**Cargo Driven Intermodal Transportation**

Project Plan

Full Proposal for Dinalog

Submitted by Delft University of Technology

Delft, May 15, 2012

**Summary**

The Port of Rotterdam and its business partners realize that new concepts and facilities are needed that add value to cargo with minimum costs and a minimum use of land and road infrastructure, and with minimum emissions. Smart and competitive intermodal transport- and logistic solutions are key here.

To support this, cargo handling has to be done differently than in the past. The focus on moving containers from one point to another has to be complemented by a focus on the cargo inside the containers. This gives rise to cargo driven intermodal transportation. Known concepts, in particular cross-docking, could be introduced for specific goods categories. Cross-docking allows, amongst other things, for the integration of maritime and continental cargo flows, and it will enhance the utilization (in particular re-use) of containers. These concepts are strongly related to existing initiatives such as Cool Port, and results from this project will feed the further development of these initiatives.

Indeed, the concepts need further study and expansion. The project will lead to tangible results, in particular a set of decision support tools which (1) support the analysis of information flows within cross-dock and synchromodal logistic environments with a special focus on the cargo level; (2) support the analysis of investments in warehousing; (3) support the analysis of smart solutions for the logistic chain, including the use of the existing networks.

The project will meet these project goals by means of three parallel and interacting research activities, organized in a single work package:

1. Managing cross-dock operations at the cargo level;
2. Managing container flows at the cargo level;
3. Creating value with information flows at the cargo level.

The research activities will result in analyses and tools that will support the further development of cargo driven intermodal transportation in practice.

The consortium consists of three knowledge partners (TU Delft, Erasmus Universiteit Rotterdam, TU Eindhoven) and four industry partners (Port of Roterdam, Kloosterboer Rotterdam BV, Markiezaat terminal Bergen op Zoom, Visbeen Transportgroep).

The main decision making body is the Project Management Committee (PMC) with representatives from the project partners, chaired by a content manager. Project management is done by TU Delft. There is also an advisory board with a larger group of interested stakeholders. Evaluation of the project is done on a regular basis, in particular bimonthly meetings of the PMC, and meetings with Dinalog and the Advisory Board.

Based on the findings of the project, the commercial project partners will further develop their business concepts and engage in demonstrations.

Keywords: Intermodal transport, synchromodality, cargo, perishables, break bulk, containerization, cross-docking, material handling, maritime and continental container flows, sea port, inland terminal, value of information

**A. Orientation and Project Goals**

Motivation

The Netherlands is an important hub in the world-wide trade of commodities thanks to its beneficial geographical position, the quality of its labour force and its stable socio-economic situation. Logistics is an economic activity of strategic importance for the Netherlands. Its position in international trade is challenged by developments in other countries, not only in Europe, but also world-wide.

In this proposed project 3 major Dutch universities (Erasmus Universiteit Rotterdam, Technische Universiteit Delft, Technische Universiteit Eindhoven), the Port of Rotterdam and 3 major players in the area of logistics will join forces to develop and enhance an advanced concept for the distribution of goods in the Port region of Rotterdam, which is not only important for the port itself, but at least as important for its logistic partners in other parts of the Netherlands and in the hinterland. The project consists of 3 logically linked research activities:

* market requirements and the role of cargo information;
* optimised internal logistic concepts (with a focus on cross-docking);
* advanced network design.

These research activities run in parallel with (and therefor cross-fertilize) the realisation of a new freight distribution concept, which is under development in the Port of Rotterdam. The studies and the so-called Cool Port initiative will strengthen the competitive edge of the logistic sector in the Netherlands.

The Cool Port initiative is one of the results from a major evaluation by the Port of Roterdam of its freight distribution policy. Now the Second Maasvlakte is underway, it has become clear that a next port enlargement operation is not likely given environmental and economic constraints.

What is also clear, is that accessibility of the Port of Rotterdam by road will become increasingly difficult. In the past, distribution parcs were developed to facilitate value added activities in the port area. However, such facilities resulted in extensive use of land and favour road transport. Now the Port of Rotterdam realises that facilities are needed that add value to cargo with minimum costs and a minimum use of land and road infrastructure, and with minimum emissions. In order to keep port accessibility at a reasonable level, where possible, truck transport has to be replaced by smart and competitive intermodal transport- and logistic solutions.

Cargo handling has to be done differently than in the past. The focus on moving containers from one point to another has to be complemented by a focus on the cargo inside the containers. It then becomes important to understand the internal operations of commercial (and public) warehouses. Is it possible to combine the optimisation of internal and external logistics? Known concepts, in particular cross-docking, could be introduced for specific goods categories. In case of the Cool Port initiative, which should be operational by 2014/5, the key activity is an on-dock distribution center for containerized perishables (at the pallet level), but these goods may act as a bandwagon for other goods, in particular dry commodities. The concept needs further study and expansion. Our studies will support this activity.

Cargo level logistics is found near inland terminals, because of their short distance to business parks. However, establishing distribution facilities on or internally connected to container terminals would be revolutionary for the Port of Rotterdam.

Cross-docking allows for the integration of maritime and continental cargo flows, and it will enhance the utilization (in particular re-use) of containers. Cross-docking reduces the need for local storage facilities and contributes to a significant reduction of delivery times and logistic costs.

The Port of Rotterdam expects benefits such as: (1) a modal shift from road to barge and rail transport; (2) attraction of additional cargo flows through the port of Rotterdam; (3) reduction of the imbalance between deepsea import and shortsea export flows (4) reduction of empty container transport; and (5) improved competitiveness of the Port of Rotterdam.

The intention of the Port of Rotterdam and the other participants in the project is to use the results from this project for the optimal design of intermodal networks at the pallet and the container level. The decision support tools from the project should support private and public investment decisions in facilities and infrastructure. It should also enable a transparent view of existing intermodal networks in order to facilitate modal shift from road to barge and rail.

Commercial partner Markiezaat container terminal BV (SME) was attracted because it is a growing hub in intermodal container transport and it has its own warehouses. It uses a highly efficient container logistics concept and is interested in LTL transport options. Two other interested parties, Visbeen and Kloosterboer (both larger than SME) will become part of our advisory committee. Visbeen is one of the founders of Daily Fresh and Coolbox. It has pioneered various intermodal transport solutions throughout Europe and is constantly looking for new markets.

*Relevant (other) stakeholders*

We have distinguished the following groups of stakeholders:

* Terminal and DC operators. They may win or loose as a consequence of strategic decisions, such as the Cool Port initiative. What will be the impact of this and other initiatives on their operations? Do they have more options to make money or will they be restricted in their business activities? Do they have to move to another part of the port? What is the impact of redevelopment of inner port areas on other areas in the port, in particular the Second Maasvlakte?
* Operators of trucks, barges and rail. The extension of the port with the Second Maasvlakte creates additional accessibility problems in the port, which have a negative impact on logistics, especially the total time needed for transportation between the port and the hinterland. Using areas of the port closer to the city for loading and unloading smaller seagoing vessels (Short Sea) and barges offers interesting opportunities to tackle this congestion problem. Interesting short distance shuttle concepts become feasible.
* The environment. Is it possible to accommodate larger transport flows and at the same time reduce the environmental impact?
* Third parties. Road users, people living and working in the Rotterdam region/port, etc. feel the impact of the traffic-, environmental- and economic issues related with scale increase in transport and the expansion of the port. These and similar issues will be considered in the project as well.

**Relation to Dinalog´s innovation themes**

Logistics has been identified as one of the so-called Topsectors in the Dutch economy by high ranking advisors of the Dutch government. In order to strengthen this Topsector, the special government committee Commissie Van Laarhoven[[1]](#footnote-1) has advised the Innovatieprogramma Logistiek en Supply Chains. Within this Innovatieprogramma three core themes were distinguished:

1. Cross Chain Control Center (4-C)
2. Service Logistiek (Service Logistics)
3. Regierol van Knooppunten (Transport Hubs in Control)

The Dinalog institute was created to strengthen Supply Chain Management in the Netherlands. Dinalog’s ambition is to give the Netherlands the European leadership in the management of transnational transport flows, which have one or more final European destinations by the year 2020.

Our project fits into two themes of the Dinalog Innovation Program Logistic and Supply Chains: Transport Hubs in Control – Sustainable growth of nodes, and Cross Chain Control Center.

**Transport Hubs in Control** aims at the optimal utilization of transport modes by creating an efficient multimodal network in the national and European hinterland of the mainports and nodes. Switching between modes is facilitated, and customers are offered a good service, irrespective of the particular logistics configurations deployed during shipment. This project adheres to this perspective and emphasizes in particular the need for door-to-door transport solutions.

By focussing on the cargo level, a new market for containerized transport is opened. It will also help to prevent suboptimal use of synchromodal solutions, e.g., where the distribution to final destinations is considered separately. It allows for a better use of container capacity. It also helps to align the operational needs in intermodal transport and the needs for safe and secure transport of cargo.

The consolidation and deconsolidation (cross-docking, transloading and warehousing on break-bulk platforms or in distribution parks) of cargo near sea ports and inland terminals create the potential for development of service clusters that add considerable value in global and continental supply chains. The breakbulk platform “Cool Port” is an inspiring project, and other opportunities are to be investigated in this project. The development of intermodal transport solutions at the cargo level also helps create value adding activities near the main ports and inland terminals. As such, it also stimulates the development of logistics centers such as Green Hub Venlo. The exchange of cargo level information could be facilitated by a neutral platform such as NLIP.

A **Cross Chain Control Center (4-C)** is a management center, which allows for the management of several supply chains via advanced technology, software concepts etc. Its scope includes the physical goods flows, the information and financial flows. 4-C allows for an overview of several supply chains and improves joint decision making, wich leads to lower supply chain costs, lower environmental impact, new business, employment, and a better business climate in the Netherlands. SME’s are a likely partner in 4-C concepts, as the concept allows smaller flows to be integrated in supply chain concepts for larger goods flows.

The project contributes to 4-C by focusing on ways to manage information flows between the port, the players in the intermodal network in the hinterland, and the shippers. For instance, cross-docking and the consolidation of cargo flows into FCL could be arranged across several supply chains.

The Execution Agenda for the Topsector Logistics contains all activities and initiatives, projects, research activities etc. to support to the realisation of the ambition to give the Netherlands a sustainable top position in logistics[[2]](#footnote-2). An Innovatiecontract Topsector Logistiek[[3]](#footnote-3) was developed, which contains six roadmaps for the realisation of the main goal of government policy in this area: to secure the logistic toppossition of the Netherlands.

Our project contributes to the following of these roadmaps:

1. Neutraal Logistiek Informatie Platform (NLIP): in the project, the research into markets and the importance of information leads to new insights in what is crucial logistic information, and how this information can be shared among (competitive) supply chains partners;
2. Synchromodality: the project explores the options to use several transport modes in varying intermodal configurations;
3. Cross Chain Control Centers (4C). This has already been elaborated above.

The project contributes to other goals as well, in particular development of human capital (design of concepts and cross-fertilization) and sustainable development (by substituting road transport to rail and barge, by more efficient unimodal transport, by more efficient use of space). The project is also an example of a demand-driven project, which follows from the high interest from business in the project.

**Objectives and goals**

This research project elaborates on the concept of cargo-driven intermodal transport, where design, planning, and execution of intermodal transportation are considered at the cargo level. It explores the pros and cons of cargo driven intermodal transportation for the key stakeholders, and to a lesser extent, also the wider economic impact. It determines the main success and failure factors of the concept. Then it defines a set of business cases for the concept. These help to convince our commercial business partners and the wider business community of the feasibility of the concept. The project will lead to tangible results, in particular a set of decision support tools which

* support the analysis of information flows within cross-dock and synchromodal logistic environments with a special focus on the cargo level;
* support the analysis of investments in warehousing;
* support the analysis of smart solutions for the logistic chain, including the use of the existing networks.

These decision support tools will be developed in parallel to tools already used by business and researchers.

***Expected results***

The project is a co-production between logistic scholars in the Netherlands, the Port of Rotterdam and three important players in the area of logistics and transport in Europe.

The expected results will be the following:

*1) Improved logistic decision making, improved business-climate and strengthening of the Dutch economy*

The project is not only interesting for the companies directly involved in the project, but also for others. Transfer of knowledge to the business community is then an important activity. This will be realised via frequent meetings and consultations with our business partners, while also communications with the wider business community are foreseen.

In the project several dedicated business cases will be developed. They will show the benefits of the project for individual firms. For the whole Hamburg-Le Havre (HLH) range the advanced distribution may lead to important cost savings. We may relate the economic impact of the project to the growth in container volumes as anticipated by the port of Rotterdam[[4]](#footnote-4), and in particular the market segments in which cargo level design, planning and control of intermodal transport creates benefits. For the economic impact, we focus here on refrigerated cargo. The present market potential per year (HLH range) is 2 mln TEU import and 1 mln TEU (re-) export, and a considerable growth is to be expected. In addition, the containerization of refrigerated cargo transport is 80% and anticipated to grow further[[5]](#footnote-5).

A volume of 2 mln TEU per year corresponds to 1 mln 40 ft containers, and cost savings of 50 euro per container as a result of the use of efficient measures such as high-frequent barge shuttles, reduced handling (cross-docking), and better utilization of transport means and containers. As a result, we expect yearly cost savings of at least 50 mln euro, or 500 mln euro in 10 years, which is an important contribution to the Dinalog objective of raising added value from 3 to 10 bln euro in logistics by 2020.

*2)**Scientific contributions*

A complete description of the research activities will be given in part B. Here a summary of the most important expected results will be given. The project consists of three main research activities.

a) The first research projects deals with optimisation of storage facilities. Optimisation refers to many aspects and impacts of such facilities, including the use of space, energy consumption, accessibility, investment and operational cost, throughput, flexibility and reliability. The on-dock or near-dock facility should fulfill these, sometimes conflicting, requirements. Commerical partner Kloosterboer has developed dedicated cold chain logistics and warehousing solutions in many countries of the world. It is one of the leading partners in the development of Cool Port. Working together with them in this project offers many opportunities to develop efficient storage concepts or to redesign existing concepts.

b) The second research project deals with optimised network designs. In order to optimize transport networks, it is important to understand the relation between product characteristics and -requirements and the functionalities and location of coupling/decoupling points (hubs) in a network. Among these functionalities are intermodal and technical facilities like a cross-dock facility.

c) An investigation into the importance of cargo information is the third research activity. It deals with the necessity, the kind of information needed, alternative options for getting and distributing information across the chain and the benefits of sharing firm-internal information with other firms, which may even be competitors. The latter is a challenging issue, but we believe that this is one of the crucial instruments companies can use to reach both said policy targets and improve the competitiveness of the transport and logistics sector in the Netherlands.

*Research questions*

The project will elaborate the following research questions:

1. **Managing cross-dock operations at the cargo level:** Which design considerations are to be taken into account that support the internal logistics at hubs in an intermodal transport network that is driven at the cargo level, i.e. supports consolidation and deconsolidation of possibly large volumes of containers and cargo, potentially at strategic points near the port? Such a design should incorporate temporarily buffering of cargo in multi-level facilities with compact storage. The objective should be to come up with robust designs and operation rules.
2. **Managing container flows at the cargo level:** Which design, planning, and control methods are applicable for the consolidation and deconsolidation of continental and maritime container flows at inland terminals, and how do they affect the performance of door to door transportation? The role of the sea port and the inland terminals in existing networks need to be taken into consideration while determining the optimal consolidation and deconsolidation points.
3. **Creating value with information flows at the cargo level:** What is the added value of cargo related information for the various stakeholders involved, used in innovative planning and control of intermodal transport, in particular in the case of perishable goods? Here a distinction is to be made between information at the container level (including cargo related information) and information at the pallet level, say. The added value will be expressed not only in economic terms, but also in terms of environmental and societal benefits.

These research questions will also consider the key logistic requirements of specific cargo types, e.g. temperature controlled and perishable goods, and how these requirements can be met in containerized transport. In this manner, applicability of the concepts for new combinations of products and markets will be explored.

The key scientific challenges are as follows:

1. Cargo information: selection of key logistic parameters, access to information, a way to share information between competitors, contribution to Port Decision Support Tool, etc.
2. Internal logistics: optimization of storage facilities, options to combine products with different requirements in one storage facility, management of the cold chain, combining fast and slow moving products, etc.
3. Network design: choice of methodology, application: location and role of nodes (including comparison with extended gate concept), synchromodality in practice, etc.

The results of the project will be published in professional and scientific journals. Project results will also be used for teaching activities. The Port of Rotterdam and the industrial partners may use the results for business development activities.

**Relation to government policy**

The project contributes to

* EU policy, in particular the grand challenge Smart and Integrated Logistics. One of its ambitions is to drastically reduce CO2 emissions: “Research and innovation will substantially contribute to the development and take up of the necessary solutions for all transport modes, which will drastically reduce transport emissions that are harmful to the environment (such as CO2, NOx, and SOx)”[[6]](#footnote-6);
* The Dutch policy to strengthen the logistic sector in the Netherlands (see the earlier references regarding the contribution to Dinalogs Innovation Themes). Our project contributes to two of the three core themes of Dinalog’s Innovation Program; By developing advanced logistic concepts and tools, the project strengthens the important role of the Netherlands in world-wide logistics;
* Dutch policies in in the area of economics, transport, spatial planning and the environment. By optimizing the use of space and logistic and transport infrastructures, the project contributes to several key goals of these national, regional and local policies;
* The vision of the Port of Rotterdam. Port of Rotterdam wants to be in the position she is now, which is far out the no 1 port of Europe. She wants to grow, so more cargo handling and this means there are several challenges to meet, such as: Accessability, can the port accomodate the throughput to the hinterland. Sustainability, can the port operate in an environment friendly way, e.g. less NOx, SOx and CO2 emissions. It is apparent that this can be realized only with all kinds of partnerships, especially the government and market parties.

**Orientation**

*International state of the art and the project*

In the academic literature, the design, planning, and control of intermodal networks are predominantly studied at the container level[[7]](#footnote-7). When considering demand at the cargo level, as in for instance the express delivery industry[[8]](#footnote-8), the origins, destinations, and time windows of individual shipments must be taken into account in the design, planning, and control of a multimodal network. Intermodal transportation at the cargo level involves the consolidation of shipments in containers at the origin, and transport of the container through the network, while the cargo is possibly cross-docked at facilities in the network, and deconsolidation at the destination.

The structure of the intermodal network and the services defined on the network need not only be specified at the container level, but it also need to incorporate operations at the cargo level. For example, consolidation may occur at two levels. First, LCL shipments may be consolidated in a container. Second, containers may be consolidated for freight transport, i.e. on a barge vessel. Intermodal network design models for container transport need to be developed that accommodate demand in terms of pallet shipments, and that identify optimum consolidation opportunities at both levels.

Although there is some initial research on cross-dock and compact storage design for perishables[[9]](#footnote-9),[[10]](#footnote-10) important issues with respect to design and operation of cross-docks and compact storage facilities still need to be addressed. Particularly the combination with multimodal transport extends the scope and application area of the crossdocking process considerably. Such opportunities have been mentioned Mangan et al. (2008)[[11]](#footnote-11). We intend to expand on that in this project.

Currently two types of cross-docks can be distinguished: (1) those specialized in unit load cross-docking (containers or full palllets) and (2) those specialized in cargo cross-docking. Examples of the first type are container terminals and cross-docks of various Logistics Service Providers. Examples of the second type can particularly be found in express parcel delivery, such as used in ecommerce parcel distribution (e.g. networks of DHL, TNT, Fedex). The difference between these two types of operations is the combination with storage. In container terminals, the departure time and mode are not always, or not always sufficiently accurate, available upon arrival of the load. In cross-dock operations for parcels, the departure schedule is fully known at the instant of arrival and the prime objective is to guarantee timely sortation of the parcel and merge it with the load for the departing truck.

The planning of intermodal transport is faced with a number of uncertainties due to the complexity of the transport process, as it is international, it involves a large number of organizations, and many unexpected events occur, such as delays.[[12]](#footnote-12) As a result, the planning of containers is nowadays characterized by a conservative approach where slack times are built in to avoid late arrivals at the

customer.

The provision of information may reduce uncertainty and henceforth enhance planning performance. Lee and Özer[[13]](#footnote-13) argue that quantitative modeling should be used to quantify the benefits of data capturing technologies in logistics. Psaraftis[[14]](#footnote-14) motivates the study of dynamic vehicle routing problems based on developments in information and communication technologies. The value of information in on-line transport planning has been assessed by Jaillet and Wagner[[15]](#footnote-15), and by Srour and Zuidwijk[[16]](#footnote-16) in the stylized setting of the traveling salesman problem, using competitive ratios.

The value of information has also been considered in the context of intermodal transport[[17]](#footnote-17) and in the transport and handling of perishable goods[[18]](#footnote-18). The use of cargo level information in the planning and control of intermodal transport is promising but has not yet been fully explored.

*Related ongoing developments and projects*

The project will run in parallel with the Cool Port project, which is underway in the Port of Rotterdam.

The project will run in parallel to the ongoing Dinalog project “Ultimate”, in which both EUR and TUE are also involved. There are opportunities to benefit from each other.

Fresh Corridor partner Visbeen Transportgroep is also partner in our consortium. We may benefit from its experience in the transport of perishables, while our research may help to optimize the Fresh Corridor concept.

Next to Cool Port, there are a number of other initiatives of the Port of Rotterdam Authority related to the project. The main initiatives today are:

* realizing cross dock facilities on a container terminal in the Waal- Eemhaven area for consolidation of LCL (for dry cargo);
* establishing transload facilities on the Maasvlakte for transloading 40-45ft containers;
* developing distribution facilities adjacent to the Container Transferium in Albasserdam;
* planning of a common rail terminal on the Maasvlakte;
* working out a business plan for rail shuttle incubator.

**Level of innovation**

The project will bring innovations in the following areas:

* storage solutions;
* network designs;
* information handling concepts and strategies;
* concepts which link logistic and transport decisions by business with investment decisions by business and the Port authority/-ties;
* advanced analysis and decision support tools;
* co-operation between universities, the port authority and commercial business in logistic concept design, development and implementation.

1. **Activities and Work Packages**

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| *Project overview*  The three activities are planned in parallel and in close collaboration and are organized in a single work package. The three project leaders are actively involved in the project and play a role in the interaction between activities and with the companies in the project, while the post-doctoral researchers are active in the execution of the research and interactions with companies as well. | |
|  | Activity 1: **Managing cross-dock operations at the cargo level:** |
| Duration: | 2012-2014. Projectleader: Rene de Koster (EUR) |
| Deliverables/  Milestones: | 2012-2013: A1.1 - Decision tool for selection between multiple compact storage/ cross dock systems (D1.1). |
|  | 2013-2014: A1.2 - (Near) optimal or robust design, storage and operating strategies for selected systems (D1.2). |
|  | Activity 2: **Managing container flows at the cargo level** |
| Duration | 2012-2014. Projectleader: Jan Fransoo (TUe) |
| Deliverables/  Milestones: | 2012-2013: A2.1 - Field work and data collection. Develop 2 analytical models and use this as input to some strategic discussions with the companies involved (D2.1). |
|  | 2013-2014: A2.2 - Build the simulation model, use this to obtain more general insights, and pilot the model with decision makers in the companies and the Port Authority (D2.2). |
|  | Activity 3: **Creating value with information flows at the cargo level** |
| Duration | 2012-2014. Projectleader: Rob Zuidwijk (TUD) |
| Deliverables/  Milestones: | * 2012-2013: A3.1 - Two analytical models with associated results and insights, and intermediate results that demonstrate how the analytical models are used to provide insights to the participants in the project. (D3.1). |
|  | * 2013-2014: A3.2 - A decision support tool, specific to part of the hinterland network of the port of Rotterdam, and intermediate results that demonstrate how the decision support tool is used to provide insights to the participants in the project. (D3.2). |

*Project breakdown into subprojects and activities*

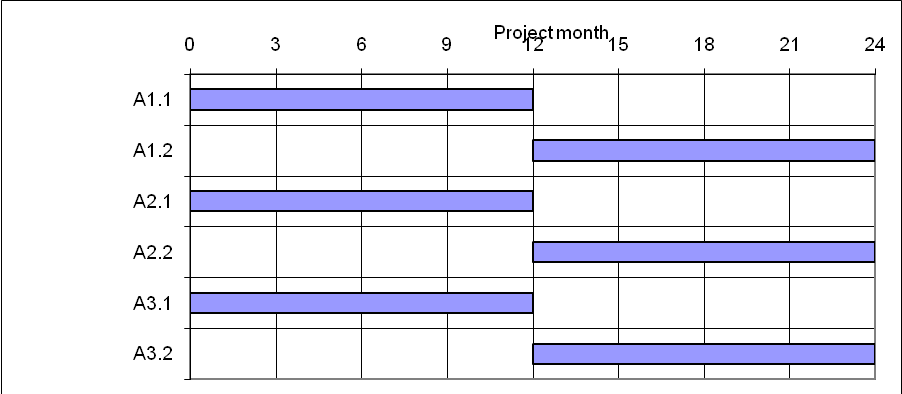
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| Activity 1: **Managing cross-dock operations at the cargo level** |
| Description:  The cross-dock operation envisioned in this project combines both unit-load and cargo cross-docking: it must be possible to store cargo temporarily, until further information becomes available. It should also be possible when this information becomes available, to rapidly retrieve the load from storage and timely merge it with other cargo in the same container. This requires a cross-dock operation that is designed for efficiency (space usage, cost), flexibility in handling (distribution information is not necessarily available upon receipt), as well as speed in operation (once the distribution mode information is available, the next departure due time should be realized). These different requirements require a non-conventional approach to the cross-dock design and operation. In addition, land for such type of operations is scarce, so space should be used efficiently. Compact cross-docks have the ability to use the limited space efficiently, paired with high performance.  Multiple compact system configurations are currently being developed that might realize the efficient cross dock process. The project aims to develop a tool by which multiple of such systems can be compared for costs, footprint, energy use/CO2 emissions, response time. In order to do this systems have to be optimized for response, including design and operation options. First results show that such systems can be cost competitive, can reduce footprint and energy consumption, and have shorter response times than more conventional systems. |
| Planning:  First year: make a decision tool for selection between multiple compact storage/ cross dock systems. We will do this in close cooperation with Kloosterboer, a company with wide experience in compact storage and cross dock solutions for frozen and refrigerated products. Kloosterboer is particularly looking for such a system selection tool.  Second year: develop (near) optimal or robust design, storage and operating strategies for selected systems. |
| Work distribution: One Postdoc will work fulltime on this project for two years, in close cooperation with Prof.dr. Yugang Yu and Prof.dr. René de Koster. |
| Expected results/deliverables/milestones:  We propose automated, compact cross-dock designs, storing cargo multi-tiered on a relatively small footprint. Compact cross-dock designs are known from various industries (e.g. parking garages in various Asian cities, or Volkwagen’s Autostadt, the inspiration for the movie Mission Impossible IV). Such systems promise a short response time against acceptable cost, on a relatively small footprint. The main objectives are to come up with a decision support tool for system selection and robust design and operation rules for selected systems |

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| Activity 2: **Managing container flows at the cargo level** |
| Description:  The growth of the maritime container has been primarily driven by shipments that would be designated FTL in conventional road transportation: a full container that travels from point-to-point. In many cases, this refers to the long-distance transit leg that the cargo is traveling. At the place of origin this could be the factory or a consolidation center where different cargo is combined into full containers. The place of destination is typically a distribution center where the container is unloaded, usually stored, and then distributed using traditional (non-container) load carriers. The fast growth in containerization of ultra-short life cycle products - such as fruits, vegetables, flowers, and pharmaceuticals - has difficulty in matching this models. Some flows, such as bananas, are very voluminous, and can be handled as if it were FTL cargo. However, many other volumes are much smaller, and filling complete container loads from origin to destination is no possible. In those cases, in a container network that operates in hub-and-spoke, cross-docking while transloading may need to be conducted at the port of arrival rather than at a distribution center further downstream the supply chain. In Europe, the transloading could be towards continental containers. Potentially, also palletization would be needed.  Following the containerization of maritime loads, we also expect that containerization of continental loads will follow suit. Important drivers are the cost-effectiveness and eco-efficiency of intermodal transportation, whether by barge, rail, or short sea. Containerization of LTL continental flows is likely to be only possible in a network that operates with a limited number of hubs, where cross-docking and transloading could take place.  The Netherlands may not necessarily be the best location for such continental LTL hubs, but locations like Venlo could qualify, specifically if a virtually integrated hub would be set up with Rotterdam. Such an integration would combine continental transportation with maritime transportation.  In designing these networks, the tradeoff are qualitatively more or less clear, but not yet complete. For instance, the shorter the product life cycle, and the smaller the volume on the transit leg, the more likely a quayside crossdock/transload would make sense. Further, if the final destinations are clustered far into the hinterland, it would not be cost-effective to crossdock at the quayside.  In this activity, we will study these trade-offs by two different techniques:   1. We will build two analytical models to qualitatively study the two essential decisions: (1) when to bundle or deliver to a final DC and use the storage decoupling there to conduct final delivery vs crossdocking/transloading in the transit leg, and (2) crossdock/transload at quayside or in the hinterland. We believe at this stage that the most important parameters to drive this are (a) the length of the product life cycle, (b) the volume of the shipment size, (c) the value of the product and (d) the cost of the crossdocking operation. For the latter we will use the results and insights from activity 1. 2. We will build a more comprehensive, strategically decision support model, that takes the tradeoff from the analytical models, and integrates into an actual multicommodity multiflow network. |
| Planning:  First year: Conduct field work with the various companies in the network. Information and data collection. Cost information. Develop 2 analytical models and use this as input to some strategic discussions with the companies involved to elicit more specific information on the trade-off.  Second year: Build the simulation model, use this to obtain more general insights, and pilot the model with decision makers in the companies and the Port Authority. |
| Work distribution: The data collection and modeling will be conducted by a postdoc at TU/e. For data collection all companies will be consulted. |
| Expected results/deliverables/milestones:  We will deliver:   * Two analytical models with associated results and insights * A workshop format - to be used and reproduced - at which players in such chains can play with the analytical models, and obtain insights into forming their strategy * A simulation based decision support tool, specific to the Rotterdam/Venlo network. |

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| --- |
| Activity 3: **Creating value with information flows at the cargo level** |
| Description:  As discussed in Activities 1 and 2, there are opportunities to accommodate cargo flows by means of intermodal transport beyond the transport of a FCL from an origin to a destination, and to optimally utilize containers. Example opportunities are (1) the consolidation of LCL shipments at a facility into a container shipment, the transport of the container, and deconsolidation of the shipments for final transport; (2) cross-docking and transloading containers, e.g. maritime to continental; (3) container repositioning in a network where empty containers can be used to accommodate LCL demand; (4) the integrated planning of transport and handling of cargo in the network.  This project will analyze the role of information in reaping these opportunities. It will do so by creating a further understanding of the impact of available information on the performance of the intermodal transport network.  The accommodation of demand, given customer requirements such as time windows, while utilizing the resources such as transport vehicles and containers as much as possible, is confronted with uncertainties such as uncertain container arrivals, uncertain travel times, uncertain arrivals of orders, and uncertainty in the availability of resources, such as transport and handling capacity, and containers.  The level of uncertainty can be expressed in the level of available information and the level of control. We shall study the level of information available, both at the  cargo level and at the container level. This allows for the definition of various information levels and the development of optimal policies under such information levels. Typically, the planning situations will not be studied at the operational level, but at the tactical level e.g. by considering operational parameters that follow a stochastic distribution. We aim to demonstrate that better statistics on relevant parameters may help improve performance.  The performance of the policies under various information scenarios will be evaluated along various performance dimensions, such as revenues and costs, reliability, security, and environmental impacts.  It is anticipated that the research will demonstrate that the level of information available will have an impact on the optimal design of the cargo driven intermodal transportation network as well, next to attributes such as costs, speed, vehicle capacity etc.  The planning situations are enriched by the requirement that alternative modes of transport such as barge and rail are used and well-utilized, and that containers are utilized and repositioned well.  The project will pay special attention to the value of sharing information among sup |
| Planning:  First year: Field work with the various stakeholders in the network, and collect information and data. Two analytical models are developed that capture important characteristics of the planning situations at hand. In particular, the relative importance of capturing and sharing different information is being identified by means of the value of information along the aforementioned performance dimensions.    Second year: The analytical results are incorporated in a network planning tool that supports the strategic planning of cargo driven intermodal transportation, where the availability of information is a design parameter. The model will be developed in close collaboration with the project stakeholders. |
| Work distribution: One Postdoc will work fulltime on this project for two years, in close cooperation with Prof.dr. Rob Zuidwijk and the participants in the project. |
| Expected results/deliverables/milestones:  We will deliver:   * Two analytical models with associated results and insights; * A decision support tool, specific to part of the hinterland network of the port of Rotterdam; * Intermediate results that demonstrate how the analytical models and the decision support tool are used to provide insights to the participants in the project. |

*Planning*

The proposed length of the project is two years. The project may start on September 1, 2012 (project month 0 in chart 1), depending on the agreement with Dinalog and the actual availability of the temporary researchers.



**Chart 1. Planning chart of the project**

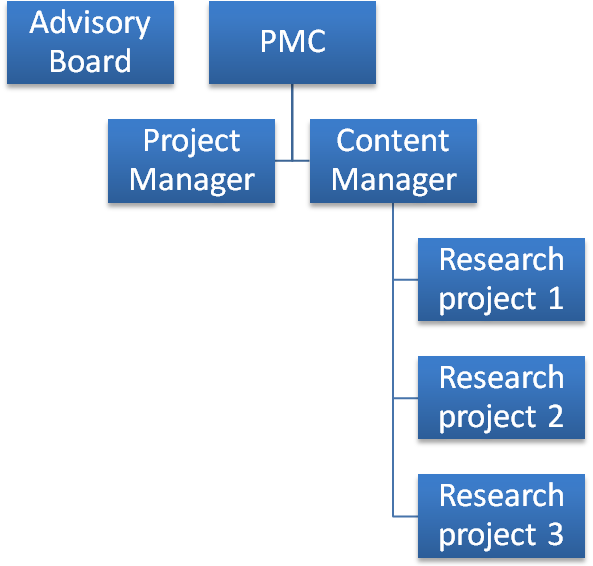
**C. Consortium and Project Organization**

*Consortium partners*

|  |  |  |
| --- | --- | --- |
| **Partner’s name** | **Role and input** | **Specific competence** |
| Rob Zuidwijk (TUD) | Content Manager  Leader of Research Activity 3 | Logistics, OR |
| Rene de Koster (EUR) | Leader of Research Activity 1 | Logistics, warehousing, optimization |
| Jan Fransoo (TUE) | Leader of Research Activity 2 | Logistics, networks, optimization |
| Jaap Vleugel (TUD) | Project manager | Project management, matching of business and scientific interests, transport and logistics |
| Jouke Schaap (HBR) | Represents the Port of Rotterdam and the business community | Business development |
| Niek Ooijevaar (HBR) | Represents the Port of Rotterdam and the business community | Business development |
| Arn van der Vorst (Markiezaat terminal) | Business case | Business development |
| Arie Visbeen (Visbeen Transportgroep) | Business case | Business development |
| Maarten Res (Kloosterboer Rotterdam BV) | Business case | Storage design and realisation |

*Project organisation and Governance*

The project organisation is structured as follows:



**Chart 2. Organisation chart**

**Project management**

Delft University of Technology (TUD) is the applicant and will take care of the project leadership. TUD has a long experience in developing and managing scientific projects in cooperation with the business community. Project management will be done by the Faculty of Civil Engineering and Geosciences, Department of Transport and Planning (Jaap Vleugel). Financial assistance is provided by the faculties’ contract managers.

The main decision making body in the project will be a project management committee (PMC), which consists of one representative of each partner. This PMC will be chaired by the Content Manager (Rob Zuidwijk). The main responsibilities of this PMC are progress monitoring, scientific dissemination, quality control, valorization of the results, and communication with the partners, Dinalog, and the extended business community. In particular, the three professors that lead the three research projects play an active role in the project which goes beyond supervising the post-doctoral researchers.

**Research partners**

The participating knowledge institutes are represented by established scholars in the field.

**Commercial partners**

The following companies have agreed to be involved in the project:

* Port of Rotterdam – facilitating and supporting business in the port area and its hinterland;
* Markiezaat terminal Bergen op Zoom – developed a very interesting concept for container logistics and intermodal transport;
* Visbeen Transportgroep – innovative intermodal transport operator, involved in innovative state-of-the-art logistic concepts, in particular for perishables;
* Kloosterboer Rotterdam BV - innovative intermodal transport operator, involved in innovative state-of-the-art logistic concepts, pioneer in cold storage.

The researchers will co-operate with these commercial partners. The research projects provide the main ingredients that will help the Port of Rotterdam to fulfill its aim of developing an analysis and decision support model for the design of intermodal networks, which is able to explore the pallet- and the container level. The industrial partners are experienced users of the storage concepts, they have developed logistic and transport concepts, that can be linked and enhanced with the results of the research projects. The project allows the industrial partners to bring in specific sub-research questions related with their business. They will also have access to the decision support models developed in the project.

The close relationship with actual commercial activities and developments in the relevant transport networks will allow for experimentation with logistic designs, in particular cross-dock and cold storage operations.

**Advisory Board**

The advisory board for the project will consist of stakeholders from Dinalog Friends, Erasmus Smart Port Rotterdam, Port Research Centre in Delft, European Supply Chain Forum in Eindhoven, and the Material Handling Forum in Rotterdam, and other interested parties.

1. **Evaluation and Monitoring**

*Scope*

The project consists of three core research projects, parallelled by the ongoing Cool Port project by the port of Rotterdam and ongoing logistic projects and ongoing business by the industrial partners.

Project management in this project has the following scope:

* evaluation and monitoring of Research Activities 1-3;
* interaction and information exchange with the Cool Port project and relevant activities of the industrial partners;
* possible involvement of additional partners in the project;
* project planning, monitoring and fulfillment of project deadlines;
* risk analysis, conflict management, major changes of staff within the partner companies, and relevant back-up solutions;
* all relevant administrative and financial management activities including project audit, scheduling of meetings, etc.

Content management in this project has the following scope:

* overall project design;
* all activities directly and indirectly related with project content, in particular monitoring of the level of the fulfillment of the project aims;
* interaction and cross-fertilization between the research activities and the commercial and industrial (research) activities;
* possible involvement of additional partners in the project;
* risk analysis, conflict management and back-up solutions;
* dissemination of project results.

*Evaluation and monitoring activities*

[Year 1]

In the first month of the project, each subproject leader will craft a project plan of 5 pages max, clearly describing the set-up of the subproject. These three project plans contain a common short list of Key Performance Indicators (KPI). These KPI will be defined by the PMC in its Quality Plan. KPI refer to fulfillment criteria in terms of scope, innovativeness of the approach, feasibility to answer the research questions, planning, manpower, budget etc.

The subproject plans will then be discussed in the PMC. The PMC will then, after having contacted the Advisory Board decide whether the subproject can continue as described or that some changes are necessary in order to make it a feasible project. Shortly after that, relevant subprojects are re-evaluated and after acceptance, they will receive the green light. Each subproject can then start in a regular manner. Each subproject should be running in month 2 or earlier if possible.

Every 4-6 weeks each subproject leader reports to the Content Manager and the Project Manager and informs them about progress, issues to be resolved and feasibility of planning. Both managers discuss these Progress reports and if necessary inform the PMC if major issues would arise. Members of the PMC, the Content Leader and the Project Leader will regulary visit the subprojects and the industrial projects to support the evaluation process.

The PMC has regular bi-monthly meetings, where the content and progress of the project will be discussed and if necessary changes to the direction and/or content of the project can be initiated. Small changes will not be discussed with Dinalog, but major ones will be discussed with Dinalog.

Every 4 months a consultation meeting between the PMC and the Advisory Board will be scheduled. On the basis of this, the Project Manager will write a Progress Report, that will be sent to Dinalog for commentary.

Meetings between the Content Leader, the Project Leader and Dinalog will be scheduled both regularly (pattern to be agreed) and also if necessary on an ad hoc basis.

Every 6 months a general assembly consisting of members of the PMC, the Advisory Board and researchers from the subprojects, from the commercial and industrial projects will be scheduled. Here important cross-fertilization and matching of project activities will be discussed.

By month 11, the final reporting of the respective first year activities will start. By the end of month 12 all first year activities should be ready. Any extension is dependent on a decision by Dinalog, following a request from the PMC, having consulted the Advisory Board.

In month 12 resp. 24 the General Assembly joins again and discusses the final reports of the project. After acceptance, they will be sent to Dinalog for commentary and approval.

[Year 2]

The same sequence as in Year 1 will be maintained.

In month 22 the work on the final reports for Year 2 will start. This is earlier than in month 11, due to additional work related with the termination of the project by month 24.

1. **Valorization and Implementation Strategy**

*Valorization*

The project is not only relevant for the companies directly involved, but even so for other, similar and non-similar companies in the transport and logistics business, for planners, investors and other decision makers in government and business. The international character of the logistic sector means that the project is also very relevant for business and governments outside the Netherlands.

The following means of valorization and dissemination will be used:

* Demonstrations initiated by the commercial partners. As indicated, the industry partners are actively involved in the further development of intermodal transport in the spirit of this project and are inclined to put the results of this project into practice;
* As the research projects are ongoing, M.Sc. projects with internships at the company support both the data collection and the establishment of intermediary results;
* Presentations at conferences for the extended business community of Dinalog, including SME’s, and through the development of other dissemination products, such as a blogs, columns, and other contributions in various media, and contributions to meetings and roadshows organized by the business partners in the project;
* Educational presentations for students in universities and colleges of higher education, and the development of educational materials based on the outcomes of the project;
* Presentations at congresses, publications in professional and scientific journals.

*Implementation*

Based on the findings of the project, the commercial project partners will further develop their business concepts and engage in demonstrations. A brief description of their business is given in the description of the consortium. Relevant in this respect are the business projects that would run in parallel with the proposed project, e.g. the Cool Port project and the Fresh Corridor project, but also business projects that are focused on dry cargo, in which the Port of Rotterdam is already taking initiatives.

It is foreseen that the project partners will use the results of the project to develop software tools that can be used by relevant stakeholders.

It is also foreseen that the project results, including the identification of relevant product and market combinations, will be adopted by a wider group of companies, among which are the participants in the advisory board.

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