the scenarios that there is a certain connection between the elaborated causes. In the first scenario the problem was caused by non-accurate delivery dates. In the first part of the second scenario we see that this cause is also mentioned, when to goods are arriving too late. Too late as in not too late delivered by the supplier, but again as a result of a non-accurate expected delivery date of the goods. When we match this to the Rofra | Home business process we can conclude that there is in fact a causal relation between these two indicated scenarios. When the expected delivery date of the goods is non-accurate, the planning department plans the customer delivery to early, based on that non-accurate delivery date, and the goods arrive too late, where too late means, later than the non-accurate delivery date. Therefore we can conclude that the results of both scenarios, the occurrence of the “red rule” problem are caused by the non-accurate expected delivery date.

Besides the non-accurate delivery date there was also pointed out another scenario in which the “red rule” problem would occur, and that is when the supplier fails to meet the expected delivery date, through reasons that fall under his responsibility. Also in this situation, we can conclude that, even if it is outside the Rofra | Home company’s responsibility, the expected delivery date and the actual delivery date eventually do not match, resulting in the “red rule” problem. Therefore we can conclude that the more accurate the expected delivery date is, the less “red rule” problems will occur. The main cause for the problem can be identified as incorrect and inaccurate expected delivery dates.

Based on the identification of the problem cause we can define the specific research problem as the accuracy of the expected delivery dates of ordered goods from external supplier. On the next page the identified causes of the “red rule” problem are summarized in a causal graphical overview in figure three.

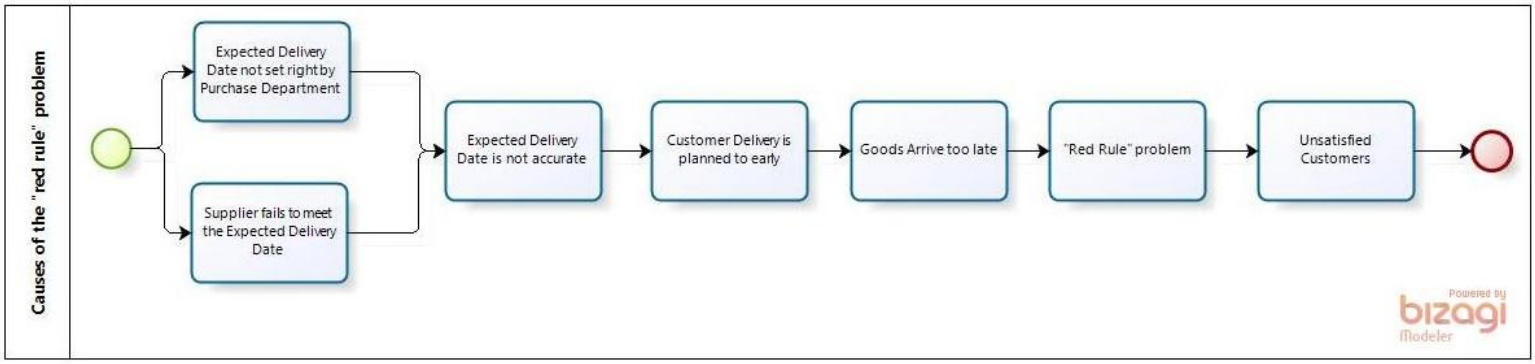

Figure 3: Causal overview of the "red rule" problem causes

2.2.3 RESEARCH PROBLEM MOTIVATION

From the cause identification in the previous section became clear that the "red rule" problem is caused by inaccurate delivery dates, which is defined as the specific research problem. The value of a solution for the problem lies in the process related to the defined research problem. In order to motivate the value of a solution for the problem, the related process is described at first. Based on the description of the related process the value of a solution for the problem is motivated.

The research problem is defined as the accuracy of the expected delivery dates of ordered goods from external suppliers in the previous section. The current inaccuracy of those expected delivery dates is on its turn caused in two scenarios. In the first scenario the Rofra | Home purchase department does not set the correct expected delivery date, in the second scenario the supplier fails to meet the expected delivery date. This conclusion can be drawn from the causal model presented in figure 3 in the previous section.

When we look at the business process description in the previous section of this thesis, we can see how the purchase process and the delivery process are organized at this moment at the Rofra | Home company. In figure 4, which is shown below, both these processes are integrated into one process, to gain a better insight in the complete process, the causal relations in the process and where in the process the problems are caused.

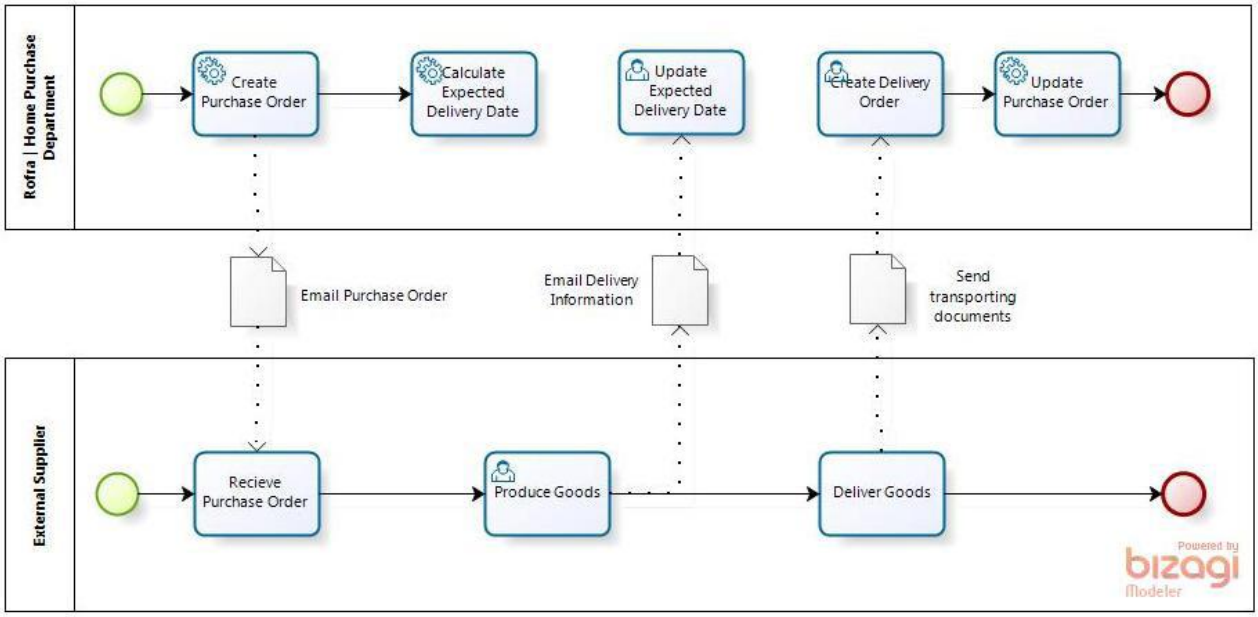

Figure 4: The Purchase and Delivery process

In figure 4 the complete purchase and delivery process is show as a causal process. Also the interaction between the Rofra | Home purchase department and the suppliers is displayed. The first step in the process is the creation of a purchase order by the purchase department. After the creation of the purchase order, the purchase order is emailed to the supplier. At the same time the Logic4 ERP software calculates the expected delivery date, based on a pre-defined delivery time per supplier. This expected delivery date is updated in the purchase order automatically.

When the supplier has produced the goods, they send an email back to the Rofra | Home purchase department with the delivery information. An example of this delivery information can be found in Appendix III. When this delivery information is received by the Rofra | Home purchase department, the purchase department need to update the expected delivery dates manually in the purchase order. Finally when the goods are the delivered, the Rofra | Home purchase department creates a delivery order, and when this order is checked and processed by the inventory staff, the goods are checked in, the stock levels are updated and the order rows in the customer order turn from red into green. At the moment that the order rows in the customer orders turn from red into green, the Rofra | Home company is sure that there is enough stock of the product to deliver to the customer, and that the stock is present at the warehouse in Vaassen.

When looking at the above described purchase and deliver process, we see that the information exchange between the supplier and the Rofra | Home purchase department is done by email. As well the purchase order information as the delivery information are exchanged by email. The supplier itself needs to fit the purchase order information from the received email into its own (if used) software system, and the delivery information also needs to be converted to an email. On the other side, at the Rofra | Home purchase department, this also needs to be done, but then the other way around. The purchase order is automatically generated by the Logic4 EPR software, but it must be manually emailed by someone of the purchase department to the supplier. Also, when the delivery information send by the supplier, arrives at the purchase department, someone at the purchase department needs to manually update the expected delivery dates in the created purchase order.

Based on the description of the process which is related to the defined research problem, the accuracy of the expected delivery date of goods ordered from external suppliers, we can motivate the value of a solution for the problem. The motivation for a solution for the problem consists of several points.

At first when we look at the process activities, as displayed in figure four, we see that the current process activities are mainly manual activities, performed by the users in the process. These manual tasks influence the accuracy and reliability of the data that is processed. Therefore a solution for the problem, which reduces the number of manual tasks in the process, and thereby enhancing the accuracy and reliability of the processed data in the process, is a valuable to the research problem.

The second motivation for a solution is that the related process to the defined research problem, is causing problems in the overall business process of the Rofra | Home company. The dissatisfied customers, as a result of the “red rule” problem, is a problem for the Rofra | Home company, which is caused by the inaccuracy of the expected delivery dates from goods ordered by external suppliers. Therefore a solution that enhances the accuracy of the expected delivery dates is valuable to the Rofra | Home company.

3 OBJECTIVES OF THE SOLUTION

The aim of this chapter is to define objectives for the solution. The identified research problem is transformed into objectives for the artifact, the Rofra | Home supplier portal.

To transform the research problem into objectives, a theoretical framework is constructed at first. Based on that theoretical framework the research problem is positioned into its scientific context, from which knowledge about the research problem and the possible solutions is inferred. From that scientific context, knowledge about the research problem and the possible solutions is transformed into objectives for the artifact.

The defined objectives serve as a blueprint for the development of the artifact, the Rofra | Home supplier portal in the next process step. The defined objectives will also serve as evaluation criteria for the evaluation of the developed artifact, the Rofra | Home supplier portal

3.1 THEORETICAL FRAMEWORK

3.1.1 INTRODUCTION

The problem identification and motivation above give a clear insight in the cause of the defined research problem, the accuracy of the expected delivery date of goods ordered from external supplier. The aim of this theoretical framework is to position the research problem into its scientific context.

The theoretical framework is focused on two different theoretical concepts which are related to the scientific context of the defined research problem. The first theoretical concept that the framework is focused on is supply chain integration. The second theoretical concept that the framework is focused on is supply chain communication and information sharing throughout the supply chain.

3.1.2 SUPPLY CHAIN INTEGRATION

A supply chain consists of suppliers, manufacturing centers, warehouses, distribution centers, retail outlets, raw materials, work-in-progress inventory and finished products that flow between the facilities (Simchi-Levi, Kaminsky, & Simch-Levi, 2008). When we look at the Rofra | Home company, we can state that the company is involved in a supply chain structure, based on the definition of Simchi-Levi et al. (2008) of a supply chain. The management of a supply chain is defined by Simchi-Levi et al. (2008) a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouse and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system wide costs while satisfying service level requirements. Another definition of supply chain management is given by Lambert and Cooper (2000). “Supply chain management is the integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders.”(Lambert & Cooper, 2000).

When looking at the definition from Simchi-Levi et al. (2008) and Lambert and Cooper (2000) above, we can state that throughout efficient integration between members of the supply chain, merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, which results in minimizing costs throughout the supply chain and maximizing the profit for shareholders and customers. Also other authors confirm this statement, “Growing evidence suggests that supply chain integration has a positive impact on operational performance outcomes, such as delivery, quality, flexibility and cost.” (Wong, Boon-itt, & Wong, 2011).

Most theory about supply chain integration distinguishes two flows in a supply chain, a flow of goods and a flow of information. Prajogo and Olhager (2012) state that both flows are equally important in the supply chain and that “Supply chain integration must comprise both information and material, and cannot restrict itself to only one.” (Prajogo & Olhager, 2012). The integration from the flow is goods is referred by Prajogo and Olhager (2012) as logistics integration, which “refers to specific logistics practices and operational activities that coordinate the flow of materials from suppliers to customers throughout the value stream” (Prajogo & Olhager, 2012). Integration of the information flow is referred by Prajogo and Olhager (2012) as Information integration, which “refers to the sharing of key information along the supply chain network which and is enabled by information technology” (Prajogo & Olhager, 2012).

The two flows within a supply chain, the flow of goods and the flow of information are schematically displayed by Simchi-Levi et al. (2008) in figure 5, displayed below. Simchi-Levi et al. (2008) state that the primary goal of the information flow in the supply chain is “to link the point of production seamlessly with the point of delivery or purchase”. According to Simchi-Levi et al. (2008) the “idea is to have an information trial that follow’s the product’s physical trial”.

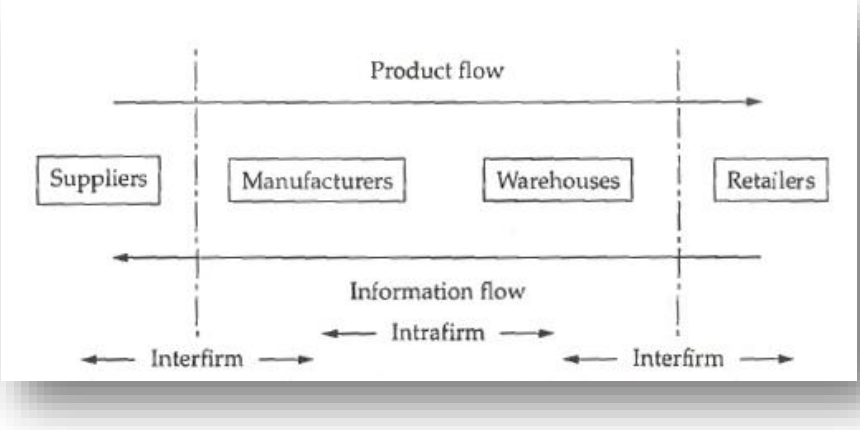

Figure 5: Flow of information and goods in the supply chain (Simchi-Levi et al., 2008)

Another graphical representation of the two flows in the supply chain is constructed by Lambert and Cooper (2000) and is presented in figure 6 on the next page. The figure “depicts a simplified supply chain network structure; the information and product flows; and the key supply chain business processes penetrating functional silos within the company and the various corporate silos across the supply chain.” (Lambert & Cooper, 2000). According to Lambert and Cooper (2000) the business processes of a single company become supply chain process, which are linked across company boundaries.

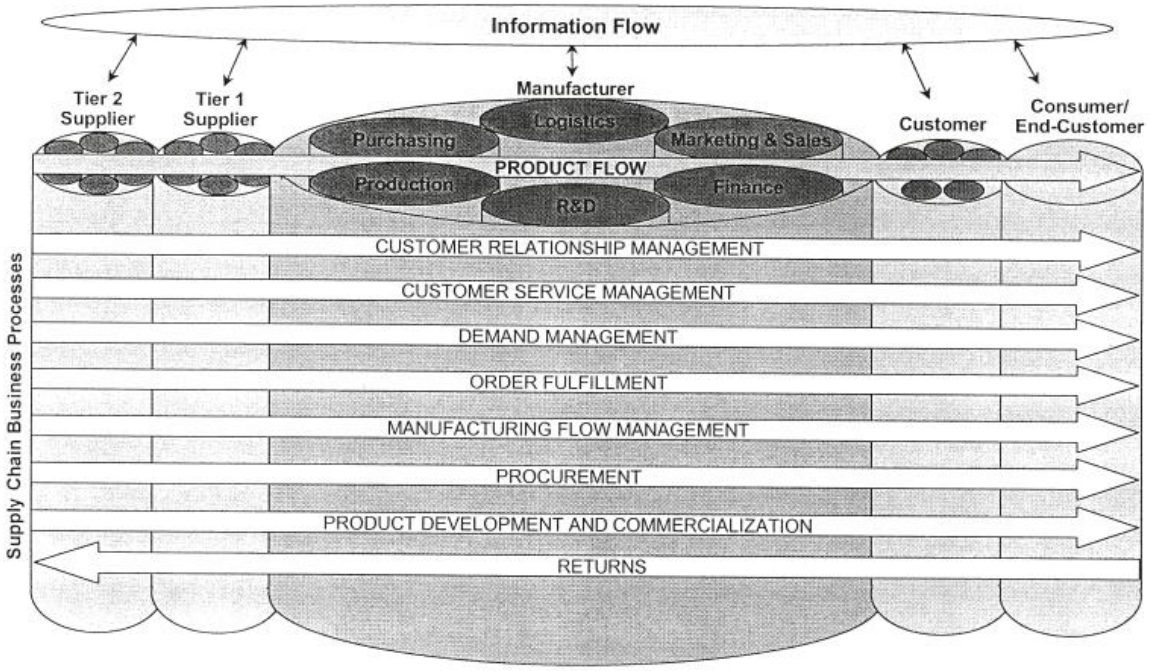

Figure 6: Supply chain management: integrating and managing business processes across the supply chain (Lambert & Cooper, 2000)

When looking at the supply chain integration aspect in figure 5, developed by Simchi-Levi et al. (2008), the product flow and the information flow are in the opposite direction. The figure shows the different members of the supply chain, Suppliers, Manufactures, Warehouses and Retailers, and that the both the flows in the supply chain flow from one member of the supply chain to another in member in the supply chain. When looking at figure 6, developed by Lambert and Cooper (2000), the supply chain processes in the supply chain are more integrated throughout the whole supply chain. Also the information flow is not a flow from right to left, but Lambert and Cooper (2000) present the information flow as a sort of pool, were all the information is gathered and all the information is available at all times for all the members of the supply chain. According to Lambert and Cooper (2000) “both upstream and downstream portions of the supply chain have interacted as disconnected entities receiving sporadic flows of information over time” but should act as “integrated processes throughout the supply chain” .

Prajogo and Olhager (2012) define the supply chain integration of the flow of goods as logistics integration. “The essence of logistics integration is well-coordinated flow of materials from suppliers which allow firms to have a smooth production process.” The logistics integration must be supported by the information flow from downstream to upstream according to Prajogo and Olhager (2012). These authors also state that “information technology and information sharing can be viewed as antecedents to material flow integration.”(Prajogo & Olhager, 2012). Therefore we can state that integration of the information flow in the supply chain is essential for logistic integration in the supply chain. This statement is also confirmed by Lambert and Cooper (2000), who state that “Operating an integrated supply chain requires continuous information flows, which in turn help to create the best product flows.”.

When researching the different levels of integration in the supply chain, Lambert and Cooper (2000) state that “integrating and managing all business process links throughout the entire supply chain is likely not appropriate. Since the drivers for integration are situational and different from process link to process link, the levels of integration should vary from link to link, and over time.“. In their research Lambert and Cooper (2000) defined four “fundamentally different types of business process links between members of a supply chain.”. These business process links are:

- **Managed business process links;** links that the focal company finds important to integrate and manage. (Lambert & Cooper, 2000)
- **Monitored business process links;** links that are not as critical to the focal company. However, it is important to the focal company that these process links are integrated and managed appropriately between the other member companies. Thus, the focal company, as frequently as necessary, simply monitors or audits how the process link is integrated and managed.(Lambert & Cooper, 2000)
- **Not-managed business process links;** links that the focal company is not actively involved in, nor are they critical enough to use resources for monitoring.(Lambert & Cooper, 2000)
- **Not-member business process links;** process links between members of the focal company’s supply chain and non-members of the supply chain. Non-member links are not considered as links of the focal company’s supply chain structure, but they can and often will affect the performance of the focal company and its supply chain.

Lambert and Cooper (2000) do not give a clear description of which processes in the supply chain should be integrated for an optimal result. Lambert and Cooper (2000) state that “the number of business processes that it is critical and/ or beneficial to integrate and manage between companies will likely vary.” What Lambert and Cooper (2000) do say is that “in each specific case, it is important that executives thoroughly analyse and discuss which key business processes to integrate and manage.”. A graphical representation of a supply chain with the business process links is presented on the next page, in figure 7.

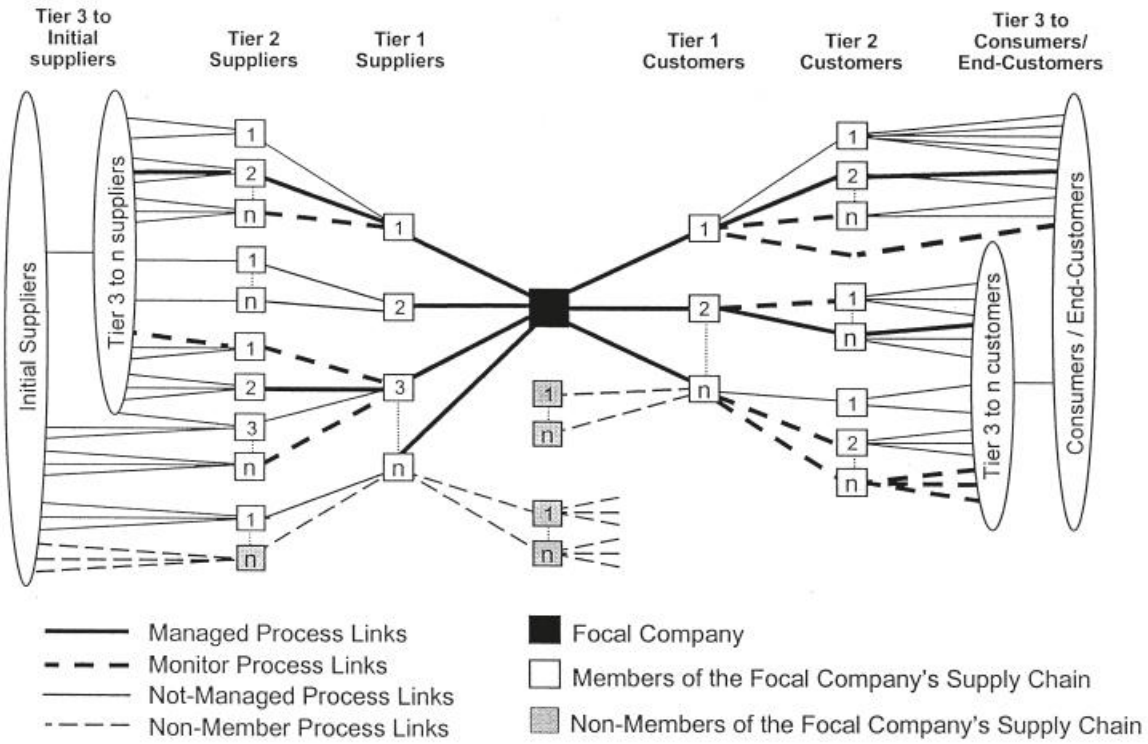

Figure 7: Types of intercompany business process links (Lambert & Cooper, 2000)

From the researched theory about supply chain management and supply chain integration we can state:

“Through logistic integration, supported by information technology and information sharing, critical business process links can be integrated in the supply chain, resulting in merchandise that is produced and distributed at the right quantities, to the right locations, at the right time, and eventually minimizing costs throughout the supply chain and maximizing the profit for shareholders and customers. “

From that statement we can derive several important aspects about supply chain integration:

- Supply chain integration consists of logistic integration and information integration
- Information integration is an essential condition for logistic integration
- Through logistic integration and information integration, critical business process links can be integrated in the supply chain.
- Supply chain integration results in better supply chain performance:
    - Merchandise is produced at the right quantities
    - Merchandise is distributed at the right quantities
    - Merchandise is distributed to the right locations
    - Merchandise is distributed at the right time
- Supply chain integration eventually leads to:
    - Minimized costs throughout the supply chain
    - Maximized profit for the shareholders and customers.

3.1.3 SUPPLY CHAIN COMMUNICATION

Communication in the supply chain is by most supply chain theory referred as information sharing throughout the supply chain by the different members of the supply chain. According to Ding, Guo, and Liu (2011) “information sharing is an important element in the integration of supply chain partners.an essential part in managing a supply chain”. A study by Zhou and Bentonjr (2007) also addresses the value of information sharing in a supply chain. The study by Zhou and Bentonjr (2007) indicated that “effective information sharing significantly enhances effective supply chain practice”. Koçoğlu, İmamoğlu, İnce, and Keskin (2011) also mention the necessity and the benefits of information sharing in a supply chain by stating that “information sharing significantly contributes in reducing supply chain costs, improving partner relationships, increasing material flow, enabling faster delivery, improving order fulfillment rate thus contributing to customer satisfaction, enhancing channel coordination, and facilitating the achievement of competitive advantage”.

For the integration in the supply chain, Koçoğlu et al. (2011) distinguish three levels of supply chain integration. Koçoğlu et al. (2011) states that these three levels are integration with customers, integration with suppliers and intra-organizational integration. Figure 8 presents “a framework displaying the relationship between supply chain integration and information sharing, the influence of supply chain integration on supply chain performance, and the effect information sharing has on supply chain performance” , developed by Koçoğlu et al. (2011).

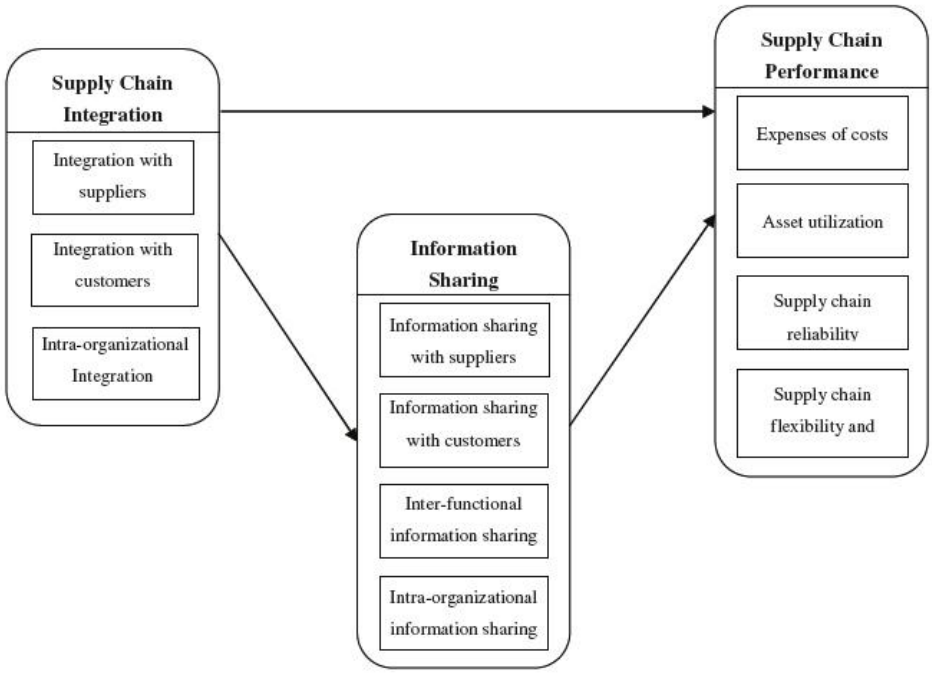

Figure 8: Supply chain integration and Information sharing (Koçoğlu et al., 2011)

The study conducted by Koçoğlu et al. (2011) showed that there is a positive triangular relationship between supply chain integration, information sharing and supply chain performance. Based on this positive triangular relationship, Koçoğlu et al. (2011) stated that "it is essential for firms to exploit the benefits associated with supply chain integration and information sharing to improve their supply chain performance".

When integrating business processes throughout the supply chain, and in particular information sharing, it now usually involves implementing an information system, which facilitates information sharing and coordination between internal and external partners in the chain (Williamson, Harrison, & Jordan, 2004). These information systems are referred to by Williamson et al. (2004) as interorganisational information systems, An interorganisational information system is defined as "a collection of IT resources, including communications networks, hardware IT applications, standards for data transmission, and human skills and experiences" (Williamson et al., 2004). According to Williamson et al. (2004) an interorganisational information system "provides a framework for electronic cooperation between businesses by allowing the processing, sharing and communication of information". The development of interoganisational information systems are devided by Williamson et al. (2004) into four phases:

- **Phase one: "**This includes paper copies of purchase orders, bills and invoices and represents most of the information flows. Information technology and telecommunications do not contribute significantly to the information system. Therefore information sharing between businesses in the supply chain and within the business is limited." (Williamson et al., 2004)
- **Phase two: "**This phase saw the development of Electronic Data Interchange that had a dramatic effect on the automation of information flows and the elimination of many labour intensive processes and procedures in partner businesses. Purchase orders, invoices as well as order status, pricing enquiries and scheduling transactions can be processed using Electronic Data Interchange." (Williamson et al., 2004)

- **Phase three: "**This phase describes a more integrated approach. Enterprise-wide systems and databases are integrated and coordination of IT operations takes place. These systems are characterized by Enterprise Resource Planning systems. This is a phase in which the limited focus of Electronic Data Interchange is being subsumed in a much larger view of data transfer and data sharing." (Williamson et al., 2004) "An Enterprise Resource Planning system can potentially improve transparency across the supply chain by removing information distortions and increasing the speed of information by reducing information delays." (Akkermans, Bogerd, Yücesan, & Wassenhove, 2003)
- **Phase four: "**Here, the supply chain is defined by strategic supplier partnerships with extensive two-way information flows. The integration of information resources has therefore been enabled by the use of web development technologies such as XML and Java, which enable business partners to integrate their information resources and therefore to accelerate the decision-making on Supply Chain Management processes. Supply Chain Management here also requires the development of new interfaces, such as portals, allowing partners access to a company's databases. This information may be used in operational or planning functions." (Williamson et al., 2004)

From the four phases, and their description, that are distinguished by Williamson et al. (2004), we can state that a higher phase of an interorganisational information system, leads to a more efficient process of information sharing within the supply chain. This statement is confirmed by Williamson et al. (2004) , stating that "This decision may also require businesses to move from one phase to another in order to experience greater operational effectiveness." According to Williamson et al. (2004) organizations "need to choose the form of coordination that is most appropriate for their business needs. García-Dastugue and Lambert (2003) state that organizations also "need to choose the appropriate level of integration for particular relationships in the supply chain and the appropriate degree of information sharing".

In the last phase of interorganisational information systems, Williamson et al. (2004) mention an extensive two way information flow throughout the supply chain. According to Williamson et al. (2004) "the Internet is now being used as one of the main networking platforms in the upstream, downstream and internal supply chains by both large and relatively small companies and has presented many opportunities for cost reduction, service improvements and greater speed agility in the supply chain".

When researching the impact of using the internet in the upstream supply chain, Williamson et al. (2004) stated that "the use of the Internet in the upstream supply chain, between suppliers and manufacturers, is impacting greatly on purchasing as well as on the coordination, communication and movement of goods and information from suppliers." Williamson et al. (2004) state that in regard to the use of internet in the upstream supply chain, the internet is "a very effective medium, which is improving information flows". On the other side, the impact of using the internet in the downstream supply chain, Williamson et al. (2004) stated that "the Internet is used in the downstream supply chain in areas such as transport scheduling, vehicle tracking and customer service. It allows information to be more readily available along the distribution chain and has also an impact on the distribution strategy."

When comparing the coordination by Electronic Data Interchange in the supply chain, to the coordination by Internet usage, García-Dastugue and Lambert (2003) researched the relation between the costs of coordination and the volume of the transactions. The results of this research are show on the next page, in figure 9. From the results of the research conducted by García-Dastugue and Lambert (2003), we can derive that at all volume of transactions, coordination through internet are the most profitable.

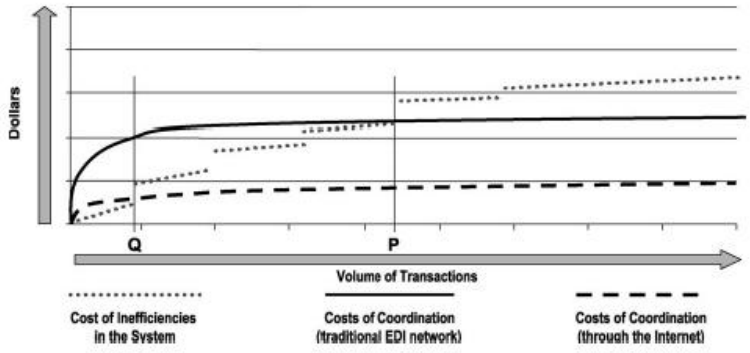

Figure 9: Cost of coordination using traditional EDI and Internet (García-Dastugue & Lambert, 2003)

According to Lancioni, Smith, and Oliva (2000) the usage of Internet provides numerous cost saving opportunities for supply chains. Lancioni et al. (2000) state that "the growth of the Internet has presented supply chains with many significant opportunities for cost reduction and service improvements". Some of the opportunities that the use of Internet provide to supply chains are, according to Lancioni et al. (2000):

- The ability to track shipments using a wide variety of modes including truck, rail, and air transport.
- The ability to contact vendors or buyers regarding customer service problems from late deliveries, stock-outs, alterations in scheduled shipment dates, late arrivals, and a wide variety of other service issues.
- The ability to check the status of orders placed with vendors.
- The ability to notify vendors of changes in configurations in products that are produced to order.
- The ability to pay invoices electronically and to check outstanding debit balances.
- The ability to track equipment locations including rail cars, trucks, and material handling equipment.
- The ability to directly communicate with vendors, customers, etc. regarding supply issues on a 7-day/24-hour basis.
- The ability to schedule pickups and deliveries.

According to Lancioni et al. (2000) "the Internet has affected inventory management most dramatically in the ability of firms to be proactive in the management of inventory systems. This is demonstrated in the ability of firms to notify customers of order-shipping delays and inventory emergencies." The research of Lancioni et al. (2000) showed that "the information available to inventory managers is becoming more readily available because of the reporting systems that can be used through the Internet."
Lancioni et al. (2000) state that the key in managing the supply chain is "fast, accurate information from a wide range of operating areas including transportation, inventory, purchasing, customer service, production scheduling, order processing, and vendor operations. The ability to react quickly to market changes and to adjust inventory, production, and transportation systems accordingly is necessary for cost efficiency and for the improved utilization of assets in the supply chain".

From the researched theory about supply chain communication and supply chain information sharing we can state:

Effective information sharing throughout an interorganisational information system, with an extensive two-way information flow, significantly enhances effective supply chain practice by the integration of supply chain partners. The use of the Internet for an interorganisational information system, is impacting greatly the upstream supply chain on purchasing as well as on the coordination, communication and movement of goods and information from suppliers. The use of the Internet for an interorganisational information system is also impacting the downstream supply chain in areas such as transport scheduling, vehicle tracking and customer service. The use of the Internet for an interorganisational information system is the most profitable, it allows information to be more readily available along the distribution chain and supplies the supply chain with fast, accurate information from a wide range of operating areas including transportation, inventory, purchasing, customer service, production scheduling, order processing, and vendor operations, which is essential for cost efficiency and for the improved utilization of assets in the supply chain.

From that statement we can derive several important aspects about supply chain communication and information sharing:

- Effective information sharing throughout an interorganisational information system, with an extensive two-way information flow, significantly enhances effective supply chain practice by the integration of supply chain partners.
- The use of the Internet for an interorganisational information system is impacting both upstream – and downstream flow in the supply chain
- The use of the Internet for an interorganisational information system is the most profitable, compared to other interorganisational information systems
- The use of the Internet for an interorganisational information system allows information to be more readily available along the distribution chain
- The use of the Internet for an interorganisational information system supplies the supply chain with fast, accurate information from a wide range of operating areas including:
    - Transportation
    - Inventory
    - Purchasing
    - Customer service
    - Production scheduling
    - Order processing
    - Vendor operations
- Supplying the supply chain with fast and accurate information which is essential for cost efficiency and for the improved utilization of assets in the supply chain.

3.2 SOLUTION OBJECTIVES

3.2.1 INTRODUCTION

To transform the research problem into objectives, a theoretical framework is constructed in the previous section. Based on that theoretical framework the research problem is positioned into its scientific context, from which knowledge about the research problem and the possible solutions is inferred. From that scientific context, knowledge about the research problem and the possible solutions is transformed into objectives for the solution.

3.2.2 RESEARCH PROBLEM AND SOLUTION KNOWLEDGE

When we review the created theoretical framework in this chapter, already was stated that the Rofra | Home company is part of a supply chain structure. A simplified graphical representation of the flow of goods in the supply chain of Rofra | Home is presented below, in figure 10.

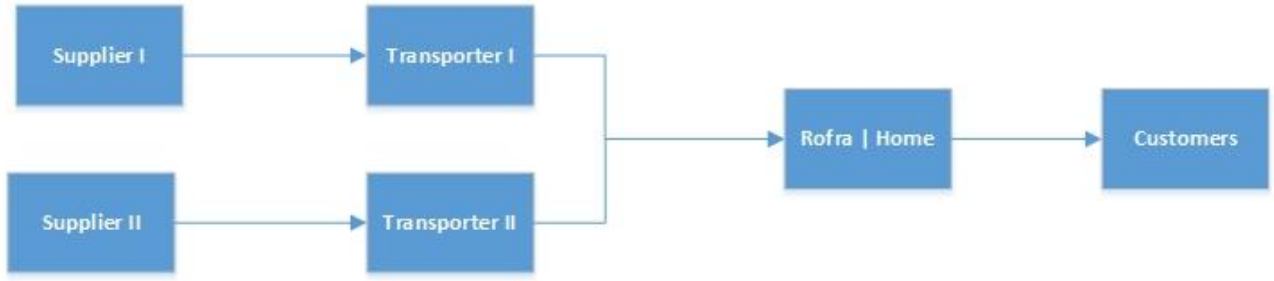

Figure 10: Simplified graphical representation of the flow of goods in the Rofra | Home supply chain

From the simplified graphical representation of the flow of goods in the Rofra | Home supply chain we can derive that the Rofra | Home company orders goods from external suppliers, which are delivered by transporters to the Rofra | Home company and from there on delivered to the Rofra | Home customers. From the theoretical framework we can derive that supply chain integration can enhance supply chain performance. A simplified graphical representation, based on the model of Lambert and Cooper (2000) and the business process description of the Rofra | Home company, of the level of integration in the Rofra | Home supply chain is presented below in figure 11.

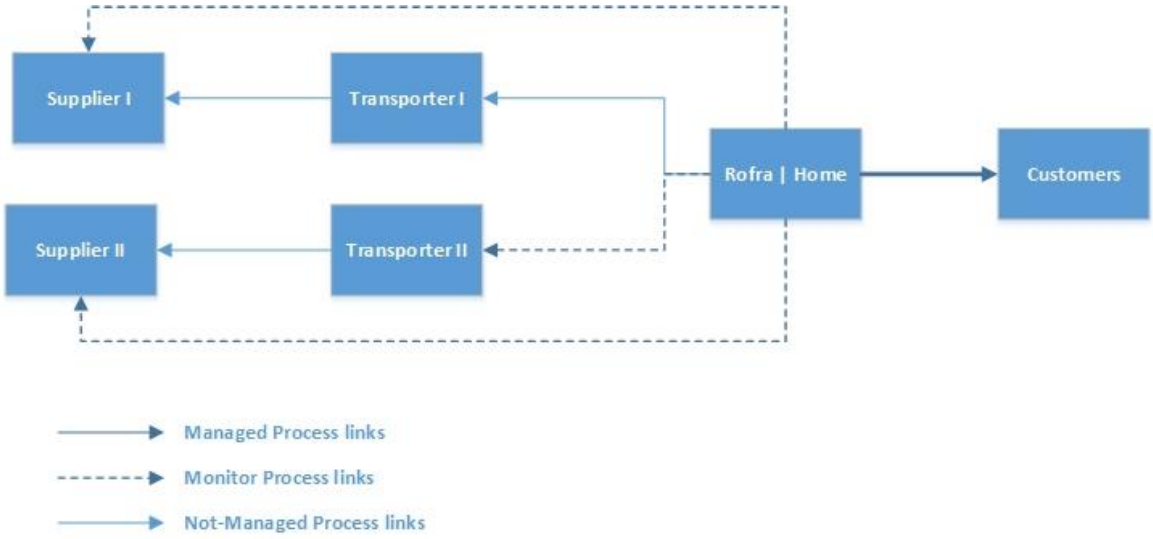

Figure 11: Simplified graphical representation of the level of integration in the Rofra | Home supply chain

From the theoretical framework we can derive that supply chain integration can enhance supply chain performance by integrating critical business process links trough logistical integration, supported by information technology and information sharing. From the Rofra | Home business process description we can derive that the Rofra | Home company uses a Just-In-Time strategy for their business process. This strategy is resulting in a great dependency on their supply chain partners, for the Rofra | Home company the external suppliers and the transportation companies. From the theoretical framework, and in particular the theory developed by Lambert and Cooper (2000), we can state that these processes in the supply chain are critical links in the business process.

When looking at the simplified graphical representation of the level of integration in the Rofra | Home supply chain, as presented in figure 11, we can distinguish four different process links:

1. A Managed process link between Rofra | Home and the Customers
2. A Monitor/ Not-Managed process link between Rofra | Home and the Transporting companies
3. A Monitor process link between Rofra | Home and the Suppliers
4. A Not-Managed process link between the Suppliers and the Transporting companies

When we compare these critical business links to the constructed theoretical framework, we can state that at this moment the business links are not integrated and managed at a right way in the supply chain. From the theoretical framework we can derive that links that are critical to the business process should be integrated and managed in the supply chain as managed process links. Process links that are not as critical to the focal company, but which are still important to the Rofra | Home company, should be integrated and managed appropriately between the other member companies and monitored by the Rofra | Home company. Based on these statements a simplified graphical representation is developed for the suggested process links between the members of the Rofra | Home supply chain, which is presented below in figure 12.

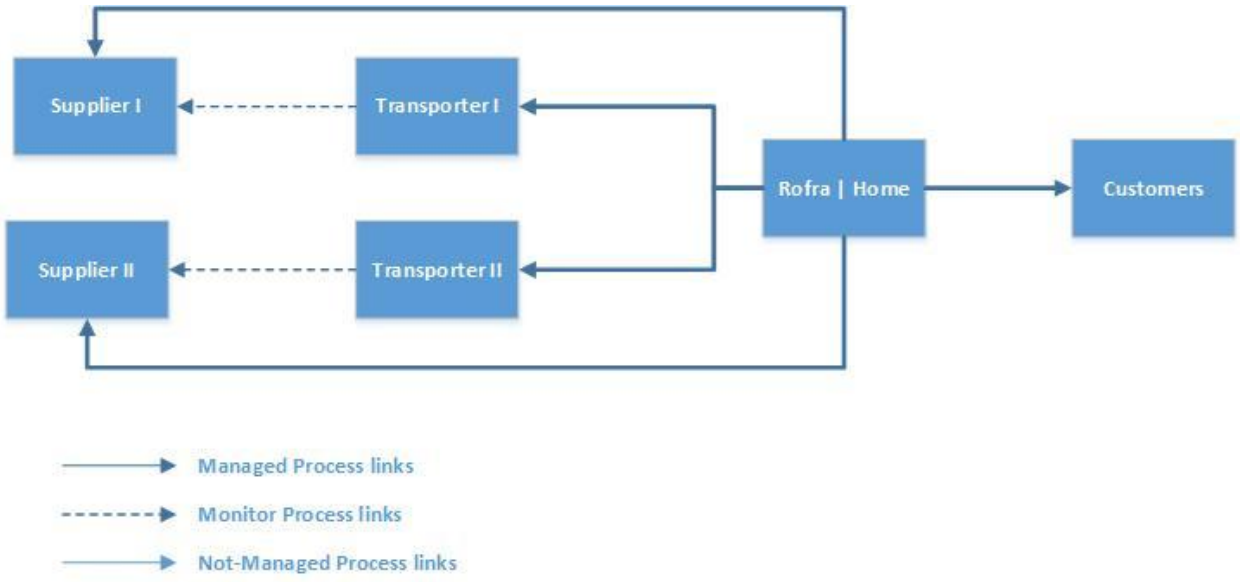

Figure 12: Simplified graphical representation of the suggested process links in the Rofra | Home supply chain

From the theoretical framework we can derive that the higher level of supply chain integration by the integration of the critical process links in the supply chain will enhance supply chain performance. In order to achieve the higher level of integration in the Rofra | Home supply chain, and therefore integrating the critical process links in the supply chain, we derive from the theoretical framework that information sharing throughout the supply chain is an important element in the supply chain integration. For the practice of information sharing in the supply chain we can derive from the theoretical framework that an interorganisational information system with an extensive two way information flow will significantly enhance effective supply chain practice by the integration of supply chain partners.

When looking at the current situation, we can state that Rofra | Home is not using an interorganisational information system for sharing information throughout the supply chain. The only information that is shared with members of the supply chain is done by email. Based on the theoretical framework, and in particular the research done by Williamson et al. (2004), we can state that the Rofra | Home company is operation in the first phase of the development of an interoganisational information system. Williamson et al. (2004) state about the first phase that "information technology and telecommunications do not contribute significantly to the information system" and that a therefore "information sharing between businesses in the supply chain and within the business is limited".

From the theoretical framework we can derive that if an organisation is moving to the next phase of interorganisational information system development, a greater operational effectiveness can be achieved by the more efficient practice of information sharing. Therefore we can state for the Rofra | Home company that in order to achieve a better practice of information sharing, an thereby gain a greater operational effectiveness, the Rofra | Home company should move on to the next phase of an interorganisational information system.

When looking at the next phases of interorganisational information systems development, we can derive from the theoretical framework that an interorganisation information system which is coordinated by using the internet, is the most profitable compared to other interorganisational information systems. The use of the Internet for an interorganisational information system allows information to be more readily available along the distribution chain, and supplies the supply chain with fast, accurate information from a wide range of operating areas which is essential for cost efficiency and for the improved utilization of assets in the supply chain.

From the theoretical framework we derived that the use of internet for interorganisational information system also provides a lot of useful, practical opportunities for the Rofra | Home company to integrate and manage the critical process links in the supply chain such as:

- The ability to track shipments using a wide variety of modes including truck, rail, and air transport.
- The ability to contact vendors or buyers regarding customer service problems from late deliveries, stock-outs, alterations in scheduled shipment dates, late arrivals, and a wide variety of other service issues.
- The ability to check the status of orders placed with vendors.
- The ability to notify vendors of changes in configurations in products that are produced to order.
- The ability to pay invoices electronically and to check outstanding debit balances.
- The ability to track equipment locations including rail cars, trucks, and material handling equipment.
- The ability to directly communicate with vendors, customers, etc. regarding supply issues on a 7-day/24-hour basis.
- The ability to schedule pickups and deliveries.

3.2.3 SOLUTION OBJECTIVES

From the scientific context and the theoretical framework, knowledge about the research problem and the possible solutions is inferred in the previous section. For the development of the artifact these knowledge is transformed into objectives for the solution.

From the knowledge about the research problem and the possible solutions we can derive that the supply chain performance needs to enhance, in order to resolve the research problem. In order to improve the supply chain performance to gain more accurate expected delivery dates for goods ordered from external supplier, the critical process links in the supply chain process should be more integrated, as presented in figure 11. From that statement we derive the first condition, and at the same time the goal of the solution:

> *"The goal of the solution for the defined research problem, the accuracy of expected delivery dates for goods ordered from external supplier, is to integrate and manage critical business links in the supply chain as managed process links."*

In order to achieve that goal we need to translate the knowledge about the research problem and the possible solutions into objectives for the solution. From the knowledge about the research problem and the possible solutions we can derive that information sharing throughout the supply chain is an important element in the supply chain integration. For the information sharing practice, there was stated that the Rofra | Home company needed to move to the next phase of developing an interorganisational information system. Therefore the can state that:

- The artifact which will be developed, has to be an interorganisational information system.

For the next phase of the interorganisational information system, two important objectives can be derived from the knowledge about the research problem and the possible solutions:

- The artifact that will be developed, the interorganisational information system, should have an extensive two way information flow
- The artifact that will be developed, the interorganisational information system should be coordinated by using the internet
- The artifact that will be developed should have a seamless integration possibility with the current Logic4 ERP-software.

From the problem identification and the knowledge about the research problem and the possible solutions we can derive the objectives for the practical functionalities for the artifact that will be developed, an interorganisational information system for the Rofra | Home company:

- The ability to track shipments
- The ability to contact vendors regarding customer service problems from late deliveries, stock-outs, alterations in scheduled shipment dates and late arrivals
- The ability to check the status of orders placed with vendors
- The ability to notify vendors of changes in configurations in products that are produced to order.
- The ability to pay check outstanding debit balances.
- The ability to directly communicate with vendors regarding supply issues on a 7-day/24-hour basis in a structured way
- The ability to schedule pickups and deliveries

The defined objectives serve as a blueprint for the development of the artifact, the Rofra | Home supplier portal in the next process step. The defined objectives will also serve as evaluation criteria for the evaluation of the developed artifact, the Rofra | Home supplier portal.

4. DESIGN AND DEVELOPMENT

The aim of this chapter is to design and develop the artifact, the Rofra | Home supplier portal.

The desired functionality and the architecture of the artifact are designed and modelled at first, based on the determined solution objectives in the previous section. For modelling the desired functionality and architecture, the modelling language BPMN 2.0 is used. Based on this model, a demonstration version of the artifact, the Rofra | Home supplier portal, is created.

For the development of the demonstration version of the artifact, a computer program called Bizagi is used. Bizagi is a business process modeling program that is based on the BPMN 2.0 standard notations. The program uses a model driven approach which is consistent which the chosen research methodology, and therefore chosen for the development of a prototype of the Rofra | Home supplier portal.

4.1 DESIGN

4.1.1 INTRODUCTION

For the design of the artifact the current situation, the purchasing and delivery process, is modelled and analysed at first. Based on the model and analysis of the current situation, ass also on the determined solution objectives, the desired functionality and the architecture of the new artifact is designed, and modelled into a new purchasing and delivery process.

4.1.2 THE CURRENT PROCESS

For the analysis of the current situation, the purchasing- and delivery process is modelled. For the modelling of this process, the modelling language BPMN 2.0 is used. BPMN stands for Business Process Modeling Notation, and is developed by The Business Process Management Initiative. According to White and Miers (2008) BPMN is “a flow chart based notation for defining business processes from the simple to the more complex models required to support process execution”. A brief overview of the BMPN 2.0 modelling language is included in figure 17, which can be found in appendix III.

Based on the problem identification, the current purchasing- and delivery processes in modelled in a software program called Bizagi Process Modeler in the BPMN 2.0 modelling language. A graphical representation of the model can be found on the next page, in figure 13.

When looking at the model of the current process, the purchase- and delivery process are separated from each other. Both processes are operating in an own pool. “A pool represents a participant in a process. It is also acts as a graphical container for partitioning a set of activities from other pools. The activities within separate pools are considered self-contained processes”(White & Miers, 2008). Between the two pools, there are several message flows, meaning communication between the two pools (White & Miers, 2008). In the Rofra | Home supply chain model the message flows are indicating email traffic or the transmit of documents between the Rofra | Home purchase department and the external supplier. From the modelled process we can state that the process at the Rofra | Home company and the process at the external supplier are not integrated into one process at the moment. The only thing connecting the two processes are the message flows. Therefore we can conclude that at this moment the process at the supplier is not connected to the process at the Rofra | Home company, the only connection between the two processes are the message flow and that both processes, more or less, operate independent from each other.

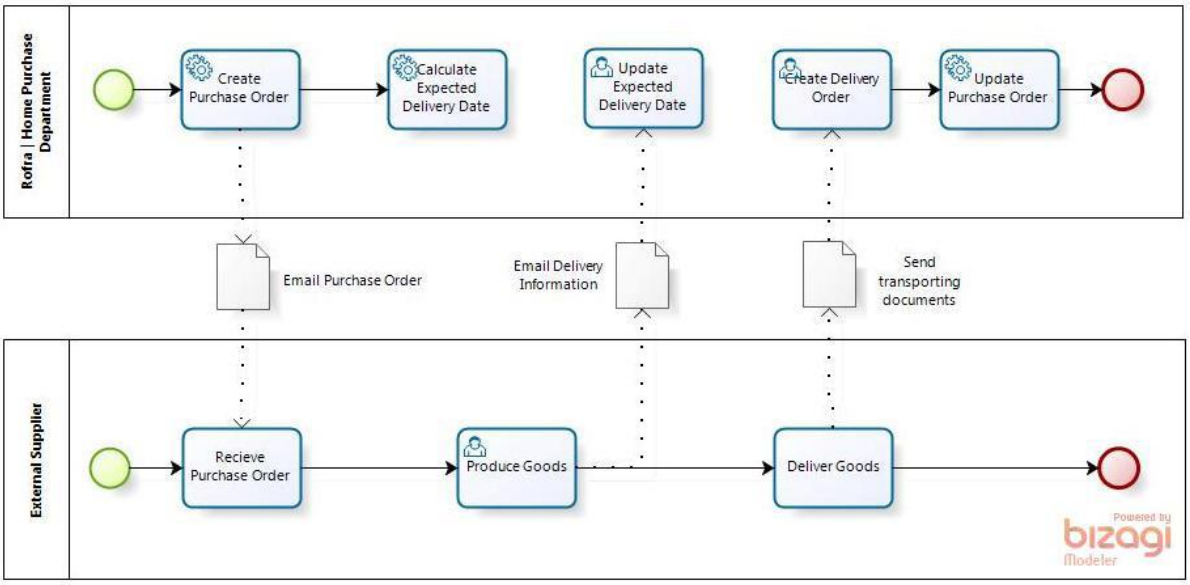

Figure 13: the current purchasing- and delivery processes modelled in the BPMN 2.0 modelling language

4.1.3 THE NEW PROCESS

Based on the briefly analysis in the previous section, and the the determined solution objectives, a new process is constructed and modelled, also by using the BPMN 2.0 modelling language and the Bizagi Proces Model software.

The goal of the new model, derived from the determined solution objectives, was to integrate the critical business link between the Rofra | Home company and the external suppliers, into a managed business link. To achieve this goal, the purchase- and buying process are combined to one process, meaning that the whole process should operate in one pool. To distinguish the different roles in the pool, there were created two lanes in the pool. A lane is “a sub-partition of a pool and is used to separate the activities associated with a specific company function or role” (White & Miers, 2008). Sequence flows, the flows between the activities in the model, cannot cross the borders of a pool, but they can cross the borders of lanes within a pool. There the model was constructed as one process, in one pool and the pool was divided into two lanes, one lane for the Rofra | Home purchase department and the other lane for the external supplier. This is done in order to create one integrated process, as required by the set of requirements which are presented in the previous section. The constructed model of the new, integrated process is displayed below, in figure 14.

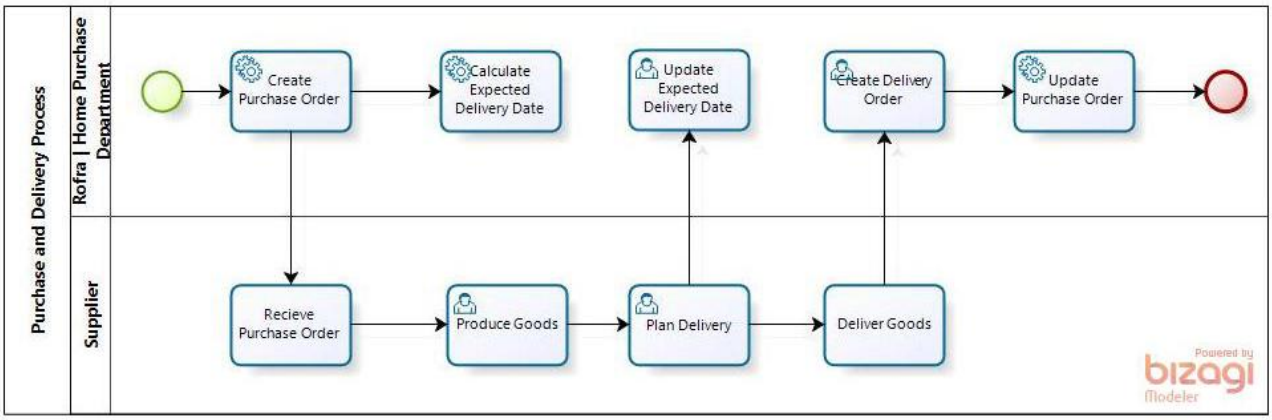

Figure 14: The integrated purchase- and delivery process modelled in BPMN 2.0 language

In the model of the integrated purchase- and delivery process, there are some new established connections between the activities. These connections make the purchase process and the delivery process to one integrated process. The establishment of these connections should happen through the use of an interorganisational information system, the Rofra | Home supplier portal. Therefore the presented model in figure 14 served as a blueprint for the development of the process model of the interorganisational information system, the Rofra | Home supplier portal.

The solution objectives for the interorganisational information system, which were determined in the previous section, are used, together with the problem identification and the blueprint presented in figure 14, for the design of the eventual process model for the interorgansational information system, the Rofra | Home supplier portal. For the design of the process model, the process is divided into several steps, called milestones in the BPMN 2.0 modelling language. These milestones were created to structure the process and the created miles are:

- Create Buying Order
- Acceptance of Buying Order
- Planning Deliveries
- Making deliveries

A graphical representation of the designed process model for the interorganisational information system, the Rofra | Home supplier portal, is given below in figure 15. In this model, all the activities represent a form or a function in the eventual web application. The sequence flows dictate the way the process is going, together with the included gateways. The behaviour of the gateways which are included in the model is configured through the business rules of the process.

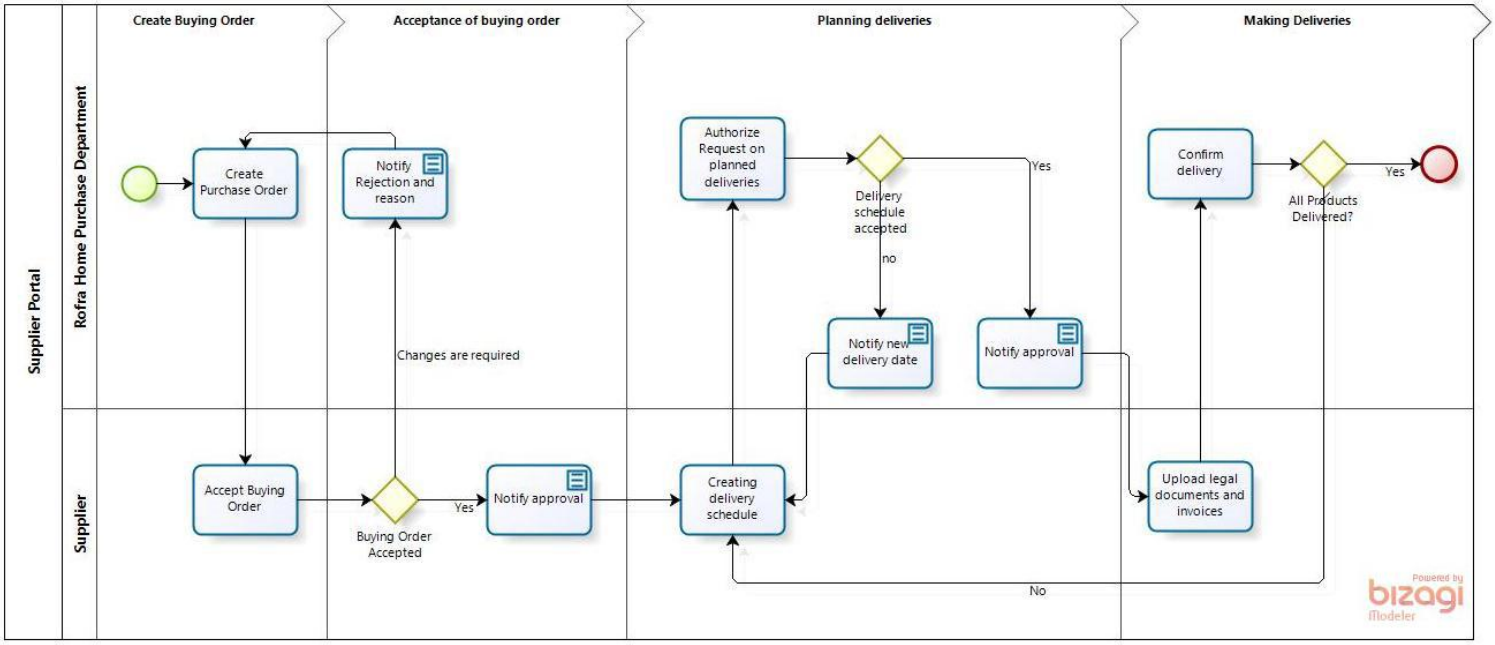

Figure 15: The designed process model for the supplier portal in BPMN 2.0 modelling language

4.2 DEVELOPMENT

4.2.1 INTRODUCTION

Based on the new designed and modelled purchasing and delivery process, the data model for the artifact, the supplier portal, is developed. After the construction of the data model, the forms for the artifact, as well as the business rules for the artifact were developed, based on the newly designed process and the determined solution objectives from the previous section. The last step in the development of the Rofra | Home supplier portal was the user assignment.

The development of the data model, the forms, the business rules and the user assignment, resulted in a demonstration version of the Rofra | Home supplier portal.

4.2.2 THE DATA MODEL

For the development of the data model, and the eventual demo of the Rofra | Home supplier portal, the software program Bizagi Studio was used. This program aligns with the software used for the modelling of the processes in the BPMN 2.0 modelling language.

The developed process model for the supplier portal was the blueprint for the development of the data model for the supplier portal. From the process model we can derive two main constructs. The first one is the purchase order that the Rofra | Home company places at an external supplier. The second construct we can derive from the process model is the delivery that the external supplier is making to the Rofra | Home company.

These constructs were than developed more into detail. Because the supplier portal has to be linked to the current Logic4 ERP-software of the Rofra | Home company, the development of the entities and variables is based on the data model structure of the Logic4 ERP- software in order to provide a seamless integration of the supplier portal into the current Logic4 ERP-software. A purchase order consists of general information like order date and order number. But a purchase order also needs to contain order rules. These order rules on their turn contain for example a product and a desired quantity. The same process was done for developing the delivery construct more into detail.

After constructing the essential entities and variables, these entities and variables were organized in different tables. Between these tables, entities and variables there are several connections in the form of relations. The next step in the process was to construct these relationships. The eventual data model for the Rofra | Home supplier portal is displayed on the next page, in figure 16.

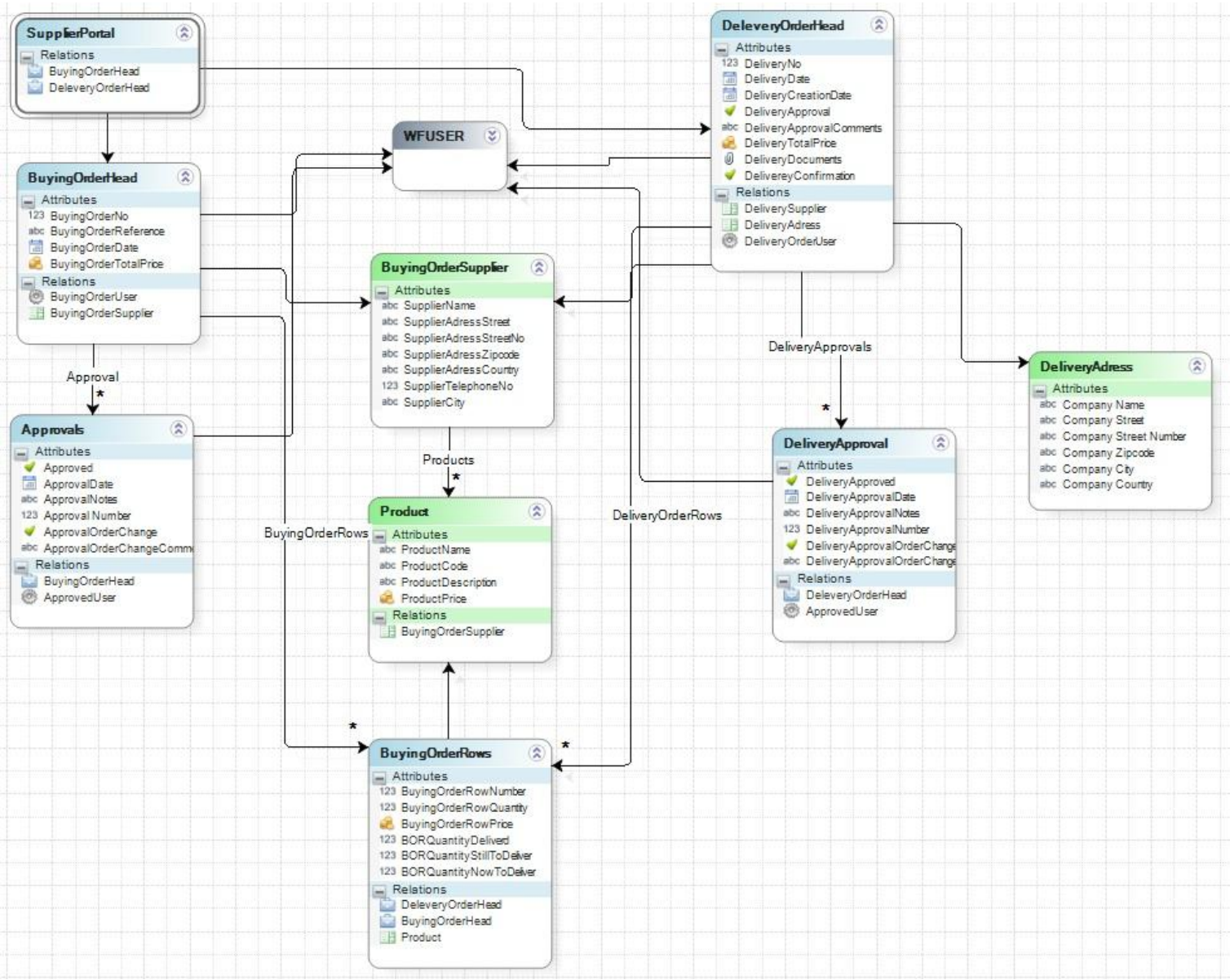

Figure 16: The data model of the Rofra | Home supplier portal.

4.2.3 FORMS, BUSINESS RULES AND USER ASSIGNMENT

After the development of the data model for the Rofra | Home supplier portal, the forms were created in the Bizagi Studio software. For every activity in the process model a form for the supplier portal web application is developed, except for the notification activities. These notification activities are set as an automated message to inform the involved user about the notification.

Subsequent to the creation of the forms, the business rules were defined for the inserted gateways in the process model. Three gateways are included, the first gateway should only let the sequence flow pass on to the next activity is the buying order is approved, otherwise it should notify the Rofra | Home purchase department that the buying order is not accepted and that changes are necessary.

The second gateway should only let the sequence flow pass on to the next activity if the scheduled delivery by the supplier is accepted by the Rofra | Home company, otherwise a notification should be send to the supplier that the Rofra | Home purchase department did not accepted the suggested delivery date, and that changes are required.

The third and last gateway is at the end of the process model of the supplier portal. This gateway should only allow the process to end, if all the goods are delivered, otherwise the sequence flow is redirected back creating a delivery, for the remaining quantity of goods.

After the creation of the forms and defining the business rules for the gateways, the users were assigned to the different activities. For the Rofra | Home supplier portal demo, two users were created. The first user is the Rofra | Home purchase department, the second user is the supplier. The assignment of the users to the different activities is an essential element in the development of the supplier portal, the right activities should be assigned to the correct user. The user assignment is also the last step in the process in creating the Rofra | Home supplier portal demo.

5. DEMONSTRATION

The aim of this chapter is to demonstrate the developed artifact, the Rofra | Home supplier portal. The demonstration of the artifact focusses on the usage of the artifact to solve the defined research problem, the accuracy of the expected delivery dates of goods ordered from external suppliers.

5.1 PROCESS SIMULATION

5.1.1 INTRODUCTION

The artifact, the Rofra | Home supplier portal, is developed in a software program called Bizagi Studio. At this moment the supplier portal is running on a local Microsoft SQL 2005 server. The supplier portal is also not connected and integrated with the current Logic4 ERP-software that the Rofra | Home company is using. Therefore the demonstration of the artifact is based on a simulation of the purchase and delivery process at the Rofra | Home company with fictitious data, and was executed on the local server.

The simulation of the purchase and delivery process was set up using the newly designed purchase and delivery process, which has been displayed in figure 15 in the previous section. For the simulation two different users were created:

User 1: Rofra | Home purchasing department
Username: Rofra
Password: 1234
Domain: domain

User 1: External Supplier
Username: Supplier
Password: 1234
Domain: domain

Based on the milestones in the newly designed purchase and delivery process, the simulation was divided into four steps, which are mentioned below. Every step of the simulation is explained and illustrated with screenshots in the next section.

The four steps in the simulation:

- Create Buying Order
- Acceptance Buying Order
- Planning Deliveries
- Making Deliveries

5.1.2 CREATE BUYING ORDER

The first step in the simulation of the developed Rofra | Home supplier portal is the creation of a purchase order by the Rofra | Home purchase department. Because the developed supplier portal is not linked to the Logic4 ERP-software at this moment, the creating of a purchase order is done by hand in the simulation. The data model of the developed Rofra | Home supplier portal however, does allow a seamless integration of the Rofra | Home supplier with the Logic4 ERP-software in order to directly upload a purchase order into the Rofra | Home supplier portal web application.

When creating the purchase order, the Rofra | Home purchase department selects the supplier from which it wants to order goods. A description of the purchase order can be given and the user that is creating the purchase order is automatically “detected” in the portal and registered as the one creating the purchase order.

A grid for the purchase order rules is filled with the goods that are ordered and the quantity of goods that will be ordered. At the same time the Rofra | Home purchase department can view the price of the ordered goods and the total order price. A screenshot from this first step is shown in figure 17, which can be found in appendix IV.

5.1.3 ACCEPTANCE OF BUYING ORDER

The second step in the Rofra | Home supplier simulation is the purchase order approval by the supplier. At the bottom of the created form the supplier can approve or decline the purchase order. When the supplier declines the purchase order, the created business rules for the gateway direct the sequence flow back to the first step. The supplier can add a reason for the decline to the approval. A screenshot from this step is shown in figure 18, which can be found in appendix IV.

When the purchase order is declined by the supplier, the process returns to the first step, giving the Rofra | Home purchase department the ability the change the purchase order. When the changes are made to the purchase order, the Rofra | Home purchase department can indicate that the required changes has been made, from which the purchase order needs again an approval from the supplier. All the approvals and approval notes are collected in a table and displayed in a grid in the purchase order. A screenshot of a declined purchase order is shown in figure 19, which can be found in appendix IV. A screenshot of a changed purchase order, returning to the supplier for another approval is displayed in figure 20, which can be found in appendix IV.

5.1.4 PLANNING DELIVERIES

After the approval the supplier starts producing the goods and need to create a delivery schedule for the ordered goods. The supplier selects a delivery date, the delivery address and the products that are delivered at that date and which quantity is delivered. A screenshot of the delivery schedule creation can be found in figure 21, which can be found in appendix IV.

The next is the approval of the delivery schedule by the Rofra | Home purchase department. The approval of the delivery schedule is done in the same way as the approval of a purchase order. If the delivery schedule is approved, the process continues to the next activity, if the delivery schedule is declined the supplier will receive a notification that the delivery schedule is declined and that it needs to be changed. A screenshot of the approval of the delivery schedule by the Rofra | Home purchase department is presented in figure 22, which can be found in appendix IV.

Because the developed supplier portal is not linked to the Logic4 ERP-software at this moment, the expected delivery dates in the customer orders cannot be updated based on the delivery information in the Rofra | Home supplier portal simulation. The data model of the developed Rofra | Home supplier portal however, does allow a seamless integration of the Rofra | Home supplier with the Logic4 ERP-software in order to directly update the customer orders in the Logic4 ERP-software with the delivery information from the supplier portal.

When the delivery schedule is approved, the next activity in the Rofra | Home supplier portal simulation is for the supplier to upload the legal documents regarding the planned delivery. For every delivery there are legal documents acquired, the process will not continue unless these documents are uploaded. A screenshot of the uploading of the legal documents is presented in figure 23, which can be found in appendix IV.

5.1.5 MAKING DELIVERIES

If the goods are delivered at the Rofra | Home company, the next step in the Rofra | Home supplier portal simulation is to confirm the delivery. A screenshot of the delivery confirmation is presented in figure 24, which can be found in appendix IV.

Because the developed supplier portal is not linked to the Logic4 ERP-software at this moment, the quantity of the delivered goods are not updated in the Logic4 ERP-software. The data model of the developed Rofra | Home supplier portal however, does allow a seamless integration of the Rofra | Home supplier with the Logic4 ERP-software in order to directly update the delivered quantities in the Logic4 ERP-software.

If all the goods are delivered the process will end in the Rofra | Home supplier portal simulation. If not all the goods are delivered, the sequence flow in the process is redirected back to the creation of a delivery schedule by the supplier in order to deliver the remaining quantity of the ordered goods.

6. EVALUATION

The aim of this chapter is to evaluate how well the developed artifact, the Rofra | Home supplier portal, supports a solution to the defined research problem, the accuracy of the expected delivery date from goods ordered from external supplier.

6.1 EVALUATION CRITERIA

6.1.1 INTRODUCTION

Based on the problem identification the specific research problem was defined as the accuracy of the expected delivery dates of ordered goods from external supplier. To transform the research problem into objectives, a theoretical framework was constructed at first. Based on that theoretical framework the research problem was positioned into its scientific context, from which knowledge about the research problem and the possible solutions was inferred. From that scientific context, knowledge about the research problem and the possible solutions was transformed into objectives for the artifact.

The defined objectives served as a blueprint for the development of the artifact, the Rofra | Home supplier portal. The performance of the developed artifact is derived from the performed simulation in the previous chapter, and the defined objectives will now serve as evaluation criteria for the evaluation of how well the developed artifact, the Rofra | Home supplier portal, supports a solution to the defined research problem.

6.1.1 EVALUATION CRITERIA

From the defined objectives for the solution we can derive that the first objective of the solution was the defined goal of the solution. The goal of the solution was defined as:

> *"The goal of the solution for defined research problem, the accuracy of expected delivery dates for goods ordered from external supplier, is to integrate and manage critical business links in the supply chain as managed process links."*

In order to achieve that goal, objectives for the structure of the solution were defined. These objectives are transformed into evaluation criteria for the structure of the artifact, and are presented below:

- **The developed artifact:**
  - is an interorganisational information system.
  - facilitates an extensive two way information flow.
  - is coordinated by using the internet.
  - have a seamless integration possibility with the current Logic4 ERP-software.

There were also objectives defined for the practical functionalities of the artifact, the Rofra | Home supplier portal. These objectives are transformed into evaluation criteria for the functionalities of the artifact, the Rofra | Home supplier portal, and are presented below:

- **The functionalities of the developed artifact should include:**
  - The ability to track shipments
  - The ability to contact vendors regarding customer service problems from late deliveries, stock-outs, alterations in scheduled shipment dates and late arrivals
  - The ability to check the status of orders placed with vendors
  - The ability to notify vendors of changes in configurations in products that are produced to order.
  - The ability to pay check outstanding debit balances.
  - The ability to directly communicate with vendors regarding supply issues on a 7-day/24-hour basis in a structured way
  - The ability to schedule pickups and deliveries

In order to evaluate how well the developed artifact, the Rofra | Home supplier portal, supports a solution to the defined research problem, based on the defined evaluation criteria, an evaluation scheme was created. The evaluation scheme consists of the defined evaluation criteria, which will be evaluated by using a four step likert scale. The first step of the likert scale, very poor, was replaced with “Not available”. The evaluation scheme is displayed below, in table 3.

Evaluation Scheme					
No.	**Artifact Structure**	**Not available**	**Poor**	**Moderate**	**Good**
1	Interorganisational Information System				
2	Extensive two way information flow				
3	Coordinated by using internet				
4	Seamless integration with Logic4				
No.	**Artifact functionality**	**Not available**	**Poor**	**Moderate**	**Good**
5	Tracking shipments				
6	Contacting vendors on service problems				
7	Contacting vendors on schipment schedules				
8	Contacting vendors on late arrivals				
9	Check status of orders placed with vendors				
10	Notify vendors about configuration changes				
11	Check outstanding debit balances				
12	Communicate with vendors 24/7				
13	Schedule pickups and deliveries				

Table 3: Evaluation scheme for the developed artifact, the Rofra | Home supplier portal

6.2 ARTIFACT EVALUATION

6.2.1 INTRODUCTION

Based on the constructed evaluation scheme in the previous section, the developed artifact, the Rofra | Home supplier portal, is evaluated. The input for the evaluation is derived from the process simulation in the previous chapter. The results of the evaluation are displayed below, in table 4.

Evaluation Scheme					
No.	**Artifact Structure**	**Not available**	**Poor**	**Moderate**	**Good**
1	Interorganisational Information System				X
2	Extensive two way information flow			X	
3	Coordinated by using internet				X
4	Seamless integration with Logic4				X
No.	**Artifact functionality**	**Not available**	**Poor**	**Moderate**	**Good**
5	Tracking shipments			X	
6	Contacting vendors on service problems	X			
7	Contacting vendors on schipment schedules				X
8	Contacting vendors on late arrivals			X	
9	Check status of orders placed with vendors				X
10	Notify vendors about configuration changes	X			
11	Check outstanding debit balances	X			
12	Communicate with vendors 24/7			X	
13	Schedule pickups and deliveries				X

Table 4: Evaluation of the developed artifact, the Rofra | Home supplier portal

6.2.1 EVALUATION RESULTS

In the evaluation all the aspects of the developed artifact were evaluated. When looking at the artifact structure evaluation results, we can see that the artifact was designed as an interorganisation information system, that it is coordinated by using internet and that a seamless integration with Logic4 is possible. The seamless integration with the Logic4 ERP-software is evaluated, based on the designed data model of the developed artifact. The data model was designed in such a way that it facilitates a seamless integration with the current Logic4 ERP-software. The extensive information flow was evaluated as moderate. This is done because the developed artifact does not offer all the practical functionalities that were defined as solution objective. Because of that, the developed artifact cannot “prevent” that email traffic between the Rofra | Home purchase department and the external suppliers is still necessary.

When looking at the evaluation of the artifact functionalities, we can conclude that several functionalities were evaluated as good in the simulation, some functionalities were evaluated as moderate and some functionalities are not available in the developed artifact, the Rofra | Home supplier portal.

The tracking of shipments and the contacting vendors on late arrivals were evaluated as moderate. The moderate evaluation is based on the fact that when the ordered goods depart from the external supplier, there is no possibility in the developed artifact to track the goods on their journey to the main warehouse of Rofra | Home in Vaassen. Based on the uploaded legal documents and freight documents the freight can be traced manually. Therefore these functionalities were evaluated as moderate.

The scheduling of pickups and deliveries, as well as contacting vendors about shipment schedules, were evaluated as good. In the performed simulation the supplier created a delivery schedule, which needed to be approved by the Rofra | Home purchase department. Therefore these functionalities of the developed artifact were evaluated as good.

The status checking of placed orders at external suppliers was also evaluated as good, based on the performed simulation. The supplier has to approve the purchase order that have been created by the Rofra | Home purchase department, in order to continue the sequence flow in the developed artifact. Also by the creation of a delivery schedule, and the delivery conformation, the status of the purchase order is followed throughout the whole purchase and delivery process. Therefore the status checking of placed orders functionality of the developed artifact was evaluated as good.

The communication with vendors 24/7 was evaluated as moderate. Based on the fact that, as stated before, the developed artifact cannot "prevent" that email traffic between the Rofra | Home purchase department and the external suppliers is still necessary. However, trough the coordinating the artifact by using internet, the communication that takes place within the developed artifact, is possible 24 hours a day, 7 days a week. Therefore this functionality was evaluated as moderate.

Contacting the vendor about service problems was evaluated as not available, as well as notifying the vendors about configuration changes and checking outstanding debit balances. These functionalities are not available in the developed artifact, and therefore evaluated as not available.

6.2.1 EVALUATION CONCLUSION AND RECOMMENDATIONS

When looking at the evaluating results, we can conclude that the developed artifact was evaluated good at some evaluation criteria, and less good on other evaluation criteria. The goal of the developed artifact was defined as:

> *"The goal of the solution for defined research problem, the accuracy of expected delivery dates for goods ordered from external supplier, is to integrate and manage critical business links in the supply chain as managed process links."*

Based on the evaluation results we can conclude that the evaluation criteria of the developed artifact which were rated as good, contribute to the integration of critical business links in the supply chain, in order to enhance the accuracy of the expected delivery dates for goods ordered from ordered external suppliers.

The developed artifact was also evaluated as moderate on some evaluation criteria, and even some functionalities were not available in the developed artifact. Therefore we would recommend the development of these functionalities, in order to enhance the accuracy of the expected delivery dates for goods ordered from ordered external suppliers even more.

Shipment and tracking information can be added to the artifact by integration external services such as Marine Traffic into the developed artifact. Marine Traffic is an external service which can trace vessels all over the world, based on ship ID or ship name. This external service offers an XML connection, to integrate the tracking information into the developed artifact.

To enhance the two way information flow we would recommend the integration of the not available functionalities into the developed artifact. When these functionalities are integrated in the artifact, any email traffic between the Rofra | Home purchase department and the external suppliers is not necessary any more.

7. CONCLUSION AND DISCUSSION

This bachelor thesis is finished with a conclusion which is based on the performed research. This chapter also contains a discussion about the findings of the research and the methodology that was used to perform the research.

7.1 CONCLUSION

The aim of this research was to develop and build a prototype of the Rofra | Home supplier portal for sharing essential information throughout the supply chain, in order to resolve the "red rule problem". The research question for this research was defined as:

“How should the Rofra | Home supplier portal be designed, for sharing essential information throughout their supply chain, in order to resolve the "red rule" problem?”

In order to answer this research question a six design science research methodology was used. The design research on the Rofra | Home supplier portal was conducted by following a problem centered approach.

In the first process step of the research the specific research problem was defined as the accuracy of the expected delivery dates of ordered goods from external supplier, which was indicated as the cause for the “red rule” problem at the Rofra | Home company.

At the next step the specific solution objectives were defined. The goal of the solution was to integrate and manage critical business links in the supply chain as managed process links. The solution objectives were defined as structure objectives for the artifact and functional objectives for the artifact. The defined objectives served as a blueprint for the development of the artifact.

The desired functionality and the architecture of the artifact were designed and modelled at first, based on the determined solution objectives. Based on the model and analysis of the current situation, ass also on the determined solution objectives, the desired functionality and the architecture of the new artifact was designed, and modelled into a new purchasing and delivery process. From there on a demonstration version of the artifact was developed.

The demonstration version of the artifact was used for a simulation of the newly designed purchasing and delivery process. Based on this simulation the developed artifact was evaluated. For the evaluation of the artifact, the developed solution objectives were transferred into evaluation criteria, and structured in an evaluation scheme.

Based on the evaluation results we concluded that the evaluation criteria of the developed artifact which were rated as good, contribute to the integration of critical business links in the supply chain, in order to enhance the accuracy of the expected delivery dates for goods ordered from ordered external suppliers. We recommended that in order to enhance the two way information flow, which was evaluated as moderate, the integration of the not available functionalities into the developed artifact should happen.

Overall we can conclude that the developed artifact did contribute at resolving the “red rule” problem, but that the missing functionalities in the developed demonstration version of the artifact could enhance the integration of critical business links in the supply chain, in order to improve the accuracy of the expected delivery dates for goods ordered from ordered external suppliers, which will resolve the “red rule” problem.

7.1 DISCUSSION

The defined “red rule” problem at the Rofra | Home company is not a unique problem in the supply chain management practice. The theory about supply chain integration and supply chain management is extensive about this subject. But is integration in the supply chain, the solution for this problem? And what are the risks of the supply chain integration?

It looks like the theory studied about supply chain integration is very about those questions. Supply chain integration enhances supply chain performance. But what is actually happening when we talk about supply chain integration? The development of the Rofra | Home supplier portal is a perfect example of the answer to that question.

The developed artifact, the Rofra | Home supplier portal, integrates certain business processes in the Rofra | Home supply chain. These processes are linked together, and defined as supply chain integration. What actually happens is that by the integration of these processes, the transparency in the supply chain increases. We saw that with the developed supplier portal, it increases the transparency in the supply, by structuring the information flow. The results of the simulation of the developed supplier portal show also that a certain benefit can be obtained in the form of efficiency. The information flow is more structured, and can therefore be processed much more efficient.

But what are the seam side of this integration in the Rofra | Home supply chain? In the current situation the Rofra | Home company controls their own processes and these processes are “protected” for influences from outside the company. But when integrating in the supply chain, the own business process is directly connected to the processes of their supplier. The information provided by the supplier in the portal, becomes leading for their own business process. Who is controlling the quality of the information in this new situation? And what happens if the wrong information is entered by the supplier, and directly processed in the Rofra | Home business process? The dependence on the information, and the quality of the information increases for the Rofra | Home company.

Therefore we can question if supply chain integration does improve supply chain performance. Supply chain integration leads to both a more transparent supply chain, and on the seam side, supply chain integration leads to a greater dependence in the supply chain.

Based on that statement we discover the need, and the necessity for a monitoring system, which monitors the quality of the information, the reliability of the information and the accuracy of the information. Without monitoring these elements closely, the own business process becomes vulnerable for failures of supply chain partners.

Therefore we would like to recommend as a subject for further research on supply chain integration, and especially the integration of information flows in the supply chain, that a monitoring system, which monitors the quality of the information, the reliability of the information and the accuracy of the information, is researched and developed.

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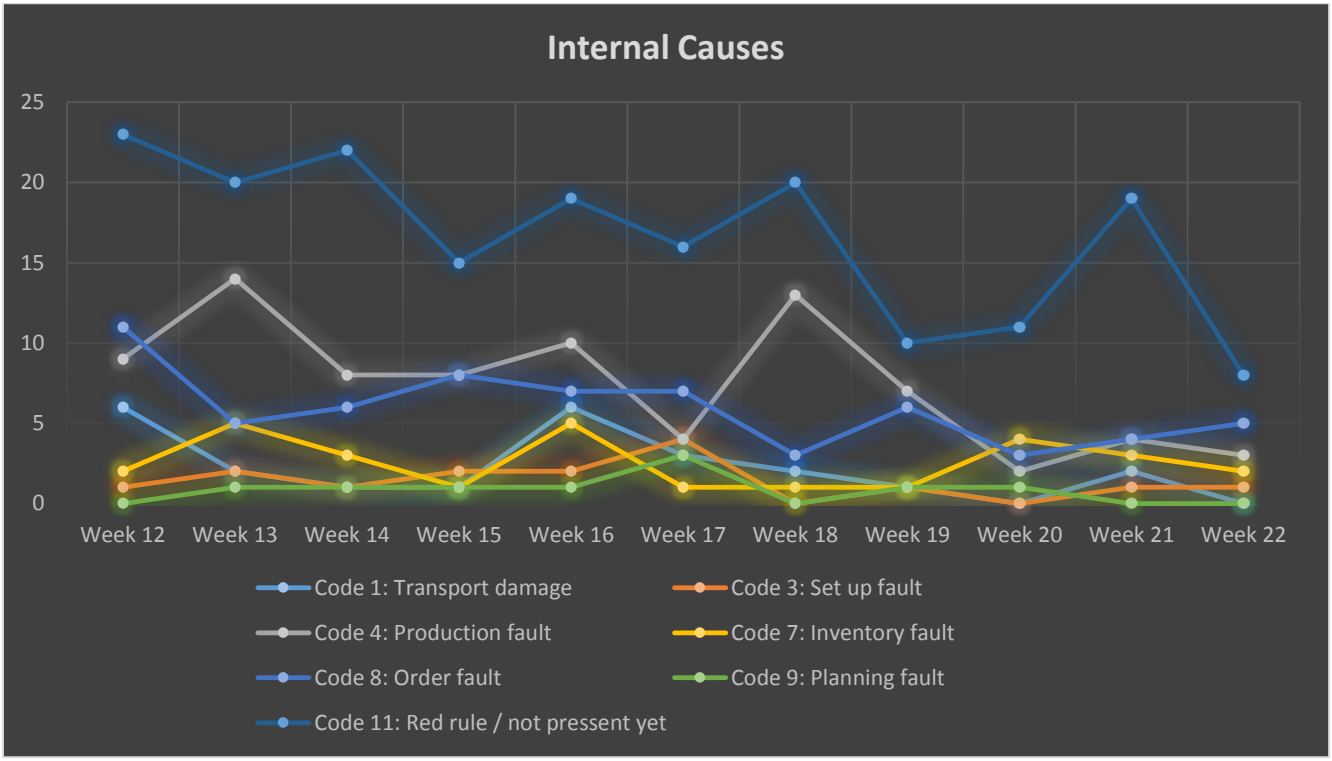
APPENDIX

APPENDIX I

Code and Description:	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19	Week 20	Week 21	Week 22	Total:
Code 1: Transport damage	6	2	1	1	6	3	2	1	0	2	0	24
Code 3: Set up fault	1	2	1	2	2	4	0	1	0	1	1	15
Code 4: Production fault	9	14	8	8	10	4	13	7	2	4	3	82
Code 7: Inventory fault	2	5	3	1	5	1	1	1	4	3	2	28
Code 8: Order fault	11	5	6	8	7	7	3	6	3	4	5	65
Code 9: Planning fault	0	1	1	1	1	3	0	1	1	0	0	9
Code 11: Red rule / not pressent yet	23	20	22	15	19	16	20	10	11	19	8	183
Total:	**52**	**49**	**42**	**36**	**50**	**38**	**39**	**27**	**21**	**33**	**19**	406

Table 5: Internal Causes

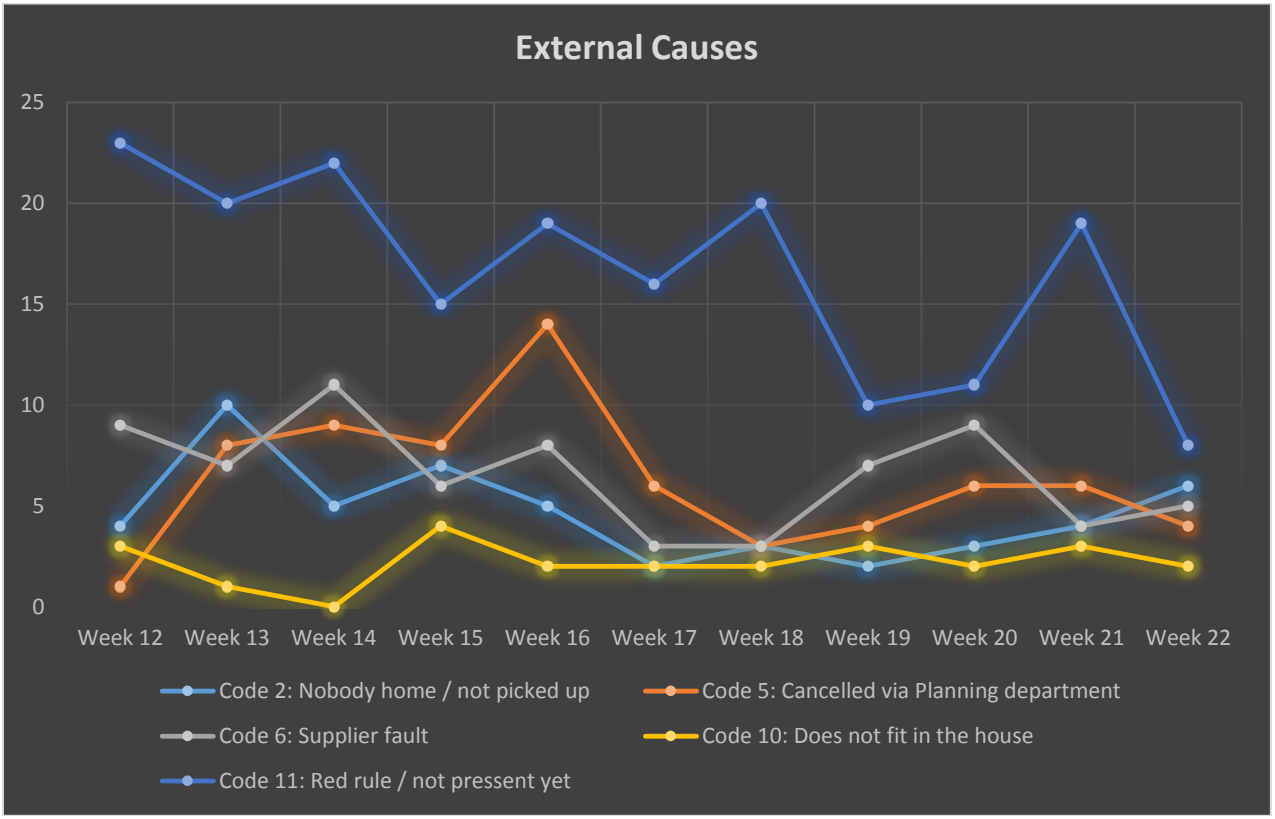


Graph 1: Internal Causes

APPENDIX II

Code and Description:	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19	Week 20	Week 21	Week 22	Total:
Code 2: Nobody home / not picked up	4	10	5	7	5	2	3	2	3	4	6	51
Code 5: Cancelled via Planning department	1	8	9	8	14	6	3	4	6	6	4	69
Code 6: Supplier fault	9	7	11	6	8	3	3	7	9	4	5	72
Code 10: Does not fit in the house	3	1	0	4	2	2	2	3	2	3	2	24
Code 11: Red rule / not pressent yet	23	20	22	15	19	16	20	10	11	19	8	183
Total:	**40**	**46**	**47**	**40**	**48**	**29**	**31**	**26**	**31**	**36**	**25**	**399**

Table 6: External Causes



Graph 2: External Causes

APPENDIX III

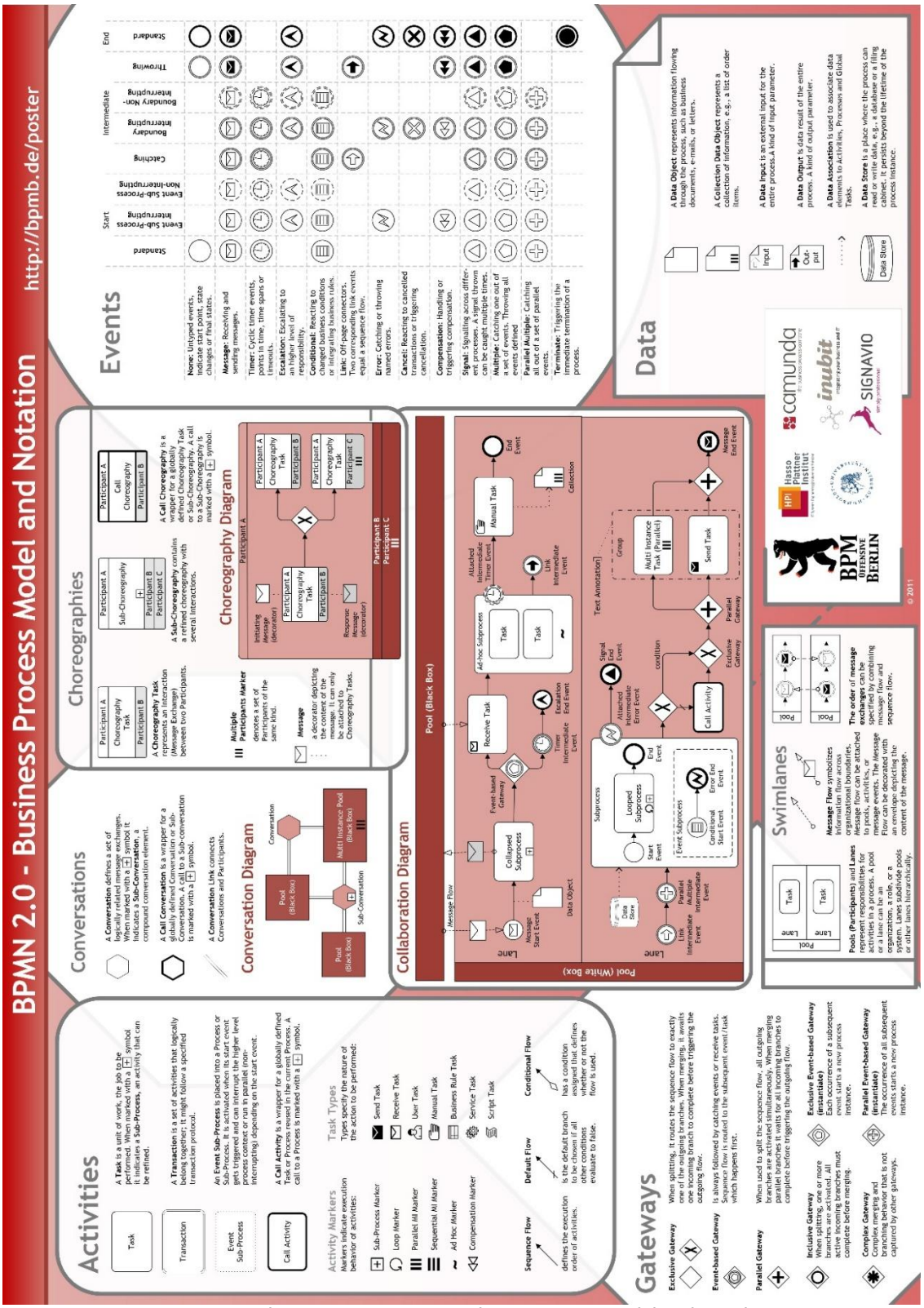


Figure 17: BPNM 2.0 Business process model and notation

APPENDIX IV

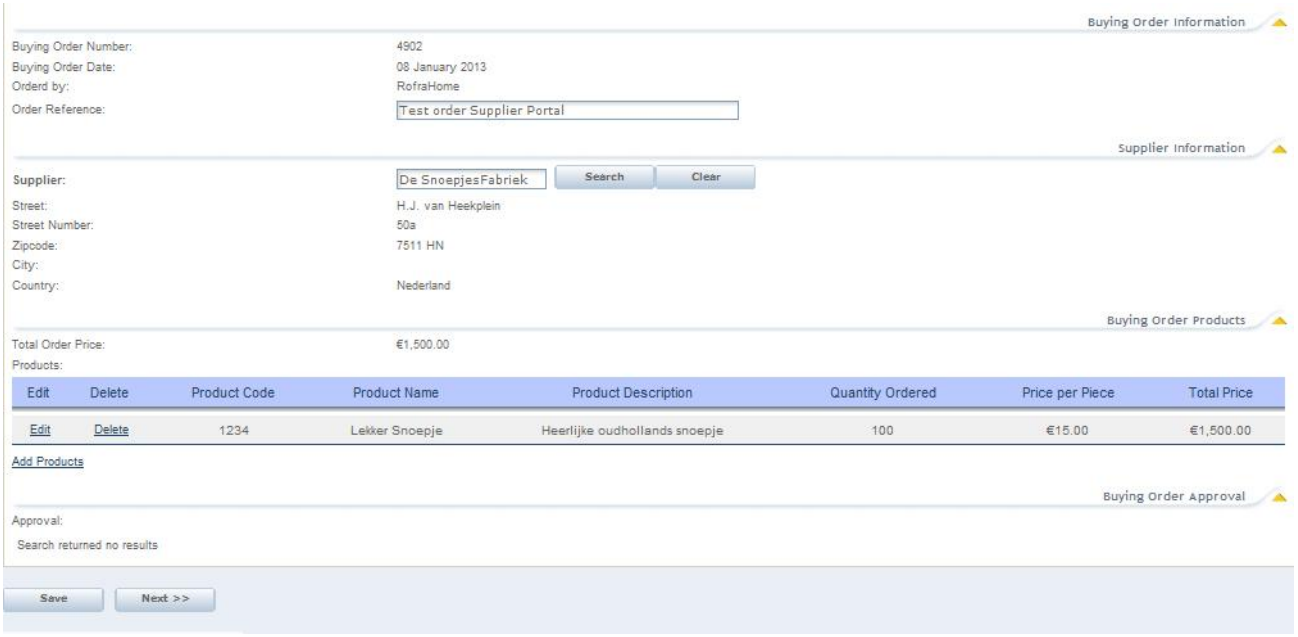


Figure 17: Step one in the Rofra | Home supplier portal demo

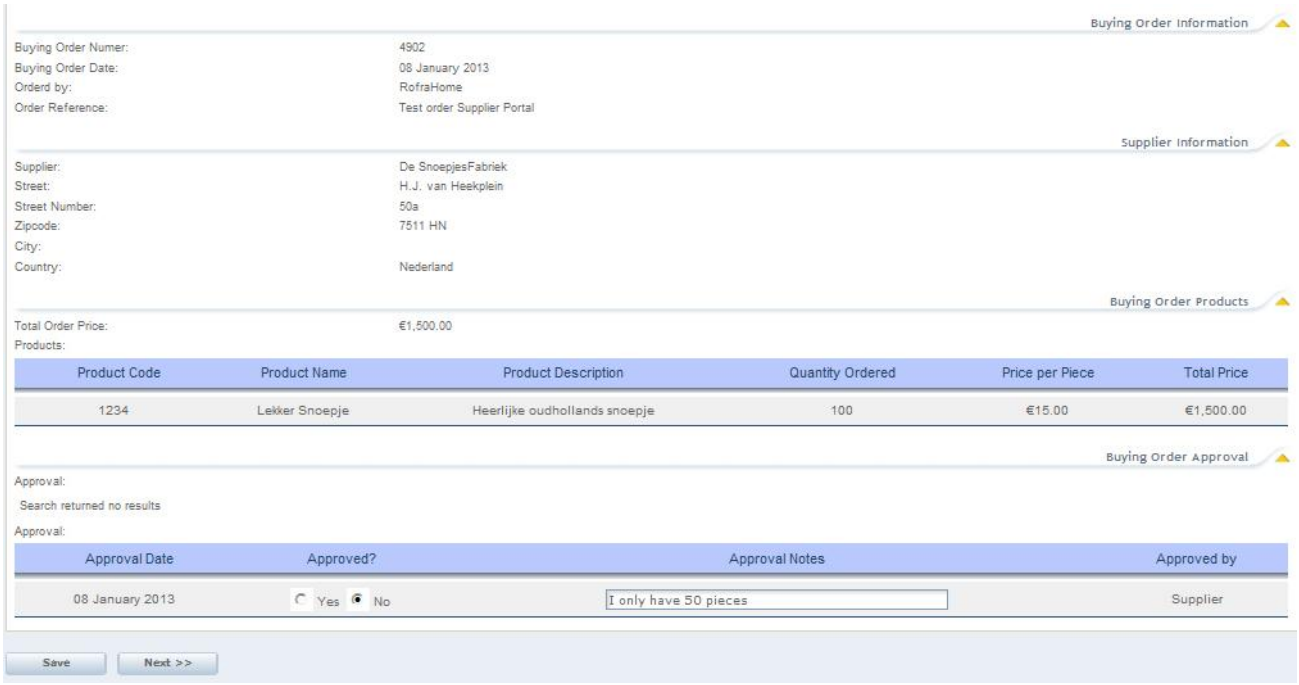


Figure 18: Step two in the Rofra | Home supplier portal demo

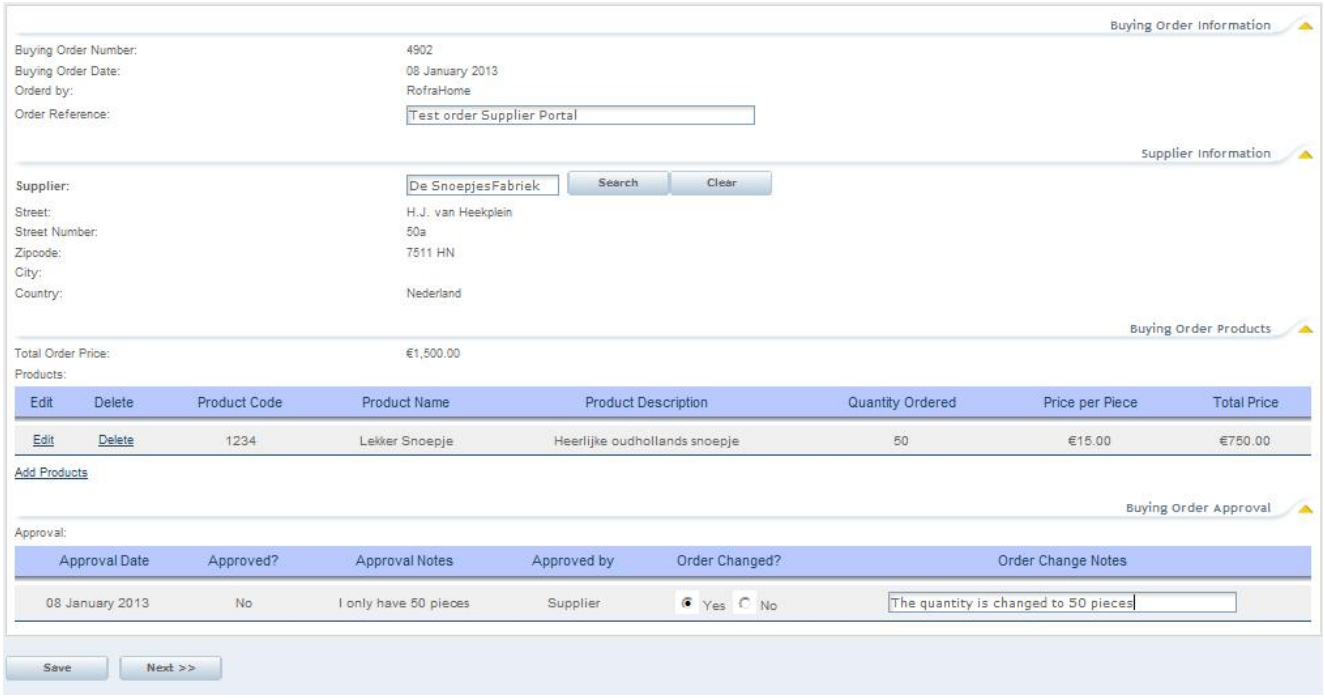


Figure 19: A declined purchase order which need adjustment by the Rofra | Home purchase department

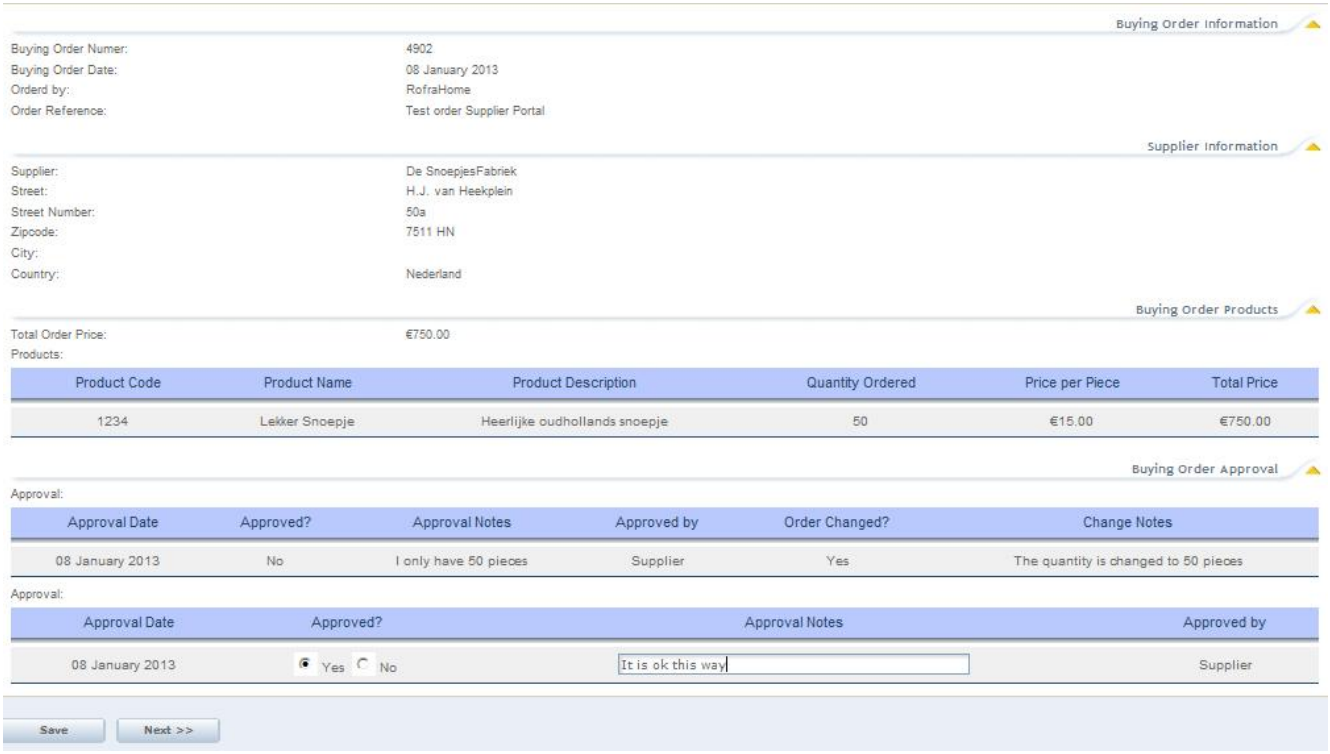


Figure 20: A declined purchase order which has been adjusted and need another approval of the supplier

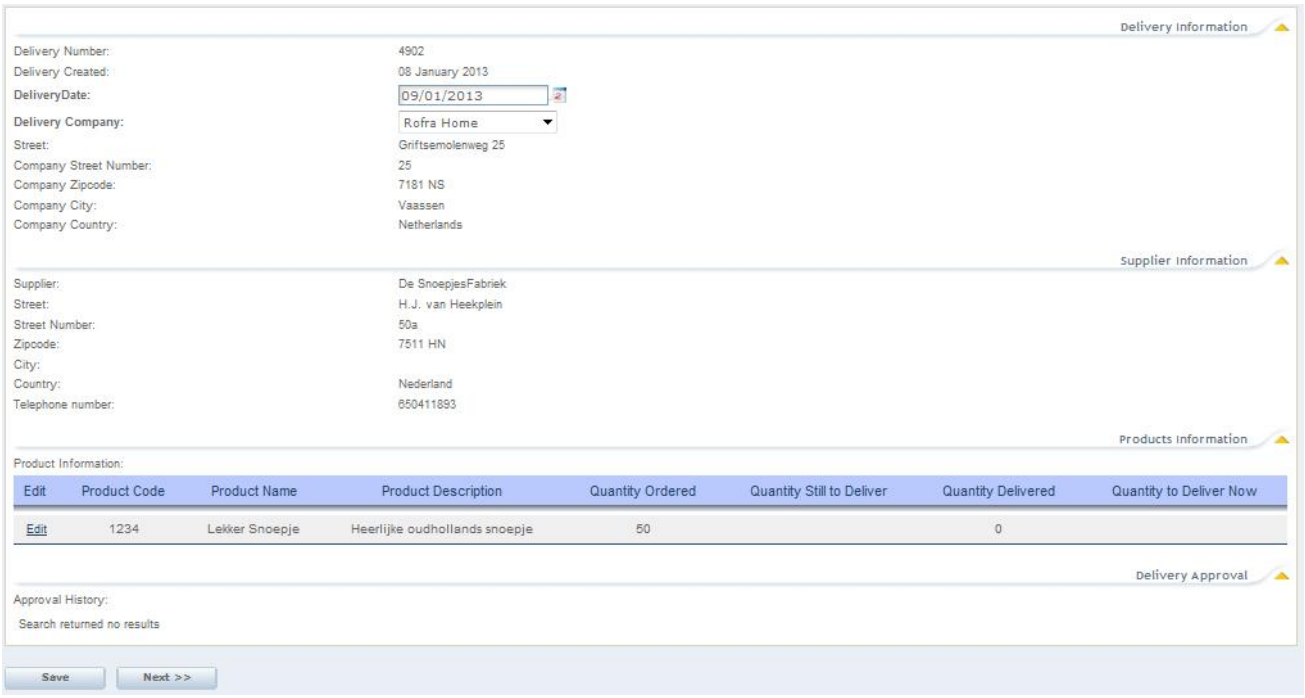


Figure 21: The creation of a delivery schedule in the Rofra | Home supplier portal demo

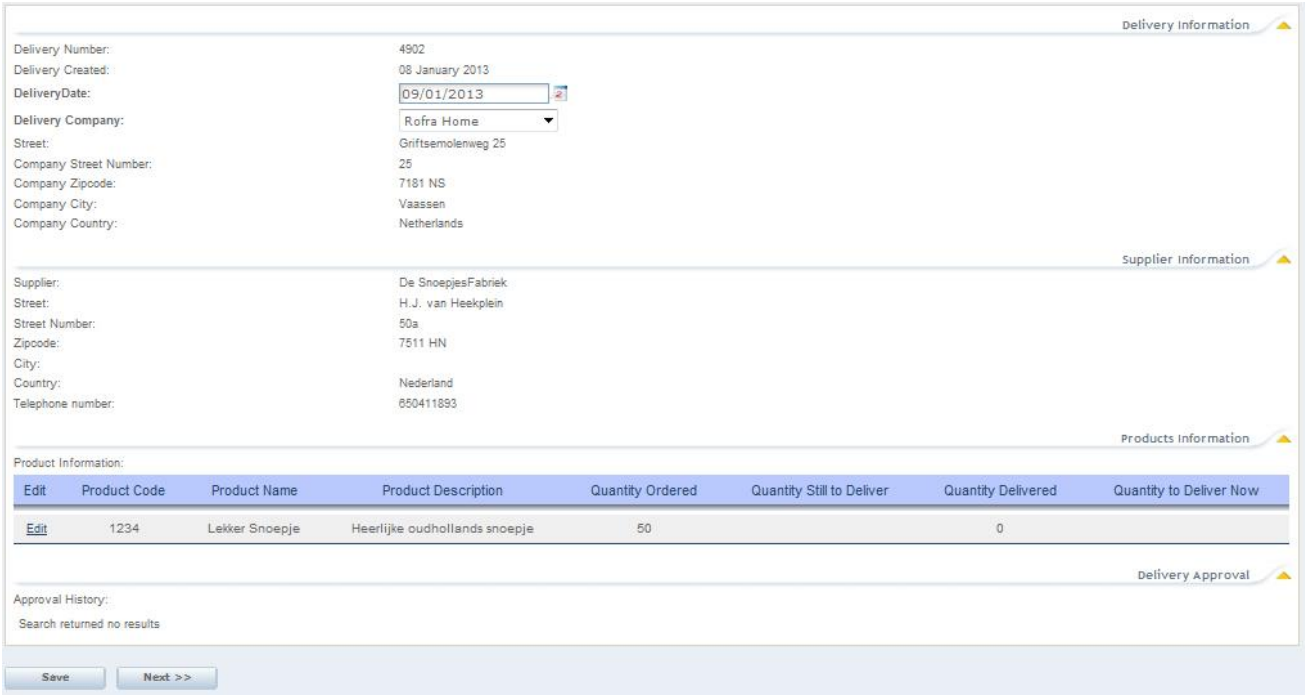


Figure 22: The approval of the delivery schedule by the Rofra | Home purchase department

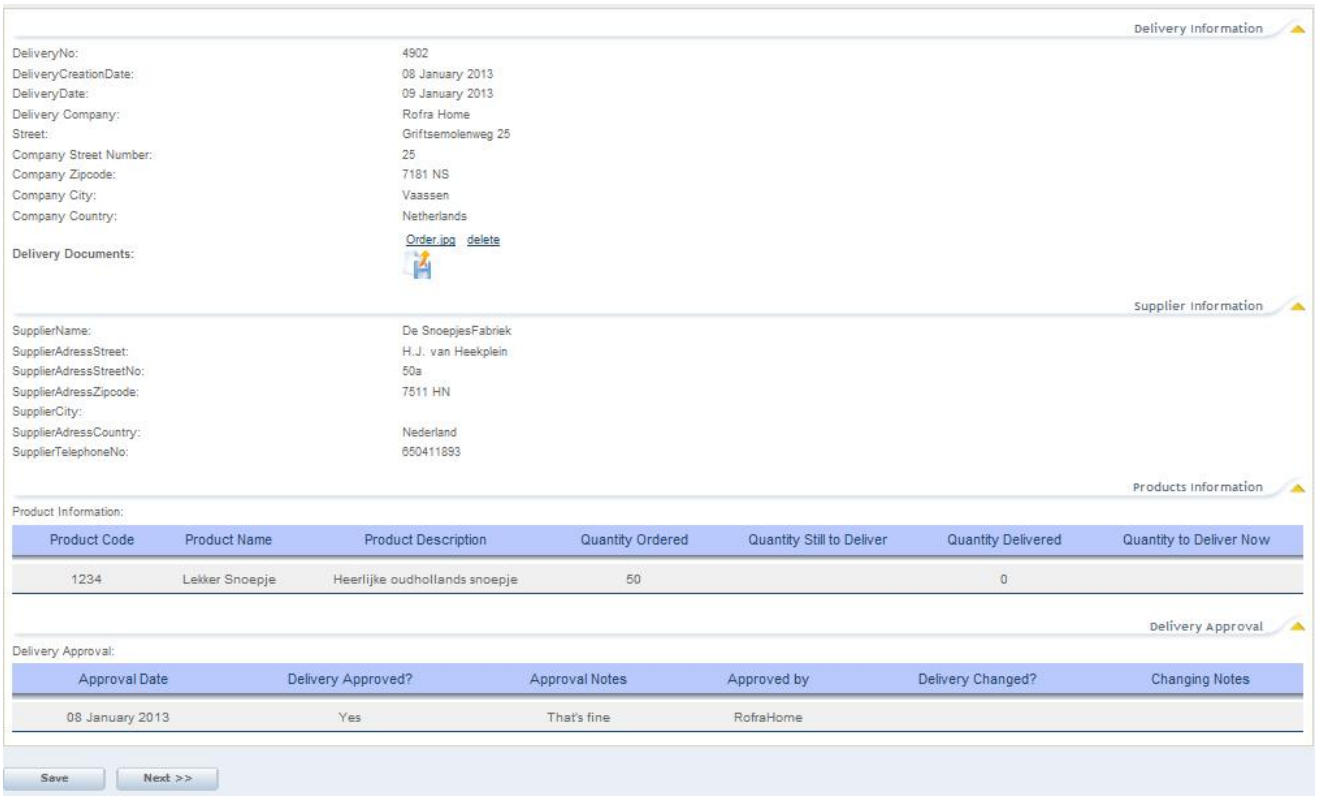


Figure 23: a screenshot from uploading the legal documents by the supplier in the supplier portal demo

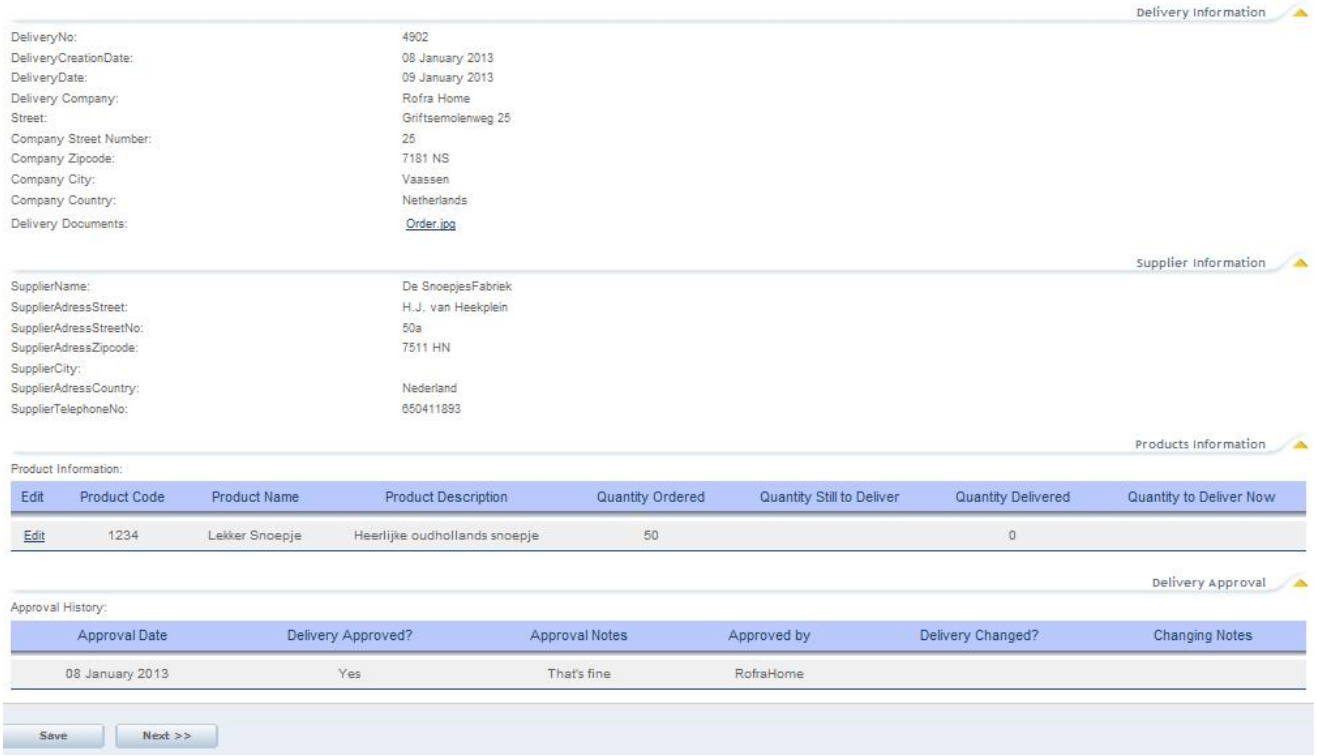


Figure 24: The confirmation of the delivery by the Rofra | Home purchase department