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Hans M. Moonen

Arthur C. Oink

Jos Van Hillegersberg

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Hans M. Moonen, Arthur C. Oink *, Jos van Hillegersberg **
* RSM Erasmus University,
Department of Decision and Information Sciences
Burg. Oudlaan 50, P.O. Box 1738,
3000 DR, Rotterdam, The Netherlands
{hmoonen, aoink,}@rsm.nl
** University of Twente,
Department of Information Systems & Change Management
P.O. Box 217
7500 AE, Enschede, The Netherlands
j.vanhillegersberg@utwente.nl

Abstract: Inter-organizational systems are only used to some extend within the domain of transportation and logistics. Distributed agent technologies show a large potential to build a new generation of inter-organizational systems that overcome the hurdles earlier technologies were not able to take [2, 4]. In this paper we present an ongoing research project in which we try to establish a WebServices based agent platform to be used by a logistics service provider (LSP) in an inter-organizational context – which will connect the LSP's internal processes, with processes that span organizational boundaries and therefore is likely to result in interesting process improvements; cost savings and improved competitive advantage are expected outcomes. This paper describes the process we followed, and gives a glimp of our preliminary findings. We conclude the paper with a short discussion and our research agenda.

I. Introduction

Despite their 'spider in the web' character, the domain of transportation and logistics does still only show a limited application of inter-organizational systems [2]. Although sophisticated systems have been arrived and adopted for routeplanning, warehouse optimization and plant control, a widespread adoption of inter-organizational (planning) systems (IOS) is still lacking. Only some of the larger companies actively utilize EDI or XML technologies for integration with business partners, but most companies still use the phone and fax as their primary means for their inter-organizational coordination activities. Most of the solutions that do work, work in a point-to-point context: a direct integration between two companies. Centralized hubs or exchanges show only limited adoption [1].

We hypothize that in order to get industry wide adoption of IOS several factors need to be satisfied: there is a need to utilize open non-proprietary standards, a need for (cheap) quick connect capabilities, and the system's architecture should be of a decentralized control type: not giving away ones own business processes, only a basic exchange of data [6, 7, 9].

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The Distributed Engine for Advanced Logistics (DEAL) project is a large Dutch government funded long-term research project focused on the creation of an agent based inter-organizational information system for road logistics. Seven partners participate within DEAL [10, 11]. Within the context of DEAL, a wide array of research takes place: ranging from work on performance indicators, to very technical agent technology research, and from mathematical optimization to work on LSP strategies.

This work-in-progress paper is the result of design research performed by the RSM Erasmus University at LSP Post-Kogeko, both partners within DEAL. We describe the approach we followed: from workfloor visits to the planning and IT departments, to our redesign, and workshop-sessions that leaded us to new steps that improved our designs. Finally we give a first impression of the new designs we are developing and are about to prototype within the next months – i.e. we detail a customer linkage we are developing together with Post-Kogeko's customer CoolControl.

II. Post-Kogeko

Post-Kogeko is a Maasland, The Netherlands, based Logistical Service Provider (LSP), active in distribution, forwarding and transport. This includes, among others the transport of: fresh goods, fruits and vegetables, bread, and sea-containers. Post-Kogeko employs currently around 300 employees, and is constantly seeking for growth opportunities and process improvements. It partners in DEAL, which it perceives as an important development to establish an information processing environment that might help them in better serving its customers needs.

Within the context of DEAL we started a process analysis project with Post-Kogeko, focused on their container transport unit. The choice to focus on the container unit was made together with Post-Kogeko management – its main reasons were the relatively low automation of this unit, its inter-organizational setting with many external stakeholders, and Post-Kogeko's plans for further growth in this area.

The physical flow in the Post-Kogeko container business is almost always as following: a loaded container has to be picked up at a container terminal in the Port of Rotterdam, transported to a customer's site, where it will be unloaded by the customer, after which the empty container is transported back again to the same or a different container terminal in the Port – this process is depicted in Figure 1. The (container) planning department takes care of all the work that needs to happen before actual execution can start: it receives the customer orders, handles the paper work with the customs and the terminal, checks whether containers are already available for transportation, and assigns specific trucks to specific orders.

In principal a relatively straightforward and simple planning process, but complicated by the fact that from the containers that have to be transported during a certain day, only half of these is actually available at 6 O'clock in the morning when operations start. The rest will only leave the sea going vessel somewhere within the next twelve hours. As a result, planning truly has an event based character.

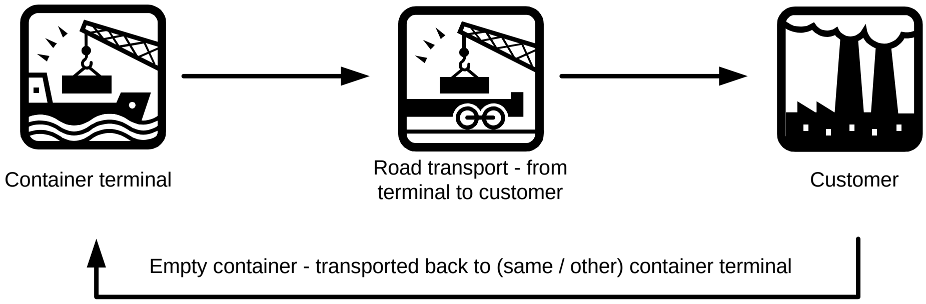

Figure 1 – Basic physical flow of containers in the Post-Kogeko container business

III. The Research Design

The research methodology we followed is a combination of design science as is a usual approach within the computer sciences [5], and action research [3] coming from the social sciences. The objective of our work was to first investigate whether there are actual possibilities and needs for an agent-based inter-organizational planning system within the Post-Kogeko container unit, and if so to move ahead and start designing and implementing such a system.

Two days on the planning floor were our starting point. We were sitting together with the planners, followed and observed their way or working. Meanwhile there was plenty of time to not only observe the way they worked, and the things they did, but also to ask for explanations and all kind of process details.

An in-depth session with the IT administrator responsible for the systems was our next step. He showed us the systems, the integrations, and gave us a login to CarrierWeb (one of the systems) and an Excel data dump of the planning system Qfreight.

Following this, we analyzed the data from the planning system, to further understand the environment, i.e. with respect to inter-organizational dependencies and linkages with respect to both customers and container terminals.

In parallel with the previous steps we worked on process descriptions of the container planning process – UML models, as well as textual descriptions. Our analysis of the business process revealed many small inter-dependent sub-processes, and therefore we choose to model the process in small sub-processes and not as one large integrated process. Having all those inter-dependent sub-processes, we started rethinking each and all of them which lead to some redesign suggestions – sometimes as simple as just automating the process, sometimes creative solutions were we added new functionality.

IV. Data Analysis

The two days on floor, in-depth sessions at the planning department resulted in a series of UML-diagrams. We choose to model the process in smaller sub-processes, since that was what we observed in practice – furthermore this gives the advantage that it is easier to focus on specific parts. We will discuss the sub processes in order of appearance.

The first sub-process is the order-intake. See Figure 2, which shows the activity diagram for the order-intake. Here the customer sends an order to Post-Kogeko. If Post-Kogeko accepts the order (which they usually do), the order is entered in Qfreight – one of the two IT-systems Post-Kogeko uses. Customers usually sent their orders using fax (occurs the most), e-mail or telephone. In this phase errors can occur, due to manual re-entry of data, e.g. a planner can enter an order twice (which happened). This process can easily be automated using a database webfront or WebService where customers can enter orders themselves. All what than would be left for the planner is to validate the order and accept it.

The remaining part of the process can roughly be divided into two separate sub-processes. The first sub-process concerns the planning of the first orders to be executed the coming day. This is done at the end of the previous day because of late-arriving orders. The second sub-process concerns the rest of the orders. This is performed in real-time during the day.

The first sub-process contains two steps. First, the planner marks all the orders that need to be executed first, see Figure 3. Customers define time windows for their orders, so this is fairly easy done. In the second step, the planner assigns a truck driver to each order he just marked.

Here the planner takes in mind personal preferences and other parameters of concern. See Figure 4. If there are not enough drivers available the planner asks the other department if they have drivers available. If they don't, they hire charters (which are external carriers/drivers that temporarily are employed for Post-Kogeko).

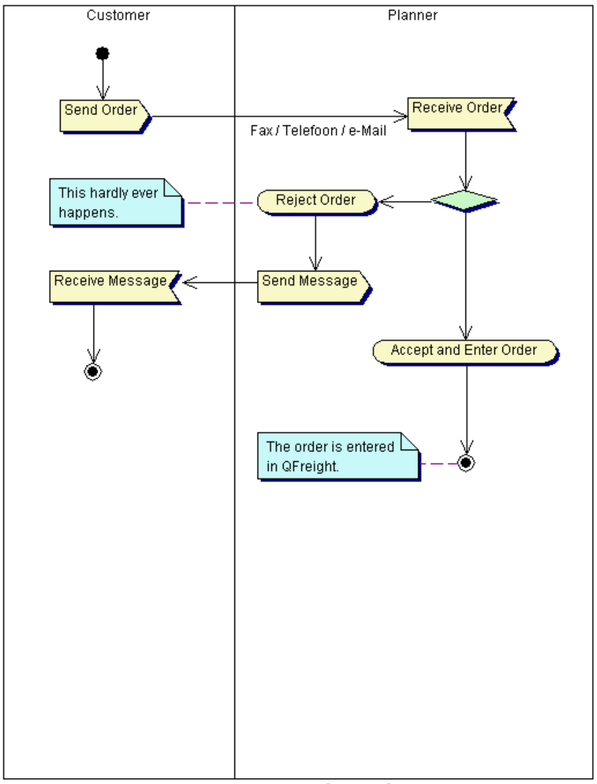

Figure 2 – Order-intake

This process can be automated using a decision-support system. The system could automatically build a list of orders to be executed first. It could also calculate how many truck-hours are needed and conclude that it would save a driver if for example an order is executed later. If you take this one step further, the system could also negotiate with the customer about the time-window the order had to be executed.

The second sub-process is the more complicated one. Here a planner assigns a new order to a driver when the driver is finished with a previous order, see Figure 5. On the one hand the planner continuously monitors the status of a driver (using CarrierWeb). On the other hand the planner monitors the status of a container and checks to see of the custom-papers are ready. Planners can check the status of a container on some of the websites of the terminals where the containers arrive. When both drivers are available and the container is unloaded from the ship, the driver can execute the order. This last part is complicated in a sense that the planner has to anticipate on the arrival of the containers. He already send the driver in the direction of the next order he/she is about to execute. This is also the part of the process where a lot of delays emerge, e.g. a driver is sent to a terminal and when he/she arrives the container is still on the ship because it is delayed.

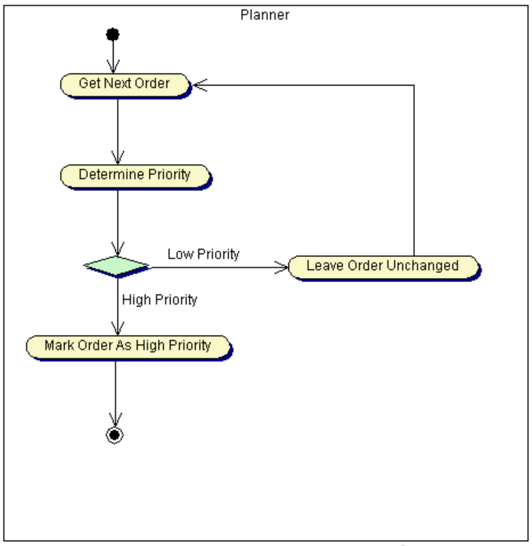

Figure 3 – Set priority orders

This process should be automated using a multi agent planning system (MAS). Within the DEAL-consortium, various parties are busy designing MAS' to overcome the planning problem.

The last part of the process is the order execution. The terminal loads the container and the driver drives to the destination-address. Here the customer unloads the container and afterwards the driver returns the empty container to the return-address (often the same terminal as the pick-up). Once empty the driver gets the next order assigned.

Another part of our process-analysis concerned about an analysis of a dataset of Post-Kogeko's orderhistory. Therefore we received all the orders executed in the first three weeks of 2005 – which accounts up to 1216 orders. Here we noticed some very interesting facts. For example, a small group of customers is responsible for the largest part of all orders. As can be seen in Figure 6, the nine biggest customers (1/3 of the total customer-base) equal 84% of all orders. One note has to be made, this data also contains 408 so called OffHire-orders, which are a special kind of order. If we leave these orders out of the dataset, CoolControl is the biggest customer. We estimate that if Post-Kogeko automates the order-intake process, it will roughly save them about half a day of work for one of its planners. This is the basis to make a prototype of an inter-organizational coupling to the customers.

Another interesting fact we noticed is that the four biggest terminals are responsible for 77% of the orders. See Figure 7. Planners now have to manually check a website of a terminal if they want to know the status of a container. We estimated that if we could realize an inter-organizational coupling to the four biggest terminals it will save Post-Kogeko about an hour a day.

V. Prototype Building

In a focused process workshop with the Post-Kogeko planners and management we went through our process analysis and redesign suggestions. The session was an interesting learning experience for both sides. A concrete choice was made to focus our efforts for the next period on three concrete sub-projects: namely the designing of an event-based internal planning engine, an inter-organizational coupling to the terminals, as well as one to the customers. Pragmatically, we decided to start with the latter, since the first will be worked on in parallel in a larger research effort within the DEAL consortium, and access to customers was easier to arrange than access to container terminals.

Together with Coolcontrol, which is one of Post-Kogeko's top customers, we sat together discussing their process and linkages with Post-Kogeko. We gained insight in their processes, and the way they communicate with Post-Kogeko. Coolcontrol, still largely working with the fax and phone, reacted very enthusiastic to our plans, and committed to work along with us in a redesign and prototyping effort to work on an electronic integration between them and Post-Kogeko.

After having ensured interest from Post-Kogeko in our redesign as well as from one of its customers we can start our design work. Concretely, we plan to utilize a WebServices based process orchestration environment [e.g Oracle BPEL Process Manager – which is freely available for research purposes], to build a process oriented agent system [8, 9, 12, 13]. A BPEL process, or other specific WebService, can be seen as a light-weight agent, which is possible to trigger and interact with other services/agents. The advantages of such a platform above specific agent toolkits are the ease of integrating with existing systems, the proven technologies and use of open standards.

As we outlined in our research description, the next step was to have a detailed process workshop together with Post-Kogeko planners and management. In this session we validated our models and spoke about some suggestions for improvements and ideas how to build automated support functionality for these processes. In good conversation we decided to focus our design efforts on the design for an internal planning engine (which relates to the sub processes of planning the first and second order), an inter-organizational coupling to the terminals, as well as one to the customers – automating order intake, and giving a customer more visibility in Post-Kogeko's processes.

As the previous paragraph showed, a process redesign with inter-organizational couplings could be very profitable for Post-Kogeko. It not only makes the process more efficient, it also adds additional functionality. We choose to go for an agent-oriented design, and plan to utilize BPEL (Business Process Execution Language) – which is a WebServices based standard for the design and deployment of process driven WebServices. Those WebServices can invoke other WebServices, either inbound within the own organization, or externally to another organization's information system. Using Oracle BPEL Process Manager we are able to build a service oriented architecture for Post-Kogeko. We utilize the open source application server JBoss as our application server platform, therewith making it of little risk for Post-Kogeko to start using it [since it does not need to invest in expensive server software before experimenting with our pilot system]. As a starting point we decided to look at the order intake process and set up the specifications together with the largest customer CoolControl – a firm active in the import and trade of tropical fruits.

CoolControl is very interested in automated order intake functionality for Post-Kogeko – a process that now still looks like fax-forwarding. Besides the ease of entering orders directly they also let us know that they are interested in a limited track&trace-functionality, e.g. they would like to know half an hour in advance when a container arrives at the destination-address. Concretely they stated: "*currently we call upto 20 times a day, to figure out where our containers are… we would be very much helped with such functionality automated on a website*". Another functionality they are interested in, is a history of the orders they entered in the Post-Kogeko system. This way, they don't have to store it themselves – something they currently only do to a limited extend.

The next step is to built services that can be accessed via an external WebService or simply manually through a simple web-interface where the customer can log in and place orders, watch its order history, and view the status of orders in execution [container waiting to be picked up, container in transport, etc.].

The next inter-organizational coupling we plan to look at is a coupling with the container terminals. Together with them we plan to build a WebService which accepts container-numbers as parameter and returns the status of the containers – saving large amounts of time of planners manually tracking whether containers are available already. Additionally, a software agent can query the web services as long as a certain requirement isn't met, e.g. container not unloaded – this way avoiding process inefficiencies where containers are available already at the terminal, but not yet tracked/discovered by the LSP to be picked up. Additional inter-organizational couplings that are closely related to this terminal coupling is a coupling with the customs, to track whether paper-work is arranged already, and the container is declared to freely enter for hinterland transport.

Beside these inter-organizational couplings, which basically deal with information exchange, we also consider the actual planning itself. Currently various researchers working within the DEAL-consortium are designing MAS-planning systems. The agents from the planning system will use various WebServices for their requirements. Few are already implemented, and therefore we plan to build some prototype BPEL WebServices in order to get a fully functional system. The MAS systems designed by the different DEAL-researchers than could be relatively easily plugged in and evaluated within the Post-Kogeko context.

VI. Lessons Learned

The transportation industry is an industry with still surprisingly limited automation [10, 11]. And although some parties do use automated systems for their own planning purposes, most inter-organizational communication is still largely a manual process with many data re-entry steps.

Interesting enough, we notice a large availability of sophisticated technologies in the chain; like for example the CarrierWeb system that Post-Kogeko utilizes and that provides every minute an update on the location of all its trucks, the driving speed, the temperature of the cargo its transporting (if needed), and so on. What we however see is that all this information is largely led to human interpretation, and no (automated) intelligent services are build on top of these. It would for example be relatively easy to calculate knowing the location and speed of a particular truck when this truck is likely to reach its destination (i.e. when taking traffic jams into account, a service that can be obtained from elsewhere).

In this research we follow a very pragmatic approach, where we work along with the company stakeholders, observe their processes, and use these as a starting point for our redesigns. Reasoning from these we start small, with very obvious WebServices, but with some of the immediate needs. Perhaps not directly the most interesting parts that provide an intellectual challenge, but elements that are definitely needed in establishing a company wide information architecture, that is relatively easy to couple and link with other organizations – thus enabling a process driven inter-organizational system.

In this paper we show part of our data analysis and process redesign, our ideas for the prototype, and show some preliminary conclusions. Open research questions for the remainder of this research are, among others:

- Can we utilize WebServices environments to establish agent-based inter-organizational systems?
- How useful are such platforms in SME's?

Is this design approach, as described above, a good way to establish such systems in practice?

References

Find below a list of used references. This list is not extensive. For a future version of this paper we might extend it – as we add a more thorough literature review to our paper.

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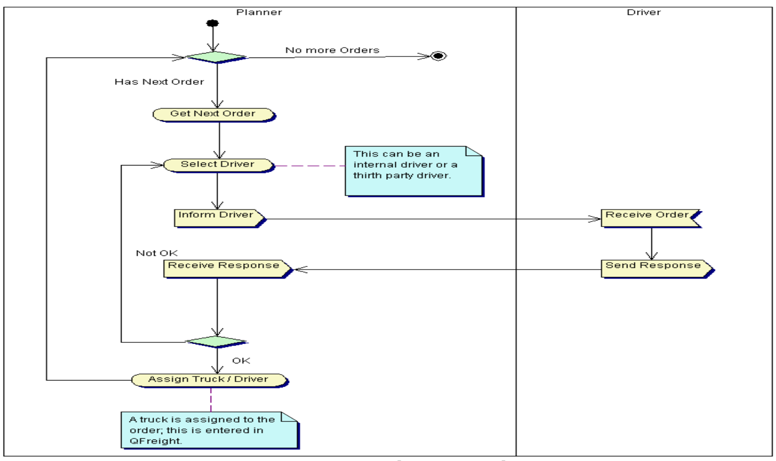

Figure 4 – Assign drivers to orders

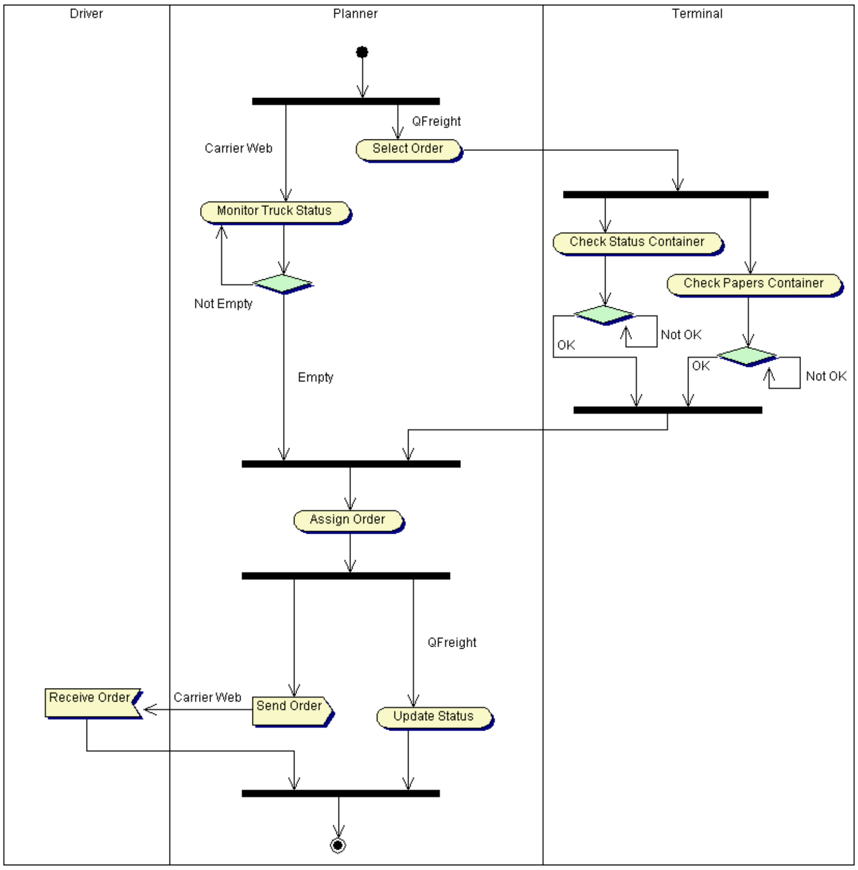

Figure 5 – Assign second (or later) order

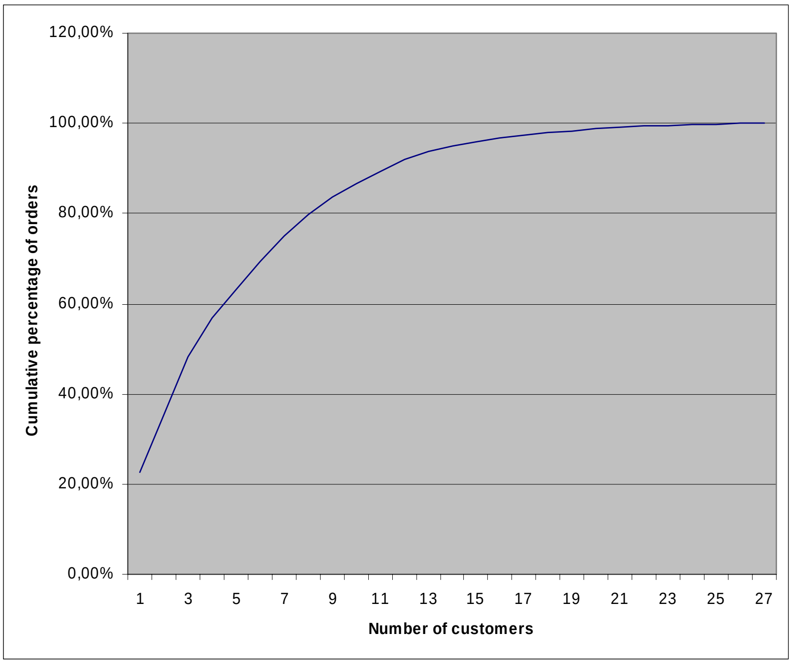

Figure 6 – Customers and their orders

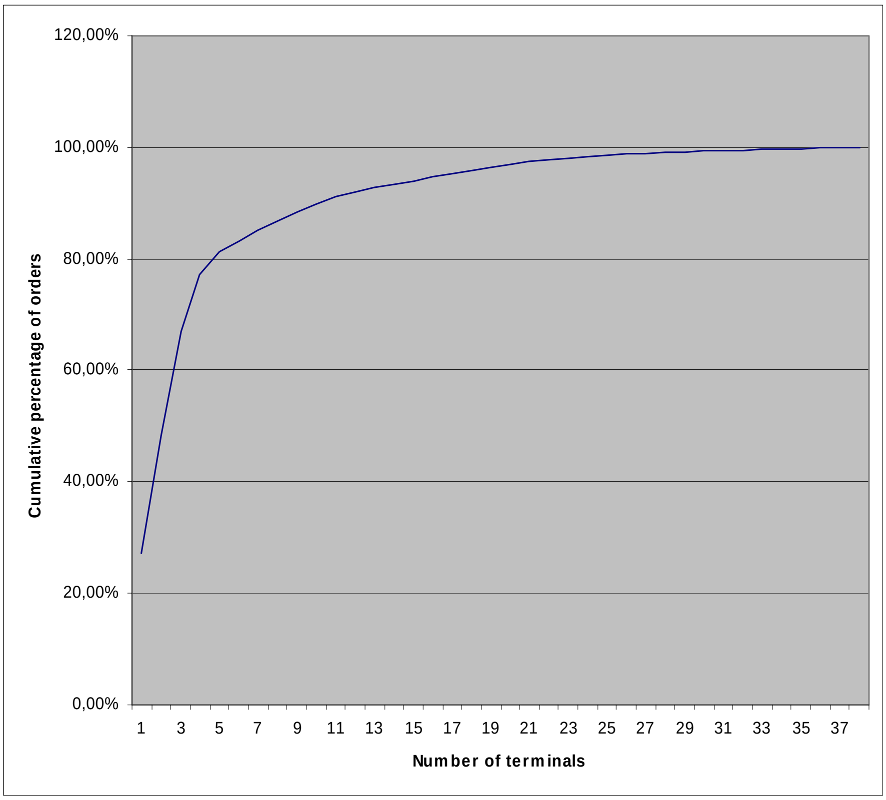

Figure 7 – Terminals and the amount of orders picked-up