Smart logistics

Inaugural lecture
Prof. Tom Van Woensel
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/ Department of Industrial Engineering & Innovation Sciences

Technische Universiteit
Eindhoven
University of Technology

Smart Logistics

Where innovation starts

Inaugural lecture prof. Tom Van Woensel

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Presented on March 23, 2012
at Eindhoven University of Technology

Prologue

The Netherlands is ranked fourth in the Logistics Performance Index, published in 2010 by the World Bank. The Ministry of Economic Affairs, Agriculture and Innovation (see www.hollandtrade.com) explains this excellent ranking "*due to the favorable geographic location of the country in the heart of Europe, a sound infrastructure that includes the Port of Rotterdam, the Port of Amsterdam, Amsterdam Airport Schiphol and a sophisticated logistics sector*". The Netherlands is not doing a bad job, but... Let's look a bit closer at the evolution of this index over time. In 2007, the Netherlands ranked second, so it dropped by two places in the ranking in four years while Singapore and Germany were stable and remained in the top three both in 2007 and in 2010. This fall in ranking is remarkable given the amount of attention for logistics in the Netherlands and shows the need to improve in this field in order to keep up (see for example, the reports of the Commissie Van Laarhoven, 2006; Top Team Logistics, 2011).

Let me give a few examples of the current state of logistics.

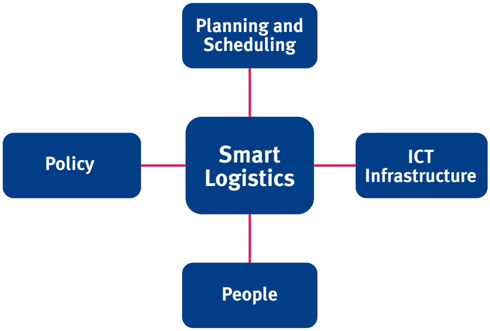
1. A UK study (McKinnon, 1999) showed that in 22% of all cases, trucks were running empty and the average truck utilization was only around 75%. Similar numbers are seen in EU studies: most European countries report percentages between 15% and 40% of vehicle-kilometers recorded as empty. The Netherlands reports a percentage of around 24%, having relatively fewer empty vehicle-kilometers than the European average (27% for national transport). However, when looking at the average truck utilization, the Netherlands is lagging behind compared to the European average (Eurostat, 2010).
2. More and more city areas regulate and limit the access for freight trucks to specific time windows or impose the use of certain equipment (e.g. electric vehicles). A common way to limit access to the city is to impose hard time windows in the form of entry limiting poles. Being late immediately means that delivery is impossible. Moreover, the delivery efficiency in cities is low, leading, for example, to many vehicles delivering in the same street during similar hours. These issues are typical examples of government policies not being

aligned with logistics' organization. In the extreme case, this leads to the opposite of what was originally intended: more emissions, more safety issues, etc.

3. If we know that many traffic jams recur at a certain place and a specific time, why do planning tools route vehicles on those congested roads? Using advanced information from navigation systems (e.g. TomTom), it is perfectly possible to avoid time lost in traffic jams. Barriers are policymaking (e.g. city regulations) and decentralized decision making. In Belgium, Colruyt and Delhaize tested the value of delivering to their stores before the morning traffic jams in 9 municipalities: important savings in fuel, emissions and travel times are observed (PIEK project, 2012).

Analyzing these examples show that sufficient information availability alone is not enough. Also the planning and scheduling tools need to make use of this rich information. Next to this, government plays a key role in the success or failure of logistics' innovation. At the end of the line, people are organizing and executing logistical activities.

The examples above demonstrate the huge potential for improvement. The road towards outstanding logistics' performance is **Smart Logistics**. Explicitly adding the qualifier *smart* suggests that today's logistical activities are not *smart* (or at least not *smart* enough). But what is Smart Logistics about? Without going into an endless discussion on the relationships and differences between Logistics versus Supply Chain Management (see Larson and Halldorsson (2004) for more discussion), we define Logistics as efficient and cost-effective managerial decisions related to the design, planning and control of the supply chain processes. Smart Logistics does this in a *smart* way. Smart means that planning and scheduling, ICT infrastructure, people and governmental policymaking need to be efficiently aligned.



Smart Logistics equals 3P+I (i.e. Planning, People, Policy and Infrastructure), and is the synchronized interplay of these four key domains. **ICT infrastructure** is an enabler for planning and scheduling via providing the right information resources at the right time and place. Nowadays, larger quantities along with more detailed and faster information are available. This allows for better **planning and scheduling**. But this is also a challenge as many planning and scheduling tools are not able to handle this amount and quality of information. One example is the limited use of advanced traffic information in the route planning tools. Some researchers and practitioners go further and claim that adequate advanced planning is not needed anymore as all the required information is available in real-time. They argue that it is sufficient to have fast reaction or repair strategies. These fast repair strategies assume full flexibility in real-time, which is usually only true in practice to a limited extent. The role of **people** is important, as they need to interpret and implement the outcomes of the planning and scheduling tools. People need to be adequately trained to thoroughly understand and manage properly the complex logistical processes. Last, but not least, **governmental policies** have a critical impact on the success or failure of logistical activities. Note that in many cases, policymaking has been counterproductive to rather than strengthened Smart Logistics. Since policy has a fundamental impact on the costs of the logistics activities of companies, the private sector is directly affected.

In the remainder of this lecture, I will spend little time on the role of government. However, in the public sector, just as for the industry, accurate and realistic modeling of operational and logistical functions is a necessary precondition for effective operational planning and control for society as a whole. Policymakers need to develop a thorough understanding of the effects of their policies. Ideally, operations should drive policymaking rather than the reverse. A few examples of inefficient policy include the misalignment of working time regulations for trucks, trains and barges to enable feasible combinations of transportation modes, city entry limitations, etc.

In all the proposed research, I have assumed that the ICT infrastructure and requisite data are more or less available. More and more data are collected via various companies and government departments (like TomTom and traffic data). However, such data are very scattered at different places, which is hardly a boon to decision-making. I should mention here the GET project, led by Remco Dijkman from the Information Systems group in our department, which aims to develop tools to provide all the necessary historical and real-time information to all stakeholders via a single integrated platform.

A number of ongoing economic, societal and environmental developments indicate the challenging future and importance of Smart Logistics.

1. The transport industry represents an important part of the economy: within the EU it directly employs around 10 million people and accounts for about 5% of GDP (White Paper EU, 2011). European reports show that freight transport increased by 40% from 1995 to 2010. From 1998 to 2008, the largest share in this growth was due to road transport, growing by over one-third, compared to around 13% growth in rail and 11% growth in inland waterways. EU projections show a growth of 25% between 2010 and 2030 for freight transport by road, rail and water together (SOER, 2010).
2. An important global evolution is the urbanization trend leading to larger cities, emptying the countryside and small towns. Within the OECD countries, this evolution is very clear: in 1950, 50% of the population lived in cities, 77% in 2000 and it is expected that by 2020 this share will grow to 85% (OECD, 2003). Cities are challenged by this growth and need to control good flows within urban areas to reduce the adverse impact on living conditions (congestion, pollution, etc.), but without affecting key city activities.
3. Transport externalities go hand in hand with expected growth and are a major concern. Road congestion generally increases following the evolution of concentration of economic activities around cities and other clusters of activities (ports, industrial zones). Consequently, these urban areas also bear the major burden of traffic congestion and other negative effects of transport, such as pollution. Urban transport is responsible for about a quarter of CO_2 emissions from transport. A further complexity in mobility in urban regions is that freight and people use largely the same infrastructure.
4. Oil, directly linked to emissions, will become scarcer in future decades and be sourced increasingly from uncertain supplies (White Paper EU, 2011). Consequently, fuel prices are expected to increase over the coming decade and make decarbonization of distribution activities necessary.

These developments give an interesting snapshot of the challenges faced by logistics in the future. Transportation demand is growing and is expected to continue growing. Last-mile logistics are situated more and more in growing urban areas, due to the increasing urban population growth. Both the internal (i.e. operational) costs and the external (i.e. congestion, pollution, noise, etc.) costs are key logistics drivers, but the share of external costs is becoming increasingly important. Finally, the last-mile is becoming (over-)congested and, additionally requires decarbonization to reduce pollution. Increased complexity and uncertainty in the logistical operations are common underlying factors, an ideal and fertile setting for an engineer's approach to Smart Logistics. In what follows, I describe the complete playing field from a control point of view. Since the real-world system is highly complex and intertwined, we deconstruct this into smaller components, without losing sight of the overall picture. In my research, the real-world system under consideration is the Transportation Chain.

The Transportation Chain

Consider the *Transportation Chain*. It starts where the goods originate (e.g. production) and ends at the final destination (e.g. store, customer, etc.). Figure 1 depicts the Transportation Chain deconstructed into three parts: the Pickup Chain (or the first mile), the Transit Chain and the Delivery Chain (or the last mile). In each part of the Transportation Chain an operator (e.g. LSP, shipper, etc.) is active. Note that this could also be a single integrated operator throughout the chain. In between the Pickup Chain and the Transit Chain, we position the *Pickup Decoupling Point* (PDP), a consolidation point where control of the goods is moved to the Transit Chain operator. In between the Transit Chain and the Delivery Chain, we position the *Customer Delivery Decoupling Point* (CDDP). The CDDP is defined as the point in time and space where control is given to the Delivery Chain operator.

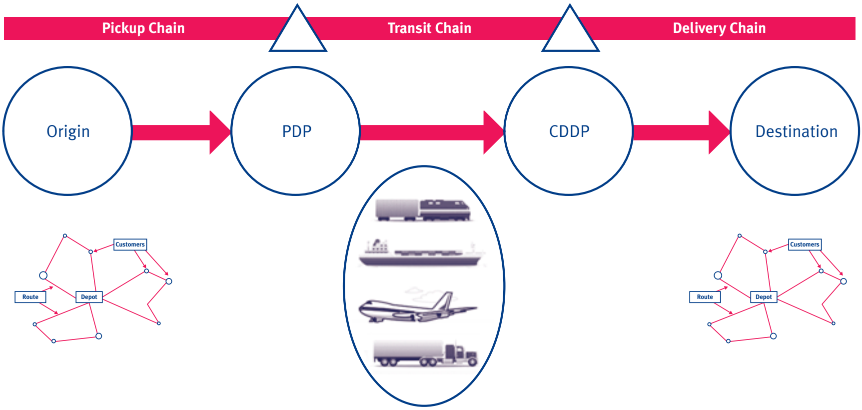


Figure 1

The Transportation Chain

Depending upon the supply chain, we can specify the Transportation Chain and the different processes following the above framework. Note that the Pickup Chain and the Delivery Chain are leading in the structure of the Transportation Chain. These two components drive the structure and efficiency of the Transit Chain. Driven by the use of multiple transportation modes, the Transit Chain could also have multiple Decoupling Points, where control is handed over to a different transportation mode.

The three parts of the Transportation Chain are different in their characteristics. Figure 2 gives an overview of the characteristics comparing the Pickup Chain, the Transit Chain and the Delivery Chain. The Pickup Chain and the Delivery Chain are rather similar to each other in terms of characteristics. If combined, the challenges are in the joint coordination of the pickup and delivery operations in these two chains.

	Transit Chain	**Pickup/Delivery Chain**
Load	Full Truck Load (FTL)	Less than Truck Load (LTL)
Transportation modes	Multiple modes: road, rail, air and sea	Single mode: mainly road
Transit time	Long (at least a day)	Short (within the day)
Handling unit	Containers and pallets	Parcels and (mixed) pallets
Stops	Direct shipments	Multiple stops (routing)

Figure 2

Characteristics of the Transit and Pickup/Delivery Chain

The Transportation Chain with its components as depicted in Figure 1 is a basic structure for describing logistics operations. Depending upon the specific product being shipped, the Transportation Chain may look slightly different. Parts of this basic set-up may not be available (e.g. no pickup tours). On the other hand, different parts are sometimes intertwined: the pickup operations and delivery operations usually occur jointly in the same (urban) area. Flows in the Transportation Chain are bi-directional as well (and usually unbalanced in volume), for example, product flows and returnable transport items (e.g. empty containers, pallets, etc.). My research in Smart Logistics is completely embedded in the Transportation Chain.

As noted earlier, the challenges in the Transportation Chain are to efficiently handle increased uncertainty and high complexity. This is important since the real-life world does not fit into a deterministic and static straitjacket, which is assumed by so many published models and industry tools. Any decision, action, plan or schedule built on unrealistic assumptions is bound to be less than optimal once realized. This is a key starting point in all my research, today and tomorrow.

My research approaches this real-life uncertainty and complexity by first formulating conceptual models (based on a sound understanding of the real-life system) and, secondly, by building mathematical models that can be analyzed and optimized. A lot of exciting work still needs to be done. Important new research areas emerge in terms being able to adequately represent real-life environments. Efficiently coping with these rich models is an important and challenging problem both in real-life and academic environments. This research outline builds extensively on the vast and sound foundations of academic literature and industrial experience.

In what follows, I discuss three research themes focusing primarily on the Smart Logistics aspects of planning and scheduling, and people. The first theme deals with the Pickup and Delivery Chain. The second theme is about the Transit Chain. The last theme deals with integration approaches for the complete Transportation Chain.

Theme 1: Pickup and Delivery Chains

Consolidation activities are needed for efficient and effective management of the various resources in the Transportation Chain. This is important in both the Pickup and the Delivery Chain where different requests get combined into routes and schedules. The *Vehicle Routing Problem* (VRP) is a representation of the less-than-truckload pickup or delivery problem incurred by many logistics service provider companies.

The VRP can be described as "*the problem of designing optimal delivery or collection routes from one or several depots to a number of geographically scattered cities or customers, subject to side constraints*" (Laporte, 1992; Cordeau et al., 2002). The Vehicle Routing Problem boils down to a combinatorial optimization and integer-programming problem, which falls into the category of NP-hard problems, meaning that the computational effort required increases exponentially with the problem size. A huge number of variants have been researched by a large academic community and discussed extensively in the relevant literature. Figure 3 depicts the Vehicle Routing Problem in its basic form.

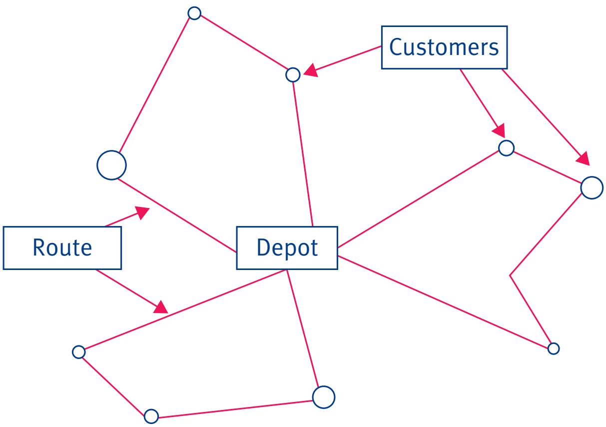


Figure 3

The Vehicle Routing Problem

The VRP aims to design least-cost vehicle routes such that every customer is visited exactly once by exactly one vehicle and all vehicle routes start and end at the depot. The following extra constraints are usually considered as well (for more details, see Toth and Vigo, 2002):

- Capacity restrictions: every vehicle route has a total demand not exceeding the vehicle capacity;
- Length restrictions: every vehicle route has a total route length not exceeding the maximum length or a specific number of customers on that route;
- Time windows: every customer must be visited within a predefined time interval. This leads to some extra decisions with regards the possibility of waiting or not (see for a review Cordeau et al., 2002).

Clearly, the basic VRP definition is interesting, but not always sufficient for real-life planning. Complexity issues like time-dependency and stochasticity do not directly fit into this formulation. In real life accidents occur, travel times depend upon the moment one leaves the distribution center or customer (and on many more factors), road networks are congested, demand varies or is unknown, etc. Considering these time-dependent and stochastic phenomena leads to rich Vehicle Routing Problems, handled in both an offline and online setting. Offline means the generation of schedules beforehand (e.g. before the working day) whereas online refers to the actual realization of the schedule (e.g. during the working day). More and more, researchers are shifting towards considering stochasticity and time-dependency in their models. As an alternative, other researchers immediately go to the online setting to cope with the real-life complexity. It is my belief that most of the benefits are in the offline setting. Once the plan is made and executed little degrees of freedom are available to repair disrupted schedules in the online mode. These different observations are the starting point of my research in rich VRP: stochasticity, time-dependency and offline.

In recent years, many co-authors and I have worked on a number of rich VRP topics. Travel times change, relatively predictably, depending upon the time of the day. Extending the routing models with dynamic travel time information is done in three steps. First, expected travel times are added (Van Woensel et al., 2007; 2008), in a second step, the variability of the travel times is considered (Lecluyse et al., 2009) and in a last step, the complete travel time distribution is taken into account in the model (Tas et al., 2011). Important gains in the realizations of schedules taking into account travel time information were observed. The use of complete travel time distributions also leads to related arrival time distributions, which are compared with the customers' time windows, resulting in delivery

reliability measures at customer level (Tas et al., 2011). Realizing that many carrier companies quote their expected arrival times to their customers, we coined the concept of Self-Imposed Time Windows (Jabali et al., 2010). Self-Imposed Time Windows treat time windows as endogenous decision-variable and give additional flexibility to the carrier company. Within this vehicle routing framework, we identified the trade-off between jointly minimizing emissions and the total travel time and examine the effect of varying the maximum speeds on the total emissions produced on the routes (Jabali et al., 2012, Franceschetti et al. 2012).
In real life unpredictable events, which do not follow a clean and clear distribution, occur (e.g. accidents on the route). We modeled these delay disruptions as perturbations. More specifically, a model has been developed that is capable of optimizing the relevant costs taking into account these unplanned delays (Jabali et al., 2008).

Offline or online planning?

An interesting research path is to identify how much needs to be done offline versus online. This trade-off is interesting from a computational, solution quality and usability point of view. Consider shortest path problems, as seen in navigation systems. These systems respond to traffic incidents by using online information to generate shortest paths that are less affected by these disruptions. As such, using real-time information provides improved solutions for these navigation systems. However, this information does not come free since using this may lead to longer calculation times and high information retrieval costs. Therefore, we need to build adequate policies beforehand that have the potential to respond to these possible network disruptions (Sever et al., 2011). The offline versus online issue is even more interesting when looking into the combination of pickups and deliveries, and considering stochasticity.

Challenges in urban areas

The importance of rich VRPs is even greater when relating them to urban environments. The use of new equipment challenges many current planning and scheduling models. Consider the use of electric vehicles; the problem there lies in their limited range of operation. This leads to several research questions related to the impact on the urban routing and scheduling of these vehicles and how and where to charge/decouple vehicles, driver scheduling, number of charging places, etc.
Note that a major source of urban transport demand arises from the large number of retailers. Clearly, evolution has led to lower stock levels in retail outlets. Specifically, the interplay between stock and handling processes versus use of

(shelf) space prompts stock ordering and demand for transport. This generates inventory-routing models, which are characterized by the simultaneous relevance of routing and stock issues. The literature on this does not cover stochasticity or time-dependency, which is the basis for our future research.

Theme 2: Transit Chains

Consolidation improves the performance of the Pickup and Delivery Chain but is also needed to achieve a high efficiency in the Transit Chain. Consolidated freight (collected and reorganized at the PDP) is moved over a long distance. Standardized units are used (containers as well as industry-specific equipment, like caged roll containers in the horticultural sector or Unit Load Devices (ULDs) in aircrafts). An increasing share of global transport is containerized, primarily to reduce handling costs and to increase accessibility in the use of multiple modes of transportation. The flexibility needed to be independent of a specific mode of transport substantially increases the coordination and planning issues along the Transit Chain (Fransoo and Lee, 2011). Additionally, the use of standardized containers leads to imbalances in the supply-and-demand network for empty containers. A good allocation of empty containers in the network decreases repositioning costs to satisfy future movements. A review dealing with repositioning of empty containers can be found in Francesco et al. (2009). Our future research involves the management of the Transit Chain and the planning and scheduling of different transportation modes in the Transit Chains.

Managing the Transit Chain

Container-based transportation has grown rapidly in recent decades, driven by a general expansion in intercontinental transport. Relatively little research has been done in the strategic design and operations of hinterland networks (Christiansen et al., 2007). A hinterland network starts from the moment the containers arrive in the port (deep-sea vessel) up to the point of delivery at the customer location. A substantial level of variability characterizes hinterland networks. As a consequence, this hinterland chain is characterized by an extensive use of short-term planning and re-planning of transportation, leading to a significant underutilization of their transportation modes, as this requires more advanced information and greater control of the actual transit times. This variability is also detrimental to the balance of demand for empty and full containers.

Similar issues in hinterland networks occur in other environments as well. The Dinalog project DaVinc³i focuses on the future horticultural supply chain where an increasing shift into virtualization of the flower and plant trade is prompting important changes in the organization of its Transportation Chains. Trade locations (based on the auction clocks) are decoupled from the logistical hubs in the network. This leads to a different Transportation Chain and completely different Transit Chains. Other important factors to consider in the logistical planning include the role of variability, the management of full and empty equipment, the vase lives of the products, etc.

Multi-modality or co-modality or inter-modality or synchro-modality or...?

Efficient use of different transportation modes in the Transit Chain, enabled by the use of standardized containers, presents a challenge. Over the years, different ascriptions have been used for multiple transportation modes in the Transit Chain: multi-modal, co-modal, inter-modal and, more recently, synchro-modal. Good definitions help to understand these, at first sight, different names:

- The United Nations Convention on International Multi-modal Transport of Goods (1980) defines **multi-modal** transport as "*the carriage of goods by at least two different modes of transport*".
- **Inter-modal** transportation is defined as "*the movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes*" (United Nations Economic Commission for Europe, 2001)
- For the European Commission, **co-modal** refers to the "*use of different modes on their own and in combination*" in the aim to obtain "*an optimal and sustainable utilization of resources*" (Commission of the European Communities, 2006).
- **Synchro-modal** involves a "*structured, efficient and synchronic combination of two or more transportation modes*" (Topteam Logistiek, 2011).

It is striking to see the common aspects in all definitions: the use of more than one transportation mode. Of course, the devil is in the details and some definitions put more emphasis on certain aspects of the transportation process. Synchro-modal emphasizes the (real-time) flexibility aspect, inter-modal focuses on the same loading unit, and co-modal adds resource utilization. Note, however, that the basic definition of multi-modal transport does not exclude any of the other definitions. In my view, the definition of multi-modal transportation is still valid and should be used rather than developing new definitions.

Similar to the discussion in Theme 1, there is a discussion as to what extent multi-modal planning is done offline or online. It is important to mention that many goods are delivered following a very fast service pattern despite, in many cases, the absence of the necessity to do so. This opens up the prospect for adequate offline multi-modal planning of the transport movements in the Transit Chain. Shipment sizes (after consolidation) should be such that all resources in the Transit Chain are used as efficiently as possible while maintaining a requested service level. An online adaptation related to real-time problems (as in synchro-modality) of these offline-prepared plans seems very difficult in the Transit Chain due to the very limited degrees of freedom to switch modes in practice. This depends largely on the underlying Transit Chain and the number of available transportation modes between the different nodes. This is still an unfinished discussion where academia needs to help in defining properly the important issues.

Future challenges for academia, private companies and governments are to use the existing infrastructure and resources more efficiently by developing sophisticated multi-modal Transit Chains through better information availability and exchange, and better planning and scheduling. Finally, note that efficient multi-modal transportation needs to be matched with public policies to enable effective multi-modal implementations.

Theme 3: Approaches to Transportation Chain integration

The first two themes dealt with coordination and consolidation issues in distinct parts of the Transportation Chain. This third theme discusses two Transportation Chain integration approaches: one-stop drops and combined people-and-freight transport.

One-stop drop

The first integration approach focuses on the final destination point. The key role of logistics is to enable demand fulfillment at the final Transportation Chain destination. Multiple suppliers lead to uncoordinated multiple shipments to the same destination. Consolidating these shipments into a store-ready box once they are available for transport at their origin leads to significant gains. Similar to one-stop shopping, I refer to this approach as *one-stop drops*. Multi-supplier shipments are delivered to shops in a one-stop drop (as opposed to many different deliveries). Suppliers gain from lower logistics costs, stores benefit from fewer deliveries and the environment profits from a reduction of emissions. This is the starting point for the Dinalog 4C4D research project.

The Dinalog demonstration project, 'Bundling at the origin', aims to do this consolidation in China for fashion products. In this project, multiple suppliers of fashion retail products collaborate horizontally to bundle volumes in Asia and prepare shipments of multiple suppliers but sorted for individual stores. The combined freight budget is over one billion euros for the companies involved. Currently, these large freight flows are very fragmented so there is significant potential to substantially improve these flows. In the case of this demonstration project, consolidation is done at a Chinese distribution center in the port of departure. However, this could also be done in European ports where containers from different suppliers arrive. Specifically, smaller seaports, like the Zeeland Seaports, have the space and the potential needed to act as these store-based consolidation centers, leading to one-stop drops. Following Mangan et al. (2008), offering these port-centric logistics is an opportunity for ports to move from a passive role in the supply chain to a more active role. Open research questions relate to the development of algorithms for effective and efficient consolidation planning and fair gain-sharing mechanisms.

Combined people-and-freight transport

The second approach to enable smarter and greener transport looks into new combinations of people-and-freight transport. In practice, some well-known examples already exist: passenger aircrafts also carry freight and the Norwegian Hurtigruten line takes mail, cargo and passengers. The objective is to design integrated people-and-freight, multi-modal transportation networks and related planning and scheduling policies to enable efficient and reliable delivery of each parcel, retail delivery, etc. The key reasoning is that the right combination of modes is selected for every package sent. Depending upon the origin, destination, timings of pickup and delivery, etc., it might be better to use pure freight operations or a combination of people-and-freight transport or a pure people transportation mode. Additionally, the combination of different modes of transportation can be considered. As such, this extends the concept of multi-modality to also considering people transport as an option.

The potential value for high-density urban areas is clear, but there is also potential for low-density areas with population shrinkage. In these areas offering high quality public transport services results in high costs and low utilization. Delivery routes to individual consumers or stores usually consist of a few stops and longer travel distances. Integration of both networks will result in significant cost savings, higher delivery reliability, possibility to offer public transport to residents and environmental benefits.

A number of people-and-freight combinations are considered. Taxis could be used to pick up or deliver small parcels. They could also be integrated in a hub-and-spoke variant of a distribution network, like an empty taxi that goes back to the airport to pick up new passenger. Instead, this taxi could take some parcels to be delivered to the airport hub of a logistics service provider. Alternatively, research could reveal the willingness of passengers to allow for a small detour to pick up parcels. In many cities, buses travel in an intricate urban network and their start-and-end stations are usually in the middle of the city. These buses could be used to deliver small to medium volume to urban retail outlets. Additionally, the bus schedules would need to be adapted to accommodate the freight flows. Another example is the use of trains to replenish the railway station based stores and restaurants. Trains stop very close to these retail outlets so they could deliver the stocks and other products. This is important since railway stations tend to be located in time- and vehicle-restricted urban areas.

These examples show the opportunities that lie in the combination of freight and people transport. The main challenge is clock speed, the required speed in the Transportation Chain. Clearly, the clock speed in the airline industry and in ferry liners is relatively low compared to taxis, buses and trains. Nowadays, given new technology and real-time availability of information, we can think ahead to new and challenging solutions and make a major leap forward.

People and Smart Logistics

I also want to spend some time on the role of people in Smart Logistics. People have important tacit knowledge of the logistical processes, which cannot be underestimated. In a paper on retail operations, we showed that considering this knowledge in the planning tools effectively improves performance (Van Donselaar et al., 2010). Taking this knowledge into account in the planning and scheduling tools is challenging but worthwhile. Along the same lines, people should be visually presented with the right information in order to make decisions. For this, we joined forces with Jack van Wijk and Mark de Berg from the Mathematics and Computer Science department.

One of my main academic activities is teaching. Students need to be properly trained to understand the different problems as discussed in Smart Logistics. Figure 4 shows the problem-solving cycle as presented in Mitroff et al. (1974).

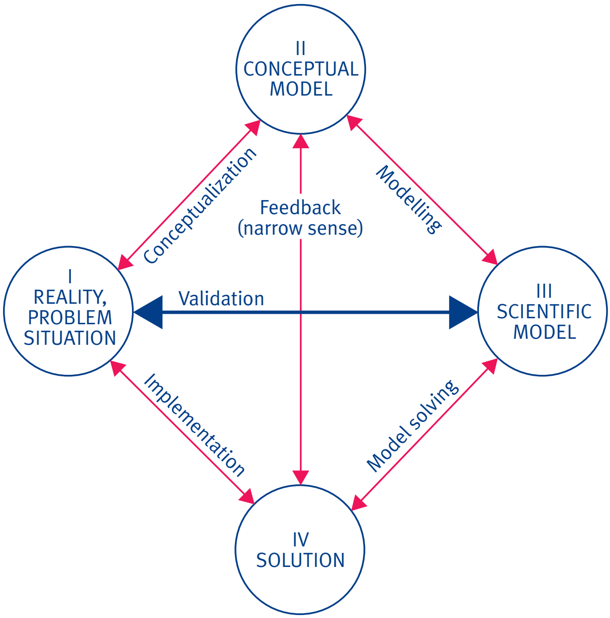


Figure 4

Problem-solving cycle according to Mitroff et al. (1974)

Although Mitroff et al. argue that the cycle can start anywhere in the graph, I believe that it should start at the node ‘reality/problem situation’. A proper understanding of reality leads to success in the problem-solving cycle. Many courses we offer in our programs start from this observation. Specifically, I want to mention the elective MSc courses Retail Operations and Strategic Decision-making, and Operational Optimization in Transportation and Logistics. Both courses start from an understanding of the real-life system, then develop conceptual models, via the scientific (mathematical) models and, finally, deal with efficient model-solution techniques. Scientific models completely disconnected from reality are meaningless for this reality. This is also one of the reasons why we want people working in the Operations, Planning, Accounting and Control group (OPAC) to have good industrial knowledge for the problems we are working on.

Logistics professionals face similar issues. They usually have good knowledge of the reality or problem situation but are unaware, in many cases, of the conceptual and scientific models used in the tools and software they employ in practice. This is key to a proper understanding of the proposed solutions originating from these tools. This is even harder in a changing logistics world. Societies, like the European Supply Chain Forum (eSCF) and the Vereniging Logistiek Management (VLM), have an important responsibility here. The VLM’s objective is to promote the professional development of (future) logisticians by providing a large network and exchanging knowledge and experience.

Epilogue

My colleague Peter de Langen started his inaugural lecture with the slogan: ‘The Netherlands is Logistics’. This slogan, developed by a coalition of logistics organizations, is aimed at increasing awareness of the importance of logistics. However, ‘Logistics’ only is not ambitious enough and no longer appropriate to the current needs. Consequently, I think we should revise this slogan to:

‘The Netherlands is Smart Logistics’

Our university contributes directly to Smart Logistics in the Netherlands and in Europe. The research presented in these three themes is directly connected to the TU/e Strategic Area Smart Mobility. In Smart Mobility, more than 200 TU/e researchers from various disciplines work on clean, efficient and smart vehicle technology, logistics systems and traffic systems with the aim of minimizing emissions, traffic jams and accidents. Within the Netherlands, my research is directly tied to Dinalog and the Logistics top team as witnessed by the different Dinalog projects in our OPAC group. Over the years, our research agenda has become increasingly aligned to the EU framework program agenda. More work still needs to be done there, both in acquiring research funding and in setting the EU logistics research agenda. My colleagues Ton de Kok and Jan Fransoo have spent numerous hours on setting the logistics research agenda and I am happy to see that the Netherlands is moving faster and faster. My research agenda is fully compatible with their efforts.

Acknowledgements

At the end of this inaugural lecture it is appropriate to thank the many people who made my appointment to full professor possible. First of all, I would like to thank the Executive Board of the university and the Board of the Industrial Engineering & Innovation Sciences department for having appointed me as full professor of Freight Transport & Logistics.

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Curriculum Vitae

Prof. Tom Van Woensel was appointed fulltime professor of Freight Transport & Logistics in the Department of Industrial Engineering and Innovation Sciences at Eindhoven University of Technology (TU/e) on July 1, 2011.

Tom Van Woensel holds a BSc, MSc and PhD in Applied Economics (Operations Management) from the University of Antwerp (Belgium). In 2003, he moved to Eindhoven University of Technology specializing in freight transport, logistics and retail operations. He participates in several national (Dinalog) and international research and development projects and supervises many MSc and PhD students in this challenging research area. Tom Van Woensel published over 40 papers in academic journals (including Management Science, Production and Operations Management, Computers and Operations Research, Transportation Research, etc.). He is board member of the European Supply Chain Forum, a collaborative effort involving about 30 large multinational companies.

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