FINAL PROJECT REPORT

BPJ 420

Workflow Solution for Multiple Departments and their Requirements

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EXECUTIVE SUMMARY

In this report it is firstly stated who the company Agrinet is and what workflow entails. The problem is stated which is that the current workflow system is flawed and that the aim of the project is solving these problems. The instances of problems experienced are classified in the main groups that include duplication of efforts, unsegregated duties, un-centralised changes, an unclear and slow approval process and a too paper-based process.

The literature study includes workflow concepts, motivation for the choice of business process modelling notation and different workflow improvement theories that include the theory of constraints, business process re-engineering, lean manufacturing, business process maturity and SCOR performance metrics. Literature is also reviewed on approaches for achieving the aim, such as the FAST system analysis method and the model-based and integrated process improvement methodology.

The project approach is formulated based on the literature and involves steps such as a problem investigation, conceptual design, solution development, solution verification, -analysis and -validation and a future implementation and benchmarking plan. The problem investigation phase comprises of identifying the actors, documenting the process, investigating the current usage of electronic data interchange, depicting the service level agreement with Embrace, modelling the process with a context DFD and business process modelling notation and evaluating the business process maturity.

The conceptual design includes the identification of the functional requirements that are created by identifying problems in the process and designing solutions for them. Non-functional requirements are also identified with the usage of the PIECES framework defining general element that would make the solution satisfactory. These functional requirements are then added to the AS IS process to create the TO BE process or solution. Additionally a second solution is developed as there are functional requirements that describe electronic data interchange as sole communication mode which eliminates a significant amount of solution 1's process steps.

In the solution verification phase the designer confirms that all the problems and non-functional requirements are addressed by solution 1 and it is also found that solution 2 addresses these non-functional requirements to a greater extent. The business process maturity of solution 1 is found to be at level 2, defined and solution 2's is at 4, integrated. Although it seems at this point that solution 2 is the better solution, further analysis is conducted such as a feasibility study for only using electronic data interchange. As it is found feasible a cost analysis is conducted and used as input to the positive impact matrix, used to finally establish solution 2 as the best solution.

The chosen solution is validated, with a positive response from both experts and an implementation plan is developed by ranking the use cases according to certain criteria and creating a road map for the implementation of only electronic data interchange as communication mode. As the business process maturity level is now at level 4, metrics are chosen from the SCOR framework to measure and benchmark the process. It is concluded that although it is a long term solution, solution 2 will be implemented with the outlined steps. Areas for further investigation are lastly identified in the conclusion.

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GLOSSARY

Abbreviation	Meaning
#	Amount/ Number
APICS SCC	APICS Supply Chain Council
B2B	Business to Business
BPI	Business Process Improvement
BPM	Business Process Management
BPMN	Business Process Modelling Notation
BPR	Business Process Re-Engineering
CN	Credit Note
COD	Cash on Delivery
Context DFD	Context Dataflow Diagram
DN	Delivery Note
DRP	Distribution Resource Plan
EDI	Electronic Data Interchange
ERD	Entity Relationship Diagram.
ERP	Enterprise Resource Planning
F4F	First for Farmers
GRN	Goods Received Note
GRV	Goods Received Voucher
IS	Information System
MIPI	Model-Based And Integrated Process Improvement
PO	Purchase Order
SLA	Service Level Agreement
SO	Sales Order
SCOR	Supply Chain Operations Reference

1. INTRODUCTION AND BACKGROUND

The company Agrinet supplies and distributes industrial products, general merchandise and irrigation products to retail and industrial markets in sub-Saharan Africa. Agrinet thus forms part of a bigger supply chain in which it sometimes partake the role of intermediate customer in the buying of products to add value to and re-sell. Agrinet is a large company with a cost of sales of 600 million rand to purchase the 240 thousand orders received per year and annual turnover of 1 billion rand. The company has two outlets, one in Bellville and one in Samrand and it is Agrinet Samrand that is the focus of this project.

Agrinet buys make-to-stock as well as make-to-order products form their suppliers as per forecast, based on previous years' and months' forecasts and as new and old customers request it. The products are classified according to the following main types: hardware, outdoor, electrical, agricultural (that is subdivided into "paints & accessories" and "gardening"), mechanical, irrigation (that is subdivided into "technical" and "general and systems") and power products.

The workflow is the flow of information through the business entity regarding the products and transactions or master data, with inputs from different actors who carry out the work in the process. As workflows are responsible for the execution of processes and transfer of master data through departments it needs to be maintained as it impacts important business aspects such as inventory management, general efficiency and customer satisfaction.

The scope of the project is on the procurement organization master data workflow (and all the departments therein). The actors are the entities that directly or indirectly carry out work, which in the case of the procurement organization of Agrinet, are the following:

1) The **procurement manager** who is responsible for the whole procurement organization, everyone else fall underneath his authority.
2) The **workshop manager** who is responsible for all the warehouse personnel at the receiving department.
3) The **product managers** who are associated with all the main types of products and responsible for the applicable buyers, consultants, technical sales representatives and telephonic sales personnel. They can be described as middle-management and report to the procurement manager.
4) The **junior product managers** are assigned underneath product managers when a type of product is subdivided, they are also responsible for the buyers concerned.
5) The **head of inventory** who is responsible for the demand planner.

The structure is depicted in this simple organogram (Figure 1). The full organogram can be found in appendix B.

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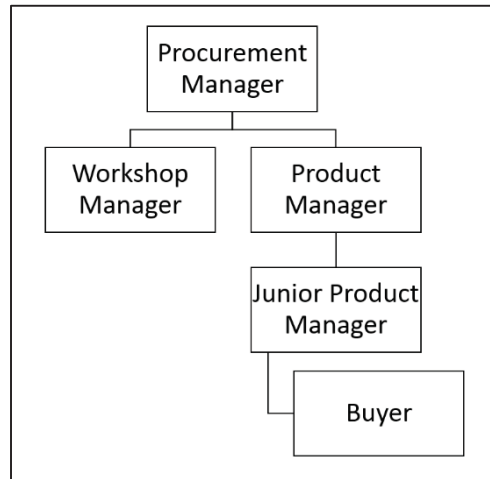
Figure 1: Basic Organogram of Procurement Organization

The other departments that also play important roles are the **creditors department** who authorise payment to the suppliers, the **finance department** that pays the suppliers and the **call centre** who is responsible for receiving sales orders from customers. The actors that are employed by Agrinet are referred to as the internal actors and the actors that Agrinet receive goods from or supply goods to are the external actors, the **suppliers** and **customers**. All of the actors and their roles are described in more detail in chapter 4 of the report, the problem investigation.

The master data is the critical data that is shared and used by the different applications that the enterprise resource planning (ERP) system consists of and can be divided into four categories: "Parties", for instance suppliers, "places", "things" that represents the products and "financial and organizational" master data such as organizational structures.

The workflow of the following types of master data of Agrinet will be investigated, as they are relevant to the scope of the procurement organization (Table 1):

Table 1: Master Data Type, Entity and Amount

Master Data Type	Entity	Amount
Parties	Suppliers	900
Things	Products	19 000 SKU's
Financial and organizational	Cost price	Related to product

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The master data of a product includes the following items (Figure 2):

Product Master Data
*Product Code (PK)
*Product Description
*Applicable Outlet
*Stock Pareto
*Minimum Order Quantity
*Preferred Supplier
*Product Status
*Cost Price
*Selling Price

Figure 2: Example of Product Master Data

1) **Product code:** The code as assigned by Agrinet.
2) **Product description:** What the product is.
3) **Applicable outlet:** Which outlet the product is allocated to: Bellville or Samrand.
4) **Stock pareto:** A code relating to the status of the particular product, which can be either A, B, C, D or N. For example N is used for a "non-stock item" which means that the product is not stocked and will have to be ordered for the first time. B and C is employed for "fast moving consumer goods".
5) **Minimum order quantity:** The batch size in which a product can be ordered.
6) **Preferred supplier:** The supplier- or vendor code, as assigned by Agrinet, relates to a particular supplier of that product. (Every product is automatically linked to a supplier upon being registered on the system.)
7) **Product status:** A product can either be available, ordered, currently in transit or a back order. The latter is applicable to the buyer who needs to fulfil the back order by buying the amount of the product as indicated by the system.
8) **Cost price:** The price at which a product is bought at a supplier.
9) **Selling price:** The price at which a product is sold to a customer.
10) **Buyer:** Who the buyer of a particular product is, based on the type of product.

Each supplier has a similar master data file that includes the supplier number, where the supplier is based, what the preferred communication mode of the supplier is which can be fax, email, telephone or electronic data interchange (EDI) and all other relevant information about the supplier. Embrace automatically recognises this preferred communication mode and will take that into account with transactions and communicate with the supplier in that way.

Agrinet makes use of the ERP system called Embrace that also manages the workflow and is linked to the program Optimiza to make use of its planning and forecasting capabilities. Embrace consists of different modules that a business would buy, depending on what its business needs are. Agrinet, as a distribution centre, bought and use the following modules: accounts payable, cash book, inventory management, output management, purchasing, warehouse management, web services and workflow.

EDI is when internal actors directly communicate with external actors by means of the ERP system. The external actors i.e. the suppliers and customers can thus be divided into two categories: EDI and non-EDI. With non-EDI instances, the system is not automatically updated, but the information is received through a paper-based method and has to be manually inserted into the system by one of the internal actors that are applicable.

Although the company is functioning well, there are problems with regard to the workflow or business processes. Management listed the types of problems, as seen in
Table 2, with a key assigned to each of them to match to an occurrence of this problem in Table 3.

Table 2: Key of Master Data Workflow Problems

Key	Type of Problem	Meaning of Problem
D	Duplication of efforts	The same task is repeated more than once.
U	Unsegregated duties	Duties are not distributed between actors and too many tasks has to be completed by an actor.
C	Un-centralised changes	It relates to duplication of efforts, where the same amendment to the system has to be repeated.
A	Unclear and slow approval process	Some activities need to be approved before execution, it is not always clear who is responsible for the approval and the approval process takes time.
P	Too paper-based process	The information system's capabilities are not utilised as much as it could be. Tasks that could be automated are executed manually.

Table 3: Identified Problems

#	Identified Problems	Category
1.	Purchase orders are manually followed up on.	D, P
2.	Documents are physically transferred between departments and not electronically.	D, P
3.	The process is executed in a very sequential fashion.	U
4.	There are a lack of checks and approvals for some of the activities performed.	A
5.	Some approval processes such as that of the forecasts are very long and tedious.	A, D
6.	There are a lot of non-EDI customers and suppliers requiring more manual efforts from the internal actors.	C, D, P

The instances mentioned are but a few of the symptoms of the flawed workflow system and further investigation into the problems are presented in chapter 4. The aim of the project is to design a workflow solution to eliminate or mitigate the currently experienced problems. The aim of the project can thus be translated as to improve the business processes involving the users and the information system.

2. LITERATURE REVIEW

2.1   Describing Workflow

Some of the important concepts with regard to workflow are described below. The terminology is used throughout the report and it is explained to clarify what is meant when a certain term is used along with examples related to the project.

*The following definitions, from "workflow" to "actor" are listed as described by Van der Aalst and Van Hee (2004) in their book entitled *Workflow Management*.

Workflow* is described as all the cases, resources and triggers that relate to a certain process. As mentioned in chapter 1, a business process is a synonym for workflow.

The **cases*** can be described as products in progress, for instance a particular sales order placed by a customer that receive a particular sales order code.

A **task*** is a particular process, like following up on purchase orders. It is an atomic process that cannot be subdivided. Tasks are not linked to specific cases, but the same tasks are carried out for many cases. There are three different types of tasks:

1) Manual tasks are performed by people without any application intervention, like signing a document.
2) Automatic tasks are performed by applications without any human intervention.
3) Semi-automatic tasks involve interactive applications like word processors.

A **work item*** is a combination of a case and task which is about to be carried out. The work item disappears when it is acted upon, in other words, when the performance of the task starts it is referred to as an **activity***. By looking at the case's state it can be determined which work items are waiting to be handled. For instance a distribution resource plan (DRP) that needs approval.

A work item can be carried out, or in other words, a task can be performed once the state of the applicable case allows it. **"Triggering"** or a **trigger*** is when a resource has taken initiative to act upon a work item or perform the task to transform it into an activity. Not all work items require triggers as they are automatically performed without the involvement of other resources. There are three different types of triggers:

1) Resource initiated (for instance a buyer that must first retrieve the order from their "in-tray").
2) Externally generated (with the arrival of an electronic data interchange or EDI message at the supplier of an order placed).
3) Time based.

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A **resource*** can be described as an agent, participant, user or performer. They are the means of production and include actors or people, applications, departments and business units. A certain resource can only perform a certain task and they are also grouped into different **resource classes***. A certain resource can belong to more than one resource class and they are divided based on the place they have in the organization (for example they may be part of the creditors department) or because of the functional characteristics or skills they possess like a buyer. The latter can be described as the **role** assigned to the resource.

An **actor*** is the person, machine, or organizational unit that directly or indirectly carries out the work.

2.2 Workflow Patterns

The student is familiar with the flowcharting technique or business process modelling notation (BPMN), which is why it was the first choice when having to decide which notation to use. In order to ensure that it would be sufficient, the most basic workflow patterns are described below by Van der Aalst et al. (2003) and compared to the patterns available in BPMN (White, 2004) in .

Table 4: Workflow Patterns of Van der Aalst et al. (2003) Compared to BPMN Patterns of White (2004)

#	Workflow Pattern	Description	BPMN Notation
1.	Sequence	An activity that can only be enabled if a prior activity has been completed.	A simple arrow is used to show that two processes happen in sequence, it is called a normal flow.
2.	Parallel split (AND-split)	Where a case is divided into more than one part that can be worked on at the same time.	A diamond or gateway with a cross is used to show that the following processes can be completed in parallel.
3.	Synchronization (AND-join)	The opposite of a parallel-split as many different activities converge into one task that has to be performed after the prior tasks have all been completed.	A parallel gateway is used once again to illustrate the synchronization as the processes come together at the gateway.
4.	Exclusive choice (XOR-split)	It is a certain point in the process of workflow where only one of a few workflow options can be chosen.	An inclusive gateway or a diamond, with or without an "X" in the middle is used after which the different processes are shown.
5.	Simple merge (XOR-join)	When a number of workflow paths re-converge. It is not the same as synchronization as only one condition has to be met for the next task to be performed.	A gateway is used to show a merge, the flows come together at the gateway.

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6.	Multi Choice (OR-Split)	When a point in the process is reached where more than one of the branches can be chosen.	It is modelled with an inclusive gateway with a circle in it.
7.	Synchronizing merge	It is a certain stage in the workflow process when more than one paths join as one.	Modelled as an inclusive gateway where many flows exit through the gateway as one.
8.	Multi-merge	The place in the workflow process where at least two processes re-converge without synchronizing.	Modelled with an inclusive gateway.
9.	Discriminator	A place in the workflow process that is delayed until one of the incoming processes are completed because only then the successive activity can take place.	Modelled with a complex gateway with a star drawn in the middle.
10.	Arbitrary cycles	A place in the workflow process where certain activities can be repeated.	Modelled as a round arrow drawn at the bottom of a task or square with round edges.
11.	Implicit termination	When a sub-process must be concluded when nothing more should be done in that sub-process.	Modelled as a lightning-bolt in a circle, it is the error symbol that is used to show the termination of a task.
12.	Multiple instances without synchronization	Within a single case, multiple instances of an activity can take place. These activities are independent and don't need to be synchronised.	Modelled as a task or sub-process and three lines at the bottom, vertical if the activities take place in parallel and horizontal if they take place sequentially.
13.	Multiple instances with a priori design/ runtime knowledge	Within a single case, multiple instances of an activity can take place, but unlike the previous workflow pattern, the number of times the activity must take place is known when the process is designed or before the process is run and is followed up by another activity.	Modelled the same as the previous workflow pattern but with a boundary event such as a message (which is drawn as an envelope) to stop the process at the predetermined time.
14.	Multiple instances without a priori runtime knowledge	This workflow pattern is the same as the workflow pattern described in 13, except for the fact that new instances of an activity can be created while others are being executed.	Modelled as a sub-process with a boundary event.

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15.	Deferred choice (deferred XOR split)	It is a place in a workflow where one of many routes can be chosen, the choice is however not made based on data such as with the XOR-split, but any available alternative can be chosen. However, only one of the alternatives will be executed.	Modelled as an event-based gateway, or a diamond with a double circle and pentagon in the middle.
16.	Interleaved parallel routing	When a set of activities is executed in no particular order.	Modelled as an ad-hoc sub-process with embedded inner-activities sequence flows, gateways and intermediate events.
17.	Milestone	Some activities are enabled when a particular milestone is reached, up until that milestone has terminated.	Modelled as a sub-process with a boundary event such as a clock or withdraw message.
18.	Cancel activity	An activity is disabled when it is cancelled.	Modelled as a sub-process with a reverse-sign boundary event.
19.	Cancel case	It is when a case is completely removed.	Modelled as a sub-process with a cancel-boundary event, a circle with an "X" in the middle.

It is clear that all the most basic workflow patterns can be modelled with BPMN and thus the notation can be used to represent the workflow or business processes.

2.3 Workflow Improvement Theories

There are many industrial engineering techniques available for improving workflow including the theory of constraints, business process re-engineering, lean manufacturing and a business process maturity evaluation. The SCOR model is also included as a means of measuring performance. The techniques will be described below and then discussed.

2.3.1 Theory of Constraints

The theory of constraints relates to bottlenecks in the process that need to be eliminated. The bottlenecks are, according to WebFinance, Inc (2015), the resource in a process that is already at its full capacity and consequently any additional demand will have to be put on hold. Thus the resources succeeding the bottleneck cannot continue, as they have to wait for the department to complete its tasks. Table 5 describes the different types of bottlenecks in a process and what causes these bottlenecks (Van der Aalst and Van Hee, 2004).

Table 5: Reasons for Typical Bottlenecks (Van der Aalst and Van Hee, 2004)

Type of Bottleneck	Possible Reasons
Too many cases in progress	• Not enough flexibility with regard to the resources. (A certain resource can only perform a certain task.) • An inconsistent supply of cases. (At some days there are many different cases and other days there are very little cases to take care of.) • Too much steps have to be taken in sequence instead of making use of parallelisation: where one step can continue without having to wait for the completion of another.
Too long completion time	• The processing time can be a lot quicker compared to the time that the case actually is in the system.
A low service level	• When completion times cannot be guaranteed and it is too inconsistent. • When the waiting times are too large. (This especially refers to times when no new cases can be handled even though the resource is not occupied.)

In order to be able to identify where the bottleneck is located, benchmarking is used which is determining what the acceptable levels of performance is that a particular instance of workflow must achieve to the current level of performance of that workflow-instance. The bottleneck can then be determined by comparing the benchmark values to the current performance (Van der Aalst and Van Hee, 2004).

2.3.2 Business Process Re-Engineering

Business process re-engineering (BPR) or business process redesign can be described as the re-evaluation of the current business processes (work flows), job definitions, the organizational structures and management systems (WebFinance, 2015).

The entire concept of BPR can be explained with the words: fundamental, radical, dramatic, and process (Talwar, 1993). Fundamental means, going back to the basics when wanting to change a business process and asking why it is done at all and in the particular way. Radical is stated to show that the re-engineering must represent a total cessation of the current way a process is executed, not just an improvement. Dramatic is to show that the changes must have far-reaching effects related to cost, quality and service. Lastly, process is highlighted as a dramatic improvement can only come about if the focus is on the business processes (Talwar, 1993).

A process mind-set is very important for the improvement of workflows. A mistake frequently made is adding information technology to badly formulated processes under the assumption that the technology will fix the problems. The manual practices must firstly be as efficient as possible on its own, otherwise only limited results will be achieved with technology. This is why BPR is encouraged as by radically changing some of former processes steps, information technology and the capital expenditure that accompanies it may not be needed and if technology is still decided upon, much greater benefits will be gained from it (Van der Aalst and Van Hee, 2004).

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The basic steps in redesigning a workflow are illustrated in Figure 3, as gathered from Van der Aalst and Van Hee (2004). Firstly it has to be determined what workflow to redesign, then the objective of that workflow is determined, the steps to be taken to change the workflow must be recognised and lastly the resource allocated to the workflow determined.

Figure 3: Steps in Redesigning a Workflow (Van der Aalst and Van Hee, 2004)

More detailed steps and practices for the re-engineering of workflows are listed in Table 6:

Table 6: Re-Engineering Steps of Workflows (Van der Aalst and Van Hee, 2004)

#	Step	Definition
1.	**Establish a process's objective**	Ask the question, why is a process needed?
2.	**Discard resources in a process definition**	View the process as independent from the potential the employees and applications have to offer. If the allocation of work is considered in the process definition, the best person may not be assigned to the process.
3.	**Evaluate what tasks are needed**	Tasks that are only there for security, such as monitoring tasks that do not actually add value, should be eliminated.
4.	**Evaluate a task's scope**	Consider the possibility of combining a few tasks into one as it can reduce set-up times, but pay caution to not make the task's scope too large as it will inhibit flexibility.
5.	**Make processes as simple as possible**	Simpler processes are easier to manage an understood by human resources that have to execute the task. Often simplification can be achieved by adding more "intelligence" to the tasks.
6.	**Generic processes**	As far as possible, create generic processes that can be used for many different cases. Rather use gateways to separate different cases in a process than defining separate processes.
7.	**Parallelisation**	Whenever two or more tasks can be completed independently, let them be performed at the same time (parallelisation). Tasks that are completed sequentially will result in much longer completion times and the resources are not fully utilised.

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#	Step	Definition (Continued)
8.	**Make use of new developments with regard to networks and databases**	Physical barriers have become less relevant with computerization of documents and new process structures.
9.	**Centralisation and connections between geographically dispersed resources**	As technology lowers the physical barriers of sections in an organization, it is easier for the organizational units to transfer work in general and if one organizational unit has an over-flow of cases as oppose to the other that are not fully utilised at that moment. Centralised changes would also give different resources immediate access to a case in its current state.
10.	**Resource Speciality**	Utilise resources according to where their speciality lies.
11.	**Repetition of similar tasks per resource**	If a resource does similar tasks repeatedly, less time will be spent on set-ups and routine working will make the particular resource very skilled in that area.

Based upon these listed guiding principles, workflows or business processes can be designed that result in efficient and effective processing of cases. Trade-offs will have to be made between alternatives to implement the most suitable guideline for the applicable workflow. Analysing the workflow with regard to quantitative factors and performance indicators thoroughly is important to select the correct guideline for the workflow.

2.3.3 Lean Manufacturing

Lean manufacturing involves the removal of all types of wastes from a process in order to improve it (Hicks, 2007). Traditionally, seven types of wastes are identified with lean, but Hicks (2007) added an eighth. Although this is not a manufacturing, but procurement process that is being investigated, some of the wastes can still be prevalent in some of the steps. The seven wastes are listed in Table 7 and the instances where they occur in the procurement processes are written down in green.

Table 7: Types of Waste Associated with Lean Manufacturing (Hicks, 2007)

Type of Waste	Description
1. Over-production	When operations continue after they should have been concluded. This results in too much inventory. *This can happen if too much inventory is ordered based on an incorrect forecast.*
2. Waiting	It is also referred to as queuing, it relates to long periods of inactivity. *This relates to supplier lead times, a customer may cancel an order if it takes too long to be delivered.*
3. Transport	This is the unnecessary movement of materials. *This is prevalent when there are a lack of automation and documents have to physically be delivered.*
4. Extra processing	Unnecessary operations such as rework that occur because of, for example, defects. *This can happen if an incorrect batch-size was selected and the order has to be placed again.*
5. Inventory	Any inventory that is not directly needed for current customer orders. *This again can happen if too much inventory is ordered based on an incorrect forecast.*
6. Motion	It is any unnecessary steps taken by resources. *This is prevalent when there are a lack of automation and documents have to physically be delivered.*
7. Defects	Inventory or services that does not satisfy the needs of a customer. *This can occur if the wrong inventory is ordered.*
8. Under-utilisation	This relates to people not being used to their full capacity and when their creative ideas for improving the processes are not taken into account. This category can be observed in all of the above steps. *This is again prevalent when there are a lack of automation and too much manual efforts have to compensate for the lack thereof.*

2.3.4 Business Process Maturity

Nowadays competition in many industries are based upon the strategic assets of the company. Processes are seen as a strategic asset that requires investment and development as their maturity increases as the organization is rather viewed as an arrangement of integrated processes than as a group of functional areas (McCormack et al., 2009). Because of the latter determining the process maturity of an organization is becoming all the more important. Over the past thirty years many different maturity models have been developed along with roadmaps on how to achieve certain levels (McCormack et al., 2009).

As the process-oriented view of organisations is adopted, business process management is a new widely accepted concept that emphasizes the fact that a process has a life cycle, or in other words it goes through different phases of development that must be defined, measured and controlled (McCormack et al., 2009).

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The higher the level of a business process's maturity, the more advantages will be available to the business, according to McCormack et al. (2009), such as:

- More control over the results of processes.
- More accurate forecasting on the outcome of performance and costs.
- More defined goals are reached effectively.
- Higher performance targets can be set by management.

For business process management, the McCormack maturity model (2009) has been established, with the following levels as described in Table 8.

Table 8: Business Process Maturity Stage (McCormack et al., 2009)

Business Process Maturity Stage	Key Aspects per Maturity Stage
Level 1: Ad hoc	- The processes are not properly structured or defined. - There are no process measures in place. - The jobs and organizational structures are based upon traditional, dated functions and not horizontal processes.
Level 2: Defined	- The basic organizational processes are defined, documented and modelled in flow charts. - In order to change one of these processes there is a formal procedure that has to take place. - Jobs and organizational structures do not include a process aspect, but still remain basically functional. - The representatives from the functional areas like sales or procurement regularly meet to synchronise and coordinate these areas with each other, but only as representatives of their traditional functions.
Level 3: Linked	"Linked" is the breakthrough level. - Managers make use of process management for strategic purposes and get results from that. - Broad process jobs, and structures are put in place beyond the traditional functions.
Level 4: Integrated	- The company and its suppliers and vendors and suppliers are taking their cooperation to the process level. - The organizational structures and jobs are now based on the different processes. - Traditional functions are not as important anymore as they are starting to equal or in some cases even subordinate to processes. - The organisation attach a high level of importance to management systems process measures.

2.3.5 SCOR Performance Metrics

The APICS Supply Chain Council or APICS SCC (2015) is the biggest supply chain organization in the world, established for the purposes of advancing supply chains through research and benchmarking. The Supply Chain Operations Reference (SCOR) model is developed by them and is known as the most extensively accepted framework to evaluate and compare the activities and performance in a supply chain. As Agrinet plays the role of a distributor in a larger supply chain and the scope includes the suppliers, the performance attributes of SCOR are investigated in Table 9.

Table 9: SCOR Performance Attributes (APICS_SCC, 2015)

Performance Attribute	Definition
1. Reliability	The ability to perform a tasks as expected, in other words the predictability of a process-outcome relates to reliability. Typical metrics include: timeliness, correct quantity and expected quality.
2. Responsiveness	The speed tasks are performed with or how fast the supply chain delivers a product to a customer. An example of a metrics is cycle-time.
3. Agility	Agility is the ability to respond to external influences, by maintaining their competitive advantage in a changing market environment. Metrics include flexibility and adaptability.
4. Costs	Cost relate to the funding of supply chain processes like labour and operating cost. A metric includes cost of goods sold.
5. Asset Management	If assets are efficiently utilized, asset-management has been achieved, it includes inventory reduction and outsourcing-decisions. Metrics include inventory days of supply and the utilization of capacity.

2.3.6 Discussion of Workflow Improvement Theories

2.3.6.1   Theory of Constraints

Determining the bottleneck of the process and benchmarking is currently not an achievable goal because of the ad hoc nature of the processes for example the exact numbers processes by resources per daily cannot be calculated due to the high variability in the process. Thus applying the theory of constraints is not possible yet, but it will be useful if the processes are not as ad hoc.

2.3.6.2   Business Process Re-Engineering

BPR is a very effective technique as it provides practical examples of where and how the workflow can be improved. The basic steps of what, why, how and whom should be applied to every workflow to determine which are really necessary and which are redundant. Other practical steps that has potential are changing the scope of a task, simple and generic processes, utilising technology and centralisation. BPR will be applied to the AS IS model to determine where changes can be made that will be represented as functional requirements.

2.3.6.3 Lean Manufacturing

Although lean is intended for manufacturing processes, by looking at its definitions of waste it is also applicable to this procurement process such as over-production, extra processing and inventory that relate to incorrect forecasts. The lack of automation also causes too much transport and motion in the process and under-utilisation of people is also a symptom of too much time wasted due to a lack of automation.

2.3.6.4 Business Process Maturity

Evaluating and improving the business process maturity is a very sensible technique to apply at this stage as it is very hard to set performance goals for level 1, ad hoc processes, which is believed to be the current level of maturity of the processes, but will be confirmed in chapter 4 when the AS IS is evaluated.

2.3.6.5 SCOR Performance Metrics

SCOR has not been properly investigated yet, but some of the aspects it encompasses such as reliability, responsiveness, agility, costs and asset management are important attributes that future performance can be measured with.

2.4 Project Approach

For the project approach, there are two aspects that need to be taken into consideration. Firstly it is the fact that the project is done for an information system and secondly that the project is done to improve business processes. By looking at both aspects the proper approach can be formulated.

2.4.1 FAST System Analysis Strategies

In system development there exists the FAST-methodology as developed by Bentley et al. (2007) that take the classical phases of information system development and subdividing them into the different "FAST Phases". The goal of the FAST-methodology is to provide a collection of integrated approaches used for system development and problem solving in existing information systems. For the purposes of the project, the techniques described will be used to help formulate the project approach. As it is only the analysis and improvement of an existing information system, only the steps of the FAST-methodology associated with system analysis are relevant to the project and will be examined, see Figure 4 and Table 10:

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Fast Phases	Classic Phases			
	Project Initiation	System Analysis	System Design	System Implementation
Scope Definition	X			
Problem Analysis	X	X		
Requierements Analysis		X		
Logical Design		X		
Decision Analysis				
Physical design and Integration			X	
Construction and Testing			X	X
Installation and Delivery				X

Figure 4: FAST Methodology and Steps Selected **(Bentley et al., 2007)**

Table 10: System Analysis Steps and Techniques (Bentley et al., 2007)

1. Problem Analysis Phase This phase encompasses investigating the current information system and investigating the problems, directives and opportunities that triggered the project.		
1.1	**Understand the problem domain**	To understand the problem domain, the system domain needs to be understood. To define the system domain, the building blocks of an information system can be used that include knowledge, processes and communications. Communications is very relevant to this project as it describes the different users and locations served by the information system. It can be modelled with use cases (a succession of related interactions between a user and the system to achieve a certain goal) and context data flow diagrams (context DFDs) that show all the primary inputs and outputs between the system and the users. Different fact finding techniques can also be employed for instance the viewing of existing documentation, site visits, questionnaires and interviews.
1.2	**Analyse problems and opportunities**	A problem or needs should be properly understood before a solution can be given, the Ishikawa diagram is handy as it identifies the causes and effects.
1.3	**Analyse business processes**	The importance of this step is to first look at the possibility of redesigning the existing process before looking at purchasing costly IT solutions. By imagining a "perfect world" with perfect technology and people, a need for a certain process will be evaluated with AS IS process models from which an improved TO BE model of the process will be created.

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1.4	**Establish system improvement objectives**	This step is to determine criteria that improvements in the system can be measured against and to identify constraints that will inhibit the improvements to be achieved.
	2. Requirements Analysis It is important to first establish what the requirements are before developing solutions to ensure it is in line with the customer's expectations and not just an improved solution based on the designer's own viewpoint.	
2.1	**Identify or express system requirements**	System requirements are subdivided into functional and non-functional requirements. The functional requirements describe the activities and services that the system must be able to provide and are identified as inputs, outputs, processes and stored data, depicted with use cases. The non-functional requirements describe the characteristics of a satisfactory system and documented by using the PIECES-framework's criteria: performance, information, economy, control, efficiency and service.
2.2	**Prioritize system requirements**	As not all requirements are of equal importance one must firstly get the most important requirements in place while the project is still within the budget and schedule constraints and focus on the others afterwards (time-boxing).
	3. Logical Design Phase Further documentation of the business requirements take place at this step by using data models, business processes, data flows and user interfaces. It is to validate and use the gathered requirements.	
3.1	**Structure Functional Requirements**	As previously described in step 2.3 the TO-BE process map is drawn up at this step by adding the requirements of step 3 to the AS-IS process.
3.2	**Validate Functional Requirements**	As the system users are the ones for whom the system is designed, they have to verify whether they are satisfied with what has been completed and show what they are not content with.
3.3	**Define Acceptance Test Cases**	To define the correctness of the system, test cases can be identified that will be sufficient for testing the correctness of the system.

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2.4.2 Context Dataflow Diagram

The context dataflow diagram is mentioned in the system analysis steps and techniques steps of the FAST methodology under the problem analysis phase at understanding the problem domain. It is explained according to the Visual Paradigm (2015) as a diagram that gives a visual presentation of how data flows within an information system.

By viewing the context DFD, it becomes clear what information is provided by and delivered to an entity (a person or information system) that takes part in the system processes. This information is what is needed to execute the business processes and has to be accessible and stored on the system (VisualParadigm, 2015).

It is important to note that the context DFD is the most basic form of a data flow model, or model to show the exchange of information, as it contains only one process and no data stores. The scope is on showing the interactions between the system and external parties and not the internal communications between the entities for which the ERD (entity relationship diagram) is used. To model the process flow, the BPMN (business process modelling notation) diagram is used (VisualParadigm, 2015).

The following diagram visually describes the context DFD (Figure 5):
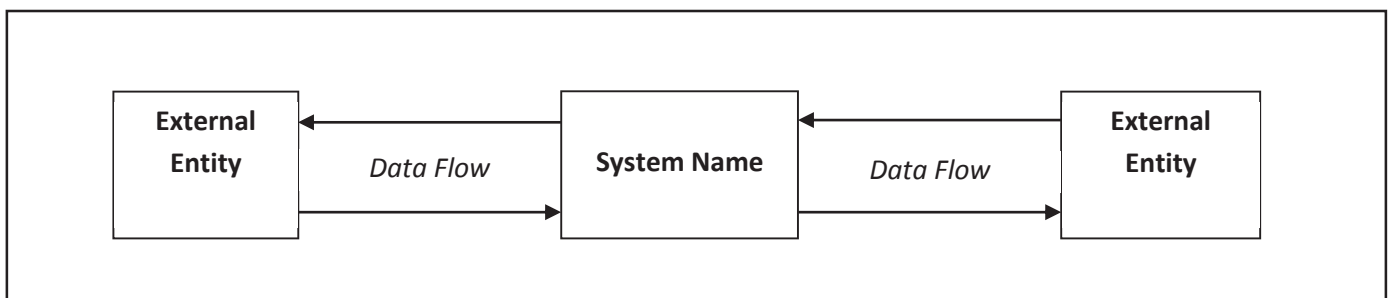
Figure 5: Illustration of Context Dataflow Diagram

- The *name of the system* is in a shape in the middle.
- The *external entities* or participants that interact with the system are placed around the system's shape.
- The *connectors* are indicators of data flow or information that is exchanged between the entities and the system.

2.4.3 Business Process Improvement Approach

As the complexity of business environments continue to increase, businesses processes are constantly being changed or upgraded to keep up with customer expectations. This activity is called business process improvement or BPI. Although there are methodologies to aid a business in the improvement of their processes, according to Adesola and Baines **(2005)** none of them are sufficient to support the practitioner through all the stages of BPI. This limitation is addressed with the creation of the model-based and integrated process improvement (MIPI) methodology shown in Figure 6. This methodology has been developed based on literature available on the topic and developed further with the inputs of experts in the field. Current methods were assessed and their key-steps combined to develop MIPI (Adesola and Baines, 2005).
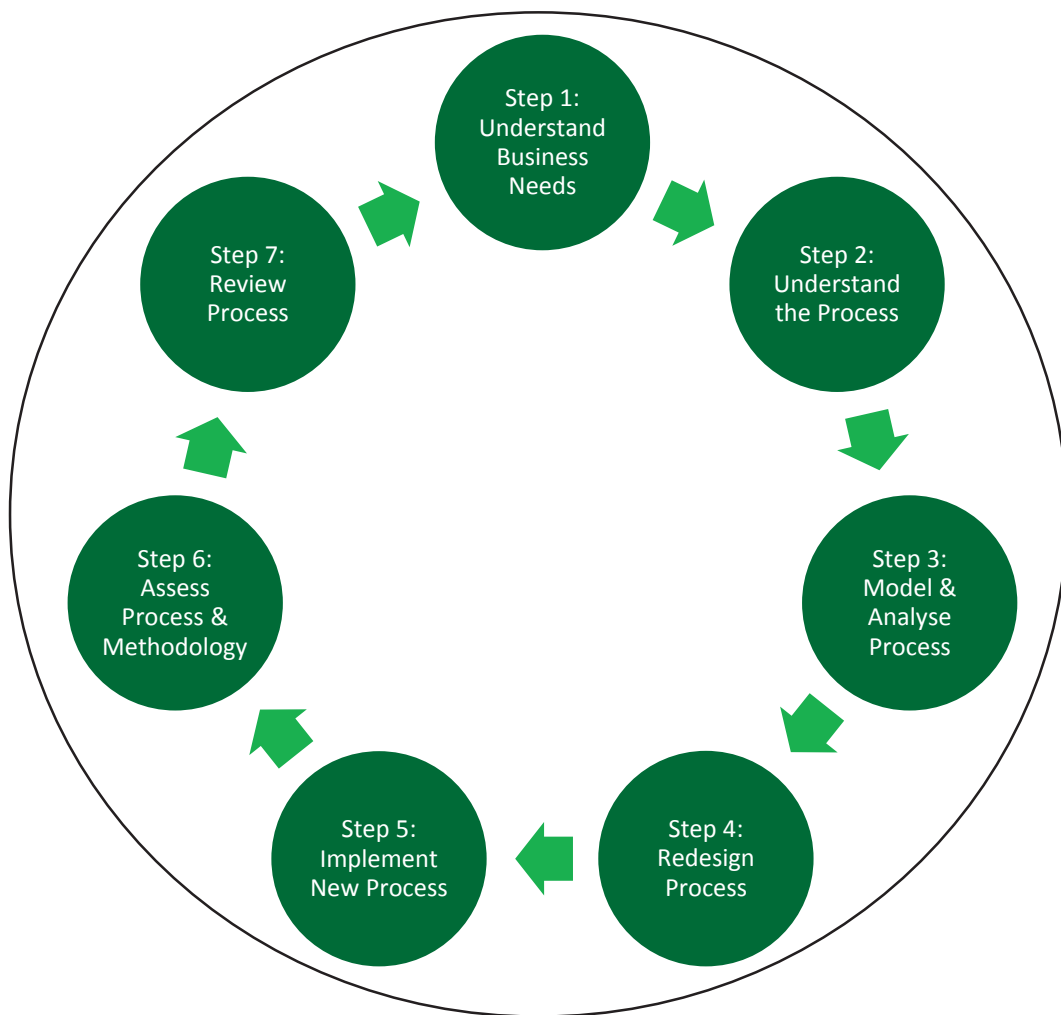
Figure 6: Model-based and Integrated Process Improvement Methodology (Adesola and Baines, 2005)

Each step in the MIPI method can be explained as follows, in Table 11:

Table 11: Steps of MIPI (Adesola and Baines, 2005)

#	Step	Elaboration
1.	Understand business needs	• The vision and strategic objectives has to be developed. • An organizational model developed and current practices evaluated. • Prioritise the objectives and set targets that can be measured. • Techniques include SWOT-, Pareto-, force field- and stakeholder analysis.
2.	Understand the process	• The architecture of the business process has to be identified, scoped and defined. • Document the AS IS process information with techniques such as a walkthrough and process flowchart. • Use cause and effect analysis to investigate the problems.
3.	Model & analyse process	• Verification and validation of the model. • Measure the current process performance. • Analyse the current business processes and evaluate which steps actually add value.
4.	Redesign process	• Determine what the performance criteria for the re-designed process should be by means of brainstorming. • Identify on what areas should be focused during the redesign and requirements. • Create a model of the TO BE process and validate it. • Identify what information technology would be necessary for the TO BE process. • Set performance goals for the redesigned process by making use of benchmarking.
5.	Implement new process	• After the implementation has been approved, it must be planned. • The change management plan has to be reviewed and communicated. • The new process has to be made operational and the staff trained.
6.	Assess new process & methodology	• The process deployment must take place and performance data gathered. • An action plan must be put in place. • An evaluation measurement report with the applicable criteria should be set up as well as a customer's measurement survey.
7.	Review new process	• Look at the business from a strategic point of view. • Put process and performance targets in place and develop a plan to meet these targets. • After implementation review the process improvement.

2.4.3 Discussion of Literature on the Project Approach

2.4.3.1 Discussion of FAST System Analysis Strategies

For the purposes of the project approach, the following FAST analysis strategies are used:

- **Problem analysis**: Understanding the problem domain is an important step as the focus of the project is on improving the processes. After the interviews and site visits, every business event and the related steps were written down and modelled. AS IS models are used to analyse the business processes and problem instances are identified from the models.

- **Requirement analysis:** To demonstrate the functional requirements use cases are used and PIECES for the non-functional. For the design all requirements are incorporated, but priorities must be set in the implementation phase.

- **Logical design phase:** For the logical design the functional requirements will be added to create the TO BE process map which will be validated by experts on the process.

2.4.3.2 Discussion of the Context Dataflow Diagram

The context DFD is a useful tool in the problem investigation phase, to understand what information is provided by the information system and what information system is received by it. It also gives an indication of who are the role-players that interact with the system.

2.4.3.3 Discussion of the MIPI Methodology

In the project approach, the following steps from the MIPI methodology are used:

To understand the **business needs**, measurable targets will be set to be reached in the improved process. For the **process understanding** the AS IS state will be written down, **modelled and analysed** to ensure that all processes add value. From the analysis phase, the criteria for the **re-designed** process are determined that should be included in the TO BE process and validate it by comparing it to the identified requirements. Additional information technology are also indicated where necessary and performance goals are also set in terms of process maturity. A complete plan for **implementation** will be developed. An **evaluation** or validation sheet will be created for the new process in order for an expert to review it and the changes suggested by the expert will be taken into consideration.

2.5 Project Approach Techniques

The following describes the literature on the different techniques used to execute the project approach.

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2.5.1 Porter's Strategy

Porter's strategy, as developed by Michael E. Porter in 2008 is used to determine what Agrinet's strategic position in the market looks likes as this will influence managerial decisions. Figure 7 shows a diagram depicting the strategy and describes Porter's five forces.

Figure 7: Porter's Strategy (Porter, 2008)

Table 12: Description of Porter's Five Forces (Porter, 2008)

#	Force	Description
1.	Threat of new entrants	It describes how easy new competitors can become part of the market and lay claim to the company's customers.
2.	Threat of substitutes	It is how many other products are available and easily accessible that can be used instead of the company's.
3.	Bargaining power customers	It gives a measure of how much leverage the customer has compared to the company with regard to having decisions made in their favour.
4.	Bargaining power of suppliers	It gives a measure of how much leverage the company has compared to the suppliers to have prices and conditions in their favour.
5.	Rivalry amongst existing competitors	It gives an indication of how competitive the industry already is.

In the application of Porter's strategy, the focus will be mainly on the bargaining power of the customers and suppliers as it will significantly impact some of the decisions to be made.

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2.5.2 Feasibility Analysis

In order to evaluate the solution, the feasibility analysis matrix is used as defined by Bentley et al. (2007). The aim of using the matrix is to understand how feasible the solution is and if the solution is modified to streamline the process even more, how feasible that adjusted solution will be in comparison to the first. An example of the feasibility analysis matrix is shown in Figure 8 and defines the feasibility categories as listed in the matrix.

Simple Feasibility Analysis Matrix			
	Weight	Short Term Solution	Long Term Solution
Operational Feasibility			
Cultural Feasibility			
Technical Feasibility			
Economic Feasibility			
Schedule Feasibility			
Legal Feasibility			
Weighted Score			

Figure 8: Feasibility Analysis Matrix (Bentley et al., 2007)

Table 13: Feasibility Analysis Matrix (APICS_SCC, 2015, Bentley et al., 2007)

#	Feasibility Category	Description
1	Operational	Operational feasibility measures how well the solution adheres to the requirements created to solve the problems and take advantage of new opportunities.
2	Cultural/ Political	Cultural feasibility measures how the different stakeholders feel about the new solution and to what degree they will accept the change, given the organizational and external climate. It should be considered if management and the users will support the solution and in what areas will there be resistance to change.
3	Technical	Technical feasibility measures the practicality of a technical solution and if the technical resources and experts are available for the implementation and maintenance.
4	Schedule	Schedule feasibility measures how reasonable the timeline is in which the project is conducted.
5	Economic	Economic feasibility measures how cost-effective the solution will be and how large the financial impact is.
6	Legal	Legal feasibility measures how effectively a solution can be implemented without imposing on legal or contractual boundaries.

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The following describes how the feasibility analysis matrix will be applied to determine which solution is the most suitable:

1) Depending on the importance that each feasibility criteria has for the business, a percentage out of a 100 will be allocated so that in the end all the percentages must add up to 100%. This is the "weight" as indicated in the matrix.
2) For each feasibility criteria, the solution will receive a score out of a 100 of how feasible it is in that instance. (These scores are independent of each other and need not be a 100 cumulatively.) Reasons for why the applicable score is given should also be provided.
3) For each feasibility criteria the percentages and scores are then multiplied and a value will be obtained. All of these values are then summed to give each solution a total score.
4) The total scores are then compared to each other and the solution with the highest score will be chosen.

Bentley's feasibility analysis matrix is an effective tool that assigns quantitative weights and scores to a variety of applicable qualitative factors. It gives a good overview of where a solution stands with regard to feasibility and how feasible additional upgrades to the solution are.

2.5.3 Use Case Ranking

As all use cases cannot be implemented at the same time Bentley et al. (2007) devised a use case ranking- and priority matrix as shown in   Figure 9.

Use Case Ranking- and Priority Matrix									
Use Case Name	**Ranking Criteria**						**Total Score**	**Priority**	**Build Cycle**
	1	**2**	**3**	**4**	**5**	**6**			

Figure 9: Use Case Ranking- and Priority Matrix (Bentley et al., 2007)

Each use case is given a score out of five of how well it adheres to the 6 stated criterions; all these scores are then summed to give each use case a total score. A use case is then allocated to a build cycle based on the score it achieved. For example, if a use case scored high, it becomes a high priority and will be in the first build cycle.

This will ensure that resources are firstly allocated to the most important use cases and the rest thereafter.

3. PROJECT APPROACH

The following describes the project approach according to the outcomes of BPJ 410 and BPJ 420.

3.1   Problem Investigation

The problem investigation entails the documentation of the AS IS process, after interviews and site visits at the procurement offices, in the following ways:

- Identification of all the actors in the procurement process.
- Capture and write down of all the process-steps.
- Investigation of electronic data interchange (EDI) usage at Agrinet.
- Investigation of the service level agreement with Embrace.
- Modelling the interaction of the enterprise resource planning (ERP) system with the different users with the help of a context dataflow diagram (context DFD).
- Modelling the AS IS process with business process modelling notation (BPMN).
- Explaining the symbols used in the BPMN models.
- The current business process maturity is also evaluated.

3.2   Conceptual Design

The conceptual design consists of defining all the requirements for the TO BE, improved solution.

3.2.1 Identification of Functional Requirements

The functional requirements are created to be solutions for the problems found in the process. The opportunities for change are selected by considering:

- The instances that relate to the problems (mentioned in the introduction and background).
- Problems and improvement objectives collected from Agrinet employees in the interviews.
- Shortcomings observed by the student during the AS IS documentation and analysis.
- Steps involved in business process re-engineering.

3.2.2 Identification of Non-Functional Requirements

The constructional or non-functional requirements are expressed using the PIECES framework, to look at how the system fares in terms of performance, information, economy, control (security), efficiency and service.

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3.3   Solution Development

1) A solution or TO BE model is developed by adding the functional requirements to the AS IS process and depicting it with BPMN.

2) From this first solution a second solution is developed with only EDI as communication mode between Agrinet and the external actors.

3.4   Solution Verification

3.4.1 Requirements Verification

1) Solution 1 is evaluated by the designer to ensure that it adheres to all of the non-functional requirements and addresses the problems as stated by management in the beginning.

2) In addition to solution 1 meeting the requirements, it is shown to what extent the requirements are met with solution 2 having only EDI as communication mode.

3.4.2 Business Process Maturity Evaluation

1) The designer ensures that solution 1 is at least at level 2 of business process maturity in order for an improvement to have taken place.

2) Solution 2's business process maturity is evaluated and compared to that of solution 1.

3.5   Solutions Analysis

3.5.1 EDI Feasibility Analysis: Solution 2

As it is determined in the solution verification that solution 1 addresses the non-functional requirements, but solution 2 does it to a greater extent, the feasibility of solution 2 is investigated by inspecting the current EDI situation as well as the resons for the lack thereof.

3.5.2 Solution Cost Analysis

As the impact analysis in the next step requires an economic analysis, the immediate cost of each solution is calculated and compared and the long term implications are investigated.

3.5.3 Solution Impact Analysis Matrix

The criteria of Bentley's feasibility analysis matrix are used to evaluate the positive impact of each solution, compare it and make a final decision on which solution to implement.

3.6 Solution Validation

As the processes cannot be measured, experts validated the solution by reviewing it with the aid of a validation questionnaire. The experts are chosen on the basis of being most knowledgeable on the entire procurement organization and because they look at different aspects for a reliable validation.

3.7 Future Implementation and Benchmarking

As the solution will not be implemented within the time period of the BPJ modules, a practical guide is established on how to implement the changes and to continuously measure their performance after implementation.

3.7.1 Practical Implementation

The practical implementation plan consists of the following:

- It is investigated which functional requirements are inapplicable with only EDI as communication mode.
- To establish the implementation order of the functional requirements, they are ranked according to certain criteria and implemented based on the scores
- A dependency table is used to determine which functional requirements depend on others to be implemented beforehand.
- With the consideration of the previous steps, the order in which to implement the changes is determined and the steps towards a fully EDI process are listed.

3.7.2 Future Benchmarking

As mentioned in the solution verification, the newly designed solution would have at least a level 2 in business process maturity and the defined process's performance can now be measured and benchmarked. The applicable SCOR performance metrics are listed and the various ways of collecting data for the formulas related to these metrics are discussed.

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4. PROBLEM INVESTIGATION

4.1 Actors Identification

In Table 14 all of the actors involved in the procurement process are listed as well as a short description of their roles with regard to procurement:

Table 14: Actors in Procurement Process

Actor	Description (According to their Tasks)
Internal Actors (Agrinet)	
Procurement Organization	
1. **Demand Planner**	The individual responsible for extracting the forecasts and thereafter reviewing and approving it, creating the DRP (distribution resource plan) and sending out purchase orders based on the forecasts. He is also the first level for purchase orders (POs).
2. **Product Managers**	The individuals at each product type responsible for reviewing the purchase order forecasts and approving new suppliers.
3. **Buyers**	Individuals at each product type responsible for reviewing and adjusting the DRP, placing purchase orders at suppliers, confirming, following up and cancelling these purchase orders. They are also responsible for finding and creating new suppliers and they are involved in the negotiation process of purchase order discrepancies at suppliers.
4. **Creditors Department**	The department that receive, upload and authorise the payment of invoices. If there are any discrepancies, with regard to the invoices, they will contact the supplier's debtor to sort it out and receive a credit note (CN) where applicable. They open accounts for new suppliers and authorise payments to the existing suppliers based on the invoices after their accounts have been reconciled.
5. **Finance Department**	The individuals responsible for getting the authorised payment batches from the creditors department, approving the payments and paying the suppliers.
6. **Receiving Department (Warehouse)**	The department responsible for receiving picking-slips, and picking the stock. They physically receiving the purchase order and in some instances invoice therewith, adjust and sign the delivery note (DN) and create the goods received voucher (GRV), the goods received note (GRN) and bin the items. They copy and file the invoice and delivery note and take the original invoices they receive to the creditors department as well as the delivery notes if there were discrepancies. The warehouse manager falls under this department.

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	Selling Organization	
7. Sales Department	The individual at each product type that is responsible for reviewing the sales forecasts.
8. Call Centre	The call centre is responsible for receiving and uploading sales orders (SOs), following up on customer's electronic data interchange (EDI) mistakes and taking care of sales order cancellations
9. Company representative	The company representatives market Agrinet and gain new customers.
10. Debtors Department	New customers are scouted by the company representatives and accounts for them are created by the debtors from whom they receive invoices.
	General	
11. IT Department	The IT department is responsible for receiving the faxes and sending them in email format to the buyers and sending the sales orders that didn't go through to the call centre for follow up. They also convert the sales orders from customer's information systems to an acceptable format for Embrace.
	External Actors (Other Companies and Individuals)	
12. Suppliers (EDI/ non-EDI)*	Individuals or organisations that are created by the buyers and receive and confirm purchase orders placed at them and negotiate if placed orders are cancelled. They send invoices to the creditors and negotiate discrepancies with them. Suppliers physically deliver the inventory at the receiving department and deliver and sign the necessary documentation. They are also paid by the finance personnel for the inventory delivered.
13. Customers (EDI/ non-EDI)*	Individuals or organisations that place and cancel sales orders at the call centre, where incorrect EDI-orders are also taken care of. The IT department also receive sales orders from customers' information systems and convert it into Embrace's format. The orders picked at the receiving department are based on sales orders from the customers.

*EDI suppliers and customers communicate directly with the system, the communication with non-EDI suppliers and customers take part outside of the system and the system has to be manually updated.

4.2   AS IS Process Steps

The procurement process is divided into 8 sub-processes which consists of all the different business processes of which some are not classified as part of the procurement organization, but if they influence it, they are included. As the level of automation of the processes relate to some of the problems observed in the introduction, the communication mode at each step is emphasized as well as the manner in which some tasks are conducted.

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4.2.1 DRP Approval Processes

- The demand planner extracts and reviews all the computer-calculated forecasts of Optimiza after the monthly sales and operations planning meeting and **physically** gives it to the sales department to review the sales forecasts.

- After the sales department reviewed the forecasts they **physically** give the forecasts to the product managers who review the order forecasts and **physically** give it back to the demand planner for approval.

- The demand planner approves the changes or corrects it where necessary, creates the DRP (distribution resource plan) and sends an **email** copy of DRP to the buyers. The buyers review the DRP with their knowledge of what is possible for a supplier to deliver and **emails** it back to the demand planner.

- The demand planner checks the DRP again and gives the final approval, after which it is sent out through **Embrace, the information system**. Each supplier is set up to receive the order according to their preferred communication mode. (When a supplier is created, the supplier indicates what their preferred communication mode is and Agrinet will send the order through the system, but the order will be received by the means they had chosen. The different communication modes include emails, faxes or EDI.)

4.2.2 Purchase Orders Processes

- The buyers receive a daily buyer's report in an **email** from the call centre that is generated by Embrace based on all of the back-orders for a type product that the buyer is responsible for. (Back orders are created when there are not any inventory available to satisfy the customer's sales order and the buyer has to place a purchase order at a supplier.)

- The buyers create an order form on the system per supplier that contains all the purchase orders for that supplier. The order form is then sent out through Embrace and reaches the suppliers through their preferred communication mode.

- Purchase orders go through a workflow system in Embrace that is set up for 5 levels of approvals based on the price requested for the purchase order as shown in Table 15.

Table 15: Workflow of Purchase Orders

Amount	Approver
< R100 000	Demand Planner
> 100 000	Prod Manager
> 500 000	National Procurement Manager
> 1000 000	Financial- And Managing Director

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- After a supplier has received an order, the supplier has to confirm ability and willingness to deliver. Acknowledgement can come in the following ways:

i. EDI suppliers' confirmation is automatically sent through with **EDI** (electronic data interchange) by their information system if all the information regarding the order is correct, such as the pack sizes. If all the information concerning the order is not correct the buyer will receive a **notification email** from the supplier's information system that the order has not been accepted. The buyer will then have to completely recreate the order with the correct pack-sizes and resend the order with **EDI**.

ii. Non EDI suppliers send a verification **email** or fax. (All of the faxes are received as emails because of the fax to email system that is in place.)

- Orders at suppliers need to be followed up on by the buyers, which is called expediting. An expediting report is created and sent through the **Embrace** to the supplier and received by them in their preferred communication mode, as explained above. It is in that mode that they too will respond.

- If the supplier cannot supply anymore as agreed upon, the buyer has to **manually** update the system by cancelling the order or changing the arrival time.

4.2.3 Cancellation of Sales Orders Processes

- A customer will cancel with his/ her order by notifying the call centre through an **email or telephonically** and will then be **emailed** a cancellation form that they need to fill out with valid reasons for cancellation.

- If a valid reason has been given, the call centre will **give** the matter to the buyer who directly deals with the supplier.

i. If the order has not yet gone through to the supplier, it can be simply cancelled on **Embrace.**

ii. If the order has already gone through to the supplier, the buyer will first have to contact the supplier with an **email or telephone call** to find out if cancellation is possible and if there are any cancellation fees involved. The buyer will then notify the call centre to **call or email** the customer with the new information to find out if they still want to cancel and then the buyer will inform the supplier via **telephone or email** of their decision. The buyer will then cancel the order on the **Embrace**.

- It is important to note that non-stock items that have been especially sourced for the customer cannot be cancelled.

4.2.4 Supplier Creation Processes

- Most suppliers have already been created on the system, but when a customer requests a non-stock item, for instance (stocked items are already linked to suppliers) the buyer will do research on what suppliers sell that item and contact them by means of **email or telephone.**

- To create a supplier standard forms are to be completed by the supplier and **emailed** back to the buyer, requesting information such as VAT-information, BEE-status and payment terms. The buyer also **physically** gives the product manager a vendor-application form detailing estimated amounts to be spent at the supplier. Once the form has been approved, it is **emailed** to the creditors that update the system with the new supplier and fill in the credit application **received** from the supplier in order to open an account there.

4.2.5 Sales Order Processes

- Customers give their orders at the call centre by means of their preferred communication mode as per creation of the customer:

i. The sales orders of EDI-Customers are automatically registered on **Embrace**.

ii. Another way in which orders are registered from an information system to Embrace is when some companies send a file of sales orders with an **email** to the IT department from their information system. The IT personnel save the email's content on a drive and then make use of a program to upload all the orders onto Embrace in the acceptable format.

iii. Orders received by **email or telephone** has to be manually added to the system. (Faxes are converted to emails, sent to a central computer and from there on distributed amongst the different call centre employees.)

- The system will then check if the product is stocked:

i. If it is stocked an invoice is generated for the customer and sent through the **system** and received by the customer in their preferred communication mode. If there are inventory, a picking slip will be released to the warehouse through **Embrace**, otherwise the quantity needed become a back order that will be **sent** to the buyer on the buyer's report. (As mentioned, a particular buyer is responsible for a particular product type and will receive orders for that type of product.)

ii. If the product is not stocked, the product information will be sent through **email** to the buyers on the buyer's report to find and create a supplier for the product and add the product to the system. Thus the product is now stocked and the above steps can be taken.

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- With EDI there are no human intervention, the system takes note of the sales orders, but one of the call centre employees is responsible for following up on EDI mistakes of customers, like incorrect batch sizes which Embrace cannot accept. All of these orders is **emailed** to the employee from the IT department and she follows up on these mistakes with the customers through **emails** to notify them and negotiate in what way they want to rectify it. The customer will **email** this information and the employee will make the changes on **Embrace** whilst the customer updates their own information system.

4.2.6 Customer Creation Processes

- To create a new customer that a company representative has identified, a few forms are sent to that customer to fill out and that must be **emailed** back with information regarding their details and VAT-information.

- This information is then **sent** to the debtors who send the potential customer's details to the insurance company to check the credibility. If the client is credible, the insurance company will email the debtors and an account will be opened for the customer. The account number is then **sent** to the new customer and he can start placing sales orders.

4.2.7 Physical Inventory Receiving Processes

- The supplier **physically** delivers the order at the receiving department (warehouse) which is accompanied by a delivery note with Agrinet's purchase order number on the document. The supplier keeps the original delivery note and provides the receiving department with a duplicate. Sometimes the invoices are also physically brought with the delivery note.

- The purchase order number is then **logged** onto the computer to open the purchase order entity and the purchase order shipment document is printed out.

- **Two checks** take place in this process:

  i. The delivery note and purchase order shipment document are then compared with regard to the product code as well as the product quantity.

  ii. Secondly the physical delivery is compared to the purchase order shipment document and a blue sticker is **pasted** on the pallet as indication to the receiving personnel that the items have already been checked.

- The delivery notes have to be **signed** by the warehouse manager and supplier. If there are any discrepancies on what has been delivered and what should have been delivered it is indicated on the delivery note, for instance too little inventory that have been received. Sometimes inventory has to be sent back, which should also be made clear on the delivery note, as too much have been delivered or a cancelled purchase order's inventory was still sent.

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- The delivery notes and invoices are all kept by the receiving department in folders and boxes and the tax invoices are **physically sent** to the financial department and the invoices to the creditors. A copy of every invoice are made and filed with the delivery notes and invoices with discrepancies are marked explicitly as it is a high priority of the creditors to communicate with the suppliers to resolve the discrepancy.

- All of the discrepancies with regard to purchase orders are **written** up by the receiving personnel in a book. (All the orders where inventory have been sent back.)

- Once both checks have been completed, what has been received is **typed** onto the system to create a GRN (goods received note) on the system that can be accessed by the creditors. The GRN is an indication of what has actually been received. This information is then printed onto a sticker that is called a GRV (goods received voucher) that is **pasted** onto the applicable pallet after which the pallet is moved to the bin-lines and then binned. Only after an item has been binned, it is registered on the system as available inventory.

- Once the GRN has been registered, the inventory status is known to **Embrace** and based on the back orders and new sales orders for the stock's inventory, picking slips will be created at the receiving department.

- Once the picking slip is created, the system will be updated with the decline in inventory levels as a picking slip essentially means that the inventory has now left the warehouse and cannot be claimed by a customer anymore.

- With the picking slip a **notification** is sent to the debit department to create an invoice for the customer which will be sent through **Embrace** and received by the customers in their preferred communication mode.

- The receiving department then **physically** picks and delivers the applicable inventory to the customer.

4.2.8 Payment of Suppliers Processes

- Invoices reach creditors in one of 3 ways:

i. The invoice accompanies the delivery note at the receiving department and it is then **physically** brought to the creditor every morning and uploaded manually by the creditor onto the system.

ii. The supplier only gives a delivery note at the receiving department and **emails** the invoice to the creditors' department.

iii.   With EDI suppliers, the invoice will be received on the **Embrace** system to the correct purchase order. (There are instances where the documentation were not correctly uploaded or there are discrepancies and the invoice is not accepted by the system. The suppliers will then take note of this on their side of the information system and will then **email** the invoice to the creditor.

- For every purchase order the GRN and invoice are compared by the system to verify that they match and if they don't the creditor will **email** the supplier and both parties will investigate the matter on their side to determine who is to blame:

i.   The supplier's debtor examine their records to determine what has been sent out of their warehouse and what has been delivered according to the (adjusted) delivery note.

ii.   The creditor will also examine Agrinet's copy of the (adjusted) delivery note they **physically** receive from the receiving department. The invoice will also be **taken** to the buyer who will compare the invoice to the purchase order. As a control measure, there is a log book that the buyer will sign, indicating the invoice is with him and the creditor will also sign once the invoice has been retrieved.

- The supplier and creditor will then **email** the other on the findings to settle the discrepancy and if the mistake is on the supplier's side, a credit note will be **emailed** to Agrinet by the supplier's debtor.

- The creditor will then reconcile the accounts with the credit notes taken into consideration and authorise the payments on Embrace which will inform the client that they will be paid through their preferred communication mode. These authorised Embrace payments are then printed out and **physically taken** to the finance personnel in batches of 10, who will pay the suppliers.

- The finance department receives a **physical** batch of 10 of authorised Embrace payments and an employee **manually** uploads it onto the Nedbank account whilst double checking the accounts and payments. The totals of the Nedbank account and batches have to coincide.

- The uploaded information can then be accessed by the finance employees on their **computer**, but only after two employees re-checked the information and gave approval will the payments be made to the applicable supplier.

- The batches are then **physically** given back to creditors for record-keeping.

4.3   EDI Usage at Agrinet

As EDI is a fundamental communication mode at Agrinet and a best practice with regard to communication with external actors, the different ways in which it is implemented has to be investigated.

There are two EDI models that Agrinet makes use of. The first is business to business (B2B) direct integration and the second B2B portal integration. B2B direct integration are for the customers or suppliers at Agrinet that spend or receive R1.2 million or more at Agrinet, they too have to become clients of First for Farmers (F4F) and pay a monthly fee to them. The smaller customers and suppliers that spend or receive less than R1.2 million make use of portal integration. They do not pay for this service as it is not worthwhile for them to pay compared to the amount of business they do at Agrinet and the fee is included in Agrinet's monthly fee.

4.3.1 B2B Direct Integration

B2B middleware integration is when the two enterprise resource planning (ERP) systems cannot directly communicate with each other in the correct format and needs a middleware service provider to convert the formats of the ERP systems so that the two can communicate with each other and integrate as shown in Figure 10.
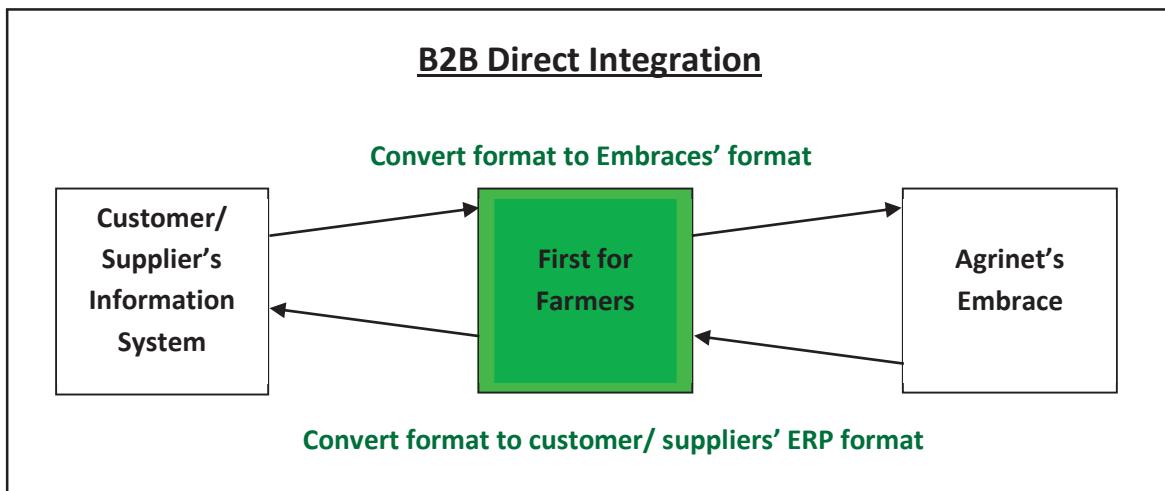
Figure 10: Business to Business Middleware Integration

With B2B direct integration, the process is seamless as the information goes from one information system to the next with F4F as "middleman" or middleware to convert the information form Embrace's information system to a compatible format for the customer or supplier's information system. The inverse of the process also occurs where the information from the customer or supplier's information system is converted to the correct format to be accepted by Embrace. There is thus no human intervention in the process.

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4.3.2 B2B Portal Integration

As mentioned, B2B portal integration are for the smaller companies that do business with Agrinet and is a free service to them. The process is, however, not completely seamless as Agrinet receives the information directly into Embrace (no human intervention as if it is B2B direct integration) but the other companies have to manually upload and download the information such as the invoices. F4F again act as middleware that convert the formats back and forth as shown in Figure 11.
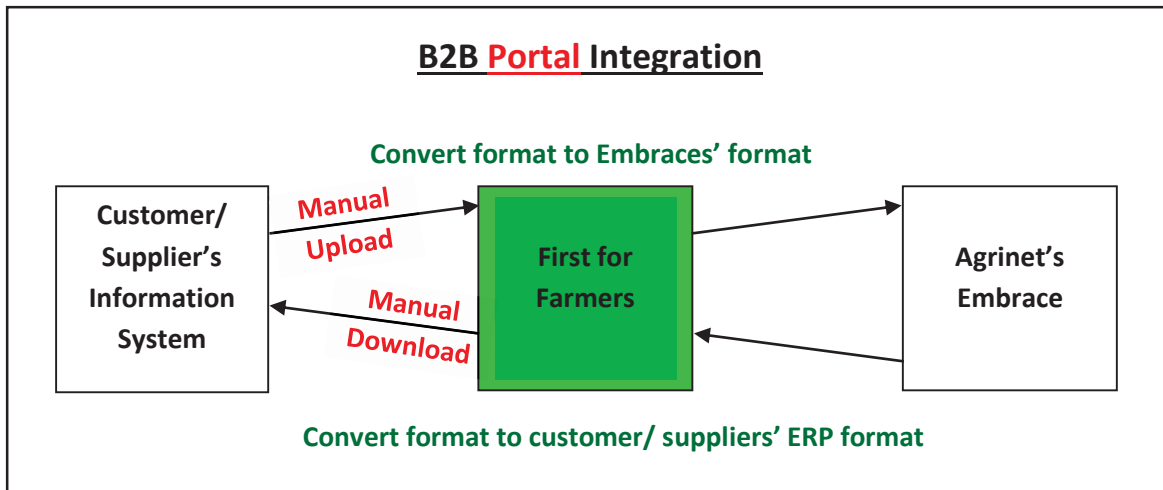

Figure 11: Business to Business Direct Integration

4.4 Embrace Service Level Agreement

In order to be able to establish what configurations are possible, the service level agreement (SLA) with Embrace are reviewed, highlighting the following with regard to payment for their services:

1) If the problem is a bug in the software from the initial set up of Embrace, the Embrace-team will come and sort it out free of charge.

2) If the problem occurred due to parameters that was changed on the software and extra programming in addition to what Embrace did in the beginning, then Embrace will send a technician and the company will be charged for the time the technician spent on finding and eliminating the mistake. Embrace's technician's rate is R 1 000 per hour.

3) Embrace has a helpdesk that can be phoned where the first 15 minutes of the conversation is free. If more communication is necessary and the mistake is the company's, Embrace will charge the company for the time they are spending on the phone call to sort the problem out.

4) Agrinet has people who can do some programming on Embrace, but for big configurations they will have to get a specialist in that will most suitably be from Embrace as they are most knowledgeable with the program.

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4.5   System and User Interaction

The context dataflow diagram (context DFD) is used to show information flow to and from the information system or in other words the role of the information system in all of the business processes (Figure 12).
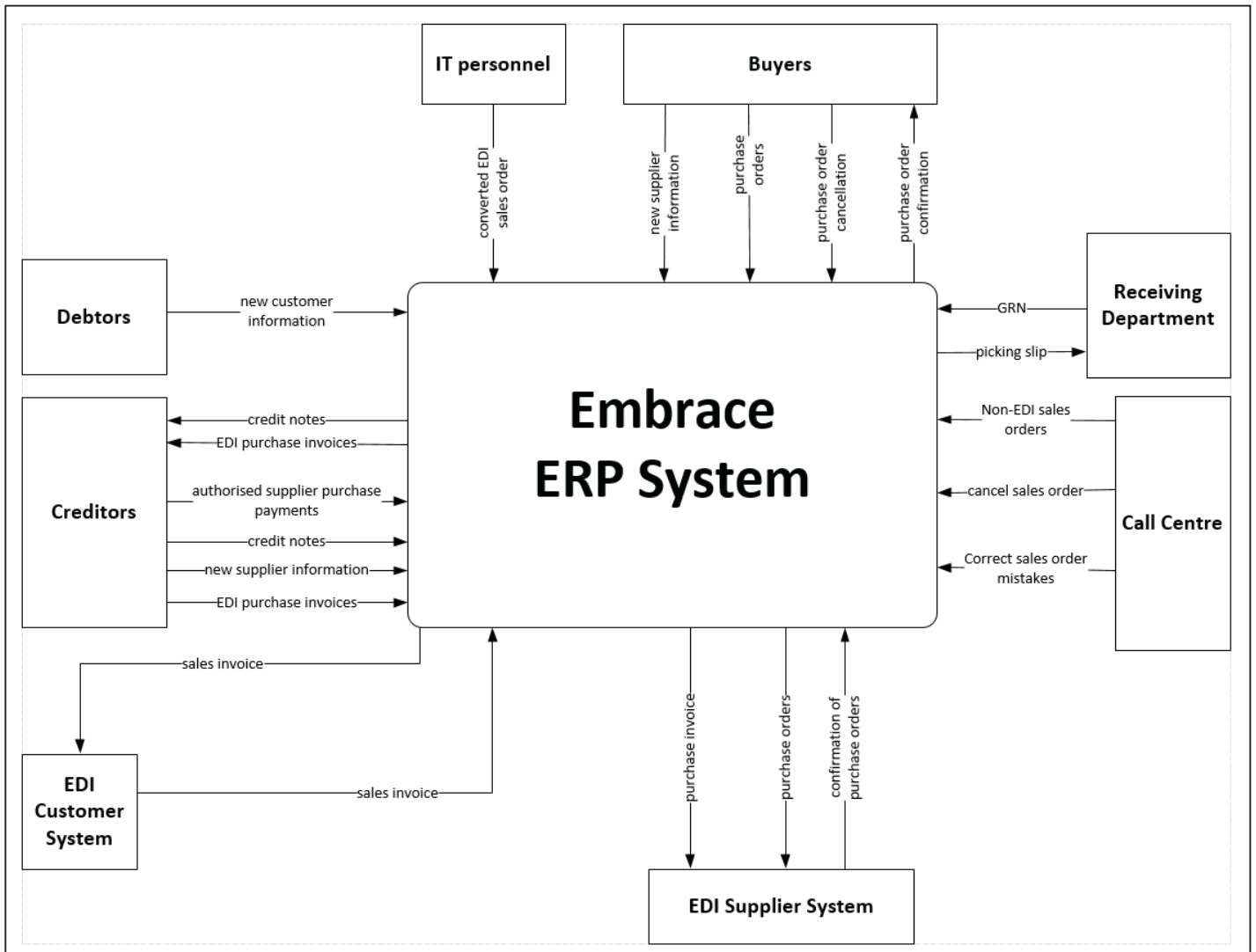
Figure 12: Context Dataflow Diagram of Embrace and the System Actors

4.6   AS IS Modelling

BPMN (business process modelling notation) diagrams are used to create models based on the documented process. Because the program is free, easy to use and download, Bizagi was chosen to do the BPMN modelling with.

4.6.1 DRP Approval Processes
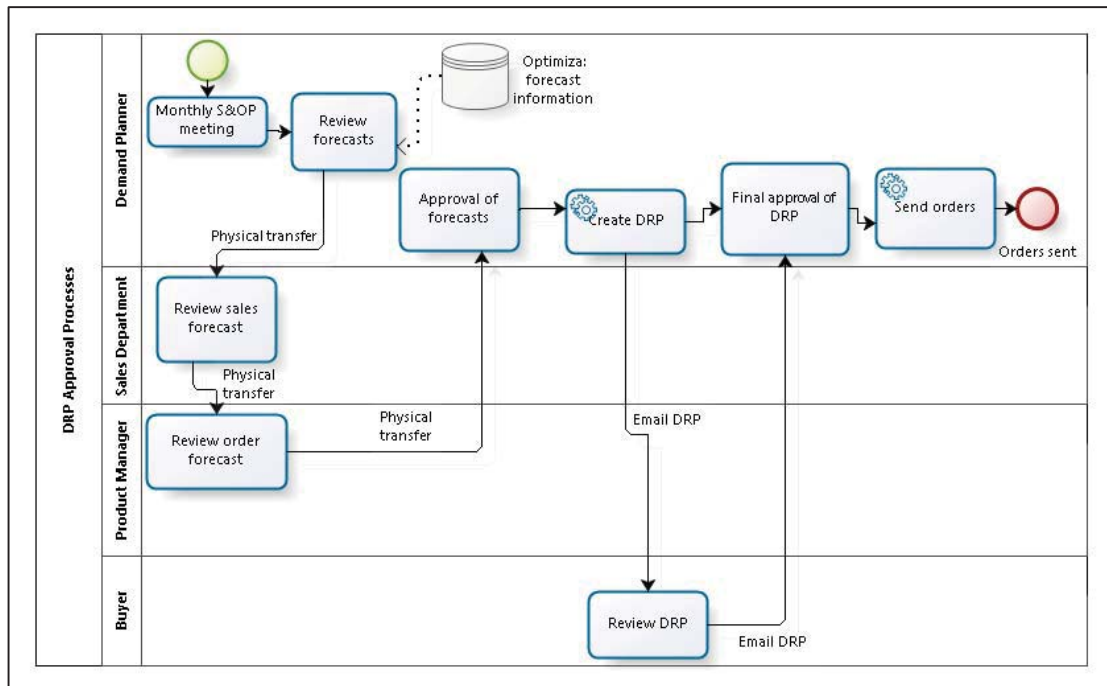
Figure 13: AS IS DRP Approval Processes

4.6.2 Purchase Orders Processes
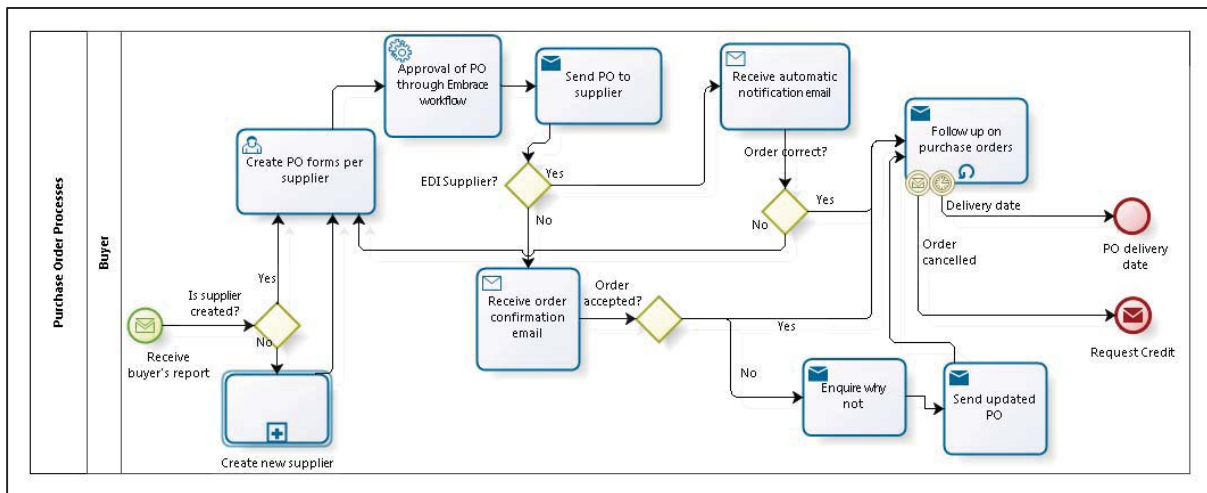
Figure 14: AS IS Purchase Orders Processes

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4.6.3 Cancellation of Sales Orders Processes
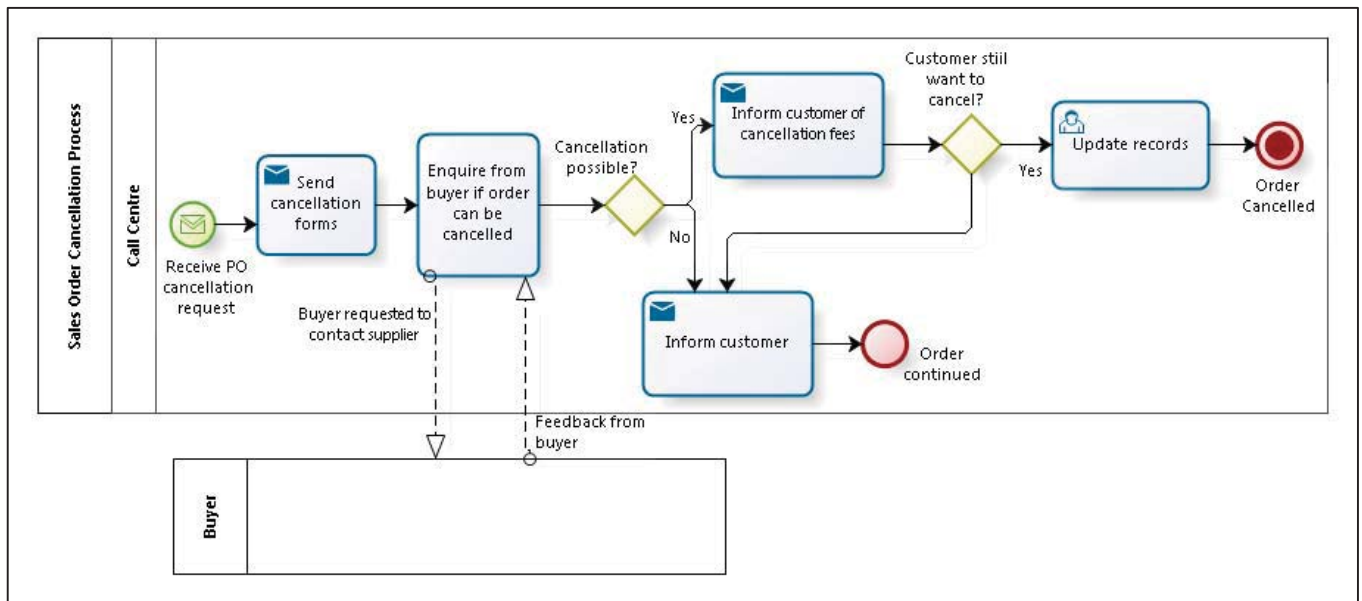
Figure 15: AS IS Sales Order Cancellation Processes

4.6.4 Supplier Creation Processes
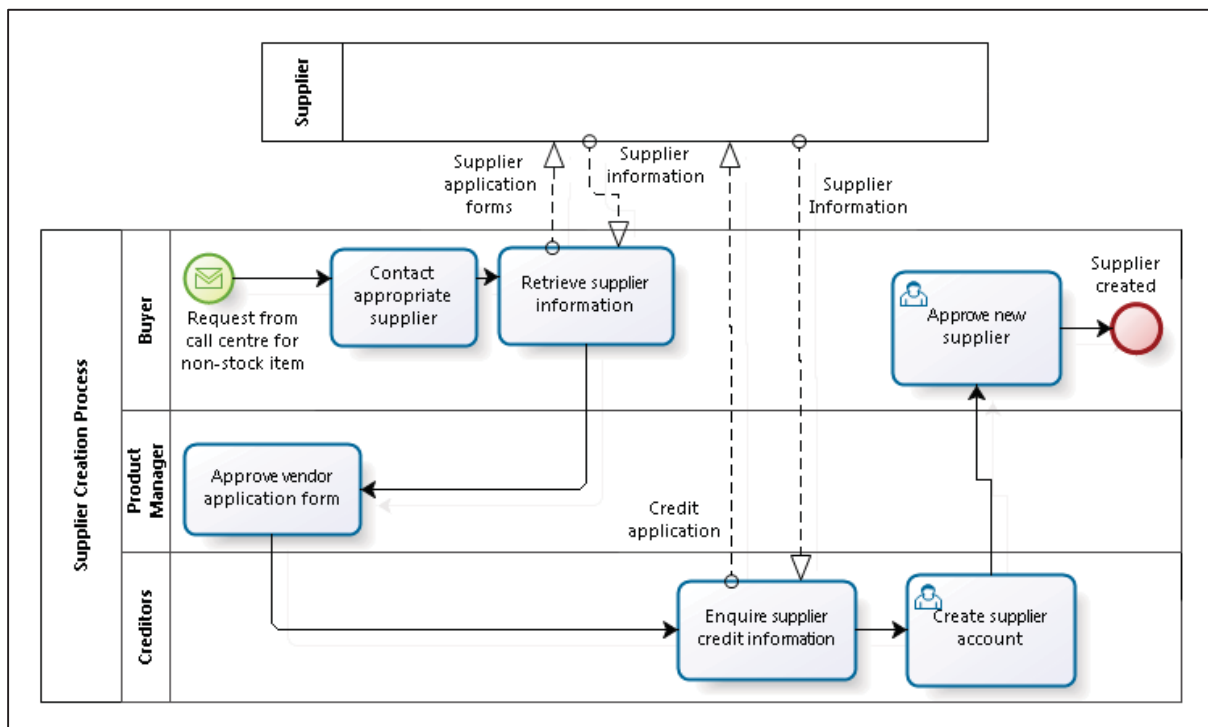
Figure 16: AS IS Supplier Creation Processes

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4.6.5 Sales Order Processes
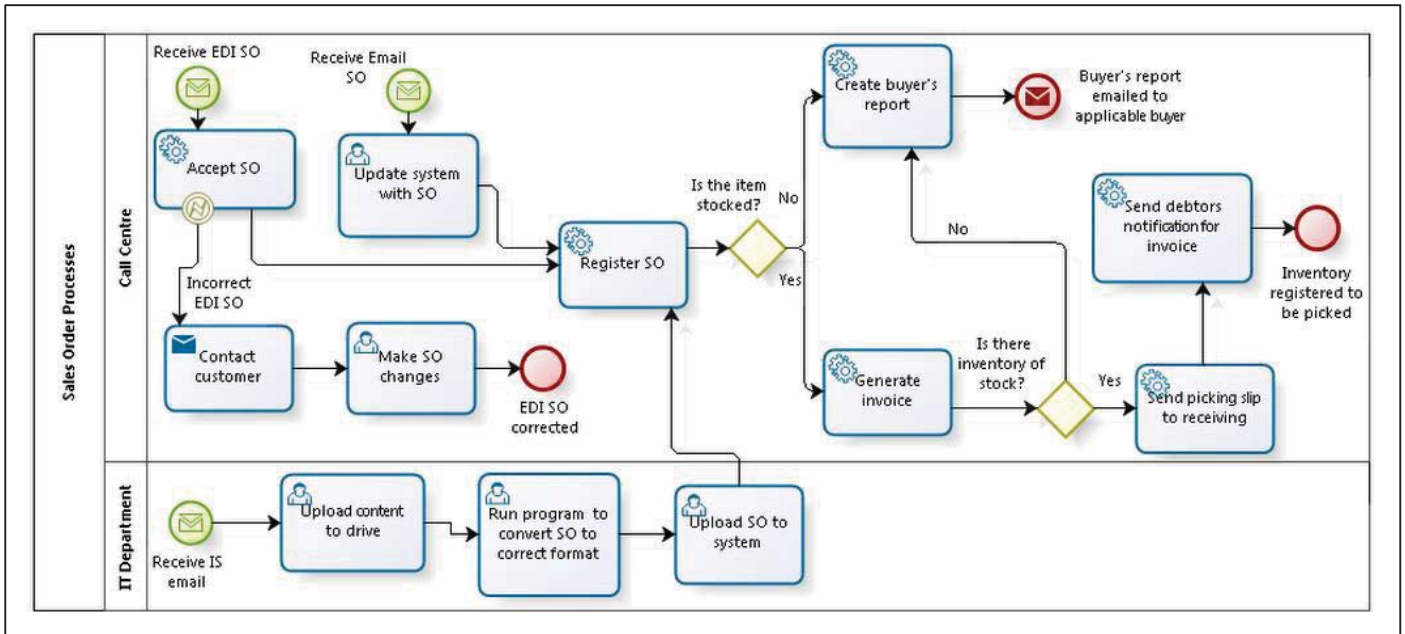
Figure 17: AS IS Sales Orders Processes

4.6.6 Customer Creation Processes
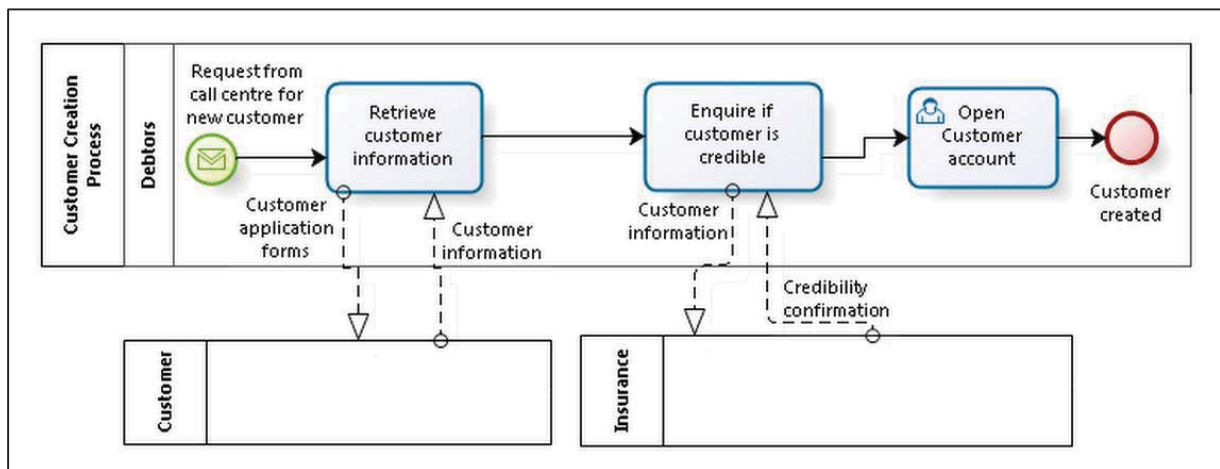
Figure 18: AS IS Customer Creation Processes

4.6.7 Physical Inventory Receiving **Processes**
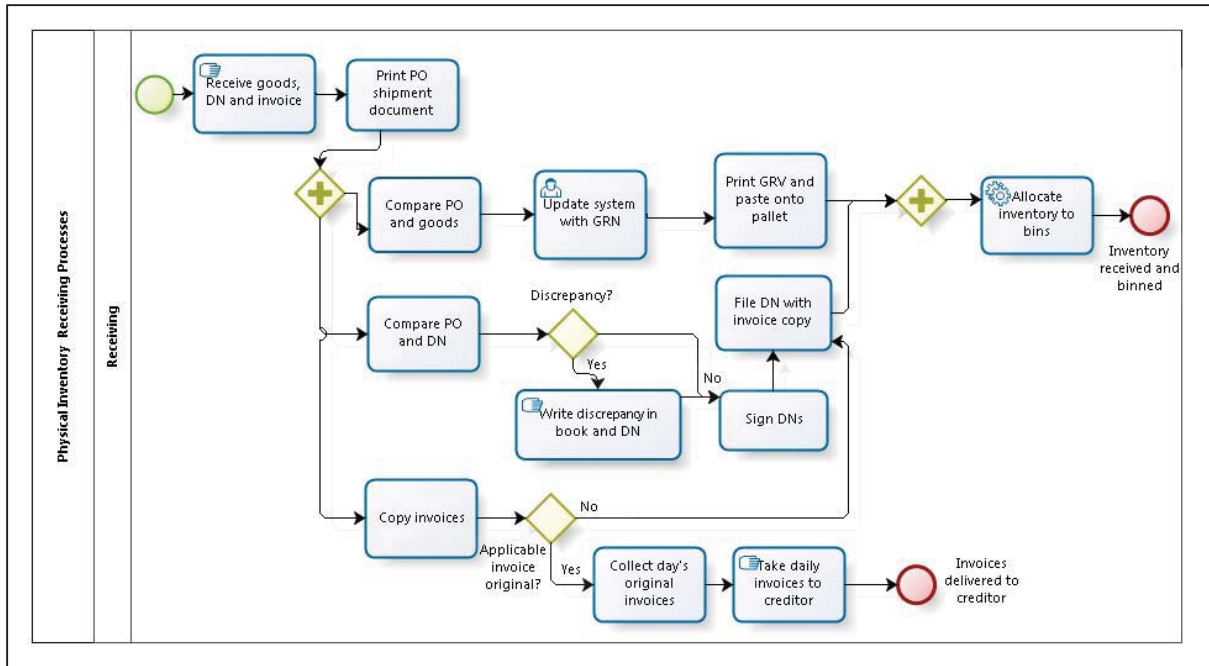
Figure 19: AS IS Physical Inventory Receiving Processes

4.6.8 Payment of Suppliers Processes
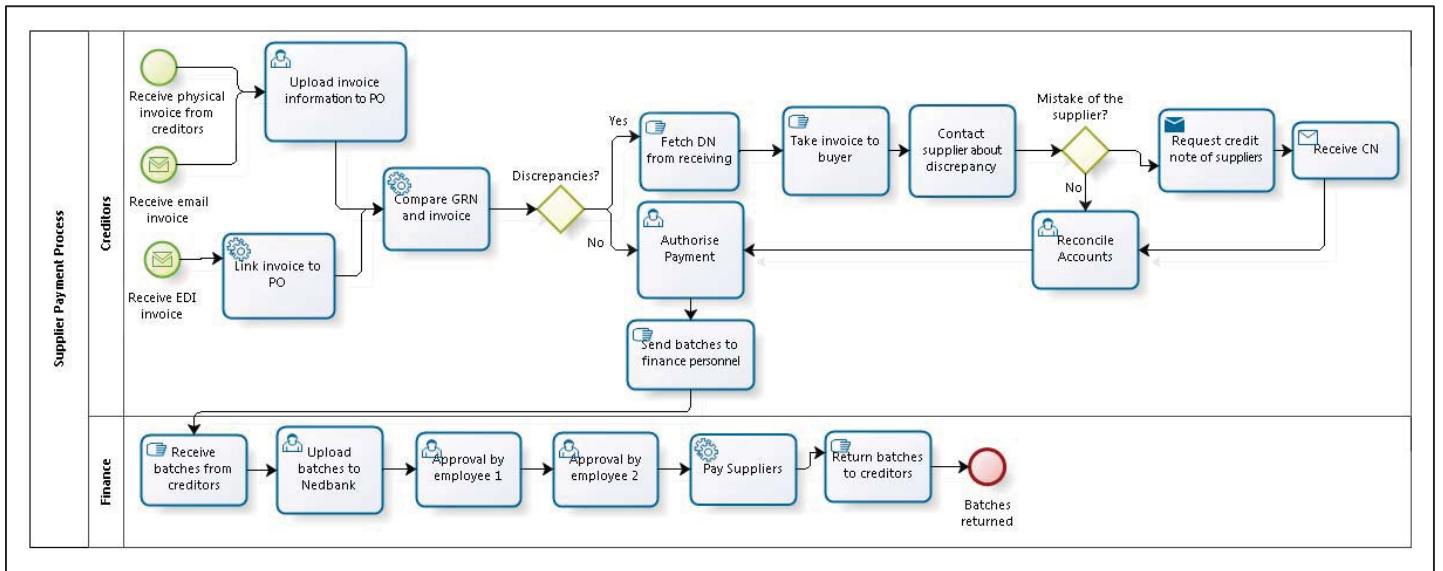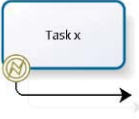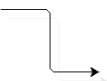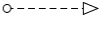
Figure 20: AS IS Payment of Suppliers Processes

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4.7   BPMN Symbol Meanings

Table 16 is used to give the meaning of the different BPMN symbols used in the models as defined by the Object Management Group (2011).

<div align="center">Table 16: Used BPMN Notation (Group, 2011)</div>

| Symbol	Name	Meaning
⬤	**Start Event**	The start event shows where a certain process will start. ✉ If a process starts with a message that has been delivered, the message start event can be used.
⬤	**End Event**	The end event shows where the process will end. ⬤ A termination end event is when the current process has been terminated. Someone stopped the process from continuing as the outcome is no longer needed or relevant. ✉ A message end event shows that the process is concluded with a message sent out.
◇	**Gateway**	The gateway is a point in the process where the sequence flow can take two or more alternative paths. ✚ Parallel gateways are used to show two processes that are simultaneously conducted.
▭	**Task**	A task is an atomic activity in the process. Tasks are performed by end-users and applications and there are many different types of tasks: ☞ Manual: A task performed without the usage of the ERP system or any application. ✉ Receive: A task where a message is received from a participant of a different pool. ✉ Send: A task where a message is sent to an external participant. 👤 User: A task performed by a human. ⚙ Service: A task performed by an automated application.
⊞	**Subprocess**	The sub process symbol links to a separate diagram with additional process steps that are not shown on this diagram.

	Exception flow	The sequence flow that originates from an intermediate event attached to an activity's boundary. It is an interruption to the normal process flow because of an error that occurred in this case.
	Loop task	A task that is repeated more than once until a certain condition is met. For instance if a timer is attached to the loop event, the task will be completed when a certain time has been reached. If a message is attached, the task will continue until a certain message has been received to inform the participant to stop.
	Data store	A data store is a way for the actors in the process to retrieve or update stored information that can be used beyond the process scope.
	Pool	A pool is a participant in the process, for instance a business entity. A pool can also take the form of a black box, where it is shown that the participant is being interacted with, but the processes are not visible (there are no internal details).
	Swim lane	The swim lanes show the sub-division of the pool and are used to illustrate the different departments within the business entity.
	Sequence flow	The sequence flow shows in what order the process's activities will be executed.
	Association	The association shows what information flow are linked to objects.
	Message flow	Message Flows show the flow of messages between two participants or pools.

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4.8   Business Process Maturity

As mentioned, the business process maturity is believed to be at level 1, ad hoc, but to be certain, the criteria of that level in the business maturity model of McCormack (2009) is used as confirmation in Table 17.

Table 17: Level 1 of Business Process Maturity (McCormack, 2009)

	Level 1 of Business Process Maturity: Ad Hoc	
#	**Key Aspects per Maturity Stage**	**Applicable to Agrinet's Processes?**
1.	Unstructured and undefined processes. The processes are not properly structured or defined.	√
2.	No process measures in place.	√
3.	The jobs and organizational structures are viewed traditionally as functional silos and not horizontal processes.	√

It can thus be concluded that the current business process maturity is at level 1.

5. CONCEPTUAL DESIGN

5.1   Functional Requirements

The functional requirements are improvements based opportunities, directives and problems identified throughout the documentation of the AS IS state. The functional requirements can be seen as the "should haves" of the improved or TO BE process. The functional requirements are depicted with use cases, diagrammatical figures, descriptions and screen shots of Embrace.

The functional requirements are listed per sub-process with an indication of which problem category (PC) is being addressed: D = Duplication of efforts; U = Unsegregated duties; C = Un-centralised changes; A = Unclear and slow approval process; P = Too paper-based process. It is also listed how the functional requirement will be achieved.

5.1.1 DRP Approval Processed

Table 18: Functional Requirements for the DRP Approval Processes
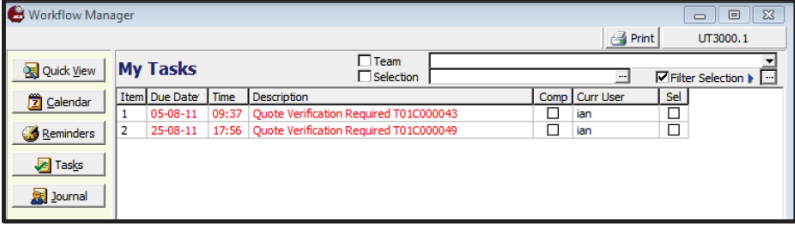
#	PC	Functional Requirement	How
i.	A, D	A buyer should not also have to check the DRP (distribution resource plan) as there are already someone from the procurement organization who reviews the order forecasts.	Rearranging the existing process steps.
ii.	A, U	The DRP's approval process can be significantly shortened by allowing the sales- and product manager to view the forecasts simultaneously.	Rearranging the existing process steps.

5.1.2 Placement of Purchase Orders Processes

Table 19: Functional Requirements of the Placement of Purchase Orders Processes
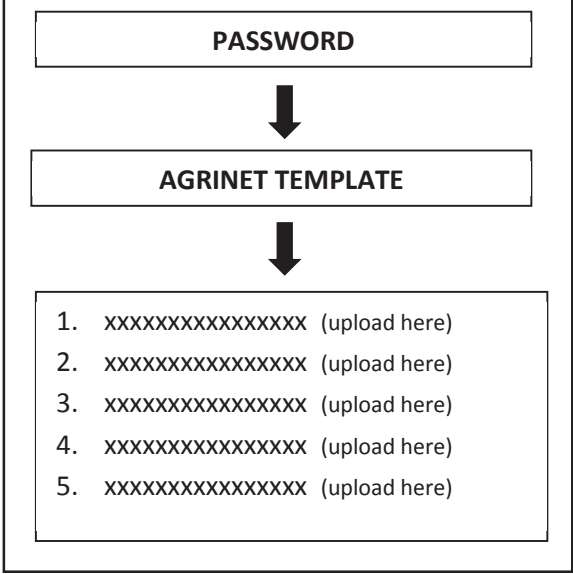
#	PC	Functional Requirement	How
i.	A, P	Upper management receives the approval of purchase orders as workflow tasks on the system, but a notification email should also be sent, notifying them of this awaiting tasks as they do not regularly log on to Embrace.	Customization of Embrace.
ii.	C, D, P	The company should strive to make use of electronic data interchange (EDI) as much as possible and thus eliminating other means of receiving orders as far as possible.	Rearranging the existing process steps.

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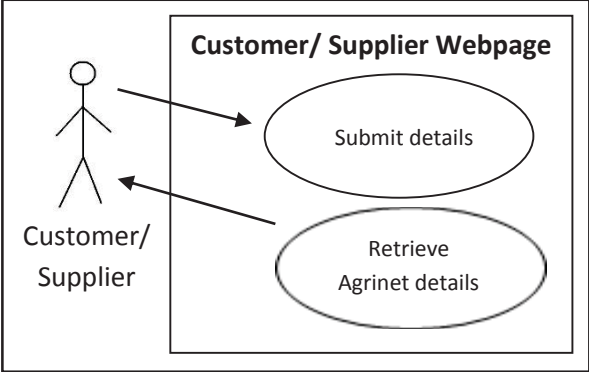
iii.	D, P	The expending process can be done by using the time-trigger function of Embrace that automatically sends notifications to remind the supplier of the purchase order as shown in Figure 21.	Customization of Embrace.
		Figure 21: Use Case of Time Triggering of Purchase Order Confirmation	
iii.	P	The lack of EDI (electronic data interchange) incorporation can be addressed by using the function in Embrace can be used to make all EDI-suppliers the "preferred supplier" by adding a "Y" in the appropriate field of the supplier's master data as shown in the Figure 22.	Customization of Embrace.
		Figure 22: Screen Shot of Making EDI Suppliers the Preferred Suppliers	

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| iv. | A, P | Instead of sending the buyer's report through an email, the buyer's report can be sent as a list of workflow items or tasks to be completed, as shown in Figure 23 which will remain on the system until they are completed and highlighted if overdue.

Figure 23: Screen Shot of Embrace's Workflow Manager | Full use of purchased Embrace modules. |

5.1.3 Supplier Creation Processes

Table 20: Functional Requirements of the Supplier Creation Processes

#	PC	Functional Requirement	
i.	A, P	A web based opportunity can be created for the creation of new suppliers and customers and where Agrinet can create a webpage template with their applicable information and have a supplier (customer) upload their documentation once off (Figure 24 and Figure 25). Each supplier (customer) will be given a unique password. From there on it should be possible to program an interface that will automatically upload all of the information onto Embrace and the creator of supplier (customer) can finalise the process by getting a workflow notification to create the supplier. **Figure 24: Diagram of Web Based Opportunity for the Creation of Suppliers (Customers)**	Programming by expert.

Figure 25: Use Case of Supplier Creation

#	PC		How
ii.	A, U	The buyers should not be allowed to create new suppliers, but rather the procurement coordinator, as there are too many suppliers unaccounted for.	Rearranging the existing process steps.

5.1.4 Sales Order Receiving Processes

Table 21: Functional Requirements of the Order Receiving Processes

#	PC	Functional Requirement	How
i.	C, D, P	Some sales orders are sent with an email as a folder directly subtracted from the company's information system. The IT department has to manually upload the folder onto one of the company's servers and run a program for this information to be accepted by Embrace instead of programming the system to automatically import the folder.	Programming by expert.
ii.	C, D, P	As mentioned with regard to the purchase orders, the company should strive to make use of EDI as opposed to other communication modes.	Rearranging the existing process steps.
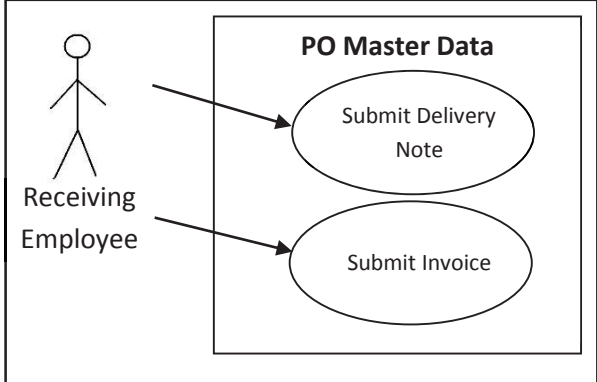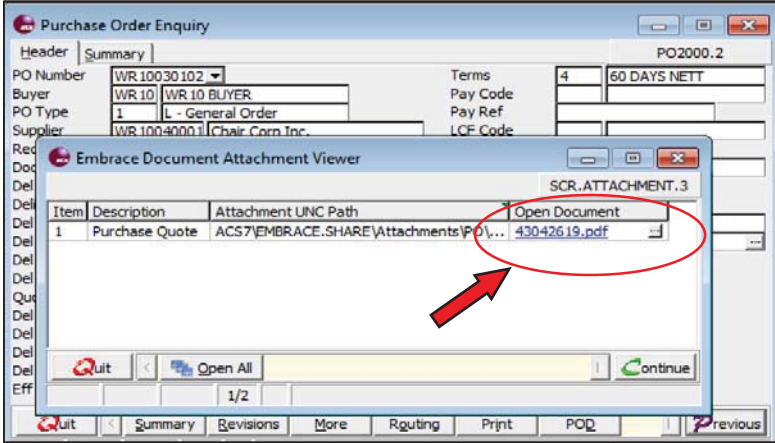
5.1.5 Customer Creation Processes

Table 22: Functional Requirements of the Customer Creation Processes

#	PC	Functional Requirement	How
i.	D, P, U	The customer creation process will be similar to the supplier creation process as described above.	Programming by expert.

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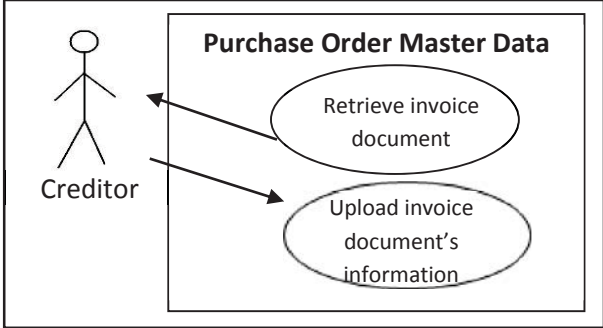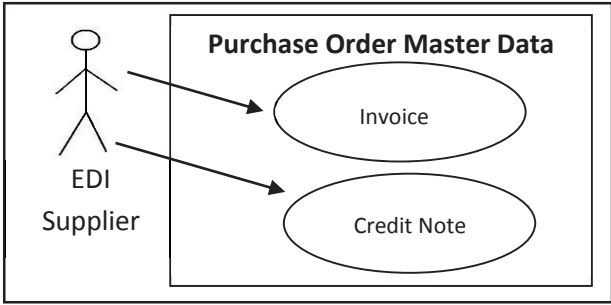
5.1.6 Physical Receiving of Goods from Suppliers Processes

Table 23: Functional Requirements of the Physical Receiving of Goods from Suppliers Processes

#	PC	Functional Requirement	How
i.	D, P	The delivery notes and invoices should be scanned in by the receiving department and uploaded onto the system to be accessible at the master data of the purchase order as shown in Figure 26. **Figure 26: Upload of Receiving Documents** Agrinet already has the module of Embrace called output management that makes it possible to upload documents onto the information system as seen in Figure 27**Figure 27**. **Figure 27: Screen Shot of Uploading Documents to Embrace** There is a scanner available at the receiving department that can be moved to the receiving area for this function. With this changes, all of the information will be stored in a paperless manner.	Move and usage of existing physical equipment; Full use of purchased Embrace modules.
ii.	P	The discrepancies that are currently written down can be stored electronically on the server in an excel-file.	Usage of existing technology.

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5.1.7 Payment of Suppliers Processes

Table 24: Functional Requirements of the Payment of Suppliers Processes

#	PC	Functional Requirement	How
i.	C, D, P, U	Embrace has the functionality where the batches of the suppliers to be paid are directly put through to the Nedbank page after the creditors created the batches via the purchased cash book module.	Full use of purchased Embrace modules.
ii.	P, U	With the invoice now uploaded, the creditor no longer has to get the invoice delivered from receiving, but can download the document form the purchase order's master data and upload the information on the email to the purchase order (Figure 28). A workflow can be created and the creditor will receive all of these invoices as tasks to complete. **Figure 28: Use Case of Creditor Receiving Documents and Uploading the Applicable Information**	Full use of purchased Embrace modules.
iii.	C, D, P	A supplier will be notified via the delivery notes that they receive back if there is a discrepancy with regard to the order. As the GRN and invoice quantities has to match for Embrace to accept it, a credit note and invoice could be sent simultaneously by an EDI supplier (Figure 29). **Figure 29: Use Case of EDI Supplier Uploading Invoice and Credit Note**	Customization of Embrace.

The impact of the functional requirements shaded in green (the functional requirements advocating EDI as sole communication mode) are so large and affects so many process steps that it warrants the design of a second solution incorporating these functional requirements in addition to the others. For this reason, two improved or TO BE solutions are developed in chapter 6.

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5.2 Non-Functional Requirements

Table 25 includes all the non-functional requirements (lean manufacturing definitions of wastes are employed here):

Table 25: Non-Functional Requirements Categorised by PIECES

Non-Functional Requirement Type	Non-Functional Requirement as Applicable to Agrinet
Performance *Performance relates to the degree to which the user's needs are satisfied.*	• Currently performance is not measured at all because of the ad hoc nature of the processes. By increasing the process maturity, measurements can be taken of what is achieved and then compared to what can be achieved, a process called benchmarking.
Information *The information must be accurate, be on time and of the correct format.*	• The lack of EDI customers and suppliers remain a problem as too much information has to be manually inserted into the system, leaving room for human errors.
Economy *Economy is as the word states, about money, to enhance profits and lower the operating costs.*	• For economy, the time is money paradigm is used, where the profits of the company will increase if the processes take less time as more orders can be processed.
Control (Security) *Control relates to access, privacy and security considerations.*	• It must be clear who are responsible for what procedures, such as who has the authority to create suppliers and customers. • If more electronic copies are created as opposed to paper-based copies, the information system has to be clear on who will have access to the server on which the copies are stored. • The different drives on which information is stored should be password protected to secure the information. • Each user of the ERP system should also receive a username and password to ensure that no one else will be able to access their workflow tasks and give approval to actions they are not sanctioned for.

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Efficiency *To be efficient, the minimum amount of waste must be produced during the execution of the process.*	• There must be no more duplication in the process steps, as addressed at the functional requirements. • Waste with regard to the utilisation of the users has to be eliminated. Motion, as explained in the literature study is a form of waste. With the lack of use of technology, some the users such as the receiving employees have to specially deliver documents to the creditors. • With the lack of automation and EDI users spend more time to perform manual tasks that could be performed by the system, such as the creditors who have to upload invoices, which again leads to under-utilisation of people. • The integrity of the information is also compromised by some customers who give their orders through EDI and phone it in as well as they do not trust their systems. Such customers have to be restricted to only be able to give their information through EDI as it wastes time to type the orders in and Embrace recognises it as a duplicate. • Sending tasks through workflow ensures that they are timeously delivered to the correct actor (person). The tasks don't get lost amongst various other emails and it will stay in the actor's in-tray until it is conducted, aiding as a constant reminder of what has to be done. Making use of workflow instead of manual communication modes is thus encouraged.
Service *For a system to achieve on the service requirement it has to be expandable, flexible and reliable.*	• The processes have to be repeatable and documented in order for another user to be able to easily take over in the event that the current user is absent. As mentioned in the literature study there are currently no standard operating procedures. • In case of workflow items, a workaround should be put in place for occurrences where the actor is not available to take care of the workflow tasks allocated to him, for instance someone with higher authority should be able to log into the account. • A good feature of Embrace is the fact that it is very expandable, new modules can easily be added to the existing and this should be done wherever a new module can simplify the process.

6. SOLUTION DEVELOPMENT

As mentioned in chapter 5, two solutions are developed from the AS IS process and represented with the BPMN diagrams as TO BE processes. Solution 1's TO BE process is generated by taking the AS IS process and adding the functional requirements (except for those that require only EDI as communication mode) to each process as indicated in the conceptual design. To indicate where functional requirements have been added, orange shading is used.

Solution 2 is a rework of solution 1 with the functional requirements advocating electronic data interchange (EDI) as sole communication mode in addition to the other functional requirements. As with the implementation of only EDI as communication mode, some of the process steps are not relevant anymore and these areas on solution 1's diagrams are shaded green. Thus green and orange shading indicate a functional requirement that is left out in solution 2.

6.1   Solution 1

6.1.1 DRP Approval Processes
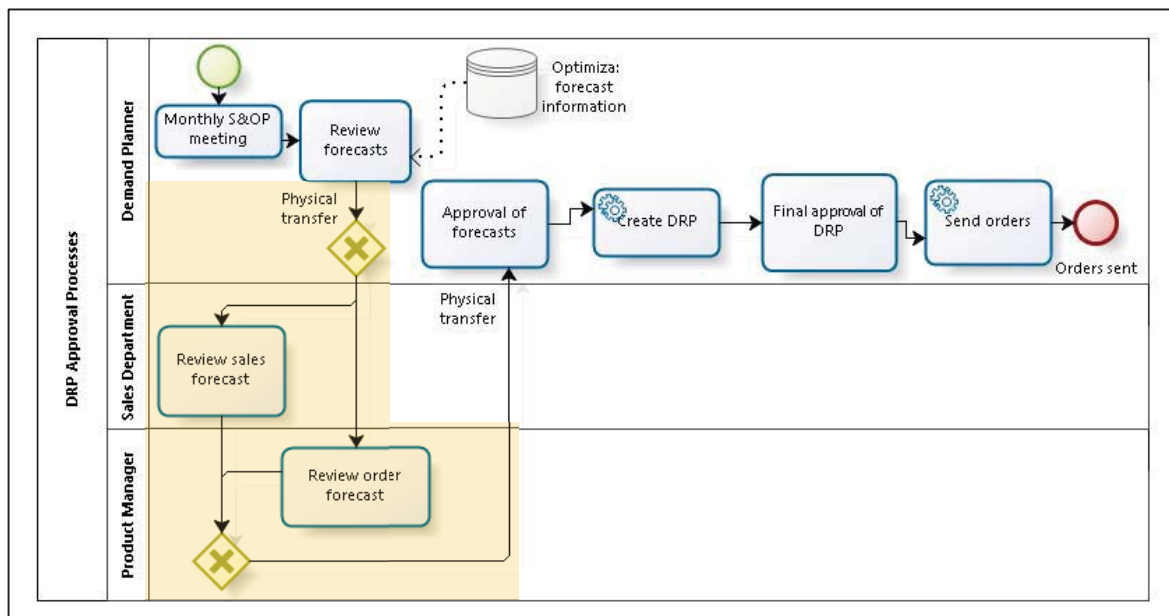
Figure 30: Solution 1 DRP Approval Processes

6.1.2 Purchase Orders Processes
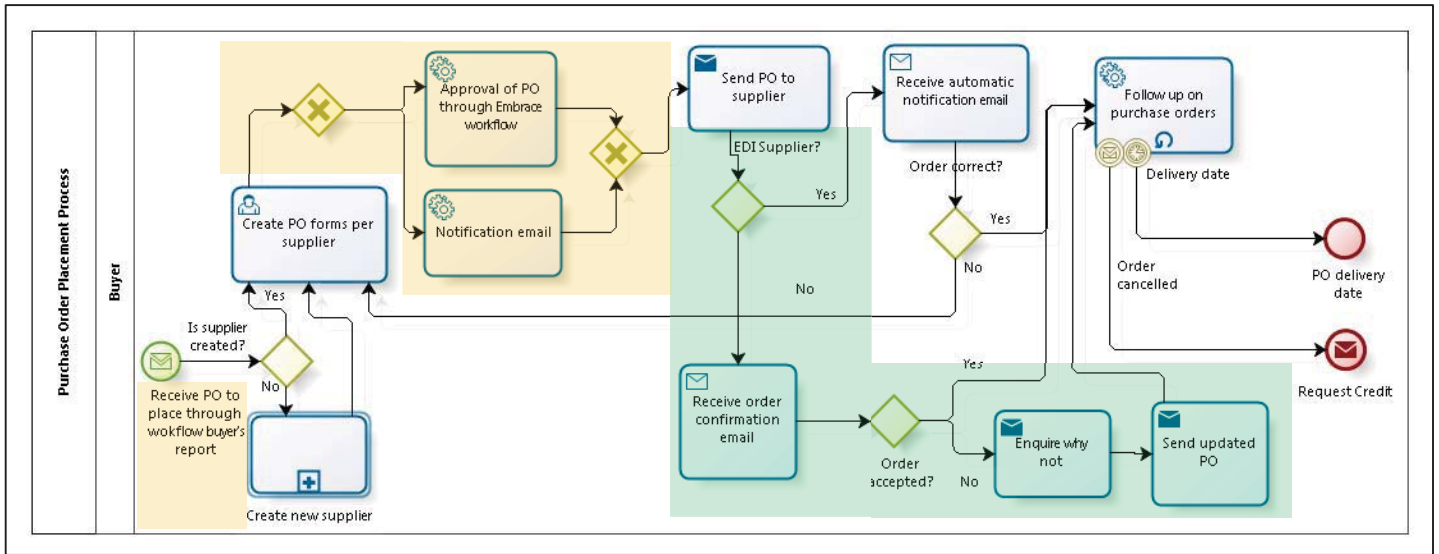
Figure 31: Solution 1 Purchase Order Processes

6.1.3 Cancellation of Sales Orders Processes
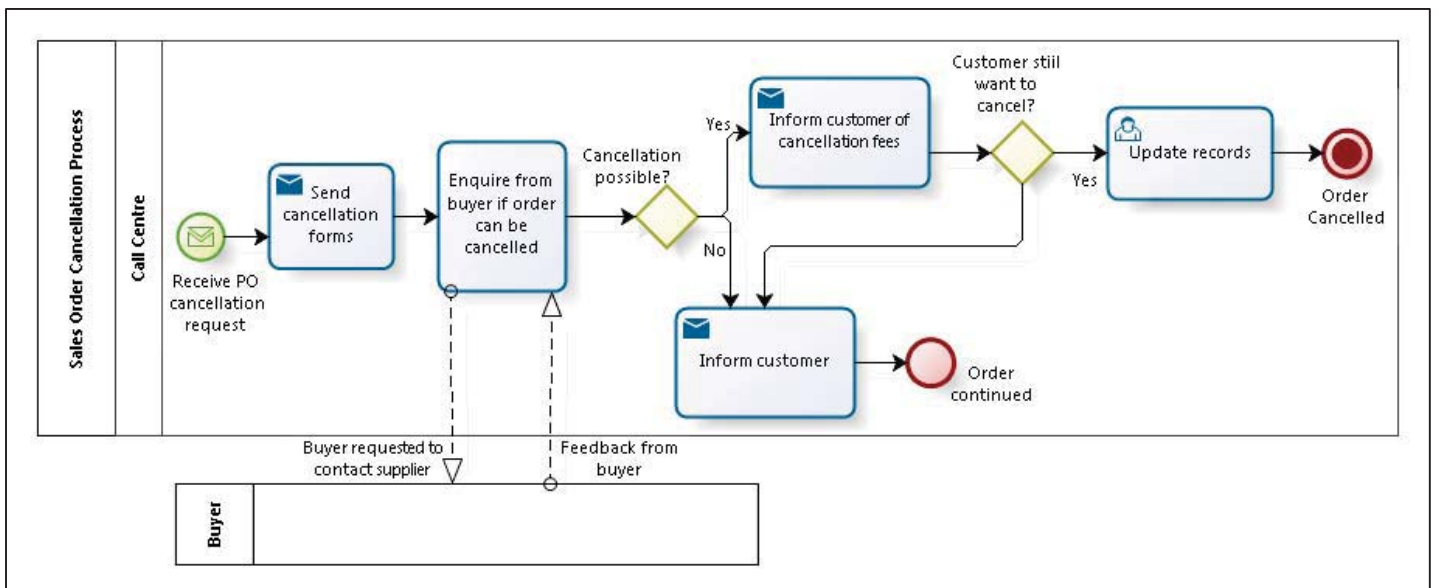
Figure 32: Solution 1 Cancellation of Sales Order Processes

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6.1.4 Supplier Creation Processes
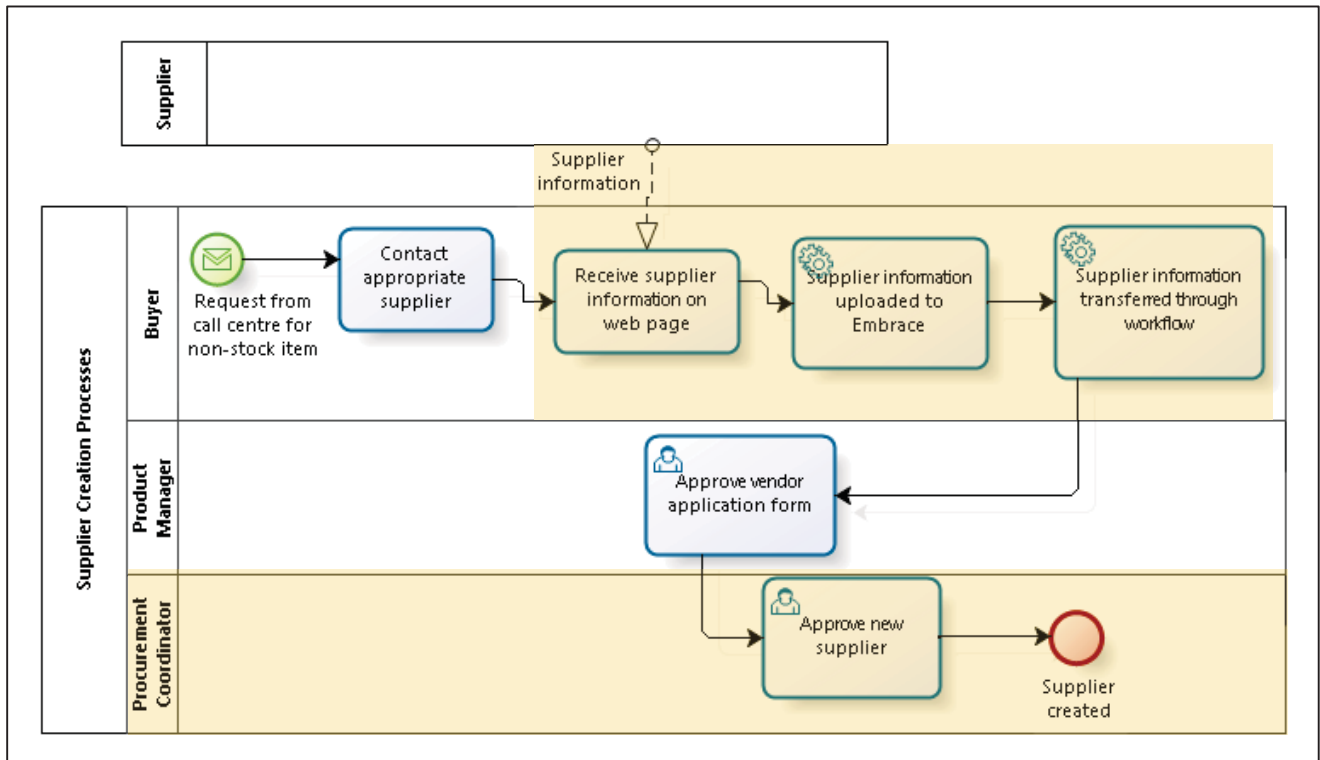
Figure 33: Solution 1 Supplier Creation Processes

6.1.5 Sales Order Processes
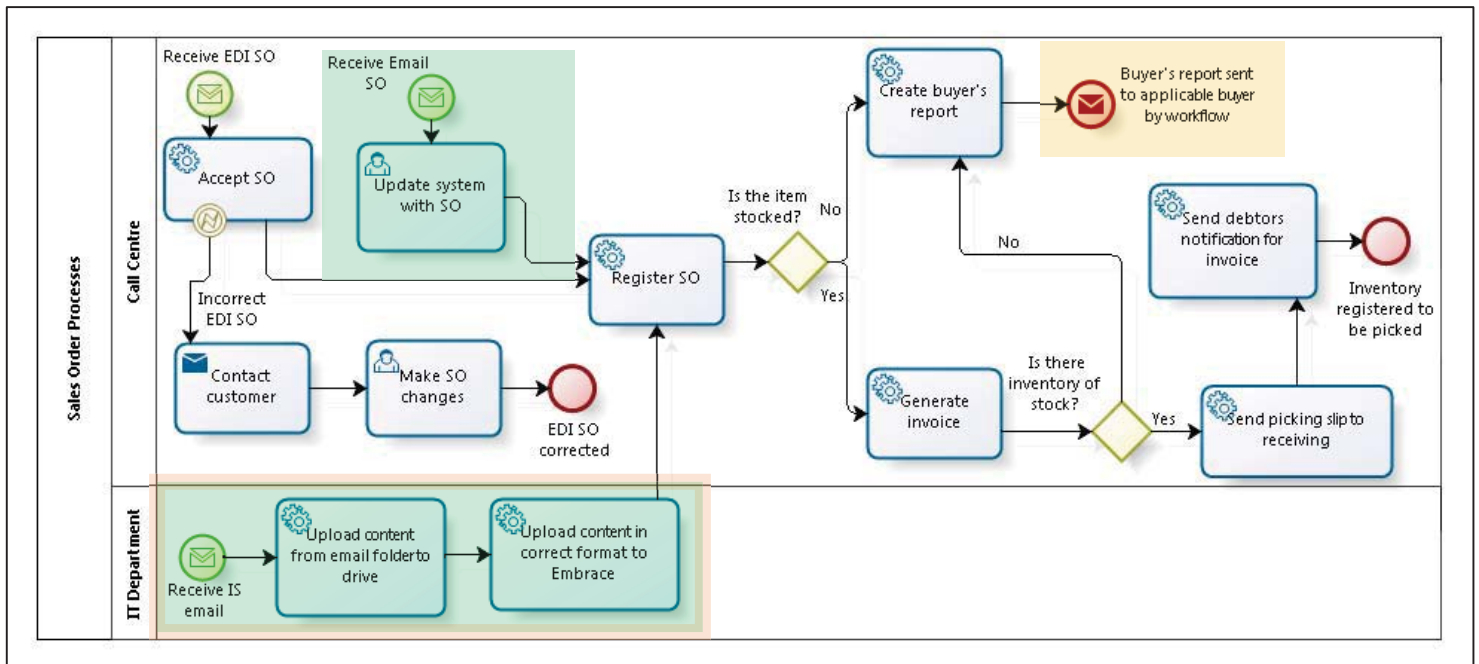
Figure 34: Solution 1 Sales Order Processes

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6.1.6 Customer Creation Processes
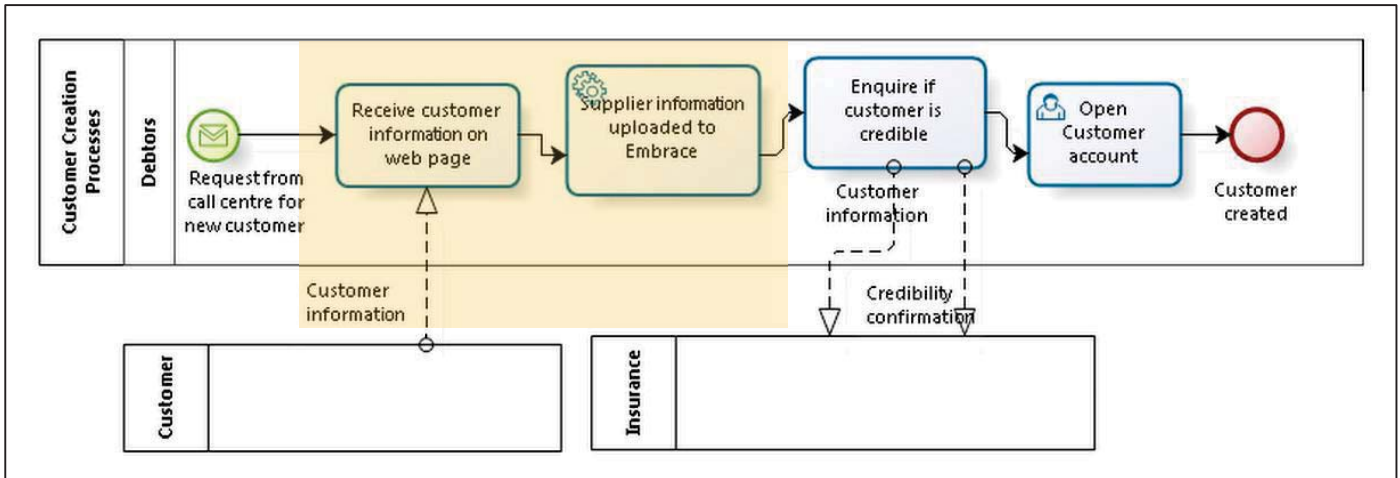
Figure 35: Solution 1 Customer Creation Processes

6.1.7 Physical Inventory Receiving Processes
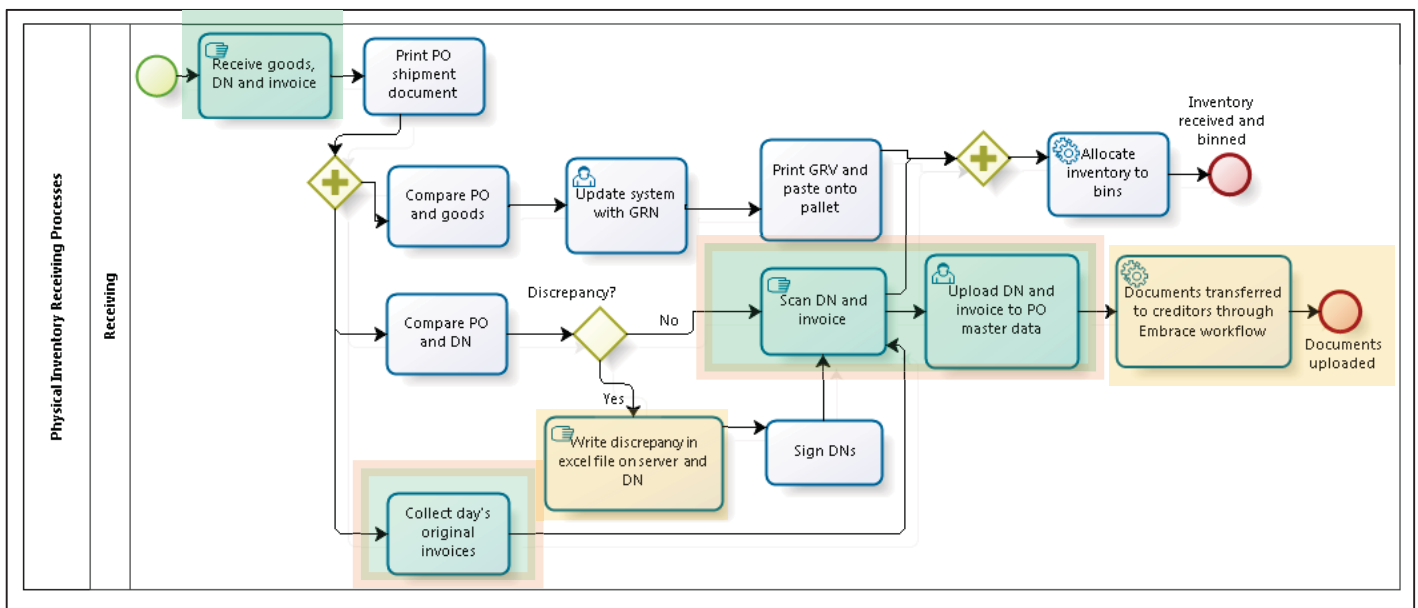
Figure 36: Solution 1 Physical Inventory Receiving Processes

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6.1.8 Payment of Suppliers Processes
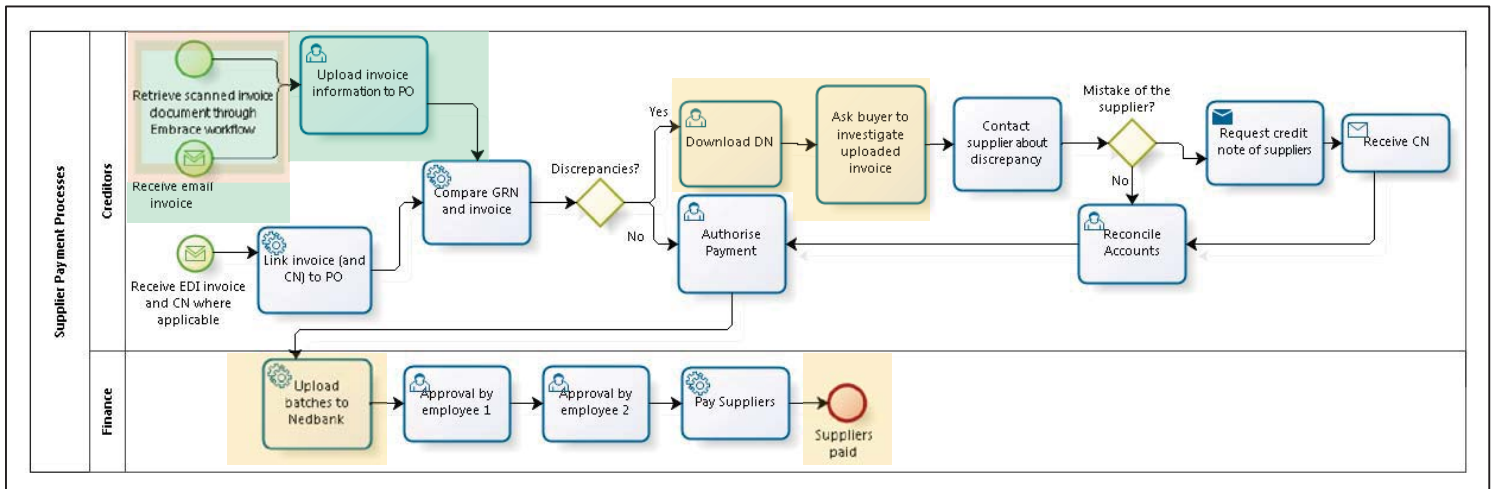
Figure 37: Solution 1 Payment of Suppliers Processes

6.2 Solution 2

6.2.1 Purchase Orders Processes
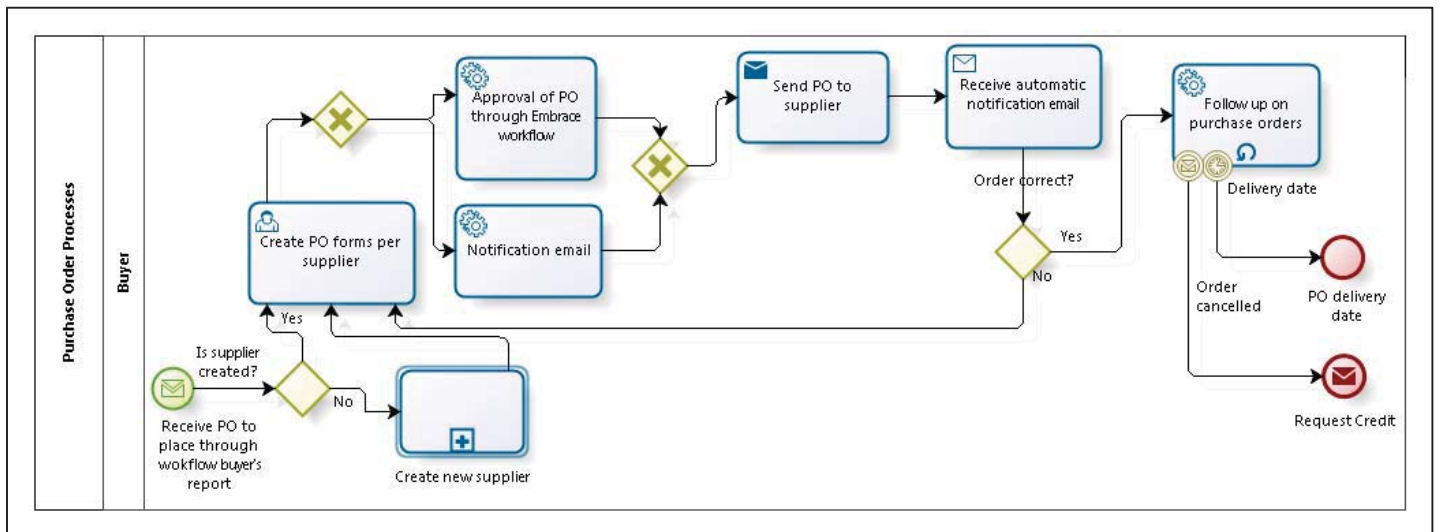
Figure 38: Solution 2 Purchase Order Processes

6.2.2 Sales Order Processes
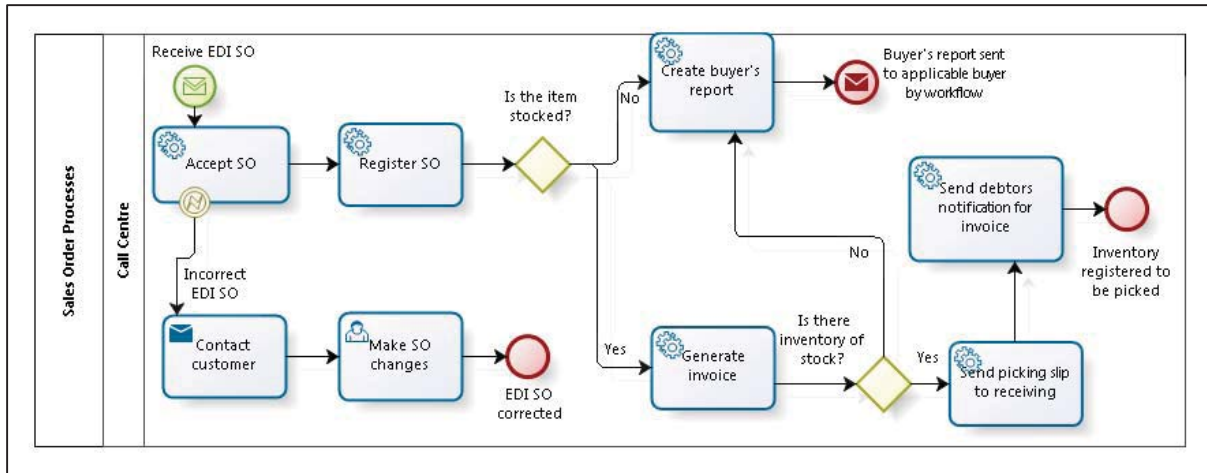
Figure 39: Solution 2 Sales Order Processes

6.2.3 Physical Inventory Receiving Processes
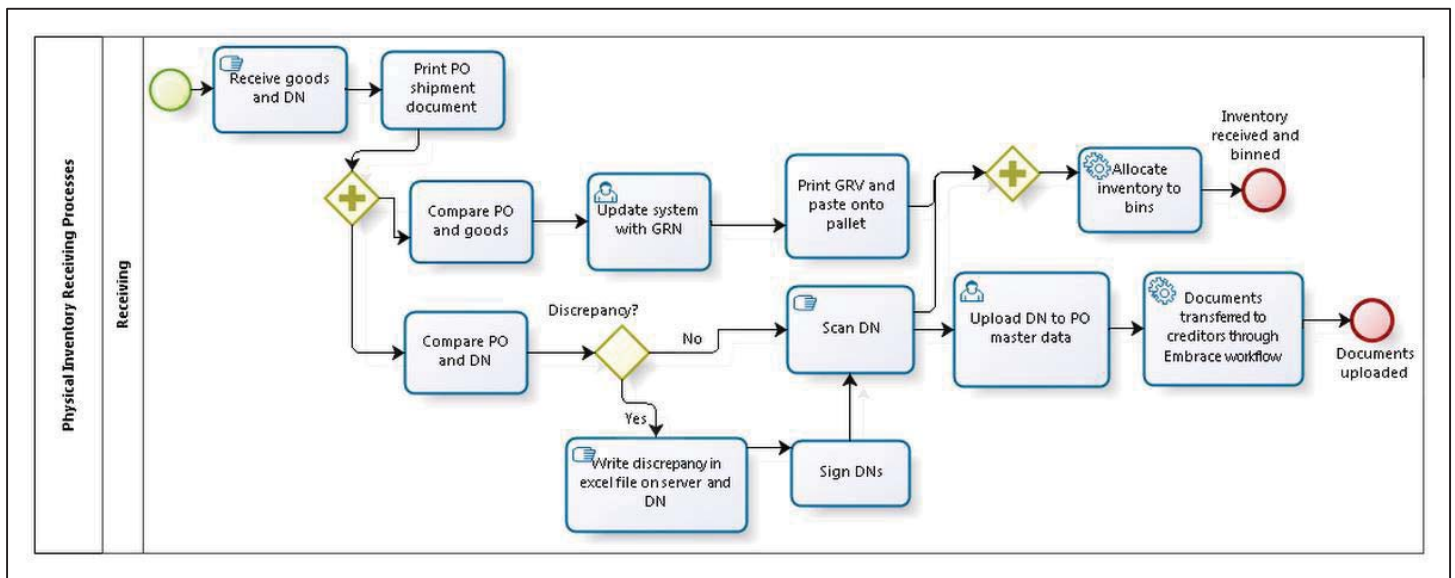
Figure 40: Solution 2 Physical Inventory Receiving Processes

6.2.4 Payment of Suppliers Processes
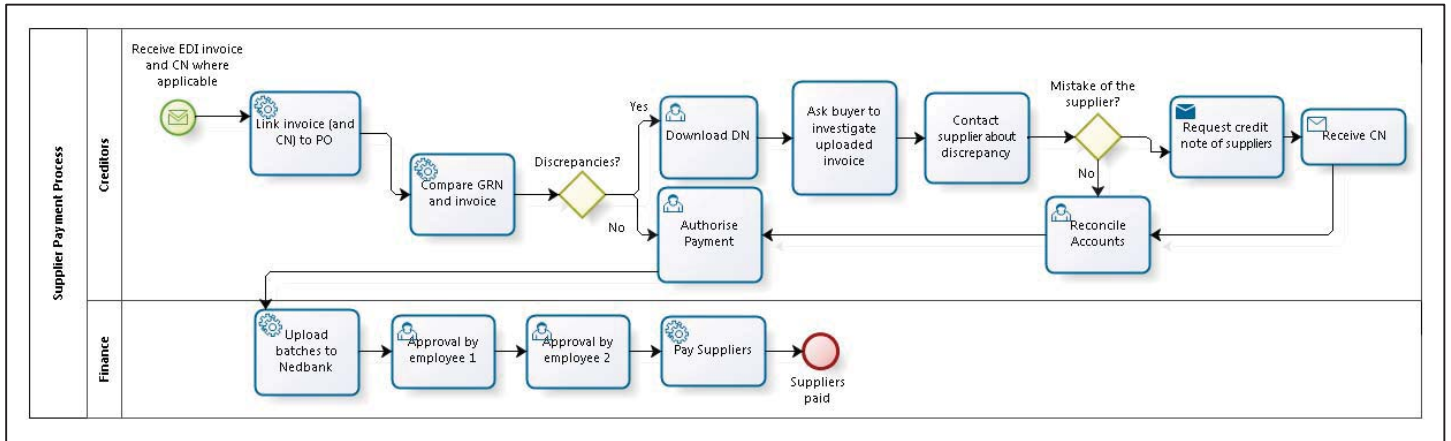
Figure 41: Solution 2 Payment of Suppliers Processes

7. SOLUTION VERIFICATION

7.1 Requirements Verification

In Table 26 solution 1 is evaluated by the designer to ensure that it addresses the problems stated in chapter 1 and in Table 27 the non-functional requirements solution 1 adheres to are checked.

In Table 27 it is also checked in what ways solution 2 adhere to the functional requirements in addition to solution 1 which will give an indication of the benefits having only electronic data interchange (EDI) as communication mode will bring.

Table 26: Address of Problems by Solutions

Problem Area	Solution 1
Duplication of efforts	√
Unsegregated duties	√
Uncentralised changes	√
Unclear and slow approval process	√
Too paper-based process	√

Table 27: Verification of Solution Adherence to Non-Functional Requirements

Solution 1 Meet Requirement?	Solution 2's Meeting of the Requirement in Addition to Solution 1
Performance	
✓ Performance can now be measured as the processes are documented.	✓ EDI usage is a best practice and therefore the process is being performed as well as it could be performed.
Information	
✓ More information is stored electronically, making it easy to obtain. ✓ More workflow usage ensures that the user cannot miss the tasks allocated to him.	✓ With EDI the process is paperless and very little room for human error.
Economy	
✓ The processes are performed faster and more orders can be processed.	✓ EDI orders are directly added to the system, thus eliminating the manual upload step, making the processes even faster. ✓ The process is paperless, so paper and printing costs are saved. ✓ Less people that have to be employed to conduct the business processes and staff can be redeployed to other areas that will add value to the business.

Control (Security)	
✓ More control measures have been installed such as information that is saved on drives with passwords. ✓ The customer and supplier creation process has also been changed so that internal actors with more authority approves it. ✓ With increased workflow usage, only the internal actor for whom the tasks are intended will see it.	✓ With EDI an internal actor cannot manipulate the information as it goes directly into the system.
Efficiency	
✓ Less duplication of process steps take place, such as the shortened DRP approval process. ✓ Wastes such as motion are being eliminated with the electronic uploads and tasks taking place in parallel. ✓ Tasks performed by humans have now been automated and are performed by the system alone.	✓ A great amount of data can be transferred in a very short time span as compared to the data being manually inserted.
Service	
✓ The processes are now documented and can be easily transferred between different users if one is sick or on leave. ✓ The information system can be reconfigured or expanded if needed to provide better service.	✓ By making use of EDI, the purchasing, production and delivery can be managed more effectively.

7.2 Business Process Maturity Evaluation

The designer ensures that solution 1 is at least at level 2 in order for an improvement to have taken place and evaluates solution 2's business process maturity (Table 28).

Table 28: Business Process Maturity Evaluation of Solutions

Solution	Business Process Maturity Goal	Goal Reached?
Solution 1	**Level 2: Defined** • Agrinet's processes are defined, documented and modelled. • A formal procedure has to take place to change a process. • The organizational structures are rather seen as processes than functional areas. • Management are encouraged by the designer to arrange for representatives from the functional areas like sales and procurement to regularly meet and coordinate with each other*.	Yes

*Not everything regarding the business process's maturity is within the control of the designer and will have to be pursued by management.

Solution	Business Process Maturity Goal	Goal Reached?
Solution 2	The additions to solution 1 to create solution 2 takes it two steps up on the process maturity ladder to: **Level 4: Integrated** • Agrinet and its customers and suppliers are cooperation on a process level with the EDI communications almost 100% of the time. • Performance can effectively be measured because of the electronic data trail that is created by EDI usage.	**Yes**

7.3   Discussion of Solution Verification

In doing the verification it became clear that solution 2 with only EDI as communication mode is the better solution as it adheres to the functional requirements to a larger degree and has the highest business process maturity. It should thus be determined whether solution 2 is in fact feasible.

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8. SOLUTION ANALYSIS

In analysing the solutions, it is firstly checked whether solution 2 is feasible and a cost analysis is conducted as input to the economic criterion of the positive impact analysis.

8.1 EDI Feasibility Analysis: Solution 2

When considering the feasibility of only making use of electronic data interchange (EDI) as communication mode, the current EDI situation needs to be investigated as well as the reasons for the lack of implementation.

8.1.1 EDI Customers and Suppliers

8.1.1.1 Quantity EDI Customers and Suppliers

The following graphs show how many customers and suppliers are currently making use of EDI (Figure 42).
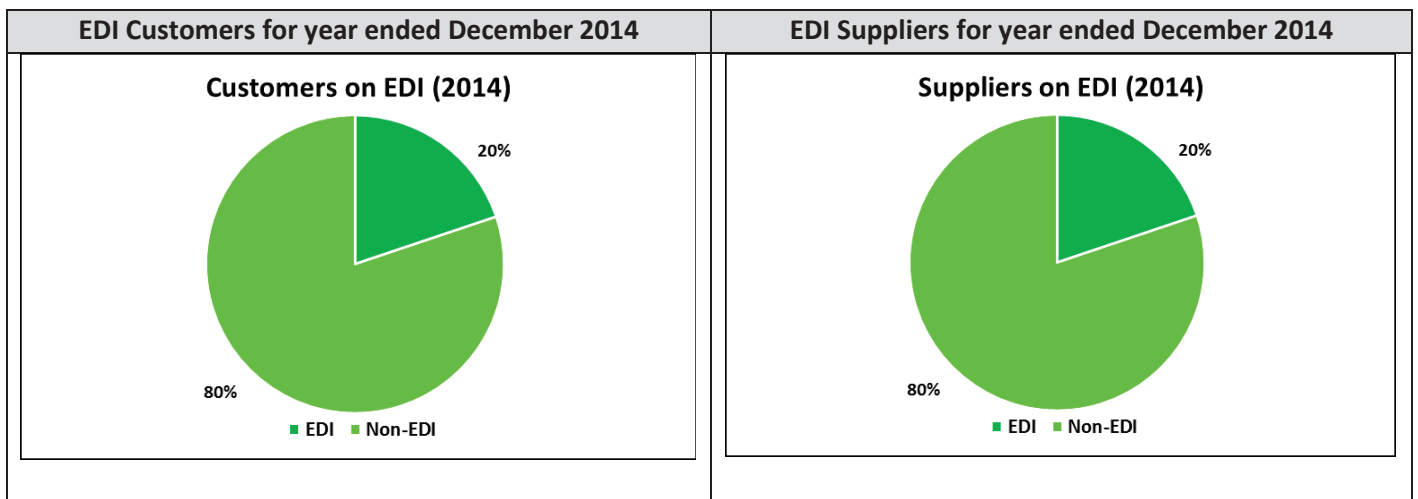
Figure 42: Customers and Suppliers on EDI

Quantity wise, there are very few external actors on EDI, the graphs however, do not show the value of the customers and suppliers or in other words how much of the orders sent and received they are responsible for.

8.1.1.2 Value of EDI Customers and Suppliers

The next graphs shown in Figure 45 and Figure 44 shows the EDI-dispersion of the customers and suppliers in terms of the amount of orders sent and received (value):
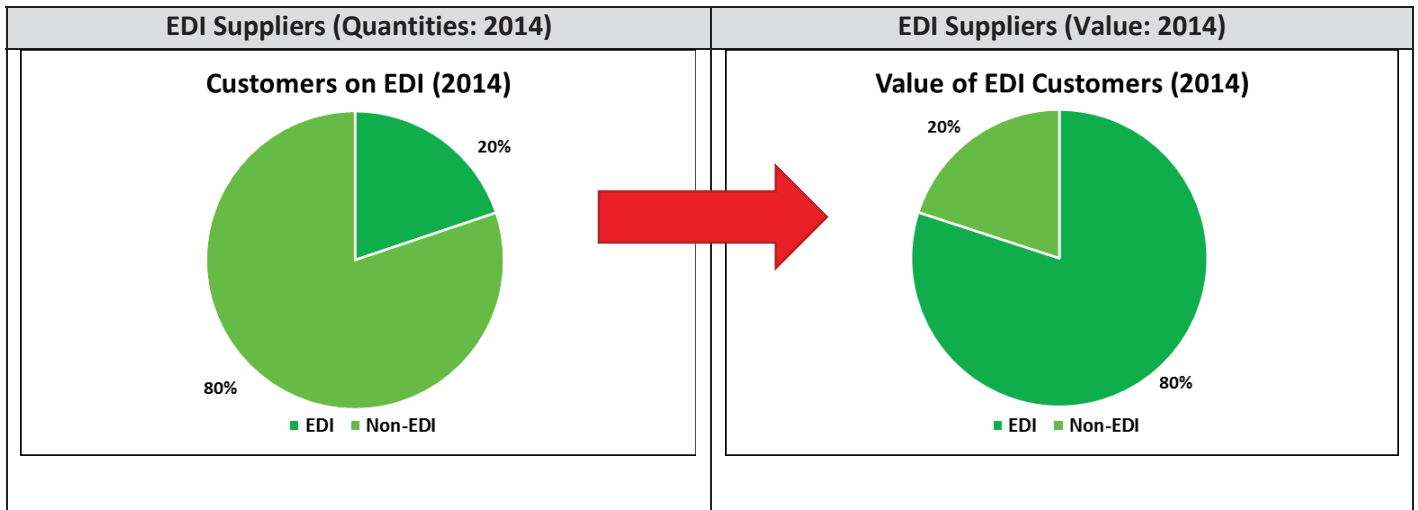
Figure 43: Quantity vs. Value of EDI Customers
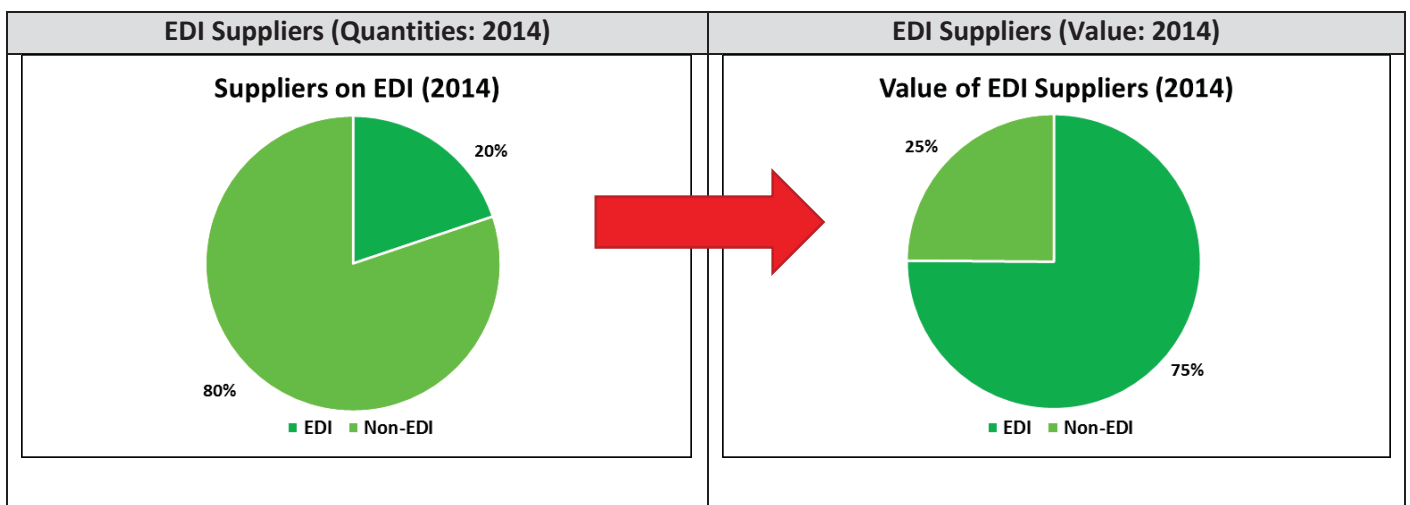
Figure 44: Quantity vs. Value of EDI Suppliers

According to the graphs below, although quantity wise there are not many customers and suppliers on EDI, but the bulk of the orders processed are via EDI.

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8.1.1.3 Value of Top Suppliers

In the following graph, only the top 20 suppliers are considered and the fraction of them making use of EDI is shown below in Figure 45. (Currently EDI is not used with overseas suppliers, which is why the top 20 suppliers overall i.e. including overseas suppliers is considered separately from the local suppliers.)
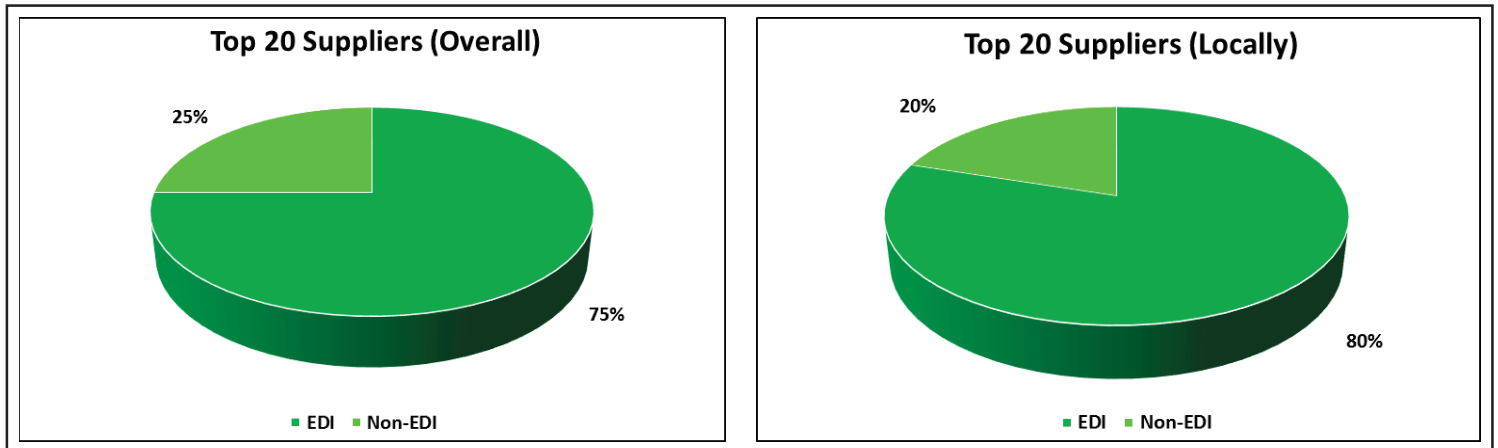
Figure 45: Top 20 Suppliers Overall and Locally

It is clear in the graphs above, that EDI is very successfully implemented amongst the top suppliers.

8.1.1.4 Discussion of EDI Customers and Suppliers

It can thus be concluded that there are not a lot of customers and suppliers on EDI, but by far the bulk of the orders are received and sent through EDI-usage. One of the reasons for the many suppliers not on EDI may be because of one of the problems noted by management which is that a lot of unauthorised suppliers have been created without the proper approval. These suppliers are thus on the system, but do not necessarily add much value.

8.1.2 Causes for EDI Lack

The following discusses the different reasons why EDI is not fully implemented, what the implication of the different reasons are and how it can be overcome.

8.1.2.1 Lack of Project Manager and Contractual Difficulties

A project manager has only been hired in 2015 to drive the EDI implementation process with the goal in mind of a completely electronic process. A new contract has been issued to be signed by Agrinet and First for Farmers (F4F), but there are still some disputes with regard to the terms and conditions that have to be settled with the implication of no new EDI customers and suppliers until the finalisation of the contract.

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Discussion

Agrinet used to have a "nice to have" mind-set with regard to EDI as it is possible to do business without EDI, although it is less streamlined. That mind-set has, however, changed as a project manager is now employed to drive the process. The fact that they have an EDI project manager is an indication that the company acknowledges the value of EDI and would like to take it further as they are doing with the new contract being finalised. It is speculated that with the new contract in place, the amount of EDI suppliers could increase to 90% of the total suppliers.

8.1.2.2   Overseas Suppliers

Overseas suppliers are not communicated with through EDI as it is a difficult process that involves cultural, language and geographic boundaries as well as system and time differences. It would also be a costly, time-consuming endeavour to give training on the usage of the EDI and to set it up.

Discussion

Although getting overseas suppliers on EDI poses many difficulties, it is not impossible. It would however be wise to firstly focus on getting the local suppliers on EDI before conquering the overseas.

8.1.2.3   Objections from Customers/ Suppliers

There are many different reasons for customers and suppliers objecting to EDI such as the following:

- External parties do not wish to incur the costs of obtaining an information system or paying the monthly fees to Agrinet which they argue is too much.
- Their current information system (should they have one) is insufficient or they do not trust it.
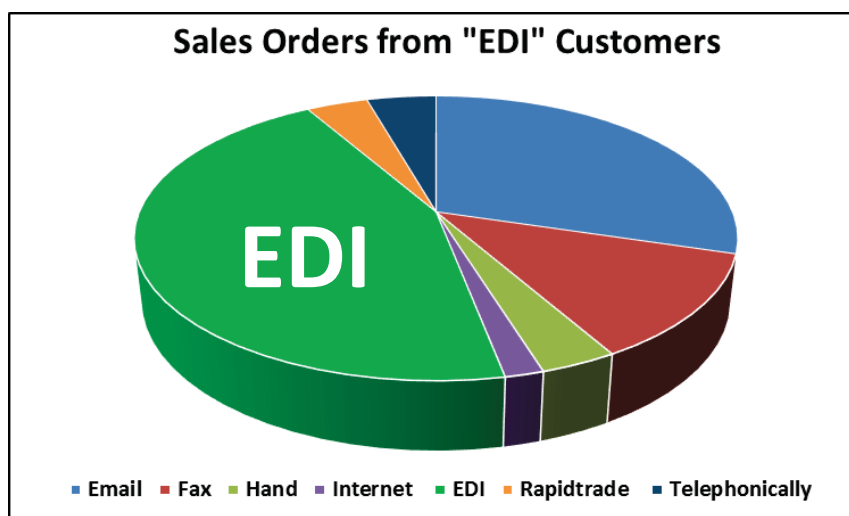
Figure 46: Different Communication Modes from EDI Suppliers

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Figure 46 shows the amount of other methods used by a sample of customers that have the ability to use EDI. This leads to another problem as orders are frequently submitted twice, through EDI and another method as the users do not trust their information system.

The different ways in which orders are received are: email; faxes (received as emails); by hand (for instance in the case of EDI mistakes); internet orders (from Agrinet's website); EDI; rapid trade (a separate system on which company representatives place customer orders) and telephonically.

- They believe the current way of doing business is good enough.
- They do not want people losing their jobs as a more computerised system requires less human intervention.

Discussion

With regard to the customers and suppliers, a process of change management has to be undergone by addressing their objections in the following ways:

- Negotiating the fees and making them aware of the possibility that if the business they bring is less than 1.2 million, Agrinet will cover their fees.
- Giving the customer "information system and EDI training" to give them confidence in their information system's capabilities.
- Educating the customer about the benefits of EDI that is for themselves as well, not just Agrinet.

8.1.2.4   Enforcing EDI

A big step to take is for management to make the decision that only EDI orders will be accepted, which will then be stipulated in the trade agreement.

Discussion

Enforcing EDI is the opposite of the change management described in section 8.1.2.3 as it will give customers and suppliers no choice in the matter and some customers and suppliers will be lost if such a decision is made. To determine likelihood of customers and suppliers leaving, their bargaining power is evaluated in Table 28 with parts of a Porter analysis:

Table 29: Porter's Forces Applicable to Agrinet

Porter's Force	Applicable to Agrinet
Bargaining Power of Suppliers	The bargaining power of the suppliers are medium as Agrinet are dependent on them, but as there are many suppliers available, they are not irreplaceable.

Porter's Force	Applicable to Agrinet
Bargaining Power of Customers	The customer's bargaining power is high as there are many different options for them to consider, should they not be successful at Agrinet.

It is clear from the analysis that it is more likely for customers to leave than suppliers as the customer's bargaining power is high and that of the supplier's medium. Thus a harsh approach should be carefully considered, Agrinet doesn't have all the bargaining power that would enable them to enforce rules and have a guarantee that all the parties would stay.

A positive side to the approach is that "EDI" customers that still send information by other means as they do not trust their information system, as shown in section 8.1.2.3, will most likely not be lost as they already have EDI, they will merely not be given the option of other communication modes.

8.1.3 Conclusion of EDI Feasibility

It can thus be concluded that full EDI implementation is feasible and part of the company's goals, but it is a long term solution. Most of the orders are already sent and received through EDI, but to get all the customers and suppliers on board will take time. Firstly the contract should be finalised, unwanted suppliers taken off the system, a process of change management and enforcing in the end. Feasibility is, however not enough, the positive impact of solution 2, with only EDI as communication mode, should be weighted up against solution 1 to see if it truly is the best solution.

8.2 Solution Cost Analysis

To be able to know the economic impact of each solution, the costs have to firstly be calculated. The costs that affect solution 1 and 2 are that of the implementation of the functional requirements and the costs related to solution 2 are that of EDI implementation.

8.2.1 Estimated Cost of Solution 1

Table 30 includes the key for the type of service needed for the functional requirement that includes configurations, programming and re-installations in order to achieve full use of the purchased Embrace modules.

Table 30: Service Type Key

Service Type	Key
Configurations (New additions to Embrace)	C
Programming	P
Full use of Embrace Modules (could include additional programming to get the module functional again)	F

Table 31 includes the different functional requirements to be executed that cannot be done by Agrinet IT staff, what type of service is needed in the execution, how long it is estimated to implement, Embrace's hourly rate and the total cost. It is also indicated to which department each functional requirement belong to. The purple shaded functional requirement is longer needed if solution 2 is implemented and will thus be ignored in the cost calculation for solution 2.

Table 31: Cost to Achieve Functional Requirement

#	Functional Requirement	Service Type	Time Spent (h)	Hourly Cost (R/h)	Total Cost (R)
	Placement of Purchase Orders Process				
1.	Expediting with time-triggering	C	40	1 000	40 000
	Customer/ Supplier Creation Process				
2.	Web-based opportunity to exchange information with new customers/ suppliers	P	80	1 000	80 000
	Sales Order Receiving Process				
3.	Sales orders sent via email as a subtracted folder from the information system must be automatically uploaded to Embrace	P	120	1 000	120 000
	Physical Receiving of Goods from Suppliers Process				
4.	Scan in of delivery notes.	R	80	1 000	80 000
	Payment of Suppliers Processes				
5.	Uploading creditor's batches directly to Nedbank	R	80	1 000	80 000
6.	Uploading the credit note with the GRN	C	120	1 000	120 000

The total costs of implementing the functional requirements are summarised in Table 32:

Table 32: Total Costs of Functional Requirements

Cost Estimation	R
Total Cost for Solution 1	520 000
Total Cost for Solution 2	400 000

Thus 120 000 is saved in immediate expenditure if solution 2 is implemented, but by implementing solution 2 there would be additional monthly costs to consider.

Due to confidentiality reasons, the exact numbers could not be published, but the following additional expenditure will have to be undergone by Agrinet to expand on their EDI usage:

1. Agrinet will pay an additional monthly amount to First for Farmers to accommodate the new EDI customers and suppliers that bring business of less than 1.2 million (B2B portal integration).

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2. Agrinet's new EDI customers and suppliers that deliver more than 1.2 million will pay a monthly service fee to First for Farmers (B2B direct integration).

To summarise if solution 1 is implemented and 2 not considered in the long term, the immediate capital expenditure for solution 1 will be more than 2 and If 2 is chosen the immediate capital expenditure will be less but there will be monthly payments to considered. Agrinet is however able to afford the additional expenses/

8.2.2 Conclusion of Cost Analysis

Thus solution 2 is a bit cheaper with regard to immediate implementation and if solution 2 is decided upon, the functional requirement that would be eliminated with EDI should not be invested in. Although solution 2 brings about a monthly monetary commitment for Agrinet and the external actors, the benefits of the streamlined process will undoubtedly outweigh the cost and Agrinet has the funds for it.

8.3 Solution Positive Impact Analysis Matrix

As mentioned in chapter 7, with the solution verification, solution 2 is the better solution and found in section 8.1 to be feasible. The criteria used in Bentley's feasibility analysis matrix are used to evaluate how much greater the positive impact of solution 2 is (if at all) to determine if it is worth the time and effort of implementation. The weights are allocated based on discussions with management on what is most important to them (Table 33).

Table 33: Feasibility Analysis Matrix for Solution 1 & 2 (Bentley et al., 2007)

Simple Feasibility and Impact Analysis Matrix			
	Weight %	Solution 1	Solution 2
Operational	50	In solution 1 changes are made to address all the problems listed by management in chapter 1. Although all the problems are addressed to some degree EDI will address the problems completely. **Score: 50**	Having EDI as the only communication mode will address the problems in a more complete manner and as it is a best practice it is the most efficient way in which the processes can be conducted. **Score: 100**
Cultural	20	Most of the changes should not have a lot of resistance as it truly shortens the processes and make it more efficient. People may object to the fact that they may have to learn to use a computer program they never needed before for instance. **Score: 80**	Changing over to a complete EDI based solution will have some resistance with regard to getting customers and suppliers to buy in to the idea as well as redeploying some of the personnel to other areas. On the other hand, the efficiency that transactions are now completed with will make many stakeholders vary pro the solution. **Score: 70**

Technical	10	The suggestions are technically possible with the help of the appropriate experts. **Score: 80**	All the technology and service providers are in place. (And the same technical changes of solution 1 is confirmed to be possible. **Score: 80**
Economic	10	Some costs will be incurred, because experts may be needed to do some of the configurations. **Score: 80**	Extra payments will have to be made to F4F to cover the costs of more EDI customers and suppliers that they need to convert the information's format of. **Score: 60**
Schedule	5	There is no specific timeline, but solution 1 should take no more than a year to implement, making its completion time much shorter than solution 2's. **Score: 100**	Solution 2 should take up to 2 years to conclude. **Score: 80**
Legal	5	No legal rules are compromised, it is only if configurations are outsourced and if paid Embrace are willing to do the configurations. **Score: 100**	In order for EDI to successfully be implemented, the contract with F4F has to be sorted out which should be concluded by the end of the year. **Score: 80**
Weighted Score		**67%**	**81%**

It is clear from the scores that the positive impact of solution 2 is 14% higher and thus worthwhile to be implemented.

9. SOLUTION VALIDATION

As the processes cannot be measured, experts validated the solution by reviewing it with the aid of the questionnaire that can be found in appendix C, for which the proof of ethical clearance can be found in appendix D.

The experts are chosen on the basis of being most knowledgeable on the entire procurement organization and because they look at different aspects for a reliable validation. The head of the inventory department has a more technical outlook and the procurement coordinator's outlook leans more towards the personnel. The filled in questionnaires can be found in Appendix E and F and its content will also be summarised below.

9.1   Validation Questionnaire

The validation questionnaire's questions are designed to validate if the re-design of the process sufficiently address the problems experienced by Agrinet. The respondents confirm the following in the questionnaire:

- The research and analysis of the current situation is done thoroughly and all requirements as specified were taken into consideration.
- That all of the problems as stated in the beginning are addressed i.e. duplication of efforts, unsegregated duties, un-centralised changes, an unclear approval process and too paper-based process.
- The TO BE solution is an improvement on the previous process, understandable and add value to the company.
- If the changes suggested are reasonable, feasible and implementable.

9.2   Head of Inventory Validation

The following summarises the feedback of the head of inventory in Table 34:

Table 34: Head of Inventory Validation

Question Section	Answer
Thorough AS IS investigation?	Yes
Address of all problems?	Yes, to a degree of 84%.
Understandable, value-adding TO BE solution?	Yes
Implementable changes?	Yes, but there will be resistance with regard to change management.

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9.3 Procurement Coordinator Validation

The following summarises the feedback of the procurement coordinator in Table 35:

Table 35: Procurement Coordinator Validation

Question Section	Answer
Thorough AS IS investigation?	Yes
Address of all problems?	Yes, to a degree of 84%.
Understandable, value-adding TO BE solution?	Mostly yes, but the constructional requirement of making the EDI supplier preferred holds some logical gaps as there may be more than one EDI supplier.
Implementable changes?	Yes, but change-resistance is inevitable.

The constructional requirement that is said to not be implementable, by the procurement coordinator, have been changed to making the EDI supplier preferred if there are only two options, but if there are more than two options, other criteria will be looked at, such as the purchase price and quality offered by the supplier. It will no longer be a programming endeavour, but rather a conscience decision to be made.

Apart from the one constructional requirement, the general feedback from the two experts are positive and thus the solution's feasibility is officially validated and it can be implemented as described in chapter 10. It is however noted that both experts agree that there will be resistance to change, which is to be expected.

10. FUTURE IMPLEMENTATION AND BENCHMARKING

10.1 Practical Implementation

10.1.1 Inapplicable Functional Requirements

Table 36 lists the functional requirements that are not applicable anymore and why not.

Table 36: Inapplicable Functional Requirements

#	Functional Requirement	Why Inapplicable
	Placement of Purchase Orders Process	
1.	Use EDI as much as possible and thus eliminating other means of receiving orders.	This is no longer merely a functional requirement, but rather the reason why there is a complete second solution.
2.	Addressing the lack of EDI by making all EDI-suppliers the "preferred supplier".	In validation it is said to not be possible as it doesn't take onto consideration scenarios where there are more than one EDI supplier.
	The Sales Order Receiving Process	
3.	Some sales orders are sent with an email as a subtracted folder from the company's information system which the IT department has to manually upload to Embrace.	As shown with the shaded areas on solution 1, if EDI is the only communication mode i.e. the selected solution 2, this functional requirement will no longer be applicable.
4.	As mentioned at the purchase orders, EDI should be the main communication mode.	A stated at 1, this is no longer merely a functional requirement, but rather the reason why there is a complete second solution.

10.1.2 Functional Requirement Ranking

In the conceptual design, the functional requirements list all of the different changes that should be made to the AS IS process. The method of Bentley et al. (2007) is used to determine the order in which the use cases should be implemented, but in this case they are described as functional requirements as they are not all use cases. To determine which changes to make first, each functional requirement is given a score out of 5 on how well they adhere to a certain criterion as showed in Table 37, with 1 being the lowest score, i.e. not adhering to the criterion and 5 the highest, i.e. adhering to the criterion.

Table 37: Ranking Criteria Key

Key for Ranking Criteria		
Ranking	**Description**	**1-5 Scale**
1	Great value gained with improvement	1 = The process stays more or less the same 5 = A lot of time is saved
2	Easy to implement	1 = Small change in steps 5 = Large change in steps
3	Inexpensive to implement	1 = Expensive 5 = Cheap
4	Degree to which primary business functions are affected	1 = Administrative steps 5 = Steps related to revenue
5	Little outside support needed	1 = Problem outsourced 3 = Problem most likely outsourced 5 = Problem solved in-house

As mentioned above, each functional requirement is now given a score out of 5 as documented in Table 38. If the score is 20 or greater, the priority is high and it has to be done in the first build cycle, if the score is 15 or greater, the priority is medium and it has to be done in the second build cycle and the score is 10 or greater the priority is low and it has to be done in the third build cycle.

Table 38: Functional Requirement Ranking- and Priority Matrix

Functional Requirement	Ranking Criteria					Total Score	Priority	Build Cycle
	1	**2**	**3**	**4**	**5**			
DRP Approval Process								
Eliminate the buyer from the DRP checking process.	3	5	5	3	5	21	High	1
Allowing the sales- and product manager to view the forecasts simultaneously.	3	5	5	3	5	21	High	1
Placement of Purchase Orders Process								
Notification email to upper management as alert of workflow tasks they have received.	4	3	2	3	2	14	Low	3
Expediting with time-triggering.	4	3	3	2	2	14	Low	3
Send buyer's report through workflow.	4	3	2	5	2	16	Medium	2

Customer/ Supplier Creation Process								
Web-based opportunity to exchange information with new customers and suppliers.	5	1	1	3	1	11	Low	3
Give the procurement coordinator the responsibility of supplier creation.	3	5	5	3	5	21	High	1
Physical Receiving of Goods from Suppliers Process								
Scan in of delivery notes.	4	3	2	5	1	15	Medium	2
Discrepancy file stored on the server.	4	5	5	3	5	22	High	1
Payment of Suppliers Processes								
Uploading creditor's batches directly to Nedbank.	5	3	2	5	1	16	Medium	2
Create a workflow for the creditor to receive the delivery notes.	5	2	2	4	1	14	Low	3
Uploading the credit note with the GRN.	5	2	1	4	1	13	Low	3

10.1.3 Dependency Table

Only one of the functional requirements are dependent on a previous to be implemented as shown in Table 39.

Table 39: Dependent Functional Requirement

Functional Requirement	Dependent On
Payment of Supplier Process	
The creditor receives a workflow of scanned in invoices to upload the information onto the system.	
	Physical Receiving of Goods from Suppliers Process
	*The invoices should be scanned in by the receiving department and uploaded onto the system.

*It is of course not possible to download something that has not been uploaded.

10.1.4 Roadmap for Implementation

The dependency listed in the dependency table will not affect the order in which the functional requirements are implemented, as the dependent functional requirements will be implemented afterwards as determined by the ranking method. As shown in Table 38, each of the functional requirements are allocated to one of the three build cycles, depending on the score they achieved in the matrix and the build cycles will be implemented in order (Figure 47). How each functional requirement will be implemented is described in chapter 5, the conceptual design and the time and cost is dealt with in chapter 8, the solution analysis.

Figure 47: Build Cycle Implementation

The EDI implementation process runs parallel to the implementation of the constructional requirement implementation and will be completed in the following steps in Figure 48 (as mentioned in section 8.1.3):
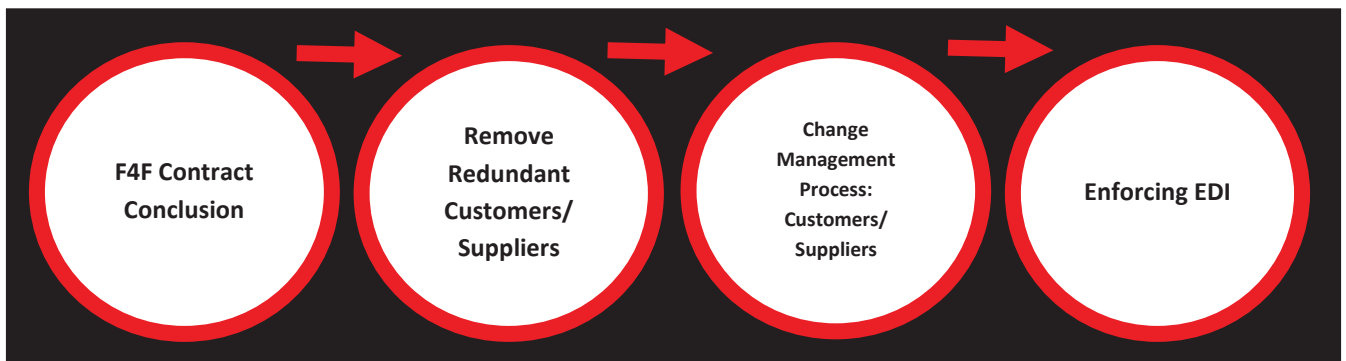
Figure 48: EDI Implementation Roadmap

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10.2 Future Benchmarking

For the mature process the performance measures of SCOR that are applicable are used to measure the current performance and set a benchmark for the company to improve on. With regard to the business processes the performance measures of reliability (Table 40) and responsiveness (Table 41) are used as they can measure the degree to which the problems stated in the beginning are solved which can be summarised as to make the process faster and the information more trustworthy. The performance measures will thus ensure that the changes implemented in the solution maintain the desired effect, as defined by SCOR. The other performance measurements, i.e. agility, costs and asset management do not fall within the scope of the project.

10.2.1 Reliability

Reliability is the ability of the actors and organisation to perform tasks as expected and the predictability of a process-outcome.

Table 40: SCOR Reliability Metrics

Metric #	Metric	Formula
RL.1.1	Perfect Order Fulfilment	$$\frac{\sum Perfect\ Orders}{\sum Orders} \times 100\%$$ **Equation 1: Perfect Order Fulfilment**
RL.2.1	% of Orders Delivered in Full	$$\frac{\sum Orders\ Delivered\ in\ Full}{\sum Orders\ Delivered} \times 100\%$$ **Equation 2: Percentage of Orders Delivered in Full**
RL.2.2	% of Orders Delivered on Time	$$\frac{\sum Orders\ Delivered\ on\ Commitment\ Date}{\sum Orders\ Delivered} \times 100\%$$ **Equation 3: Delivery Performance to Customer Commit Date**
RL.2.3	Document Accuracy	$$\frac{\sum Orders\ Delivered\ with\ Correct\ Documentation}{\sum Orders\ Delivered} \times 100\%$$ **Equation 4: Document Accuracy**
RL.2.4	Perfect Condition	$$\frac{\sum Orders\ Delivered\ in\ Perfect\ Condition}{\sum Orders\ Delivered} \times 100\%$$ **Equation 5: Perfect Condition Deliverance**

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10.2.2 Responsiveness

Responsiveness includes metrics such as the speed tasks are performed with and how fast the customer receives the order.

Table 41: SCOR Responsiveness Metrics

Metric #	Metric	Formula
RS.1.1	Order Fulfilment Cycle Time (days)	$$\frac{\sum Cycle\ Times\ for\ Delivered\ Orders}{\sum Orders\ Delivered} \times 365$$ **Equation 6: Order Fulfilment Cycle Time (Days)**
RS.2.1	Source Cycle Time	Supplier Delivery Cycle Time + Receive Product Cycle Time + Verify Product Cycle Time + Transfer Product Cycle Time + Authorise Supplier Payment Cycle Time **Equation 7: Source Cycle Time**
RS.2.3	Deliver Cycle Time	Consolidate Orders Cycle Time + Route Shipments Cycle Time + Pick Product Cycle Time + Pack Product Cycle Time + Load Vehicle & Generate Shipping Documentation Cycle Time + Ship Product Cycle Time **Equation 8: Deliver Cycle Time**

10.2.3 Execution of Performance Measures

To execute the performance measures to the process, a time period, for example a month's data that relate to the information needed for the variables in the formulas will have to be collected.

There are various ways of collecting the information:

- Some of the data can just be read of the system such as the amount of orders.

- To gather other data, manual measures will have to be put in place such as making use of time-studies (measuring the time an action takes with a stopwatch over a time period) such as the load vehicle & generate shipping documentation time.

- Other data will be based on feedback from role-players, such as the suppliers that will let Agrinet know if an order is not perfectly delivered and this should be documented.

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Calculations may have to be done to some of the gathered data to get the correct information in the correct format for the variables which will be used in the equations that will be executed to gather numerical values for each of the 8 specified metrics. These values are then the process's benchmarks. The process will then be completed for the next month as well and the two months will be compared. If the next month fares better or worse the reasons for this will have to be investigated on what was done right or wrong.

This process can be conducted for a year after which a new benchmark will be calculated with the average of a year's data. It is advised that a person is put in control of this process. Thus the company will constantly be aware of its performance as well as where there are problem areas and bottlenecks.

11. CONCLUSION

It can be concluded that all the instances of problems in the categories mentioned in the beginning i.e. duplication of efforts, unsegregated duties, un-centralised changes, an unclear and slow approval process and a too paper-based process have been addressed. Thus the aim of curing the flawed workflow or in other words, as the title states, finding a workflow solution for multiple departments and their requirements, have been achieved.

All of the problem categories are used as directives for change and functional requirements are created from them by applying the techniques listed in business process re-engineering. By adding these functional requirements to the current process, two solutions could be generated and the solution advocating only electronic data interchange is chosen. The reasons for the choice is that it addresses the non-functional requirements to a greater extent and it has the highest business process maturity.

Initially the feasibility of solution 2 was doubted, as using only electronic data interchange as communication mode is an extreme measure, but it is confirmed to be feasible. Another downside to solution 2 is that it proves to be more costly with a monthly cost commitment, but as the positive impact matrix showed, the benefits will outweigh the cost. The two experts validated the solution and agreed that the solution solves the problems and is feasible.

As the business process maturity is now at a high enough level, the process performance can be measured and benchmarked to ensure continuous improvement. Although solution 2 will take longer to implement, it can be achieved and a detailed plan is laid out to be followed as the implementation do not fall within the timeline of the project. As there are a lot of human factors involved in the implementation process it will prove to be challenging, but it remains attainable.

A thorough investigation is conducted into the business processes of Agrinet, but there are room for further investigation such as looking into why customers do not trust the information system and an in depth study of the worth and feasibility of the process measures.

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Appendix B: Procurement Organogram

LEON VAN HEERDEN
Procurement Manager

SHANTELLE PIETERSE
Procurement Coordinator

ANNEMIE ERASMUS
Senior Admin Clerk

WORKSHOP MANAGER
Willie Esterhuizen

PRODUCT MANAGER HARDWARE
Eric Reynolds

PRODUCT MANAGER OUTDOOR
Peter Nieuwenhuizen

PRODUCT MANAGER ELECTRICAL
Morne Jacobs

PRODDUCT MANAGER AGRICULTURAL GOODS
Dawie van Vrede

PRODUCT MANAGER MECHANICAL
Lourens Boshoff

PRODUCT MANAGER IRRIGATION TECHNICAL
Wynand Ueckermann

PRODUCT MANAGER IRRIGATION GENERAL & IRRIGATION SYSTEMS
Coenie Maritz

PRODUCT MANAGER POWER PRODUCTS
Chris Coetzee

ADMIN CLERK : WORKSHOP
Ohna Muller
Responsibility:
Handling of Workshop administration.

ADMIN CLERK : WORKSHOP
Wilmarie van Rooyen
Responsibility:
Handling of Workshop administration.

MECHANIC : WORKSHOP
Solomon Mankwe
Responsibility:
Repairs and maintenance of machines and equipment.

MECHANIC : WORKSHOP
VACANT
Responsibility:
Repairs and maintenance of machines and equipment.

WORKSHOP : ASSISTANTS x2 (PART TIME)
Responsibility:
Assisting in the repairs and maintenance of all equipment.

JUNIOR PRODUCT MANAGER PLUMBING
Henk Kruger
Responsibility:
Growing the Catagory and buying

BUYER : GENERAL HARDWARE
Lucy Erasmus
Responsibility:
Buying of General Hardware and associated products

BUYER : HARDWARE TOOLS
VACANT
Responsibility:
Buying of Hardware Tools and associated products

BUYER: ELECTRICAL & OUTDOOR
Mariska Strydom
Responsibility:
Buying of Outdoor and Electrical products

JUNIOR PRODUCT MANAGER PAINT & ACCESSORIES
Johan Roets
Responsibility:
Growing the Range and some buying

BUYER : PAINT & ACCESSORIES
Chappies Roux
Responsibility:
Buying of Paint Products and Accessories

BUYER : AGRICULTURAL GOODS
Ansie Hamman
Responsibility:
Buying of Gardening and Agricultural goods

JUNIOR PRODUCT MANAGER GARDENING
Kobus Landman
Responsibility:
Growing the Range and some buying

BUYER : AGRICULTURAL GOODS
VACANT
Responsibility:
Buying of Gardening and Agricultural goods

BUYER : MECHANICAL
Marili du Plessis
Responsibility:
Buying of Automotive, Mechanisation and Nuts & Bolts

TECHNICAL CONSULTANT : MECHANISATION
James Buchanan
Responsibility:
Handling of all Technical related sales queries and accompanying Reps to Customers.

BUYER : IRRIGATION GENERAL & TECHINCAL
Lee-Roy Erasmus
Responsibility :
Buying of General and Technical Irrigation products

BUYER : IRRIGATION GENERAL & TECHNICAL
Mercia Loretz
Responsibility:
Buying of General and Technical Irrigation products

BUYER : IRRIGATION GENERAL & TECHNICAL
Johan Pretorius
Responsibility:
Buying of General and Technical Irrigation products

IRRIGATION SYSTEMS CONSULTANT
Anneli Neumann
Responsibility:
Quoting and Consulting with clients about irrigation systems

IRRIGATION SYSTEMS CONSULTANT
Karien Senekal
Responsibility:
Quoting and Consulting with clients about irrigation systems

IRRIGATION SYSTEMS CONSULTANT
Jaco Oosthuizen
Responsibility:
Quoting and Consulting with clients about irrigation systems

TELESALES / SPARE PARTS
Howard Steward
Responsibility:
Handling Telephone orders and follow-ups

BUYER / TELESALES
Suzelle van Rooyen
Responsibility:
Buying of Power Products as well as Telephone orders

BUYER / TELESALES
Wynand van den Berg
Responsibility:
Buying of Power Products as well as Telephone orders

TECHNICAL REP / TECHNICAL SUPPORT
Nhlanhla Mgidi
Responsibility:
Client calls to generate sales and handling of all Technical related queries on products

TECHNICAL REP / TECHNICAL SUPPORT
VACANT
Responsibility:
Client calls to generate sales and handling of all Technical related queries on products

DEMAND PLANNER
Christiaan du Plessis

HEAD OF INVENTORY
Heinrich Pretorius

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Appendix C: Validation Questionnaire

The purpose of this questionnaire is to validate whether the re-design of the business processes by the industrial engineering student (referred to as designer) sufficiently address the problems experienced by Agrinet. The respondents will be given opportunity to review the industrial engineer's work prior to answering the questionnaire.

Respondent's Position at Agrinet: _____

AS IS (The "Before" Business Processes)

1. Was a thorough research and analysis conducted of the current business processes?
    _____

2. Was sufficient inputs from different role players in the processes considered?
    _____

3. Were all requirements taken into consideration?
    _____

Addressing of Problems

1. To what degree do you believe are each of the following problems addressed? Give a mark out of 10 and elaborate.

Type of Problem	Mark (/10)	Reasons
Duplication of efforts		
Unsegregated duties		
Un-centralised changes		
An unclear and slow approval process		
The process is too paper-based		