INNOVATION PROCESSES IN SURFACE TRANSPORT

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1. Background Material and Forms to Assist Analysis

1.1. Aide Memoire for Key Players: (LCA Europe)

- The organisation and position of the person being interviewed
- How is the innovation classified, e.g. technological, organisational, etc. And how much re-organisation was involved (*ask to score out of 10*)
- When was the innovation started and where and what are the positive and negative impacts of the innovation *(ask for scores out of 10*)
- The precise role of the person in relation to the innovation
- The impact on the spread of the innovation claimed by the person
- The formal reporting links of the person within the organisation they are working for
- The informal relationships of the person with other key actors in the innovation process
- The positive experiences of the person interviewed in relation to moving forward the innovation process, e.g. support from senior management
- The difficulties experienced by the person in performing the role ascribed by the person in relation to the innovation process, e.g. barriers (*ask to score the difficulty of the barriers out of 10*)
- How the role may be redefined and/or supported to enhance the innovation process

1.2. Example of coding qualitative data

Coding links different segments or instances in the data. We bring those fragments of data together to create categories of data that we define as having some common property or element. We define them as being about or relating to some particular topic or theme. The coding thus links all those data fragments to a particular idea or concept. The important analytical work lies in establishing and thinking about such linkages, not in the mundane processes of coding. The importance of the work lies in how we use coding and concepts, not in whether we use computer software to record them or rely on manual ways of marking and manipulating the data. As Seidel and Kelle 1995 note; “Codes represent the decisive link between the original raw data, that is, the textual material such as interview transcripts or fieldnotes, on the one hand and researcher’s theoretical concepts on the other”.

The following interview focuses on the question of what makes a good doctorate. Set out below is the interview extract, to which we have attached a number of coding categories.

INNOSUTRA step: Transcribing the interview and Sort received information on relevance

> Odette Parry: What do you think makes a good PhD?
> Dr. Fitton: I think PhDs should show a substantial contribution to research, but I don’t think that necessarily means innovation for innovation’s sake. I personally would want to favour a PhD which showed a very sound knowledge of theoretical positions, an ability to sort out those positions and put forward something in a logical coherent structured fashion. I’d favour someone who was able to do that over who has studied something that no one had thought of studying before, and you’re encouraging something that is peripheral, marginal, not necessarily of significance. So I think that what I would look for is a very acquaintance with theoretical work, an ability to sort it out and take it further- have a sufficient substantial commentary on that work, combined in the case of anthropology with fieldwork, and showing that the fieldwork had been done in a way which show empathy with the people you’d studied, and that the fieldwork and the theoretical part had been merged together.

Quite a tall order. I'd look for a "feel" about the work, I wouldn't have a list of guiding points, because I don't think you can do that- they are too different. It has been said that the strength of anthropology is its eclecticism, it relies on qualitative analysis rather than quantitative.

Odette Parry: This is really a general question. Why do you think people do anthropology PhDs?
Dr. Fitton: In some cases it's the obvious reason that doing a PhD will hopefully lead to the first rung of the academic track. My own motivation was not that clear. I was surprised when I did get a job at the end of it, but to further an interest I wanted to take as far as I could.I expect most people doing a PhD are doing it to further an interest they have. There seems to be a trend towards PhDs written to do with development, so you could say that a concern for other societies is another factor. So it's not just a selfish endeavour. I can think of one student I've had, the interest in doing a Phd wasn't there, there was an external push, she was expected to get high qualifications. And because her heart wasn't in it, she didn't have the necessary enthusiasm and drive for it.

INNOSUTRA step: Split information into fragments

Subject: Good PhD
Odette Parry: What do you think makes a good PhD?

Question 1, Fragment 1
Dr. Fitton: I think PhDs should show a substantial contribution to research, but I don't think that necessarily means innovation for innovation's sake.

Question 1, Fragment 2
I personally would want to favour a PhD which showed a very sound knowledge of theoretical positions, an ability to sort out those positions and put forward something in a logical coherent structured fashion. I'd favour someone who was able to do that over who has studied something that no one had thought of studying before, and you're encouraging something that is peripheral, marginal, not necessarily of significance. So I think that what I would look for is a very acquaintance with theoretical work, an ability to sort it out and take it further- have a sufficient substantial commentary on that work, combined in the case of anthropology with fieldwork, and showing that the fieldwork had been done in a way which show empathy with the people you'd studied, and that the fieldwork and the theoretical part had been merged together.

Question 1, Fragment 3
Quite a tall order. I'd look for a "feel" about the work, I wouldn't have a list of guiding points, because I don't think you can do that- they are too different. It has been said that the strength of anthropology is its eclecticism, it relies on qualitative analysis rather than quantitative.
Subject: indeterminate knowledge, eclecticism, qualitative methods.

Subject: Why PhD
Odette Parry: This is really a general question. Why do you think people do anthropology PhDs?

Question 2, Fragment 1
Dr. Fitton: In some cases it's the obvious reason that doing a PhD will hopefully lead to the first rung of the academic track. My own motivation was not that clear. I was surprised when I did get a job at the end of it, but to further an interest I wanted to take as far as I could. I expect most people doing a PhD are doing it to further an interest they have. There seems

to be a trend towards PhDs written to do with development, so you could say that a concern for other societies is another factor. So it's not just a selfish endeavour. I can think of one student I've had, the interest in doing a Phd wasn't there, there was an external push, she was expected to get high qualifications. And because her heart wasn't in it, she didn't have the necessary enthusiasm and drive for it.

INNOSUTRA step: Labeling and ordering and reduction of labels

Odette Parry: What do you think makes a good PhD?

Question 1, Fragment 1
Dr. Fitton: I think PhDs should show a substantial contribution to research, but I don't think that necessarily means innovation for innovation's sake.
Subject: Good PhD
Core label: Contribution
Labels: Originality

Question 1, Fragment 2
I personally would want to favour a PhD which showed a very sound knowledge of theoretical positions, an ability to sort out those positions and put forward something in a logical coherent structured fashion. I'd favour someone who was able to do that over who has studied something that no one had thought of studying before, and you're encouraging something that is peripheral, marginal, not necessarily of significance. So I think that what I would look for is a very acquaintance with theoretical work, an ability to sort it out and take it further- have a sufficient substantial commentary on that work, combined in the case of anthropology with fieldwork, and showing that the fieldwork had been done in a way which show empathy with the people you'd studied, and that the fieldwork and the theoretical part had been merged together.
Subject: Good PhD
Core label: Ability
Labels: Theory, logic, originality, fieldwork

Question 1, Fragment 3
Quite a tall order. I'd look for a "feel" about the work, I wouldn't have a list of guiding points, because I don't think you can do that- they are too different. It has been said that the strength of anthropology is its eclecticism, it relies on qualitative analysis rather than quantitative.
Subject: indeterminate knowledge, eclecticism, qualitative methods.
Subject: Good PhD
Core label: -
Labels: Indeterminate knowledge, eclecticism, qualitative methods

Odette Parry: This is really a general question. Why do you think people do anthropology PhDs?

Question 2, Fragment 1
Dr. Fitton: In some cases it's the obvious reason that doing a PhD will hopefully lead to the first rung of the academic track. My own motivation was not that clear. I was surprised when I did get a job at the end of it, but to further an interest I wanted to take as far as I could. I expect most people doing a PhD are doing it to further an interest they have. There seems to be a trend towards PhDs written to do with development, so you could say that a concern for other societies is another factor. So it's not just a selfish endeavour. I can think of one student I've had, the interest in doing a Phd wasn't there, there was an external push, she was expected to get high qualifications.
Subject: Why PhD
Core label: Motive

Label: motivation academic career, intrinsic interest, altruism, qualification

And because her heart wasn't in it, she didn't have the necessary enthusiasm and drive for it.

Subject: Why PhD
Core label: enthusiasm
Label: -

At the simplest level, the data can be reduced to two possible generic categories: "a good PhD" and "why people do a PhD". These reflect directly the questions that Odette Parry asked and reflect two of the substantive problems that the research team brought to the data-collection exercise. We could proceed a little further in the same vein. That is, as we have indicated, the first half of the interview extract definitely describes a number of abilities or attributes linked to the production of a good PhD. Coded as "ability".

1.3. Data collection template

Data collection template																	
Time Aspects																	
Managerial																	
Organizational																	
Economic and Financial																	
Market																	
Governmental																	
Cultural																	

1.4. Process description template

Process description template			Areas of attention based on previous research like MIRP in the initiation period are: the gestation period, shocks and triggers that initiated the development of an innovation, and the development of plans and budgets.	Areas of attention based on previous research like MIRP in the development period are; proliferation, setbacks, shifting performance criteria, fluid participation of personnel, top management involvement and roles, altering relationships and cooperation between innovation entrepreneurs.					Areas of attention based on previous researc like MIRP in the implementation process are linking the new with the old and early termination of the innovation.		
		Process	**Inititiation period**	**Development period**					**Implementation period**		
Key aspects	*Aspects to be considered*	*Sub process*	*Generate ideas*	*Evaluation of ideas*	*Design of innovation*	*Development of prototype*	*Evaluation of prototype*	*Redesign and production*	*Dissemination*	*Adoption*	*Implementatio*
Managerial	*Decision making barriers*										
	Intervention										
	Technical barriers										
	Support										
Organizational	*Actors involved*										
	Cooperation between innovation entrepreneurs										
	Human resource										
	Personnel involved in the innovation process										
	Lack of knowledge/training of personnel										
	Planning										
	Experts support										
	Lobbying										
Economic and Financial	*Private investment*										
	Public investment										
	Cost benefit analysis										
	Investment appraisal										
	Financial and commercial barriers										
Market	*Potential market*										
	Dissemination of the innovation										
	Rate of spread										
	Reached market										
	Support										
Governmental	*Subsidy*										
	Regulatory and legal barriers										
	Intervention										
Cultural	*Cultural and societal barriers*										
	Communication problems										
	Environmental										
	Sustainability										

1.5. Policy intervention

Type of policy analysis	Key points or not (ranked 1 – 5	Level of government involved (and public/privat e partnership ?)	Influence during the initiation period	Influence during the development period	Influence during the implementation/terminatio n period
Standardisation					
Stimulation of R&D					
Knowledge management					
Infrastructure development					
Regulation and planning					
Legislation					
Pilots and demonstrations					
Networking					
Financial resources and incentives					
Niche management					
National security/strategie s issues					
Environment issues					

Source : adapted from the methodology of Zuylen and Weber (2002)

1.6. Actor and their roles

Type of actors involved	Key points or not (ranked 1 – 5	Involved in which level of government involved (and public/private partnership?)	Influence during the initiation period	Influence during the development period	Influence during the implementation/ termination period
State experts, State administration					
Monitoring agents					
R&D Agent					
Regulator					
Innovation agent					
Implementer					
Developer					
Lobby group					
Inventors					
Industrialists, VIP in Business					
Politicians					
International organization (or E.U.)					

Source: adapted from the methodology of Zuylen and Weber (2002)

1.7. Stress tests for transport innovation in an ex-ante / ex post perspective for future projects

Indicators selected	Before Innovation (existing infrastructure)	Estimated results (forecast, planning, projected data) from experts / advisors/ planning agencies Of transport innovation	Real operation, up to date data	EVALUATION of IMPACTS of a 50 % traffic reduction	EVALUATION of IMPACTS of a 20 % traffic reduction	EVALUATION of IMPACTS of a 50 % traffic increase	EVALUATION of IMPACTS of a 20 % traffic increase
Level of traffic				- 50 %	- 20 %	+ 50 %	+ 20 %
Level of Demand							
Level of Subsidies							
Revenues from operations							
Return on investment							
Public/Private money invested							
Security issues, injuries, accident							
Extension needed, complementary infrastructure needed,							
Neighbourhood approval							
Public debate, opinion of politicians and experts							
project exported?							

1.8. Policy intervention template

Partner short name	
Title	
Domain	Road – rail – inland navigation – maritime – intermodal – other _______
Type of innovation	in success – in failure – in debate
Nationality of case	

General national framework of policy intervention
1. Actors support *(Public Administration, parapublic institutions, private partners, etc.)* **2. Which level of government ?** *(European Commission, central, regional, local, etc.)* **3. Role of competent authority?**
Applied study of policy intervention
Summary description *(max 1 page)*
<u>**Factor roles**</u> **1. Type of factors** *Identification of factors associated to the innovation emergence (technological; administrative and legal; political and process related; socio-cultural and psychological; economic; international; environmental, etc.)* **2. Innovation barriers** *Identification of the barriers to the innovation process (Lack of awareness of available information; Regulatory and legal barriers; Technical barriers; Financial and commercial barriers; Societal barrier; Decision making barriers)*

Policy roles

Type of policy analysis	Key points or not *(ranked 1–5)*	Level of government involved (and public/private partnership ?)	Influence during the initiation period	Influence during the development period	Influence during the implementation /termination period
Standardisation					
Stimulation of R&D					
Knowledge management					
Infrastructure					

development					
Regulation and planning					
Legislation					
Pilots and demonstrations					
Networking					
Financial resources and incentives					
Niche management					
National security/strategies issues					
Environment issues					

Actor roles

Type of actors involved	Key points or not *(ranked 1–5)*	Which level of government involved (and public/private partnership?)	Influence during the initiation period	Influence during the development period	Influence during the implementation /termination period
State experts, State administration					
Monitoring agents					
R&D Agent					
Regulator					
Innovation agent					
Implementer					
Developer					
Lobby group					
Inventors					
Industrialists, VIP in Business					
Politicians					
International organization (or E.U.)					

Stress test

Indicators selected	Before (existing infrastructure)	Estimated results (forecast, planning, projected data) from experts / advisors/ planning agencies	Real operation, up to date data	EVALUATION of IMPACTS of a 50 % traffic reduction	EVALUATION of IMPACTS of a 20 % traffic reduction	EVALUATION of IMPACTS of a 50 % traffic increase	EVALUATION of IMPACTS of a 20 % traffic increase
Level of traffic				- 50 %	- 20 %	+ 50 %	+ 20 %
Level of Demand							
Level of Subsidies							
Revenues from operations							
Return on investment							
Public/Private money invested							
Security issues, injuries, accident							
Extension needed, complementary infrastructure needed,							
Neighbourhood approval							
Public debate, opinion of politicians and experts							
project exported?							

Comments: *Innovation objectives achieved or not? At the end, who are the winners and the losers? Can we see underground strategies of some actors after long time of innovation?*

1.9. Factors contributing to the transport innovation

Category of factor	Sub-category	Initiation (ranked 1-5)	Development/ Spread (1-5)	Implementation (1-5)
Technological	knowledge and expertise available			
	availability of technologies			
	compliance with standards			
Administrative and legal	legislative guidelines			
	Adm partners available			
	(lack of) clarity about division of responsibilities			
Political and process-related	support, relay in local, regional assemblies			
	the role of interests groups			
	cross boundaries effects			
Socio-cultural and psychological	incentives, motivation, spirit of entrepreneurship			
	involvement in the project on the part of the stakeholders			
	link universities/research/innovation			
Economic and financial	net benefits for actors			
	revenues for actors			
	availability of subsidies			

Source: adapted from Banister (2004), and Van den Bergh et al. (2007)

1.10. Barrier table

Category of barrier	Sub-category	Initiation (ranked 1-5)	Development/Spread (1-5)	Implementation (1-5)
Available information (knowledge)	Lack of information on information			
	Lack of information on markets			
	Lack of qualified personnel			
Technical	Lack of interoperability			
	Lack of lack of standardisation and certification			
	Difficult adaptation to a new technology			
Legal and regulatory	Legislation, regulations, taxation			
	Administrative barriers			
	Weakness of property rights			
Financial and economic	High costs (too high costs)			
	Lack of funds within the enterprise and subsidies from			

	outside			
	Lack of competition in the market			
Cultural and societal	Scarce acceptability			
	Scarce attitude of personnel towards change			
	Inability to devote staff to innovation activity			
Decision making	Lack of cooperation among partners (public, private,…)			
	Fragmentation of decision levels			
	Lack of Vision and Policy Growth			

Source: adapted from Comtesse et al. 2002, and OECD 2005

2. Selected Success Cases

This chapter shows the detailed analyses of a selected set of road, rail, inland navigation, maritime and intermodal cases.

2.1. Road

Case title	**EU International road transport market liberalization: cabotage**
Domain	road ☒, rail ☐, inland navigation ☐, maritime ☐, intermodal ☐, other_______
	success ☒ failure ☐ Why do you consider it a success/failure? A successful gradual implementation of the cabotage legislation was done.
Type of innovation	technological ☐ managerial/organizational ☐ logistical ☐ cultural (*including marketing*) ☐ policy initiative ☒
Degree of development according to product life cycle classification	development ☐, introduction ☐, growth ☒, maturity ☐, saturation/decline ☐

This innovation falls into the policy innovation category. Therefore the framework for identification of key actors according to the stages of the innovation (WP3 and 4 Workplan, section 4.1.3) is not applied here. A simple identification of key actors is performed according to section 4.1.4 of the same document.

The key players identified are:
European Parliament
The Council of the European Union
European Commission
European Economic and Social Committee
Committee of the Regions
Court of Justice of the European Union
EU Member Sates
IRU, other professionals organizations and lobbies

Introduction
The EU transport road transport cabotage market liberalization case is analysed in the INNOSUTRA project. It is in the domain of road transportation and in the preliminary innovation report of the INNOSUTRA project as a success case for policy innovation.

Background and development
The history of the cabotage of road transport in the EU dates back to the Treaty of Rome of 1957, when it was specifically mentioned in the Article 75.1 (b).

It has taken several decades until cabotage was first introduced on 1 July 1990 under Council Regulations (EEC) Nr. 4059/89. This system was introduced under a quantitative restriction (quota) system on cabotage transport through a system of granting authorisations. The authorisations where issued in limited quantities and each authorisation allowed the haulier to perform an unlimited number of cabotage trips within a time period of two or one months. The authorisation could be transferred between different vehicles of the same haulier.

Already in 1992, the intra-Benelux cabotage was liberalized completely. But the cabotage regime was extended to the EFTA countries on 1 July 1994 with the exception of Austria, which joined on 1 January 1997, and Switzerland.

A Commission report on the application of the cabotage quota scheme (COM/98/0047) showed that, although the number of quotas increased yearly, these quotas were largely underused and had not attracted ‘unscrupulous’ operators into specific national markets.

In accordance with article 12 of Council Regulation No 3118/93 of 25 October 1993, most cabotage restrictions have been lifted since 1 July 1998 in the 15 Member States of the European Union. From that date onwards Regulation No 3118/93 on freight transport cabotage stipulates that any non-resident carrier who is holder of the Community authorisation is entitled to operate, *on a temporary basis* and without quantitative restrictions, national road haulage in another Member State without having a registered office or other establishment in that state.

Following their accession to the EU on 1 May 2004, restrictions have been lifted for hauliers from Cyprus, Malta and Slovenia as well. For other new EU member states, transition periods were in place with restriction periods mostly ending 1 May 2009.

The wording *on a temporary basis* in the Regulation 3118/93 turned out in the reason for discussions as in practice it was not easy to demonstrate exactly when an activity ceases to be temporary and becomes permanent.

As a result of pressure from local hauliers, a number of the EU member states (Greece, UK, Italy and France) implemented restrictive measures to counter the cabotage liberalization. This was done in anticipation of adoption of the new cabotage legislation.

On 14 May 2010, Regulation 1072/2009 comes into force. Article 8 of the Regulation limits the overall duration of cabotage to seven days and sets the maximum number of allowed cabotage operations to three. Before cabotage can start, the haulier must have entered the host Member State with a laden vehicle.

Current Situation

Currently Regulation 1072/2009 is in force which limits the overall duration of the cabotage. It came into force 14 May 2010. Article 8 of the Regulation limits the overall duration of cabotage to seven days and sets the maximum number of allowed cabotage operations to three. Before cabotage can start, the haulier must have entered the host Member State with a laden vehicle. This solves the interpretation problems that were in the Regulation 3118/93.

Currently a slight de-liberalization of cabotage has occurred. The new Regulation 1972/2009 has decreased the multilateral access to the cabotage market of the member states. This can lead to the same negative consequences that the regulation was initially set out to prevent. For example the increase in the quantity of the empty runs and the decrease of the competition levels in the road transport market could follow.

However, the European Parliament contrary to the position taken by the Commission and the Council has voted for lifting of all limits on cabotage by 2014.

Analysis

Initiation period

For this case the stimulus for the liberalization was the Treaty of Rome which allows supply of transport services by non-resident hauliers. This has lead to gradual liberalization of cabotage. Without this stimulus the liberalization of road transport cabotage market could not have happened.

In this case the background has possibly played a role. The ECMT (currently ITF) has been a supporter of construction of European road transport market since the 70s. Outside the EU the introduction of the ECMT permit system in 1973 was amongst the first steps towards liberalization of international road transport market. It must be noted that EU member states are also members of the ECMT. In practice the introduction of this system for the non-EU member countries has lead to creation of a free access to international road transport market under the quota system. This has not lead to liberalization of cabotage.

The introduction of the liberalization of road cabotage transport took much longer than expected. The initial plan was to introduce liberalization of cabotage by December 1969. It was initially supported by the European Commission, but after Council blocked the implementation, the process halted.

It was not until the intervention from the Court of Justice of the European Union (Court of Justice ruling 22 May 1985) that the Council started acting and came with the legislation initiative that would permit cabotage.

In the initiation phase of this we see that stimulus is important for initiation of the innovation process. However an important decision maker has the ability to halt the process or postpone it for substantial periods of time. Like in this case the Council has managed to postpone or slow down the initiation phase of the policy initiative.

Before adoption of 1993 regulation there was extensive debate between the supporters of "consecutive cabotage" and supporters of "general cabotage". The compromise was to not make the cabotage subject to prior international transport operation: adopting the general cabotage definition. However the compromise reached here would later in the implementation period of this policy innovation case prove to be an implementation barrier.

In general the initiation phases of the EU legislative process involve a number of stakeholders, mostly on official grounds, to participate according to the legislative procedure of the EU.

Development period

The implementation of the liberalized cabotage system was preceded by a limited quota system. The quota system was a transition stage that served for both, adjusting the practical operation practices in the companies that would be willing to perform cabotage operations, but most importantly to show that the threat that the hauliers from the other member states represent is minimal. The initial introduction of quota system was a smart move, as it allowed influencing the opinion of the market players.

As the initial quota system was a success and showed no loss of market for the local companies, some countries were willing to proceed with even more liberalisation. Intra-Benelux cabotage was liberalized within 2 years form the introduction of the cabotage. With the fears of the industry gone and the Commission reporting that cabotage quotas were largely underused, the quota system could be abolished, as there was no more opposition.

The gradual development of the cabotage system within several years seems to be the main reason for the success of this policy innovation. With the unclear results of this policy a kind of test within the limits of the quota system was needed. The quota system gave the security and a sense security and control of the process to the stakeholders.

After the accession of the new EU member states from Eastern Europe, the situation had changed. The fears of loosing the market share in the domestic markets to the hauliers from the East rose in the EU15. To protect the internal markets again the Western countries used their political power to start the process of changing the rules of the game again and introduce cabotage limitations.

However, the legislative process in the EU is relatively slow. In anticipation of the adoption of the cabotage legislation some member states unilaterally introduced the rules similar to those of the new regulation (concerning limitation of three trips in seven days) in their legislations before the EU-wide introduction. This shows the influence the hauliers in the Western EU countries have at the local level.

There was pressure from the industry organizations to restrict the liberalization of cabotage. Some member states' positions were strongly influenced (ex. France) by industry organizations in their official positions.

If we look at the development period of the cabotage system, there have been several barriers, but the main were the unwillingness of the EU member states (the Council) to start the legislation process and the failure of the legislators to agree on clear definitions in the text of the regulation.

The stimulus for this policy innovation has been weak resulting in the long time for the legislation to be produced and adopted.

Implementation period

Pressure from the industry organizations at the implementation level has affected the way cabotage was liberalised. Transition periods and a limitation of the number of trips are examples of the results of such lobbying.

During the implementation period of the regulation, some countries took active countermeasures. For example, Greece, UK, Italy and France implemented restrictive measures on cabotage. This happened in attempts to protect internal market.

Different interpretations of the regulation in different countries were a barrier for the implementation and enforcement. It was due to lack of clear definition of cabotage. As a result, new legislation had to follow. The failure to give clear definition in this case was a barrier for successful implementation of this policy innovation.

The choice of gradual implementation ensured the success of cabotage liberalization.

Conclusions

We conclude that in this initiation period of this EU level policy innovation a combination of the will to initiate from the Commission's side and the support of the EU member states is crucial. The unwillingness of one of these stakeholders is a barrier high enough to stop or substantially postpone the policy innovation.

The influence of the member states wishing to keep the cabotage markets closed in the initial stages has been the highest barrier for this innovation case. Even when the cabotage regulation was in force some member states that did not agree with the regulation were enforcing their own restrictions on cabotage to protect their local market.

We also see that gradual, well-timed implementation of the cabotage regulation has been the factor that ensured the success of this case.

While analysing this case we observed a de-liberalization trend of the cabotage market with the adoption of the new Regulation 1972/2009. This shows the reversible character of the policy innovations with the possible negative effects, in this case the decrease of the cabotage market.

Appendix

Policy intervention

Type of policy analysis	Key points or not (ranked 1 – 5	Level of government involved (and public/private partnership ?)	Influence during the initiation period	Influence during the development period	Influence during the implementation/termination period
Standardisation					
Stimulation of R&D					
Knowledge management					
Infrastructure development					
Regulation and planning		5	5	5	5
Legislation		5	5	5	5
Pilots and demonstrations					
Networking					
Financial resources and incentives					
Niche management					
National security/strategies issues					
Environment issues		3			

Source : adapted from the methodology of Zuylen and Weber (2002)

Actor and their roles

Type of actors involved	Key points or not (ranked 1 – 5	Involved in which level of government involved (and public/private partnership?)	Influence during the initiation period	Influence during the development period	Influence during the implementation/ termination period
State experts, State administration		5	5	5	5
Monitoring agents		2			2
R&D Agent					
Regulator					5
Innovation agent		5	5	5	5
Implementer			1	3	5
Developer		5	5	5	3
Lobby group			5	3	3
Inventors					
Industrialists, VIP in Business					
Politicians		5	5	5	5
International organization (or E.U.)		5	5	5	5

Source: adapted from the methodology of Zuylen and Weber (2002)

Factors contributing to the transport innovation

Category of factor	Sub-category	Initiation (ranked 1-5)	Development/ Spread (1-5)	Implementation (1-5)
Technological	knowledge and expertise available			5
	availability of technologies			
	compliance with standards			4
Administrative and legal	legislative guidelines	4	3	5
	Adm partners available	5	4	5
	(lack of) clarity about division of responsibilities			
Political and process-related	support, relay in local, regional assemblies	1	2	5
	the role of interests groups	5	5	5
	cross boundaries effects	5	5	5
Socio-cultural and psychological	incentives, motivation, spirit of entrepreneurship	1	1	3
	involvement in the project on the part of the stakeholders	3	5	3
	link universities/research/innovation	1	4	3
Economic and financial	net benefits for actors	1	4	4
	revenues for actors	1	2	4
	availability of subsidies			

Source: adapted from Banister (2004), and Van den Bergh et al. (2007)

2.2. Rail

Modalohr

Introduction

These last decades, the growth in freight transport has mainly benefited to the road compared to the technical and operational rigidity of the railway. Starting from this fact, R. Lohr defines, at the beginning of 90s, an innovative concept in terms of rail freight transport: "we must adapt the rail to the road". Consequently, the first intention of R. Lohr is to develop a rail system which could to be inserted in the transport chain of road hauliers. Systems already exist. Switzerland develops "rolling road" and France promotes the combined transport since the 80s. But they present technical constraints and negative economic balances. According to P. Mangeard[1], "If the modal transfer does not work, it's because the road hauliers must adapt their material to the rail". The second intention of R. Lohr is therefore to provide a technical solution at these defaults.

In a first time, R. Lohr designs a new wagon in the piggyback domain. On this technical basis, he develops an innovating system on the operational plan: the rail motorways. Consequently, Modalohr[2] regroups two realities: a technical innovation and an operational innovation.

Technologically, the Modalohr wagon presents the particularity to be equipped of a lateral loading system in "herring-bone" (the platform turns between the bogies), allowing the fast and simultaneous operations of loading/unloading of trucks without technical constraints. The wagon floor is lowered between the bogies in order to transport almost 85% of the road park in the tunnels at GB1 gauge whereas the "rolling roads" require the GB2 gauge (less developed on the European network rail). Such wagons present therefore the problem of piggyback under a new technical and operational angle.

Operationally, the "Autostrada Ferroviaria Alpina[3]" (AFA), implemented in 2003, is a test in full-scale of this new system. Experimental line of 175km between Aiton (France) and Orbassano (Italia) permits the transit of trucks through the Alps via the rail tunnel of Fréjus.

However, our objective is not to study the technical and operational characteristics of the Modalohr system but rather to analyze the innovation process to identify the factors of success on the base of the INNOSUTRA project.

According the methodology proposed by the WP3 and WP4, we will identify in a first time the actors and their role in the innovation process. Next, we will describe the historic of the innovation in distinguishing the major periods of its evolution (gestation, development and adoption). Lastly, we will analyze the policy intervention and the economical cost of the Modalohr system. At this time of research ([draft version nr.1], we have not enough elements to start a stress test analysis as expressed in the methodology of WP 3.4 and 4.4.

Identification of key actors and their role:

The objective of this first part is to identify the actors implicated in the innovation process and their role. We are going to see that if the system has been supported by the French political

[1] President of the Modalohr Company
[2] Do not confuse the Modalohr wagon (technical innovation) and the Modalohr Company
[3] Created in 2002 to market the new rail motorway : www.ferralpina.com

sphere and the public opinion after the disaster of Mont-Blanc tunnel in 1999[4], the actors of the transport sector reminded supporters of a wait-and-see policy.

The Modalohr system results from a convergence between an industrial, R. Lohr, at the origin of the innovation, a team composed of influent persons and the French political sphere supported by the public opinion.
The innovation is the product of the will and the imagination of one industrial, R. Lohr, president since 1963 of an Alsatian industrial group, Lohr Industry, specialized in the production of trailers for trucks and material for military transport. To develop and support his project, he constitutes a team around three key men.
Firstly, he recruits S. Lange as engineer who plays the role of technical developer and who perfects the "herring-bone" system on the wagon. Secondly, in business with R. Mangeard since the beginning to the 90s, he calls him for his qualities of business and his contacts with the political sphere. R. Mangeard accepts to sell the concept at the public authorities and sets up, in this perspective, the Modalohr Company (responsible of producing and marketing the wagon) in 2000, from which he becomes the president. Lastly, the third man called by R. Lohr is P. Essig. Experimented engineer from the National school of Bridges and Roads, ex-president of the SNCF (1985-1988) and the RATP (1992-1995), his significant influence in the rail transport sector is a key asset for the promotion of the innovation towards the transport minister of the time, J-C Gayssot, and the SNCF president, L. Gallois. With P. Mangeard, he realizes the wish of R. Lohr to "open the appetite" of the public authorities for Modalohr and also associates the SNCF (even if reluctant to the project). R. Lohr is therefore surrounded by a team able to develop the technical and operational concept and to set up the necessary links between the innovation and the public authorities to assure its development.
The first role of Modalohr has been to increase the government awareness in researching, at the time, solutions at the "all road" in the Alps. The Transport minister, J-C Gayssot, son of railway worker, adheres quickly to project for several reasons. Firstly, the pressure of public opinion on the government to find a quick solution is strong. Secondly, Modalohr is an innovating system invented by a French industrial. Lastly this solution gives a good pretext to J-C Gayssot to refuse the option "rolling road" type of Switzerland for technical reasons and by chauvinism. J-C plays therefore an essential role of leadership in the adoption of the innovation. He achieves to persuade, with the help of P. Essig, L. Gallois, president of the SNCF, to support Modalohr and buy, without invitation to tender, Modalohr wagons at the expense of the competition. He persuades also his Italian counterpart to join and announces, on October 1st 2001, the government choice for Modalohr to balance road-rail traffic in the Alps.
Reluctant during the first presentation of the Modalohr prototype in 1995, the transport sector is forced to progressively get involved to the innovation process under the pressure of French public authorities. This pressure concerns essentially the SNCF and the major national associations of road hauliers (FNTR[5], UNOSTRA[6] and TLF[7]).
Officially, the SNCF supports from 1999 the development and adoption of the Modalohr project to the request of transport minister and under the pressure of Modalohr lobbying. Unofficially, the SNCF adopts an attitude more reserved mainly for three reasons. Firstly, it rejected the project in 1995 because of its unfavorable balance of weight tare/goods. Secondly,

[4] A fire destroys the Mont-Blanc tunnel between March 24th and March 26th 1999. There are 39 victims and the tunnel is closed during three years.
[5] French National Federation of the Road Hauliers
[6] French National Association of the Union Organizations of the Automobile Transport Hauliers.
[7] Federation of the Transport and logistical Companies of France

the freight sector of the SNCF is in economical difficulties. Finally, the combined transport supporters are opposed to the project which threatens to reduce their subsidies and to challenge their system. L. Gallois, president of the SNCF, adopts therefore a strong position to deaden the critics. He introduces in 2002 the SNCF in the capital of the new company - AFA[8] - and goes to, for the first time, in a FNTR congress where he calls the members to invest in the AFA and to take shares of capital[9]; “It could be very useful that the road hauliers become shareholders of the company which will operate the rail motorway”. By this action, he launches a strong signal from rail sector to road sector and he reminds to the hauliers their duty to support the innovation and to involve themselves in the project. The issue for L. Gallois, in the involvement of hauliers, is to save the investments made by the SNCF in the AFA because without trucks, the loss of money is assured.
The position of road hauliers about the project is problematic for its promoters. Their involvement is very low and the French State doesn’t have levers as powerful as in the SNCF case, to mobilize them. This position constitutes an essential risk for the system success because without trucks, there is no traffic. Mobilization of the State, of Modalohr and the SNCF is important to persuade them to play their role of customer in putting their trucks on the wagons. M. Chaumatte, president of the AFA, insists on this point: “It is essential to do all so that the road hauliers are associated in the set-up of this project and in the management of its operating so that this service is comprehended as a road service”. However, even if the road mobilization is not here for the line inauguration, the major hauliers associations do accept to support the idea of AFA (FNTR and UNOSTRA) except for TLF which prefers a start from Lyon and is supporter of a wait-and-see position.
The mobilization of the road sector concerns also the motorway operators. They have been mobilized to involve in the adoption period of the innovation. ASF[10], AREA[11] and Sanef mobilize to reply. Sanef engages its services in the built of the Aiton Platform operated by AREA which takes part in the AFA capital.
Finally, Arkema, rare faithful customer of the AFA and number 1 of the Chemistry industry in France has played a role in the development of the AFA. Very present in Rhône valley and exporting the major part of its products in North Italy, this subsidiary from Total group is quickly interested by the Modalohr solution. D. Tual, its director in 2003, considers Modalohr as an innovating system. His company imposes on its providers to use the AFA and he sees in Modalohr a trump to assure the transport of dangerous matters with better security conditions than the road solution. It accepts therefore the innovation and is the first to participate at the experience of “jockey” system[12]. It develops also, in partnership with the Labatut haulier, pilot trucks especially designed to transit by the AFA.

We can therefore distinguish two kinds of actors in this innovation: the **active actors** (government, Modalohr) and the **passive actors** (SNCF, Trenitalia Cargo and the main road associations) but not in opposing.

[8] We must also speak about the major role, in the implementation of the AFA, played by the SNCF freight delegation from Chambery.
[9] The AFA capital is shared between the SNCF (38,5%), Trenitalia Cargo (38,5%) and the Modalohr Company (12,25%). The highway operators, platform managers and road hauliers share the rest.
[10] Highway Company of France of South
[11] Company of the Rhone-Alps highways
[12] Handling service of loading in the platforms allowing the transport of alone trailers on the AFA, without technical constraints for the trucks.

Analysis of the Innovation process

This second part consists to identify the key steps of the innovation process: initiation period, development period and adoption of the innovation by the market[13].
The gestation period corresponds to the combined transport development and to the rise of the logistics in France and in Europe during the 80s. R. Lohr observes particularly these evolutions because of his industrial production[14]. The fall of the Berlin wall in 1989 marks a turning point for his industry. He anticipates a fall of the military logistics in East of Europe. With important self-financing capacities, he decides to diversify his industry in two new sectors: the urban transport[15] and the piggyback. Although the road transport dominates the freight at the end of 80s, R. Lohr sees in the limits of the combined transport and the rolling roads Swiss one market to take: too long loading/unloading, high in deficit cost of operating and, obligatory transport of complete trucks on the rolling road and necessary adaptations of the equipment on the combined transport. From this analysis, R. Lohr identifies the need for a wagon able to transport the trailers only and without technical restraints for the road hauliers.
R. Lohr develops therefore a new concept ("adapt the rail to the road") of wagon designed around two key ideas: idea of horizontal loading/unloading and idea to transport only the trailer and not the tractor. His objective is to allow a switch of trucks from road to rail.
The development stage is made up of two periods. The first (1995-1999) corresponds to the first developments and setbacks of the innovation. The second (1999 – 2003) corresponds to the second phase of the wagon development and its adoption in 2003 by the AFA.
R. Lohr develops the wagon within his research department with his engineers and his funds without extern help. He presents a first prototype in 1995. The SNCF considers the idea to transport trucks on trains absurd and the road hauliers are reluctant at the idea of their trucks transported by the SNCF (important strike probabilities). The first attempt of R. Lohr is therefore a fail with the actors of the transport sector. The balance is negative, there is not demand.
In 1999, the Mont-Blanc disaster relaunches the project. Firstly, it traumatizes profoundly the public opinion which forces the politics to take their responsibilities and to act quickly. Secondly, it makes know the high growth since many years of the freight road traffic between France and Italy. Finally, it boosts the ecologic lobby which denounces the pollution of alpine valleys and calls to find alternative solutions to the road.
J-C Gayssot is therefore strongly exposed and looks for, in agreement with the Italians, an alternative to the "all road" to calm the polemic. R. Lohr understands the situation. If the project has not touched the actors of the transport sector, may be it could interest the politicians in lack of solutions. He constitutes a team and sets up, with P. Mangeard, the Modalohr Company which is presented to J-C Gayssot as the wonder solution. After only few months of disaster, J-C Gayssot is convinced by the project (it's innovating, it's a French innovation and it could be put in place quickly without considerable works[16]). On 28th January 2001, following a Franco-Italian summit, the transport ministers announce by mutual agreement the decision to implement a service of rail motorway. The imposed calendar is tightened; the first wagon must be produced in March 2002, its homologation must be validated before end 2002 to allow the AFA operating end 2002. In this racing, many worries appear. The calendar is very ambitious and the first assessments on the economic balance of the line are disastrous. It is considered that an operating subsidy will be necessary during the works in the Fréjus tunnel (strong disruption of the traffic and reducing of the trucks accepted

[13] Cf. Appendix 1.4, p.21
[14] His activities are double: 70% concern the road automobile transport production (auto-carriers) and 30% are militaries (tank-carriers, troops-carriers etc.).
[15]Develops the Trans Translohr, light urban tramway
[16] Alone the put to GB1 gauge planned of the Fréjus tunnel and the build of two platforms are necessaries.

on the AFA[17]). Despite these constraints, Modalohr is presented 1st October 2001 in Lyon by J-C Gayssot as the best solution to allow a road-rail progressive balancing in the Alps. In 2002, the AFA is constituted as a company 4th January 2002 at Chambéry. The works on the Aiton platform begin in April 2002 and in November for the Orbassano platform in Italy. Finally, 2003 is the adoption year. The first Modalohr train is finished in January and the operating tests are realized. The circulation authorization of Modalohr wagons is given the 12th February 2003 by the transport ministry. The service inauguration planned in June 2003 is pushed back in November in the waiting for Bruxelles authorization. Bruxelles, attentive to the competition rules because of subsidies received by the AFA, accepts the subsidy plan to the operating, being granted that this service is considered as experimental. The line is finally opened to the commercial operation the 4th November 2003.

The adoption/implementation phase is original: **the technical innovation is adopted (the wagon) but the logistic innovation begins its development (AFA).**
The first AFA task is to find customers and to resolve the technical problems. A strong voluntarist politic is developed to awareness the road hauliers. The line starts by a free operating period and it presents interesting trumps. It allows to cross the Alps in 4h (loading/unloading included) with 4 round-trip/day and a capacity of 18 complete trucks or 28 alone trailers per shuttle. The price is comparable to the road (290€) and the possibility of a digressive fare in function of the passage number makes the system financially attractive (until 20% of initial price). Finally, the possibility of "no accompanied" service allows to the haulier to optimize the utilization of its personnel. Despite these trumps, the AFA has hard beginnings much on the economical than technical plan. The works in the Fréjus tunnel degrade the traffic conditions and reduce the Vehicle Park percentage available. This niche market is again reduced by the decision taken the 15th October 2003 to obligate the trucks to travelling with their deflated suspensions for security reasons[18]. Finally, the Aiton terminal localization is strongly criticized by TLF which requires the line extension until Lyon, French side, and until Turin and Milan Italian side. The AFA knows therefore a slow start with 100 to 140 wagons/week against 1000 by the Fréjus tunnel.
In 2004, it becomes urgent to pick up new flow to assure the system survival. A new campaign for the hauliers is led: the State allows the GVWR[19] to 44 tones in a perimeter of 150 km in pre and post transporting around the AFA terminals for the AFA users, the association "rolling road 2006" is created[20] and P. Mangeard succeeds to convince few hauliers and the Arkema shipper to use the AFA. This contract saves the line in guaranteeing it at least the half of one train per day. But, certainly more efficient than these new rules, a fire in the Fréjus tunnel, on 4th June 2005, leads to its closure during several weeks and it causes a massive traffic transfer toward the AFA. It is the opportunity for AFA to build up a clientele and to demonstrate to the State its usefulness as Alpine transit actor. Consequently, the subvention is extended until the achievement of tunnel works and the activity increases (fill rate superior to 70%[21]). So, the line is still in experimentation status, but we can consider it, in 2010, as adopted. The customer loyalty is gained and the technical and logistical system works well.
But the R. Lohr and his team ambitions go beyond the AFA. They hope to mesh France of a veritable rail motorway network based on the Modalohr technology. In 2007, the rail

[17] Alone the tank trucks and the semi-trailers lowered are authorized because of the limited gauge. They represent only 7% of the heavy truck traffic in the Fréjus tunnel.
[18] 70% of the Vehicle Park concerned by the AFA is not equipped in valve. In urgency, valves in kit are supplied to the hauliers in partenariat with the French Environment and Energy Management Agency which subsidizes 30% of the cost.
[19] Gross vehicle weight rating limited in 40 tones in France except in the harbors and the combined areas.
[20] Think tank constituted by TLF, SNCF and RFF to promote the express freight railway service in France.
[21] Cf. picture 2, part III, p.13

motorway concept is registered in the Environment Round Table process as sustainable solution and the "rail motorway" (managed by the Lorry Rail Company[22]) between Luxembourg and Spain is put in service the 10th September. From the AFA experience, this rail motorway knows also hard beginnings (limited gauge, high prices, low-quality service etc.). But, to the difference its model, the Lorry Rail Company has reached its financial balance to the 1st quarter 2009[23], three years only after its launching.
The implementation period has been therefore marked by an adaptation problem to the network and to its constraints and to a wait and see attitude of road hauliers attached to their habits.

Several points are to remember in this innovation process. Firstly, the Modalohr concept is the will of a visionary industrial to the research of an activity diversification. Secondly, this innovation has not been adopted by the transport sector actors but by the public authorities. Finally, the technical innovation has given birth to a new rolling road concept that could compete, in few years, the Swiss and Austrian rolling roads.

Economic cost and policy intervention

This last part concerns the economic aspect of the innovation. Designed to be profitable, the AFA reveals a need to operating subsidy: is it irreversible? This paradox requires to identify the origin of need, then to analyze the policy intervention and to measure their effects regarding the first operating results of the AFA.

The identification of subsidy need requires to distinguishing the technical and logistical innovation to its operating conditions.

On technical and logistical plan, the system is reputed costlier than classical system of combined but more economic in terms of maintenance. A Modalohr wagon costs about 228 000€ while a wagon of Greenbrier kind[24] costs about 152 000€. But on the logistical aspect, Modalohr has the advantage thanks its lateral loading and the utilization of "big wheel" (opposed to the "little wheel"). To allow the trucks transport at European gauge, the wagons must to have platforms very close to the rail. Two solutions exist: either we lower the floor (Modalohr solution), or we reduce the wheel diameters (RoLa German system[25]). The "little wheel" solution has been criticized in France because of the fragility and the quick wear of the system. The French manufacturer, Arbel Fauvet Rail (AFR), has also designed a piggy-back wagon with big wheels less costly than Modalohr. But its system of vertical loading/unloading is less efficient. The Modalohr is therefore costly to buying[26] compared with its competitors but it has the theoretical advantage to be more economical and more efficient to operating.

[22] www.lorry-rail.com
[23] This balance has been possible because the infrastructure equipment costs have not been put back on the operating count of Lorry Rail. It's only the result of the operating count.
[24] Used in the combined transport.
[25] Flat wagons lowered fitted with bogies in 4 axles and « little wheels ».
[26] The AFA equipment in rolling material is estimated to the SNCF about 400 millions of euro: 16M€ for 35 wagons, 3 M€ for equipment of two passager wagons and 18M€ for 5 interoperable locomotives. The Aiton platform equipment has been financed by AREA with the State and collectivity aid for a cost of 12M€.

Source : own assessment

On the operating plan, we have to distinguish the service to the service conditions. The main difficulties result from the works of the Fréjus tunnel: operation no optimized (restriction on truck gauges) and alternated traffic on one track (movement restrictions to 4 round-trip/day). However, the AFA has also weakness in the service that it proposed. Firstly, the distance between the two terminals is too short to allow "the economic effacement" of the offloading. Secondly, the mountain route increases the driving charges. Finally, the line has begun by a free period for mobilize the road hauliers. Consequently to these barriers, the AFA Company requires subsidies to offer a competitive price compared with the road price for the truck transit at least until the end of works. The bet is done that, after the end of the works, the service mass and the extension of the Vehicle Park will allow to the AFA to reach the financial balance.

According the AFA team, the subsidy need comes from the exploitation system and not of the system itself reputed profitable. This last point is still to demonstrate.

The purpose of this point is to synthesize the policy intervention already presented by fragments[27]. This picture synthesizes the innovation conditions, the motivations of public authorities to support the innovation and the means applied for the project.

Already in 2001, the SNCF anticipates a negative economical balance for the AFA operation. With a fill rate of 70% in average for the eight daily trains, the operation cost is estimated at 1,5€ for State for each euro spent by a road haulier. The necessary investment is estimated at 400 million of euro for the first years of operation until 2006. But face to this economical reality, the politic stake is strong. Firstly, France has to catch up its late in the domain of the rolling roads. Secondly, the polemic of the road transit in the Alpine valleys must be reduced and Modalohr is an innovating solution and French. Finally, the government would not to be accused to be the gravedigger of a revolutionary innovation by refusing it the credits. The politic prevails therefore over the economical and J-C Gayssot put in disposition of the innovation all the levers whose he disposes to concretize it.

The financial aid is the main lever that the State activates. In 2000, two aids for the research are allocated to help R. Lohr to transform his prototype in a wagon in capacity to pass the homologation tests. An ANVAR[28] aid in the form of refundable loan (11 million of franc) and a direct aid to the program of 7 million of franc are allocated him. **Compared with the investment already realized by the industrial (70 million of franc), these two aids are minors but it allows him to assure his cash. The policy intervention is more important in the adoption phase.** The operating deficit planned by the SNCF is to 15 million of euro per

	Investment cost	**Maintenance cost**	**Functionality**	**Total**
Modalohr	-	+	+	+
Rola	+	-	-	-
Arbet Fauvet Rail	+	-	-	-

year. To allow at the AFA to cover this deficit, and to offer a transit price competitive, the French and Italian States are involved to subsidize the line operation at parity (12 million of euro/year). For not accentuate his public deficit, the State takes the subsidy in the budget allocated to the combined (30 to 40 million of euro) which sparks off lot of reactions.

Another lever activated by the State is the regulation. The best example is the dispensation on the GVWR obtained by the AFA team in 2004 from the Surface Transport Direction of the

[27] Cf. appendix 1.1, p. 18

[28] French Public Organization for the Innovation Aid.

Transport Ministry for the AFA users. Finally, the State uses of his position of ordering party as a strong lever for convince the reluctant actors (SNCF, road hauliers), control the calendar realization and to assuring of the reactivity of its services (intervention of the ADEME). So, the government investment in despite of pessimist economical prospects has been important. We can resume this political will to the M-J Héron[29] comments: “with 8 shuttles per day we are not going to resolve the problem of trucks in the Alps. But it will be a symbol”.
The symbolic dimension is therefore essential but seeing now if this experience has been beyond the symbol and if the results obtained have been at level waited.

This last point concerns the analysis a posteriori of the market that the AFA represents. **According the methodology developed by INNOSUTRA, we will present the traffic forecasts estimated before 2003 that we will compare with the results obtained.**
The SNCF builds his traffic forecasts on two periods: during the works and after the works[30]. The following picture presents these forecasts of transit per year on the AFA. For each period a low estimation and a high estimation have been calculated.
The calculation considers several factors:

- The availability in capacity of the line in slots (4 RT/day until 2006, more than 20 after[31]),
- The weight capacity of each train (14 wagons equivalent to 28 semi-trailers until 2006),
- The transit flow by the Fréjus tunnel (hopes to get 20 to 25% of Fréjus traffic after 2006),
- The Vehicle Park available (7% before 2006, more 70% after 2006).

This factors cumulated have led the research studies of the SNCF to following results.

Picture 1 : Traffic forecasts calculated by the SNCF in 2002
(total of the trucks or semi-trailers transit/year)

	Before end of Fréjus works (2003 - 2006)		**After end of Fréjus works**	
	Low	High	Low	High
SNCF – FS	36000	50000	300000	600000

Data from SNCF and AFA

These forecasts were recognized as moderates in 2003 considering the constraints which applied on the operating. After seven years of operation we are going to study the traffic results.

[29] Freight representative director of the SNCF in Chambery and responsible of the AFA implementation.
[30] In 2002, the end of the Fréjus works was planned in 2006.
[31] With only 8 round-trip/day, the SNCF estimated a gain of 154% of benefit for only 20% of extra costs.

Picture 2: Comparison of truck traffics between the AFA and the Fréjus tunnel on the 2004-2008 period.
(total of the trucks or semi-trailers transit/year)

	2004	2005	2006	2007	2008
AFA	6 513	17 379	19 740	20 418	23 382
Fréjus[32]	1 130 965	784 518	844 225	876 358	823 607
Total	1 137 478	801 897	863 965	896 776	846 989

Data from AFA and SFTRF (French Company of the Fréjus tunnel)

Two remarks: the difference between the forecasts and the results is important and an inflection point is observable at the year 2005. The deviation between which was forecasted and which is, is explained by several ways. Firstly, the SNCF has **overestimated** the adoption capacity of the road hauliers of the new service. Secondly, **the service attractivity has been lower than forecasted**. Finally**, many hauliers consider the line too short to be used.**
The inflection point identified in 2005 is the results of two phenomenons. First point, the AFA starts in 2004 a profound reform in its operating for best answer to the road hauliers needs. Further to a poll campaign[33], important modifications are realized:

- Tariff modifications : system of common subscription with the SFTRF[34],
- Operating modifications : promotion of the “jockey” system and the “no accompanied”,
- Dispensation obtained for the transport in 44 tones,
- New negotiation of the schedules with RFF for best answer to the needs.

Second point, the fire of the Fréjus tunnel, on 5th June 2005, has more effects on the road hauliers that several years of lobbying for the AFA. Fire and/or operating reform, the AFA wins its clientele during 2005 and manages to conserve its customers, sign of a satisfaction from road hauliers.

It could be therefore incorrect to speak about failure for the AFA although the results are inferiors to the initial forecasts. The economical profitability demonstration of the concept stays to do but **the line exists, has customers and has not known until now of major technical problems.**

To conclude this part, two trends on the AFA are identifiables. Its promoters believe in its economic success and transfer its difficulties on the operating conditions deteriorated by the Fréjus works while its detractors condemn it in accusing it to be a financial abyss, works in the tunnel or not.

Conclusion

The innovation process of Modalohr is relatively simple. From a new technical product, new possibilities are appeared in the piggyback domain and a new service has been put in place. But, defining the success rate of this process is difficult. **The technical success is undeniable but the economical profitable promised is still waited.**
A posteriori, the innovation management has been efficient. The development and the production of the innovation are concentrated by an industrial determinate to put in place his

[32] The traffic data of the Fréjus tunnel have been integrated in reference to know the traffic truck variation on the period.
[33] Campaign led with 35 haulier groups during 8 months to best know their habits and needs.
[34] Operator of the Fréjus tunnel and the Maurienne highway.

system. The State participates through its transport ministry and its administration in following a strict and well defined calendar. Finally, the system is strongly represented by the Modalohr Company for the promotion of the wagon and by the AFA for the new line commercialization.
So, we have an innovation whose the successful can be measured regarding the place that the AFA has today in the Alpine logistical system and not to its traffic (distortion of the works). After seven years of operating, the AFA is integrated in the logistical link of big road hauliers and nobody sees the service to stop for a come back of the "all road" except if new solutions more economical are found.
Identification of the barriers[35]:

- The innovation suffers at the begin of the very low implication of the transport actors,
- The network inadequacy in the AFA adoption (Fréjus works) continues to restrain strongly the line operating (economical distortions),
- The economical data have been always negatives on the AFA: niche market very reduced.
- The lobby of the French combined transport considers the Modalohr system as a competitor (subsidies sharing).

If the innovation is not a success because of its deficit operating, its process of development and adoption is a success thanks to several factors[36]:

- Concentration by a determined industrial during the process innovation,
- Lobby group identifiable and efficient (Modalohr Company),
- Innovation management efficient from the public authorities (transversal)
- Innovation developed on the base of a well followed and strict calendar
- Investment of the public authorities despite the negatives economical forecasts.

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Annex

Type of policy analysis

Type of policy analysis	Key points or not *(ranked 1–5)*	Level of government involved (and public/private partnership?)	Influence during the initiation period (ranked 1-5)	Influence during the development period (ranked 1-5)	Influence during the implementation /termination period (ranked 1-5)
Standardisation	-	-	-	-	-
Stimulation of R&D	2	State	1	2	1
Knowledge management	-	-	-	-	-
Infrastructure development	3	Private	1	1	3
Regulation and planning	4	State	1	4	4
Legislation	3	State	1	3	3
Pilots and demonstrations					
Networking	4	State	1	4	4
Financial resources and incentives	4	State	1	2	4
Niche management	-	-	-	-	-
National security/strategies issues	-	-	-	-	-
Environment issues	3	Public opinion	1	3	1

Comments:

The Modalohr system has been developed by Lohr industry laboratories without state aids.

Two kinds of policy intervention:

1 – Financial intervention:

- Development period: aid of 2,5M€ for the transformation of the prototype in real wagon,
- Implementation period: operating subsidy of 12M€ shared between the French state (6M€) and the Italian state (6M€).

2 – Policy and administrative intervention:

- Development period: strict management of the project.
- Implementation period: regulatory support for the project.

Factors contributing to the transport innovation

Category of factor	Sub-category	Initiation (ranked 1-5)	Development/ Spread (1-5)	Implementation (1-5)
Technological	knowledge and expertise available	4	4	4
	availability of technologies	-	-	-
	compliance with standards	-	-	2
Administrative and legal	legislative guidelines	-	3	4
	Adm partners available	1	4	4
	clarity about division of responsibilities	1	4	4
Political and process-related	support, relay in local, regional assemblies	1	4	4
	the role of interests groups	1	4	4
	cross boundaries effects	-	-	-
Socio-cultural and psychological	incentives, motivation, spirit of entrepreneurship	4	4	4
	involvement in the project on the part of the stakeholders	1	4	4
	link universities/research/innovation	1	1	1
Economic and financial	net benefits for actors	1	2	2
	revenues for actors	1	2	2
	availability of subsidies	1	2	4

Comments:

- Technological: Modalohr is technically adapted to the classical track but the Fréjus tunnel gauge constraints the system to a niche market.
- Administrative: the administrative process is accelerated and the responsibilities are well defined between the actors.
- Political: lobbying of the Modalohr Company for the transport sector actors and strong political support at the national and regional scale.
- Socio-cultural: Modalohr results from the Will of one man, R. Lohr, and from the support of his partners.
- Economical: the profitability is not yet for the line and the operating subsidies are strong.

Source: adapted from Banister (2004), and Van den Bergh et al. (2007)

Barrier table

Category of barrier	Sub-category	Initiation (ranked 1-5)	Development/ Spread (1-5)	Implementation (1-5)
Available information (knowledge)	Lack of information on information	1	1	1
	Lack of information on markets	1	1	4
	Lack of qualified personnel	1	1	1
Technical	Lack of interoperability	1	1	1
	Lack of standardisation and certification	1	1	4
	Difficult adaptation to a new technology	1	1	1
Legal and regulatory	Legislation, regulations, taxation	1	1	4
	Administrative barriers	1	1	1
	Weakness of property rights	1	1	1
Financial and economic	High costs (too high costs)	1	1	4
	Lack of funds within the enterprise and subsidies from outside	1	1	4
	Lack of competition in the market	1	1	4
Cultural and societal	Scarce acceptability	1	1	1
	Scarce attitude of personnel towards change	1	1	1
	Inability to devote staff to innovation activity	1	1	1
Decision making	Lack of cooperation among partners (public, private…)	1	1	1
	Fragmentation of decision levels	1	1	1
	Lack of Vision and Policy Growth	1	1	1

Comments:

- Information: the difference between the forecasts and the real traffics marks an important lack of market knowledge.

- Technical: the Fréjus tunnel works are, for the AFA Company, the main barrier for its development.

- Regulatory: the security conditions imposed for the tunnel crossing have contributed to lower the vehicle share that the AFA Company can load.

- Economic: the Fréjus works degrade strongly the line profitability and involve a strong subsidy need.

Source: adapted from Comtesse et al. 2002, and OECD 2005

Project Story

Project story
1989 : idea to "adapt the rail to the road" **1995 :** first presentation of the prototype and setbacks from the SNCF and the road hauliers **1999 :** Mont-Blanc disaster **2001** **January -** Franco-Italian summit to implement a rail motorway service through the Alps **October -** The French Tranport minister presents in Chambéry the Modalohr system as the best solution **2002** **January -** set up of the AFA Company in Chambéry **March -** first wagon produced and begin of the homologation **April -** begin of the Aiton platform building **November -** begin of the Orbassano platform building **2003** **February -** circulation authorization for Modalohr **June -** put back of the line starting in november **November -** starting of the line **2005** fire in the tunnel Fréjus **2006** prolongation of the Fréjus works until 2012 and prolongation of the operating subsidies.

2.3. Maritime

REEFER CONTAINERISATION

Introduction

Reefer containerisation concerns the growing percentage of perishable cargo moved in reefer containers (positioned both in containerships and in specialised reefer vessels) and the growing containerships' capacity dedicated to reefer containers. It was considered a technological innovation in the preliminary innovation report stage of the INNOSUTRA investigation, due to the innovative technologies that have been applied to containers. It was defined as a 'success' in the terms considered by the project. In particular, the number of reefer containers and containerships fitted with electrical slots for carrying reefer boxes has increased continuingly in recent years. We now require to provide a more detailed analysis of the genesis of this innovation; its development, its current progress and trend, and the lessons to be learned.

The background of this innovation will first be examined, including the reasons for launching it, and its development since 40 years ago. The current position of the innovation will then be summarised, followed by an analysis of the development process, including its impact and spread across the maritime transport sector at global level. The penultimate section of the report then concerns what lessons may be learned from the analysis of this innovative case. In the final part there is a section including the discussion and drawing some general conclusions.

In three Annexes, the Policy Intervention Template for WP3/4 is provided, and some extracts from the initial analysis in the Preliminary Innovation Report (PIR) are also provided, followed by some references.

Background and Development

The first container refrigeration unit was built in 1956 by Thermo King Corporation, an American company that 18 years before invented the first truck refrigeration unit. This company, based in Minnesota and a unit of Ingersoll Rand Company Limited, is a manufacturer of transport temperature control systems for trucks, trailers, shipboard containers and railway cars.

The introduction of reefer container traffic in 1956 led to the radical innovation of easy availability of any type of perishable products from anywhere and anytime in the world. The impact on global society can be considered vast, as consumers all over the world can consume fresh produce at any time of year and experience previously unavailable fresh produce from many other parts of the world.

In 50 years of development, many changes have happened, especially regarding reefer technologies and refrigerants used. Due to the innovative construction of the reefer or refrigerated container, which is an intermodal container for the transportation of temperature sensitive cargo, and its long period of evolution, this innovation can be defined as radical and related to a product (not to a process).

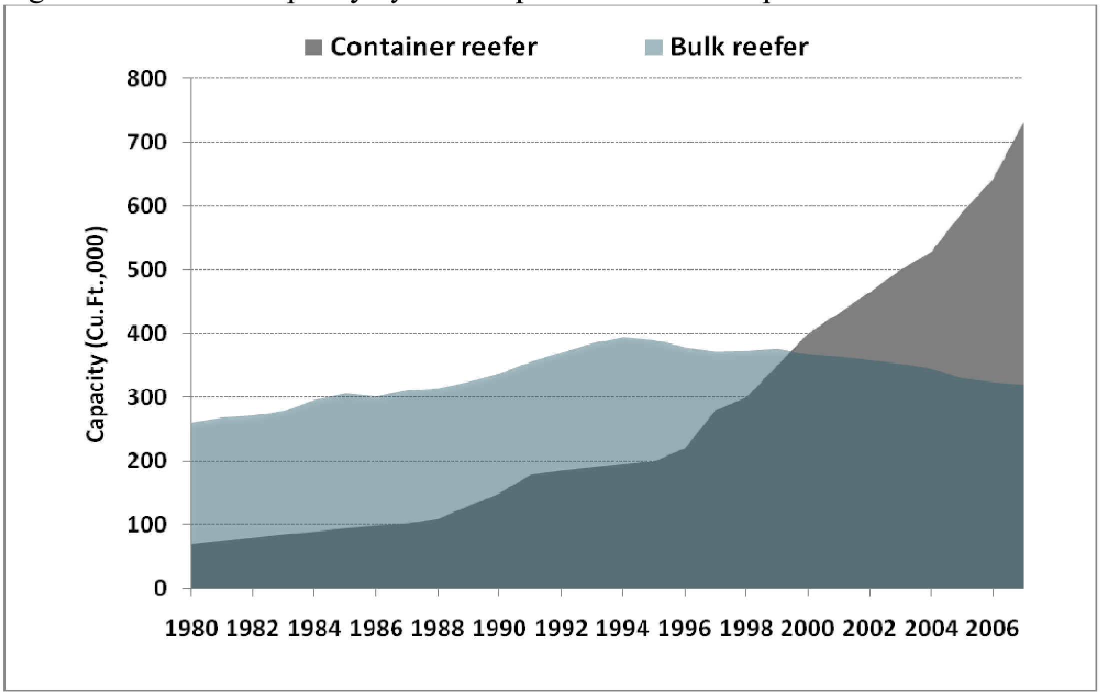
A significant change concerns the use of vapour-compression with refrigerants. From 1956 until the 1980s reefer containers used chlorofluorocarbon refrigerants (CFCs) like R12 and R502. After the Ozone Hole found in 1987 and consequent environmental policies, these refrigerants were subjected to prohibition and eliminated from the cooling system in all new reefer containers to eliminate air emissions. Thus, reefer containers started to use hydrofluorocarbon refrigerants (HFCs) that are ozone-friendly like R134a. However, HFCs have also come under criticism. In 1997, HFCs were included in the Kyoto Protocol to the Framework Convention on Climate Change. In 2006, the EU adopted a Regulation on fluorinated greenhouse gases, which makes stipulations regarding the use of fluorocarbons (FCs) and HFCs with the intention of reducing their emissions.

By the early 1990's, this has led to another change. The insulated boxes on which the reefer containers fit were initially produced in North America and in Europe. After some years and changes in refrigerants, there have been a migration to Asia, such that over 90 per cent of all box production is today localized in China. Consequently, the reefer unit manufacturers have migrated closer to the box production sites, and all the reefer units are currently built in Asia.

As a consequence of the increasing reefer containerisation, the seaborne trade of perishable products has grown in the latest years. It represents a significant part of the international reefer trade (which stood at 156 million tonnes in 2008, of which 60% was containerized according to Drewry Shipping Consultant 2010), increasing from 45 million tonnes in 1994 to 77 million tonnes in 2009.

During the last twenty years, the reefer seaborne trade has been characterized by a gradual changing process, leading from reefer specialized vessels to reefer containers. In fact, the progressive decline of the bulk reefer market, which was particularly under the pressure from the newer container reefer services launched in the 1990's (according to Drewry Shipping Consultants 1999 and 2006), is evident from the analysis of the reefer bulk fleet from 1980 onwards. A decreasing trend regards both the number of specialised ships and their capacity. The highest number of ships has been reached in 1994 (1.487 vessels); then the fleet has started to decrease. The actual bulk reefer fleet amounts to almost 1.190 ships, among which the majority (790) is characterized by a total capacity higher than 100 000 Cubic Feet. The total capacity offered has been shaped by the same negative trend, with the highest peak in 1994 (395 million of Cubic Feet) followed by a steady decline continuing until nowadays, as shown in Fig. 2.1

Figure 2.1 – Reefer capacity by bulk ships and containerships



Source: UNIGE elaboration from Drewry Shipping Consultants (2009) and Containerisation International (2009)

In contrast, the containerised fleet has shown an extraordinary increase in reefer capacity since 1980. The actual container fleet includes 4.600 containerships with a total capacity of 11,4 million TEU, whose 15,8% is dedicated to reefer (about 1,8 million TEU, accounting for 80 per cent of total reefer capacity). Massive amounts of reefer capacity have been provided by global shipping lines in the 1990s, among which Maersk Line, CMA CGM and MSC.

As a consequence the modal split between bulk reefers and containers has experienced a gradual change since 2000. In particular, the container solution has overtaken bulk reefer trade in 2005. This trend is also confirmed by economic forecasting; it is predicted that in 2015 the container share of maritime reefer trade will raise approximately to 65% (Drewry Shipping Consultants 2006) .

Current State of the Art

The current state of the art – in relation to the **technological** aspects – appears to have reached an advanced level. This is to say that the quality of cargo transported by today's reefer containers is quite high. Many cargoes travel for 5-6 weeks and the temperature can deviate as little as 0.2°C from set-point during the whole journey. This type of reliability can be achieved through the installation of a redundant refrigeration system which allows to raise or lower humidity coupled with the capacity to reduce the oxygen levels and raise CO_2.This redundant system consists of a standard ISO container, integral primary and backup refrigeration units, and integral primary and back-up diesel generator sets. The refrigeration units (and generator sets) are electrically interlocked for automatic start and stop operation as required, such that only one can operate at a time to maintain the required temperature set points. Refrigeration units with more highly reliable scroll compressors can also be used in order to maintain the desired temperatures.

Today the entire industry of reefer containers has moved to scroll, obtaining the benefits of lower weight and improved energy efficiency. This type of refrigerated container has an integral refrigeration unit for controlling the temperature inside the container. When transported by ship, integral units have to be connected to the on-board power supply system, or to the reefer plugs at a land based site like port terminals.

Over the years cargo temperatures have been dropped as new science research demonstrated the benefits of Omega 3 fish oils, and the superior preservative effects of lower temperature on some high-fat fish and shellfish. The improved quality of storing fish at lower temperature has been studied by the Danish Fisheries Institute.

Now there is a wide range of reefer container typology according to the variety of refrigerated cargo. A regular reefer container is able to carry cargoes as low as -35°C.

Maersk Line has recently developed a refrigerated container specifically for products requiring ultra-low temperatures, including tuna, sea urchins, swordfish, food cultures, and pharmaceuticals. The Super Freezer container is able to maintain temperatures as low as -60°C, which makes it an ideal solution for carriage of frozen tuna into the Japanese sushi and sashimi market. The cargo can either be loaded processed, as fillets, or as whole fish. By using a special Stuffie container, stuffing can be performed directly from the fishing vessel. This ensures that the cargo exposure to temperature variations during the loading operation is kept to an absolute minimum (Maersk Line 2010).

Another innovative technology is the controlled atmosphere (CA) system, recently developed by Maersk Line for the protection of even the most delicate fruits during shipping (called Star Fresh CA). It is particularly useful for moving climate-sensitive products such as bananas, by slowing down their ripening process and extending the shelf life of the perishable products. StarFresh is a fully integrated system, meaning that all controllers and sensors are built into the refrigeration unit itself, thereby avoiding the usual necessity of having to sacrifice valuable cargo space.

Each new model of reefer container has a microprocessor for monitoring the temperature while en route. It is active also when the container is unplugged during port or terminal operations.

Considering **economic and financial** aspects, the role of global ocean carriers has become crucial for the development of reefer containerisation. Massive investment in new containerships of larger size equipped with more and more reefer plugs have been done by Maersk Line and its main competitors at beginning of the 2000s. Reefer capacity (in slots) offered by the top 15 global maritime carriers is now equal to 1,178,000 TEU (7% of their total container capacity according to Dylaners in Containerisation International 2009). Maersk Line is the leader of the market with a fleet of reefer containers equal to 420,000 TEU, more than 50% of 40' High Cube reefer containers available at global level (Maersk Line 2010). Its new containerships have the capability of transporting approximately 20-25% of their shipments in reefer containers. The mega containerships, namely Emma Maersk and the other 7 PS Series vessels of 14,500 TEU, are equipped with 1,286 electrical plugs (equivalent to 20% of their total capacity). The number of reefer plugs increases, in absolute terms, in relation to the size growth and to the fleet age. Another factor to consider is the competitive advantage of a reefer container moved at a lower cost than the equivalent capacity in a specialised reefer (Bright 2009).

From an **environmental** viewpoint, today's reefer containers are far more efficient than any other equipment previously available. Indeed, the latest technologies use less than 50% of similar size equipment of just a few years ago. In order to reduce electricity consumption, a new software solution called QUEST was developed for providing savings of 30 kilos of CO_2 per day per refrigerated container. Maersk Line has implemented it into its reefer fleet and estimated that a reduction of 380,000 tons of CO_2 emission per year has been achieved in 2009.

Analysis/Discussion

From the previous indications it emerges that the successful incremental containerisation of the global reefer trades derives from the combination of many different key factors, mainly technological, economic and environmental.

New reefer technologies that are highly standardised has played an important role since the beginning. Recent innovations like the introduction of the reefer integral container and the controlled atmosphere (CA) systems have radically changed the previous reefer equipment, allowing to prolong the shelf life of perishable products as the applied environment can slow down their ripening process.

Another technological advantage of new reefer containers is the decrease in risk of cargo loss and deterioration (and consequently minor insurance costs) due to the presence of an internal micro-processor monitoring the temperature and humidity of the shipments, both at the terminals and on board the vessels, along the whole transport cycle.

Moreover, technology progress has led to a substantial increase in the range of refrigerated commodities which can be shipped in smaller quantities with specific temperature and humidity requirements (i.e. pharmaceutical products) instead of use more expensive air freight transportation.

However, it clearly emerges that the development of this innovation is also due to economic and financial factors linked with the support of private operators, namely global shipping lines like Maersk Line, MSC and CMA CGM. They were originally external to the reefer business segment. Indeed the seaborne reefer market was historically controlled by few owners of specialised bulk reefer ships.

The relevance of support from global maritime operators is evident from their recent investment in new reefer technologies applied both to containers and ships. The main reason for these investment is to find in the excess of capacity offered by ocean global carriers since the beginning of the 2000s. This led to the necessity of diversifying the supply of dry containers and investing in new reefer containers, in order to increase their revenues.

Also the environmental pressures deriving from international requirements (such as Kyoto Protocol and the following normative) have led to the continued evolution of reefer containers whose technology has been refined. The QUEST Project implemented by Maersk Line in 2007 and 2008 represents a significant case study as it has permitted to reduce air emissions through efficient refrigerated containers (QUEST Project 2009).

Lessons to be Learned

Reefer containerisation can be evaluated as a success which has been developed in the latest 50 years since its invention in 1956. So it is characterized by a long period of development and growth still in progress, meaning there is constantly looking for, developing and implementing new technologies improving reefer containers' performance.

The success of reefer containerisation is primarily linked with factors directly associated to the innovative product "reefer container". These factors are technological and concerns many aspects including the use of different refrigerants, controlled atmosphere, microprocessors and new software.

However, the analysis reveals the important role of other factors associated to the success of innovative reefer container in a more indirect way. These factors are mainly economic and financial, related to the support of private maritime operators originally coming from other market segments. In fact, an event external to the reefer segment – the oversupply and the consequent reduction in freight rate in the container market - has led many container operators to invest in other niche segments more profitable, like the reefer one, entering in competition with specialised reefer carriers on traditional reefer routes South-North and even with several air cargo operators (i.e. providing specialised equipment for transporting cut flowers and live seafood from Japan).

Summary and Conclusions

The success of the innovative reefer containerisation has been evaluated according to the identification of the following key factors technological, economic and environmental:

Technological factors: research and implementation of innovative reefer technologies, leading to a radical change in the maritime transport of refrigerated commodities which can be now shipped in smaller quantities with specific temperature and humidity requirements guaranteed by refrigerated containers specifically able to maintain temperatures as low as -35° (until -60°C in the case of some new models from Maersk Line). As a consequence there is a more reliable cold chain with decrease in risk of cargo damage and in cold-storage costs.

Economic and financial factors: investment from global container operators that has led to the growth in containerships' size with a proportional increase of reefer plugs. Some linked organizational and logistic benefits are the worldwide connectivity and logistics offered by the container shipping lines, having the global coverage and the resources to transport perishable cargoes to any part of the world (exploiting their network economies); a more reliable and regular supply due to departures and arrivals with fixed schedules from ports in the ocean shipping lines network.

Environmental: possible reduction in air emissions deriving from the implementation of new reefer technologies. This factors will become more important in the next years, when EU will forbid R22 refrigerants (still in use today) so many carriers will be obliged to renew their reefer fleet.

There are three main conclusions that may be drawn from the analysis and discussion of reefer containerisation, launched about 50 years ago and still in the phase of growth according to a life-cycle concept (Thanopoulou 2009).

First, it is clear the role played by research in new reefer technologies in the progressive substitution of bulk reefer vessels and also of air transport. Products such as flowers and pharmaceutics, traditionally transferred by air, are now shipped via sea due to the advantages given by new technologies on maritime transportation by container. Therefore, the reefer container sector is currently one of the most promising markets of the overall shipping industry.

Second, the strategic relevance of an industry-led approach adopted by global transport players, historically external to the reefer segment. Their support has been fundamental in promoting and establishing innovative reefer container trade especially from the 1990s, when they started to compete with bulk operators whose fleet has experienced an irreversible decline. However, for our concern the competition between bulk reefer operators and container shipping companies can not be considered a "tout-court" competition. It may be better evaluated as a certain "coexistence" as the two shipping modes can operate side-by-side for satisfying the reefer demand peaks in the southern hemisphere fruit trades. For instance, the 5500 reefer containers of bananas leaving from Guayaquil every week could not be transported only in containerships, but necessitate also the capacity on deck provided by the specialised reefer ships.

Third, these global ocean carriers have also adopted environmental policies to ensure strict compliance with international rules and regulation, stimulating further research in reefer technologies environmental-friendly.

ANNEXES

Policy Intervention Template

Partner short name	UNIGE
Title	Reefer containerisation
Domain	Road – rail – inland navigation – **maritime** – intermodal – other _______
Type of innovation	**in success** – in failure – in debate
Nationality of case	International

General national framework of policy intervention
4. Actors support *(Public Administration, parapublic institutions, private partners, etc.)* - Private partners: maritime companies and logistics global carriers - National Government: the Dutch Government (project QUEST) **5. Which level of government ?** *(European Commission, central, regional, local, etc.)* - Global and local level **6. Role of competent authority?** - Private partners : investment in research and innovation in new technologies - Dutch Government: sponsor of the QUEST project (a joint development project involving the Dutch Government, the Wageningen University and the Research Centre in the Netherlands, with the objective to develop a software solution providing a new temperature control regime to cut the energy consumption used for cooling)

Applicated study of policy intervention
Summary description *(max 1 page)* A reefer or refrigerated container is an intermodal container used for the transportation of temperature sensitive cargo. The majority of containers use vapor-compression refrigeration with HFC refrigerants that are ozone-friendly like R134a. This is due also to the fact that EU will forbid the use of R22 refrigerants from 2015. Due to their limited maintenance of the set

temperature (they are assumed to be unplugged for no longer than twelve hours without any damage to the cargo), reefer containers rely on external power, from electrical points at a land based site, a container ship or quay. During rail or road transportation they can be powered from diesel powered generators ("gen sets") with a capacity of running between 36 hours to 5 days.

Since the last few decades the reefer transportation market has been increasing due to the constant demand growth. Despite the recent global crisis affecting households in terms of purchasing power, cold chain shipments still represent basic products for human consumption. The seaborne trade of perishable products has consequently grown in the latest years as it represents a significant part of the international reefer trade (which stood at 156 million tonnes in 2008, of which 60% was containerized according to Drewry Shipping Consultant 2010), increasing from 45 million tonnes in 1994 to 77 million tonnes in 2009.

During the last twenty years, the reefer seaborne trade has been characterized by a gradual changing process, leading from specialized vessels to reefer containers. In fact, the progressive decline of the bulk reefer market, which was particularly under the pressure from the newer container reefer services in the 1990's (Drewry Shipping Consultants 1999 and 2006), is evident from the analysis of the fleet from 1980 onwards. Currently, the refrigerated cargo is increasingly containerized, making use of "reefer containers".
Reefer capacity (in slots) offered by the top 15 global carriers is equal to1.178.000 TEU (7% of their total container capacity according to Dylaners in Containerisation International 2009). Maersk Line is the leader of the market with a fleet of reefer containers equal to 420.000 TEU (Maersk Line 2010).
In order to reduce electricity consumption, and thus emissions caused by cooling containers, the QUEST reefer programme was initiated by Maersk Line in 2006 and 2007. The QUEST (Quality and Energy efficiency in Storage and Transport) programme is a joint development project sponsored by the Dutch Government and involves also the Wageningen University and the Research Centre in the Netherlands. QUEST is a software solution which provides a new temperature control regime, in order to cut the energy consumption used for cooling by up to 50 per cent. Indeed, the QUEST software provides savings of 30 kilos of CO_2 per day per refrigerated container. Maersk Line has implemented it into its reefer fleet and estimated that a reduction of 380.000 tons of CO_2 emission per year has been achieved in 2009 (Maersk Line 2009).

Factor roles

3. Type of factors

Identification of factors associated to the innovation emergence (technological; administrative and legal; political and process related; socio-cultural and psychological; economic; international; environmental, etc.)

- **Technological factors**: emergence of new reefer technologies that are standardised (like ozone-friendly refrigerants). Secondly, reefer containers are manufactured to the most advanced specifications and on the basis of extensive research. Prior to delivery, the containers undergo rigorous testing and are subjected to extreme weather conditions; from tropical to arctic environments. Moreover, reefer containers have a microprocessor that monitors the temperature en route, so when the container is unplugged this "black box" can continue to record the temperature.
- **Economic and financial factors**: necessity to diversify the supply of dry containers

from ocean global carriers at beginning of the 2000s, in order to increase their revenues. Even though global losses of US$20bn are forecast for the year 2010 for the container industry as a whole, its share of reefer goods is set to grow from 56% in 2008 to 71% in 2015 (Drewry Shipping Consultants 2006).

- **Environmental factors**: reduction of 380.000 tons of CO2 emission in 2009 (QUEST Programme applied by Maersk Line).

Category of factor	**Sub-category**	**Initiation (ranked 1-5)**	**Development/Spread (1-5)**	**Implementation (1-5)**
Technological	knowledge and expertise available	5	5	5
	availability of technologies	5	5	5
	compliance with standards	5	5	5
Administrative and legal	legislative guidelines	4	4	4
	adm. partners available	5	4	4
	(lack of) clarity about division of responsibilities	1	1	1
Political and process-related	support, relay in local, regional assemblies	3	3	3
	the role of interests groups	5	5	5
	cross boundaries effects	3	3	3
Socio-cultural and psychological	incentives, motivation, spirit of entrepreneurship	5	4	4
	involvement in the project on the part of the stakeholders	5	5	5
	link universities/research/innovation	3	3	3
Economic and financial	net benefits for actors	4	4	4
	revenues for actors	4	4	4
	subsidies available	1	1	1

4. Innovation barriers

Identification of the barriers to the innovation process (Lack of awareness of available information; Regulatory and legal barriers; Technical barriers; Financial and commercial barriers; Societal barrier; Decision making barriers)

- **Economic and financial barriers:** high costs for building a reefer container (the cost of its construction is about **20.000 US$**, 10 times higher than the cost of a dry container).
- **Available information**: lack of knowledge on reefer techniques and lack of qualified personnel (only few global shipping companies have the role of reefer manager and a team of experts specialized on reefer techniques)
- **Legal and regulatory**: EU will forbid the use of R22 refrigerants from 2015, so many carriers will be obliged to renew their reefer fleets.

Category of barrier	**Sub-category**	**Initiation (ranked 1-5)**	**Development /Spread (1-5)**	**Implementation (1-5)**

Available information (knowledge)	Lack of awareness on information	4	4	4
	Lack of information on markets	5	5	5
	Lack of qualified personnel	5	5	5
Technical	Lack of interoperability	3	3	3
	Lack of lack of standardisation and certification	5	5	5
	Difficult adaptation to a new technology	3	3	3
Legal and regulatory	Legislation, regulations, taxation	4	4	5
	Administrative barriers	2	2	2
	Weakness of property rights	2	2	2
Financial and economic	High costs (too high costs)	5	5	5
	Lack of funds within the enterprise and subsidies from outside	2	2	2
	Lack of competition in the market	4	4	4
Cultural and societal	Scarce acceptability	1	1	1
	Scarce attitude of personnel towards change	2	2	2
	Inability to devote staff to innovation activity	2	2	2

Policy intervention

Type of policy analysis	**Key points or not *(ranked 1–5)***	**Level of government involved (and public/private partnership ?)**	**Influence during the initiation period**	**Influence during the development period**	**Influence during the implementation/termination period**
Standardisation	4	Industrial	4	4	4
Stimulation of R&D	3	Industrial	4	3	3
Knowledge management	3	Industrial	3	3	3
Infrastructure development	3	Global	3	3	3
Regulation and planning	1	-	1	1	1
Legislation	2	European	2	2	2

Pilots and demonstrations	2	-	2	2	2
Networking	3	Global	4	3	3
Financial resources and incentives	3	State (Dutch)	4	3	3
Niche management	2	Industrial	3	2	2
National security/strategies issues	1	-	1	1	1
Environment issues	3	State (Dutch)	3	3	3

Actors and their roles

Type of actors involved	**Key points or not *(ranked 1–5)***	**Which level of government involved (and public/private partnership?)**	**Influence during the initiation period**	**Influence during the development period**	**Influence during the implementation/termination period**
State experts, State administration	2	State (Dutch)	2	2	2
Monitoring agents	1	-		-	-
R&D Agent	1	-		-	-
Regulator	1	-		-	-
Innovation agent	2	Industry	3	2	2
Implementer	1	-		-	-
Developer	1	-		-	-
Lobby group	4	Industrial	4	4	4
Inventors	2	Industrial	2	2	2
Industrialists, VIP in Business	5	Industrial	4	4	4
Politicians	1	State (Dutch)	1	1	1
International organization (or E.U.)	2	EU	2	2	2

Stress test

Stress tests for transport innovation	**Estimated results *(forecast, planning, projected data)***	**Real operation, up to date data**
Traffic, revenues from traffic and operation	76% of reefer cargo containerized in 2015.	62% of reefer cargo containerized in 2009.

Security issues, injuries, accidents	-	-
Extension needed, complementary infrastructure needed	Extension of the reefer areas at port terminals Increase of the number of reefer plugs for ships and terminals	-
Public/Private money invested	Public : 0€ / Autofinancing private	Public financing only for QUEST project
Return on investment	-	-
Neighbourhood approval	-	-
Public debate, opinion of politicians and experts	Public and opinion of politicians : good/ opinion of expert: good	Idem
Idea, project exported?	Extension all over the world	Extension all over the world

Comments: *Innovation objectives achieved or not? At the end, who are the winners and the losers? Can we see underground strategies of some actors after long time of innovation?*
The innovation objective of reefer containers to be competitive with specialised reefer fleet has been achieved during the latest years, in particular from the year 2005 when the rate of trade transported by container has been equal to the rate transported by bulk reefer. The winners are the global ocean carriers which have strategically invested in the reefer business segment by ordering new containerships with 15-20% of reefer capacity and new reefer containers.

Extracts from Initial Analysis Template (PIR)

Summary

The reefer containerisation is an innovation concerning the growing percentage of perishable cargo moved in reefer containers (positioned both in containerships and in specialised reefer vessels) and the growing containerships' capacity dedicated to reefer containers.
This innovation can be classified as incremental as the number of reefer containers and of containerships fitted with electrical slots for carrying reefer boxes has increased continuingly in recent years. And it is a technological innovation because of investments in innovative technologies that have been applied both to reefer vessels and to containers. Now there is a wide range of reefer container typology according to the variety of refrigerated cargo.
The volumes of reefer trade have shown a strong increase during the latest ten years, growing from 90 million tonnes in 1998 to the actual 156 million tonnes transferred to importing countries (Drewry Shipping Consultants 2010). As a consequence, shipments of perishable commodities via sea have expanded and changed: the volumes of reefer cargo carried by the specialised reefer fleet have been gradually eroded by the competition from containerships. In 2002, an estimated 1200 billion dollars worth of food was transported by a fleet of 400 000 refrigerated containers (Gac 2002). Today the containership fleet has more reefer container capacity than the whole fleet of bulk refrigerated ships.

Adoption barriers (ranking: 4/10)
There was the competition with specialised reefer fleet that prevented the concept's initial spread. In the latest years the container fleet has become dominant in global reefer trade.
Adoption rate and spread (ranking:7/10)

The reefer segment of the shipping market adopted very slowly the new reefer containers in the last 50 years

Implementation barriers (ranking::7/10)

High Investment in new reefer technologies from Maersk, CMA CGM, MSC, etc. (containers and ships), and from terminal operators for reefer equipment and storage.

Negative effects (ranking:3/10)

Logistical: longer lead times due to routes based on transhipment.

Logistical: difficulties in balancing the shipments (containers not repositioned in the export areas).

Positive effects (ranking: 8/10)

Economic: the competitive advantage of a reefer container moved at a lower cost than the equivalent capacity in a specialised reefer.
Logistical: the decrease in risk of cargo loss and deterioration (and consequently minor insurance costs) due to the constant monitoring of the temperature and humidity of the shipments, both at the terminals and on board the vessels.
Social: better quality of perishable products consigned to the final consumers.

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2.4. Inland Navigation

Y-shaped hull innovation process

Introduction
To assess the innovation process of the Y-Shaped hull we needed to collect data about the innovation process. To collect data of this innovation we were able to question the key players involved in this innovation process. The key players interviewed are described in the following chapter, chapter two. In chapter three the innovation process is described, the analysis is performed in chapter 4.

Key actors

Damen Schelde Naval Shipbuilding (DSNS)
Damen Schelde Naval Shipbuilding is a Dutch company. On their website the following is mentioned. DSNS is a naval shipyard that makes optimal use of its know-how and experience form both the military and commercial sectors and is specialised in the design and construction of naval vessels and complex commercial vessels. Royal Schelde was founded in 1875 and in 2000 became a member of the Damen Shipyards Group. The group consists of more than 30 major shipyardsand operating companies around the world, has built more than 4000 commercial and military vessels, currently employees nearly 8500 skilled workers and has nearly Eur. 1,5 billion in annual turnover.

TNO
TNO is a Dutch organisation, TNO is the abbreviation for: "toegepast natuurwetenschappelijk onderzoek" (Dutch) or "applied scientific research". On the website of TNO they mention the following mission. TNO is an independent research organisation whose expertise and research make an important contribution to the competitiveness of companies and organisations, to the economy and to the quality of society as a whole. TNO's unique position is to attributable to its versatility and capacity to integrate this knowledge. Innovation with purpose is what TNO stands for. We develop knowledge not for its sake but for practical application. To create new products that make life more pleasant and valuable and help companies innovate.

Chemgas
Chemgas exists since 1965 and is one of the main inland gas transporters on the Western Europe waters. Initially the transport they transported gas with converted inland vessels, but soon they started expanding their fleet with new gastankers, build in own management. In 1985 they started expanding their services to sea, the first maximum air draft gas coaster was build. Now they were able to transport gas between sea terminals and between inland and sea terminals. Since then they started expanding their tanker fleet. They own ten see-river tankers and twenty-five inland tankers, only gastankers. Since 2003 they are owned by "Reederei Jaegers group".

G.C.M. Deen Shipping Holding B.V.
G.C.M. Deen Shipping bv. is a Dutch company owned by Mr. Deen, the company is managed by the family Deen. Deen Shipping bv is since her foundation in 1980, as inland navigation entrepreneur, involved in many innovative projects in the inland

navigation industry. They are involved in the inland tanker industry and own inland tankers.

Rensen-Driessen Shipbuilding
Rensen-Driessen Shipbuilding is a Dutch company. Their company website mentioned the following. Rensen-Driessen Shipbuilding B.V. was established in 1980 and is a specialist in the design, construction and completion build of inland and seagoing vessels. Our company has successfully developed thanks to the right vision, our innovation and our workmanship. As a result, we have delivered over 600 vessels. We are a specialist in: mineral tankers, chemical tankers, bunker tankers, gas tankers, motor freighters, motor container carriers, push barges, low profile coasters, passenger ships and pontoons.

CCNR
The CCNR (Central Commission for the navigation on the Rhine) is the regulator on the Rhine. This is an international commission with members from all the Rhine riparian state: Germany, Belgium, France, Suisse and the Netherlands. This commission exists of different committees, committee for transport or dangerous goods is the committee that is responsible for regulations related to inland tankers published in the ADNR (regulations for the transport of dangerous goods on the Rhine). The committee owns a working group, working group transport of dangerous goods deals with new changes in the regulations for inland tankers. One of the members for the Dutch delegation was at the time of the innovation process Ing. K. den Braven. He was employed by the Dutch government (Shipping inspection). To solve matters related to the transport of gas mr. Smit Roeters, employed at Chemgas, was regularly asked to join the working group transport of dangerous goods.

Dutch government
The Durch government is involved in the innovation process with two sections: Shipping Inspection (Scheepvaartinspectie) and second the management of the waterways (Rijkswaterstaat). The Dutch government has a department NL Innovatie (former Senter Novem) that stimulates innovation.

Innovation process

Initiation period
In the initiation period there are two important steps identified. The generation of ideas is the first step and the second step is the so called shock (the awareness/trigger of the need to develop the innovation).

Generate ideas
Different parties are involved in the generation of the idea to develop a crashworthy construction for inland tankers. These parties are CCNR, TNO and DSNS.

CCNR
In 1972 CCNR decided that the maximum allowed cargo tank size for tankers was 380 m³. A Dutch company VT (Verenigde Tankrederij) asked for larger cargo tanks because they were building a vessel with a cargo capacity of 9000 m³. If they used the allowed tank size they had to install 24 cargo tanks, this amount of cargo tanks was not acceptable for VT on one hand because the investment to install these cargo tanks was too high (24 pumps and all the appendages) and on the other hand because of the increased difficulties during cargo operations (24 samples of tanks

have to be analysed before the cargo operations can be started and there is a high chance of losing overview when the cargo operations are performed). As a consequence the CCNR decided to change their policy. Cargo allowed in a single hull vessel could be transported with a double hull vessel, the safety increases and as a consequence VT was allowed to sail with larger tanks. Since 1984 the regulation for double hull tankers (type C) went into force. The first double hull tankers were built in 1989. Since these changes CCNR searched for solutions to increase the cargo tank size of inland tankers for all other types of cargo and tankers.

TNO
TNO deals with crashworthiness since the beginning. There were difficulties in predicting the results of a collision using steel constructions. When the first computers became available for calculations, the possibilities rise to predict the results using a steal construction more accurate in case of a collision. At the same time Ir. A.W. Vredeveldt was hired at TNO. He was already interested in crashworthiness because he was told by people involved in the shipping industry that the safety of vessels was in a high sense depended on the crashworthiness of the vessels.

Damen Schelde Naval Shipbuilding
The performance of steel constructions in case of extreme loads has been on the agenda of DSNS for ages. They are always extending their knowledge related to possible impacts on the construction of a vessel. A crashworthy structure is one of the subjects they are dealing with.

Shocks

CCNR
In 1997 Ing. K. den Braven was working for the Dutch government (shipping inspection) and the CCNR (working group transport of dangerous goods) and visited a seminar in the Netherlands. At this seminar Ir. A.W. Vredeveldt was promoting the Y-Shaped hull. Ir. A.W. Vredeveldt and Ing. K. den Braven started discussing the possibilities of the Y-Shaped hull in the inland tanker industry because Ing. K. den Braven would like to find solution to increase the maximum allowed cargo tank size.

TNO
At that time TNO was able to predict the results in steel constructions of vessels in case of a collision. With the possibility to predict the results the following question rise: “what are these predictions worth without knowing the validity of them?”. The engineers working with these predictions were not able to estimate the validity of their calculations. TNO figured out how to make these predictions valid, one method would definitely show the validity of the results: real scale crash tests. At TNO enough people were motivated to start this challenging project, without having a clue what the project meant. To perform a real scale crash test they needed vessels which they could damage. In the Netherlands there were vessels available because of the scrap regulations around this time. Vessels from fifteen till twenty years old were available, so these vessels were in fine condition. The next step for Ir. A.W. Vredeveldt was to inform the Dutch government (Rijkswaterstaat) about the realization of real scale crash tests. The Dutch government had to approve the project and assign a location where they could perform crash tests.

The Dutch government was enthusiastic about the project. The main reason for their enthusiasm was: they would like to know the validity of the predicted results in steel constructions in case of a collision, they would like to know this because of the regulations. As a consequence the Dutch government decided to financially support the crash tests. The support of the Dutch government was not sufficient enough to perform the crash test, more financial support was required. Everyone using the prediction software was interested in the results of the crash test. TNO contacted a Japanese user of the software, this user decided to financially support the project with a same amount of money as the Dutch government did. This was for TNO the incentive they needed to start up the crash tests. They decided that a conventional construction was tested and to compare these test results with the predicted results of computer calculations. At the same time this could be a good opportunity to perform real scale crash tests on new developed constructions. A Japanese consortium asked TNO to test their alternative construction, they developed an idea for an improved crashworthy construction.

In the search for vessels they were able to use in performing the crash tests TNO contacted scrapping companies. A scrap company told Ir. A.W. Vredeveldt that Chemgas was going to scrap a vessel. Ir. A.W. Vredeveldt contacted Chemgas and explained them why he needed a vessel. Chemgas was very interested in the crash tests because they were talking with Ir. J.W.L. Ludolphy about the development of a new crashworthy construction. The interest of Chemgas in a new crashworthy construction was that they believed that the cargo tank size could be increased if they used a more crashworthy construction. If the construction was able to absorb more energy than a conventional hull and they used this construction then the CCNR would probably approve larger cargo. The advantages of a larger allowed tank size is that the vessel will be safer and cheaper.

Damen Schelde Naval Shipbuilding
Ir. J.W.L. Ludolphy was discussing possibilities with Chemgas to improve the crashworthiness of their vessels, he saw the activities of the Japanese consortium and thought I can develop a crashworthy hull with a higher resistance to rupture. That became the y-shaped hull (Scheldehuid). He was employed at Royal Schelde Naval Shipbuilding, the subject crashworthiness has been on their agenda for ages. They are interested in constructions under extreme loads like explosions. Marine vessels do ground, strand or collide sometimes and for this reason people were internally studying the results of constructions when grounding, stranding or colliding. Related to these impacts they were studying alternative constructions that were able to absorb more energy than a conventional hull during a collision before the hull ruptured. Internally there was a lot of knowledge on the subject of crashworthiness and this knowledge had to be extended to keep the level of knowledge higher than the competition. Ir. J.W.L. Ludolphy realised that the time had come to develop and test the Y-Shaped hull by means of real scale tests. A real scale test is very unique and hard to realize so there would not be another opportunity in the near past.

Development period

Evaluation of ideas
Ir. J.W.L. Ludolphy decided to start developing a crashworthy construction, there were already a few crashworthy constructions developed. He evaluated these constructions and found out that there was a lot to improve. He decided not to use any of these ideas but to develop a new type of construction, that became the Y-Shaped hull.

Design of innovation
Ir. J.W.L. Ludolphy and Ir. A.W. Vredeveldt discussed why conventional constructions do rupture. They both agreed that they rupture because the material is not allowed to stretch, the hull is not allowed to stretch because of the transverse

frames installed on the inside of the hull. If material is not prevented from stretching it is allowed to stretch further before it will rupture. Ir. J.W.L. Ludolphy designed a new construction in which the transverse and longitudinal bulkheads are disconnected. As a consequence the hull is not as limited as before in stretching. The design is based on the fact that the space for deformation of the hull is increased. Ir. J.W.L. Ludolphy was convinced that the hull was able to absorb more energy before the tank was penetrated than in a conventional construction.

The Y-Shaped hull is based on the simple construction of reed according to Ir. J.W.L Ludolphy. The easiest method to illustrate this is by means of two pictures, one picture of the Y-Shaped hull construction and one picture of the internal structure of reed. They both have a structure of v-shaped constructions.

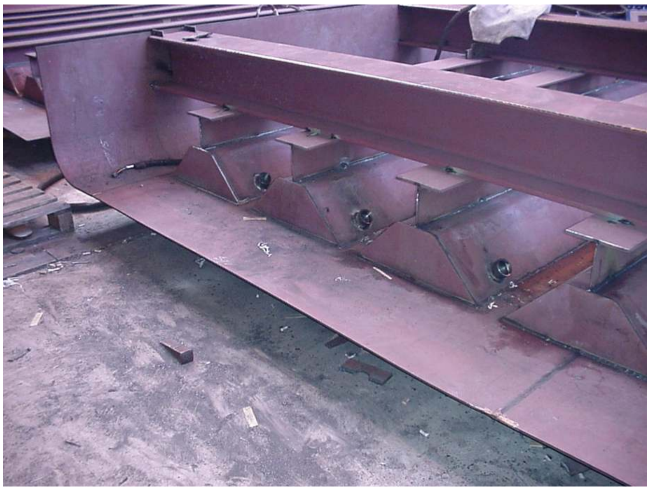

Figure 1; Crashworthy hull structure, Y-Sha **Figuur 2; Structure of reed**

Development of innovation
Ir. J.W.L. Ludolphy designed and developed the Y-Shaped hull on its own during his employment at Royal Schelde Naval Shipbuilding.

Evaluation of prototype
Ir. J.W.L. Ludolphy was convinced about the crashworthy performance of the Y-Shaped hull, for this reason he would demonstrate this by means of a real scale crash test. The investment needed for the crash test is a private investment from Royal Schelde Naval Shipbuilding. There were a German and Japanese consortium which would run some crash tests on crashworthy hulls developed by them as well, for this reason the investment needed to perform real scale crash tests could be divided between those three parties. The Dutch government was interested in the outcomes of the crash test in case of a collision with a conventional hull and they were also willing to financially support the crash tests.
The Y-Shaped hull was tested in 1998 by TNO. The results of the crash tests were predicted with finite element analysis in a software program. During the tests it was clear that the results in the software program did not match the results of the real scale crash tests. The Y-Shaped hull was able to absorb more energy than predicted by the software, for this reason the hull did not rupture while it was expected to do so. Because of the extraordinary results Royal Schelde Naval Shipbuilding decided to patent the construction. Owning this patent they realized if the concept was going to be a success, they could make a profit by selling the licences to use the patent. As a consequence they proceeded with the development of the Y-Shaped hull.

The crash test of the prototype has been performed on a piece of Y-Shaped construction. Now the time was there to implement the Y-Shaped hull into a vessel and show all the advantages.

Redesign and production

Ir. J.W.L. Ludolphy already discussed the possibilities of an Y-Shaped hull construction with Chemgas while DSNS is not specialised in the gastanker market. They are specialised in the naval industry. They decided to develop the Y-Shaped hull for the inland navigation industry to find out what the problems were and how to solve these problems before developing and implementing the Y-Shaped hull in the naval industry. The application of such an innovation is easier in a commercial application than a high end application like naval vessels. Inland tankers do have a simple geometric construction, for this reason it would probably be less hard to implement a new construction in these vessels than into naval vessels or other advanced vessels. The incentive for Chemgas to take part in the project was to increase the allowed cargo tank size of their tankers. As a consequence DSNS decided to try and implement the Y-Shaped hull in the inland tanker industry. As a consequence they had to proceed with the development of the Y-Shaped hull until it was ready to be implemented into tankers.

When it became obvious that the Y-Shaped hull was a potential innovation for the inland shipping industry DSNS analysed the market together with Rensen-Driessen Shipbuilding. They predicted the market that could be reached with this innovation.

On one hand safety is of big importance in the inland tanker industry but on the other hand ship owners in the inland tanker industry do not want to lose money on increasing the safety while it is not necessary to increase the safety (by regulations). The developers had to demonstrate more advantages than the increase of safety when the Y-Shaped hull was used. As a consequence DSNS (former Royal Schelde Naval Shipbuilding) and TNO had to demonstrate some economic advantage if the Y-Shaped hull is installed. During the discussion between Chemgas, TNO and DSNS they mentioned the incentive for Chemgas to take part in the project, they would like to increase the allowed cargo tank size. At that moment the Dutch government was involved in the project again, Ing. K. den Braven discussed possibilities to increase the cargo tank size with Ir. A.W. Vredeveldt when they met each other in advance of the crash tests. The time was there to discuss how to propose the CCNR to approve the increase of the maximum allowed tank size. Actually this is called the adoption of the Y-Shaped hull by the CCNR and will follow in the next paragraph.

During the crash tests it was not clear why the Y-Shaped hull did not rupture while the finite element analysis predicted that the construction should rupture. Until 2002 no one found the solution for this problem, as a consequence DSNS hired a student Marine Technology to solve the problem with Ir. J.W.L. Ludolphy. During the first year of solving this problem Ir. J.W.L. Ludolphy passed away. The student Marine Technology, Ir. J. Broekhuijsen, was one of the persons that was involved in the development of the Y-Shaped hull in the last period of the life of Ir. J.W.L. Ludolphy, as a consequence he was asked by Royal Schelde Naval Shipbuilding to proceed with the development of the Y-Shaped hull. This was a crucial period in the innovation process, all the activities related to the Y-Shaped hull stopped after the unexpected dead of Ir. J.W.L. Ludolphy. Ir. J. Broekhuijsen did proceed with the development of the Y-Shaped hull.

At the same time a pushed gas barge was being built for Chemgas. This is where development and adoption overlap each other. With Chemgas a partnership was started, they took the risk of building a vessel with this new construction. For this reason they received the licence rights, from DSNS, of the Y-Shaped hull application in gas tankers. At the time of producing this innovation process description these rights are expired, the condition to keep these rights is that they should use the Y-Shaped hull at a regular base in new building projects, but they did not do that and lost the rights of the Y-shaped hull in the gas tanker industry.

After the development and application for the pushed gas barges of Chemgas, DSNS and TNO tried to apply the Y-Shaped hull in type C tankers. For this application a new project was started with the support of the Dutch government, the Safe Ship project. The Dutch government financial supported the project, they received subsidy of Senter Novem (now called agentschap NL). The first concept has evaluated into many new versions, in the latter versions Rensen-Driessen Shipbuilding assisted in developing the Y-Shaped hull in type C tankers. The first application of the Y-Shaped hull in a type C tanker was the mts Apollo owned by G.C.M. Deen Shipping. This concept has been developed with the engineers of INEC (International Naval Engineering Consultants).

Since the implementation of the Y-Shaped hull there have been three to four improvements of the hull. As a consequence the development of the Y-Shaped hull never stops. At the time of describing the innovation process the developers of the Y-Shaped hull are developing a new version of the Y-Shaped hull. At the current Y-Shaped hull the trapezoidal profile is closed, the joints around the trapezoidal profile are checked for leakages and they should be airtight. Most inland tankers are being built in Southern Asia and therefore have to be transported to the Netherlands. During the transport of the hull it will move and as a consequence the joints will rupture (a little) and are not airtight anymore. The first consequence of a non-airtight profile is: insight of the profile corrosion is possible, the air can slip insight and the corrosion process is able to proceed. The second consequence is: during ballast operations of a vessel with a non-airtight profile the water will enter the trapezoidal profile. During de-ballasting of the vessel the ballast tanks will be emptied but the water in the profiles will empty less fast or not at all. The main problem existing because of the non-airtightness and water inside of the profile is that the corrosion process will accelerate and the second problem is stability because of the ballast water that will stay in the profiles/ballast tanks. The developers need to find a solution on how to conserve the insight of the trapezoidal profile. If they find this solution they will try to implement this new type of trapezoidal profile. The redesign and development is not stopped.

Implementation period

Impact of the Y-Shaped hull

At this time it would be wise to describe the impact of the Y-Shaped hull on the inland tanker industry. To implement an innovation you will need to demonstrate the advantages and disadvantages of that innovation.

Safety

The total risk during the operations of an inland tanker is smaller when they implement larger tanks and a Y-Shaped hull. The risk during sailing will be equal while the risk during cargo operation will be reduced.

For inland tankers the risk of any damage as result of leaking cargo is equal while they implement larger cargo tanks in combination with an Y-Shaped hull instead of a conventional hull with smaller cargo tanks. The energy absorbed before the

penetration of the tank will be twice as high in case of cargo tanks that are twice as big. So the chance of penetrating the cargo tank is reduced. On the other hand if a bigger cargo tank will be penetrated the outflow will be higher and therefore the effect of the
The size of inland tankers will increase due to scale effects with or without an Y-Shaped hull. If the size of the vessel increases but the cargo tank size stays equal the amount of cargo tanks increases. A vessel with larger cargo tanks needs less shore connections and less cargo tank entrances, as a consequence the chance of leakages will be reduced. Less tanks results in less handling during cargo operations, as a consequence the risk on human failure will reduce. The overview on the cargo operations is hard to manage in case of e.g. 24 tanks, as a consequence less tanks results in a reduction of the risk to loose overview during cargo operations.

Costs
The investment to build a new inland tanker with an Y-Shaped hull is smaller because of the larger cargo tanks. The amount of cargo tanks is reduced, because of the increased size of the cargo tanks, and the amount of appendages (pumps, connections, level indicators, etc) is reduced as well. This will result in significant reduction of the new building investment.

When a ship is equipped with an Y-Shaped hull the vessel will be heavier in the cargo part of vessel. This cargo part owns 3% more steel in case of an Y-Shaped hull, nowadays this is reduced to 1.5 % more steel. As a consequence the price of the vessel will increase.

A ship owner who will use the Y-Shaped hull has to pay a licence fee to DSNS. This licence fee is based on the saving of that ship owner during the new building of the vessel.

If the hull of a Y-Shaped construction is damaged the costs to repair this damage will be higher than the costs of repairing a conventional hull. This is due to the fact that an Y-Shaped hull is constructed more complex than a conventional hull.

Image
In the port of Rotterdam there is a lot of vessel movement, as a consequence the risk of colliding is high. A bunker tanker in the port of Rotterdam is transporting oil owned by huge oil refineries like Shell, BP, Esso etc. Who’s blamed when a bunker tanker collides does not matter, the next day there will be an article in the newspaper anyway with the following headline e.g.: “Shell spills oil in the port of Rotterdam”. As a consequence oil refineries request the safest available bunker tanker. In the bunker industry tankers with an Y-Shaped hull are preferred over a tanker without an Y-Shaped hull.

The rights of the Y-Shaped hull are received by Rensen-Driessen Shipbuilding and G.C.M. Deen Shipping. Everyone who would like to implement an Y-Shaped hull has to inform them and ask permission to implement the hull. As a consequence they are contacted by people who like to build a new vessel. Rensen-Driessen Shipbuilding is the only one who is able to directly, without any permission of DSNS, implement the Y-Shaped hull.

Dissemination

CCNR, Dutch Government and classification societies
During the initiation and development period the Dutch government, CCNR and the classification societies were already informed about the plan to develop a more

crashworthy construction. They were invited during the crash tests and observed the performance of the Y-Shaped hull. These regulators were constantly informed during the development of this innovation.

Market
DSNS organized a so called “Scheldedag” on the 16th of November in 2006. This day was organized by DSNS, Rensen-Driessen Shipbuilding and G.C.M. Deen Shipping. During this day the advantages and disadvantages of the Y-Shaped hull were presented. Hundreds of people, in one way or another related to the inland navigation industry, were invited during this day and interested by the organisers in this innovation.

Rensen-Driessen Shipbuilding
Rensen-Driessen shipbuilding is the only company, besides DSNS, who is able to sell the Scheldehuid. They were convinced that they could sell the Y-Shaped hull and make a profit out of it. DSNS is a shipyard for naval vessel, as a consequence they do not have many contacts in the inland shipping industry but Rensen-Driessen Shipbuilding is a major player in the inland navigation industry and does have many contacts in the sector. They started promoting the Y-Shaped hull by means of presentation on different locations in the Netherlands, they invited shipbuilders, clients, ship-owners and shippers to attend these presentations. During these presentations they highlighted the fact that the inland tanker industry can be significant safer than it was at the time. Besides these presentations they produced a brochure with the advantages and working principle of the Y-Shaped hull. Besides these common promotion activities Mr. G.C.M. Deen dared to implement the Y-Shaped hull, this was a real life example for the ship owners. The vessel build by G.C.M. Deen Shipping in 2007, MTS Apollo build with an Y-Shaped hull, was nominated vessel of the year in the inland navigation category. For this reason the Y-Shaped hull disseminated itself in the following years.

Adoption

Chemgas
Chemgas is the launching costumer for the Y-Shaped hull related to gas tankers. They were the first to adopt the Y-Shaped hull. Chemgas was already involved in the development of the Y-Shaped hull and the crash tests performed in 1998. TNO discussed with Chemgas, after the crash tests, the possibilities of this hull.

Until the first time Chemgas implemented the Y-Shaped hull they owned maximum air draft coasters with a cargo tank size of maximum 380 m3. These coasters were allowed to sail on the inland waters because of their maximum tank size. As the name indicates these coasters do sail on sea and there cargo operations are performed in sea terminals. Sea terminals are designed for larger cargo tank sizes and as a consequence discharging a relatively small vessel requires relative much time. Port charges in these ports are high and as a consequence of the relatively long mooring time the port charges are high.

In terminals, when discharging the cargo, the cargo has to be analysed before it can be discharged. A sample, that has to be analysed, is taken from every tank, when the cargo is approved the vessel can be discharged. Because of the small tank size, 380 m3, the amount of tanks is high and for this reason the time to analyse the cargo is long. During the analysis the vessel does not earn any money and as a consequence the analysis should be performed as soon as possible when the vessel enters the port. At the time of this innovation Chemgas mentioned that if the increase of the tank size was not approved they would quite operate on sea with maximum air draft coasters.

When Chemgas was able to increase the allowed tank size they would save money at new building of tankers. On the other hand they improved their image with supporting an innovation that is related to safety. Chemgas at that point was the only ship owner that dealt with safety in this manner.

On the inland waters the size of tankers kept increasing because of scale effects, Chemgas was also thinking about increasing their tanker size. At that time they were building two pushed gas barges, Chemgas 20 and Chemgas 21, with an allowed tank size of 380 m3. In each tanker they had to install 6 tanks of 380 m3 which was quite small to handle related to the terminals where they performed their cargo operations. The intention for Chemgas to participate in the development of Y-Shaped hull was to enlarge their tank size of bigger vessels that were going to be built in the future. They applied for larger cargo tanks in the Chemgas 20 and 21 not for the advantages they would have using larger cargo tanks but to speed up the approval process of larger cargo tanks when using the Y-Shaped hull by CCNR. Their motivation is that they believe that an approval for any kind of proposal will proceed faster if there are practical applications available.

CCNR

The adoption of the Y-Shaped hull was only successful if the CCNR was willing to accept that the Y-Shaped hull was able to absorb more energy than the conventional hull. As a consequence they had to accept a larger maximum cargo tank size of vessels using an Y-Shaped hull. In the regulations of CCNR there has always been the possibility of using an alternative construction if you were able to demonstrate equivalence between the alternative and the conventional construction. To demonstrate this equivalence the developers and CCNR needed to discuss on how to show the equivalence. For this reason the CCNR was involved in the project from the beginning. To modify regulations, maintained by the CCNR, the Duch government (shipping inspection) has to apply for these modifications. To convince the CCNR about the modified regulation the developers first had to convince the Dutch government about the potential of this innovation. Ing. K. Den Braven was enthusiastic about the Y-Shaped hull and willing to support and promote it.

DSNS and TNO had to develop a procedure to demonstrate the equivalence of the risk between a conventional hull and 380 m3 tanks and the Y-Shaped hull and larger tanks. For this reason they developed a risk based design approach. It took 4 to 5 years to complete and approve this risk based design approach.

Before they showed the equivalence in risk they decided to show the members of the CCNR a real scale crash test. The Y-Shaped hull was going to be tested for a second time in the presence of the regulatory organizations. After these test TNO and DSNS needed three years more to convince the CCNR that larger tanks in the tankers of Chemgas did not increase the risk of spilling any cargo.

The maximum allowed tank size in the inland navigation industry is 380 m3, the risk of this tank size can be calculated. The risk equals the probability of the penetration of a cargo tank due to a collision and the affected area around the vessel due to the outflow cargo.

Risk=Probability*Effect

A designer is able to demonstrate that the risk of an alternative construction is equal with the conventional construction when the probability of the penetration of a tank is smaller or the effect is smaller. In case of larger cargo tanks the effect will increase so the probability of penetration of the tank has to decrease.

CCNR was willing to accept larger cargo tanks if the developers were able to demonstrate the equivalence between the conventional and new construction. Now the following main problem of this innovation process arose: “How are you able to demonstrate equivalence?” “What are the agreements on how to demonstrate equivalence?” “Which statistics should we use to produce a risk analysis?” and so on. With every step the developers took in this risk analysis they had to discuss their method with the CCNR and convince them. This method was discussed in several meetings of the dangerous goods working group. The members of this group discuss the regulation twice a year. In every meeting, for years, TNO was present to discuss the method of analysing the risk of larger cargo tanks. Finally all the arguments were discussed and they reached a joint opinion, in which DSNS always used the most conservative assumptions. These conservative assumptions resulted in a minimization of the discussion with CCNR while on the other hand demonstrating the equivalence between the conventional and Y-Shaped hull became harder. Finally TNO and DSNS did manage to succeed in demonstrating the equivalence and the concept was approved by the CCNR.

It has been a hard process to convince the members of the workgroup transport of dangerous goods, mainly because of the fact that most members did not have any professional technical knowledge. They look at a proposal that does not comply with the standardized rules, as a consequence they disapprove the proposal. They are not able to objectively assess the proposal and provide useful feedback.

There is an extensive procedure before approval for a proposition is given. It starts with a proposal from a member of the working group transport of dangerous goods. This is where the proposal will be discussed, they meet once every six months to discuss the current regulations and new proposals. If there is a point of discussion that is unclear the proposal is sent back to the member who had proposed. The member has to discuss and solve the ambiguities with the initiator of the proposal. Six months later the proposal will be proposed again by the same member of the working group, it will be discussed again until every ambiguity is solved. If all the members of the working group accept the proposal it will be sent to the committee for transport of dangerous goods, they have to accept the proposal again. Every update requested by a delegate member of the working group needs two to three years before it will be approved by all the members and committees, without any discussion about the proposal.

In 2002 CCNR approved the increased cargo tank size in the pushed gas barges of Chemgas when they used an Y-Shaped hull. The adoption of the increased cargo tank size of this vessel does not automatically include the approval of larger cargo tanks when using an Y-Shaped hull.

With less conservative assumptions and other approaches it will be easier to demonstrate the equivalence, but the strength behind this concept is the conservative approach. The approval on one hand was difficult because of all the people involved that had to be convinced and on the other hand there was a lot of resistance to the idea of larger cargo tanks. The pushed gas barges of Chemgas were relatively small vessels, but the tanker of G.C.M. Deen Shipping was a relatively large vessel with cargo tanks twice the permissible size. Some delegated people and their states were reticent to the idea that a vessel of this size was sailing in their state, they thought of it as a sailing time bomb. It took a long time to convince everyone about the advantages and the safety of a vessel like this but finally everyone approved the concept.

G.C.M Deen Shipping
In 2004 G.C.M. Deen Shipping started developing large inland tankers. They liked to build a tanker of 135 meter length with 9000 ton cargo capacity. To build this vessel with the allowed cargo tank size of 380 m³ they had to implement 24 tanks. Mr. Deen did not accept this large amount of cargo tanks in his vessel because of two reasons: the investment and the safety. All 24 cargo tanks needed all the required appendages and pumps, as a consequence the more cargo tanks they implement the higher the investment will be. On the other hand the safety is at stake, the crew in charge of the cargo operations could lose overview during these operations. At the time of developing this new vessel Mr. Deen was informed on the existence of the Y-Shaped hull by an article in a magazine (Dangerous Goods). This article described the working principle of the Y-Shaped hull and mentioned that this hull was supposed to resist torpedo impacts. After reading this article Mr. Deen was interested in the possibilities of implementing this hull in the inland tanker industry. He attended the second crash tests and approached the director of DSNS requesting the use of their patent. At that time there was no standardized approval that cargo tank sizes could be increased when the Y-Shaped hull is implemented, as a consequence Mr. Deen took quite a big risk. He insured the director of DSNS that he would try to receive the standardized approval by the Dutch Government (Shipping Inspection) and CCNR. If he was able to receive the approval, DSNS insured Mr. Deen that he would receive the licence of the Y-Shaped hull. As a consequence everyone implementing the Y-Shaped hull has to pass Mr. Deen and pay the licence fee to DSNS, they will pay a part of this fee to Mr. Deen.

Mr. Deen director of Deen Shipping is one of the launching customers of the Y-Shaped hull. He asked Rensen-Driessen Shipbuilding to build a chemical inland tanker of 135 meter length 17,5 meter width with an Y-Shaped hull and an increased tank size, he requested twice the size that was approved by the CCNR at that time. The design and calculations had to be performed by DSNS (former Royal Schelde Naval Shipbuilding).

This request of Mr. Deen meant that the risk based design approach had to be approved by the CCNR again.

On the other hand Mr. Deen was a moderator, he interested other parties in the inland shipping industry for the Y-Shaped hull. He asked Rensen-Driessen Ship building to join him in selling the Y-Shaped hull in the inland shipping industry.

Rensen-Driessen Shipbuilding
G.C.M. Deen Shipping is a ship owner and does not sell vessels. As a consequence Mr. Deen realized that he was not able to implement the Y-Shaped hull in other vessels than its own. G.C.M. Deen Shipping decided to split the licence fee received from DSNS with Rensen-Driessen shipbuilding on the condition that they had to promote and sell the Y-Shaped hull. Rensen-Driessen Shipbuilding is a large player in the Dutch inland navigation industry. G.C.M. Deen Shipping and Rensen-Driessen agreed that with every tanker sold they tried to promote and implement an Y-Shaped hull.

Rensen-Driessen Shipbuilding started sounding the possible market for the Y-Shaped hull. The financial benefit and increased safety for ship owners was demonstrated by the developers of the Y-Shaped hull. Some innovative clients were willing to implement the Y-Shaped hull. At the time of the production of this innovation process description Rensen-Driessen Shipbuilding sold 19 vessels with an Y-Shaped hull.

Implementation

Chemgas
The first pushed gas barges were built in 2002 with tanks that were bigger than the maximum approved tank size. They demonstrated equivalence between a conventional hull with cargo tanks size of 380m³ and the Y-shaped hull and larger cargo tanks. The pushed gas barges were installed with 4 tanks instead of 6 tanks (standard approved tanks).

Chemgas adopted the Y-Shaped hull early in the development of that Y-Shaped construction, they were willing to act as lead costumer during the dissemination and adoption of the innovation. In 2002 they build Chemgas 20 and Chemgas 21, both pushed gas barges. The advantages of an Y-Shaped hull with these pushed gas barges were small, they installed four tanks instead of six. For the bigger vessels the Y-Shaped hull does have more advantages than for these small vessels. The reason that Chemgas implemented the Y-Shaped hull in these pushed gas barges is to demonstrate the advantages of the Y-Shaped hull to the regulators. If a customer is willing to take the risk of building a vessel with an Y-Shaped hull and larger cargo tanks than they should be convinced about the advantages this innovation entails. All the parties involved in the development process supported the building of these vessels and were convinced that with this application the approval for larger cargo tanks will be easier. In 2004 Chemgas build two tankers Emwatis and Embata. These two tankers are built to take over the transport of gas between Rotterdam (the Netherlands) and Antwerp (Belgium) by truck. During the transportation of gas by truck some accidents occurred. To increase the safety of this transport Exxon choose to transport the gas with tankers instead of trucks. The storage capacity of the gas terminals was tuned on transportation of gas by trucks, as a consequence Chemgas had to insert two small vessels instead of one large vessel. Due to safety matters they choose to implement an Y-Shaped hull. After these four vessels with an Y-Shaped hull they quite using this hull. Chemgas 20 and 21 both use the opportunity to increase the allowed tank size. The Emwatis and Embata do not use the opportunity to increase the maximum cargo tank size, simply because the vessels do not need larger tanks due to the vessel size, they have four tanks of 350 m3.

Chemgas owns sea river vessels with a limited air draft, they are able to sail on the inland waters. For these vessels it would be an advantage to use the opportunity of sailing with larger cargo tanks. The new vessels of Chemgas use this opportunity but do not use an Y-Shaped hull. They increased the distance between the outer hull and the cargo tank, as a consequence the energy before the tank is penetrated has increased as well. Sailing with this clearance between the outer hull and cargo tank means that you are not able to transport the same amount of cargo with the same volume of the vessel or you transport the same amount of cargo with a larger volume of the vessel. If a vessel only sails on inland water this would be a problem because of the limited size of the inland waters, but the vessels of Chemgas do not enter the inland waters on a regular base. If they do enter the inland waters they have to adjust their amount of cargo to the environmental conditions. For Chemgas the Y-Shaped hull is not necessary anymore, but they use the developed risk based design approach to demonstrate equivalence between the conventional hull and their hull. With an increased clearance between the outer hull and the cargo tank the risk decreases and as a consequence you will be able to insert larger cargo tanks.

G.C.M. Deen Shipping
In 2005 they started developing and designing mts Apollo, 2006 they ordered the inland tanker. In 2007 mts Apollo was built in commission of G.C.M Deen Shipping. They received the licence of the Y-Shaped hull by DSNS. As a consequence, they earned money with the implementation of the Y-Shaped hull in every vessel, as a consequence they promoted the Y-Shaped hull.

At the moment 24 inland tankers are built with an Y-Shaped hull. New building inland tankers with a cargo capacity of 5000 ton and higher are being built with an Y-Shaped hull. Mostly because of two reasons: safety and investment. The building of a cargo tank with all the appendages will cost around € 45.000/ tank, if the amount of tanks is reduced the investment costs will reduce. The other reason for implementation of the Y-Shaped hull is the increased safety during cargo operations and the decreasing risk of penetrating the cargo tank.

Implementing larger cargo tanks when using an Y-Shaped hull was not approved by the regulator at the time of developing and building the mts Apollo. Mr. Deen was willing to take this risk, he developed and build an inland tanker with 12 cargo tanks at port and 12 cargo tanks at starboard, a total of 24 cargo tanks. In between these tanks he did cut huge holes along bulkhead, as a consequence there were only 12 cargo tanks. If the proposal to use larger cargo tanks was rejected he decided to close the holes between the tanks.

After the first inland tanker with an Y-Shaped hull G.C.M. Deen Shipping build two more inland tankers with an Y-Shaped hull, Achilles and Arganon. The Achilles carries 5 larger cargo tanks instead of 10 cargo tanks with a capacity of 380 m^3. This saves 5 times €45.000 on cargo tank appendages, they had to pay a licence fee of €72.000, so the total saving on the investment of this inland tanker are: (5*€45000)-€72000=€153.000. The shipyard requires a higher investment for the steel used in the vessel, as a consequence the total saving on this vessel was around €130.000,-

CCNR
A few months before the mts. Apollo of G.C.M. Deen Shipping was finished the approval to use an increased cargo tank size was received for this vessel, 2006. Mts. Apollo had to be approved separately after the approval of the pushed gas barges and gas tankers of Chemgas because of the size of the tanker. During the development and design of mts. Apollo in 2004 the Dutch government (shipping inspection) requested to increase the allowed cargo tank size of this vessel and standardize the risk based design approach, developed by DSNS and TNO. The working group transport of dangerous goods needed six meetings to approve the risk based design approach of the mts. Apollo.

With the approval for the mts Apollo the risk based design approach was approved to be a standardized method to follow when using an alternative construction.The next step in the innovation process was implementing this risk based design approach in the ADNR, regulations for transport of dangerous goods. Half 2005 the regulations were rewritten and ready to be implemented. ADNR is updated every two year. For this reason it could be implemented in the ADNR at the first following update of the ADNR in 2007. The time between completing the text that had to be implemented and the update of 2007 was too short to implement the update in 2007, as a consequence the rewritten text is implemented in the ADNR in 2009. Finally in 2009 the ADNR was updated with a new chapter about alternative constructions, including this risk based design approach. Everyone is able to implement a new construction in the vessel if they deal with it as mentioned in chapter 9.4 alternative constructions.

The allowed tank size has increased from 380 m³ to 1000 m³ by the CCNR if you are able to demonstrate equivalence between a reference vessel and a vessel with an Y-Shaped hull. A reference tanker is a realistic view of a vessel with cargo tank size of 380 m³ and a conventional energy absorbance in case of a collision. The design of an Y-Shaped hull tanker has to be compared with this reference vessel. If the risk of cargo outflow remains the same with this Y-Shaped hull tanker and the cargo tanks are smaller than 1000m³ than the CCNR will approve the tanker.

In 2009 ADNR was updated with the possibility to perform a risk based design approach. Before ADNR was updated it was possible to sail with bigger cargo tanks with a temporarily dispensation. DSNS calculated the risk for every new building tanker and together with the Dutch Government (Shipping inspection) wrote a recommendation to the CCNR. While this recommendation is presented to the CCNR the inland tanker is able to sail with a temporarily dispensation granted by the CCNR.

Oil refineries
Oil refineries like to deal with inland tankers with a decreased risk. When oil is spilled during the cargo operation at a refinery, the refinery is in trouble because of the fact that the inland tanker is moored at the refinery. The cargo operations are always performed by humans, human failure is unavoidable, as a consequence the decreasing amount of cargo tanks result in a decrease risk during cargo operations.

The risk of penetrating the cargo tank is smaller and as a consequence the risk of leaking cargo during the operation of the vessel is smaller. In the port of Rotterdam there is a lot of vessel movement and for this reason oil refineries like to sail with the safest vessel available.

Naval industry
Actually the implementation of the Y-Shaped hull in the inland navigation industry was the first step for DSNS. The second step was to implement the Y-Shaped hull in the application of naval vessels. They did study, with the Dutch and American marine, if the Y-Shaped hull was suitable to resist the loads in naval vessels and if the hull was suitable to resist explosions half below the water surface and half above the water surface. These test and studies were finalized in 2004 with a good result but the Y-Shaped hull is never implemented in naval vessels. The reason why the hull is never implemented is the geometrics of the naval vessels, this is too complex to install an Y-Shaped hull.

Inland tanker industry
The market that is tried to be reached is the inland tanker navigation industry, especially large inland tankers (cargo capacity of > 4000 ton). Until the production of this innovation process description 24 vessels with an Y-Shaped hull are built or being built. The developers of this innovation are pleased about this market.

Analysis of the innovation process
To remain overview and conclude on the innovation process it is necessary to describe all the important aspects of the innovation process separately. Therefore the analysis is described in separate paragraphs. In paragraph 4.1 the relationships between the key actors will be described. In paragraph 4.2 the adoption of the Y-

Shaped hull will be described, the potential market and the reached market are described. In paragraph 4.3 the success factors in this innovation process are described. In paragraph 4.4 interventions and policy contribution during the innovation process is dealt with. Paragraph 4.5 deals with barriers during the innovation process of the Y-Shaped hull and how they are abolished. In paragraph 4.6 the analysis will be concluded with the lessons learned during the analysis of the Y-Shaped hull innovation process.

Key actors and their relationships

Initiation

The Dutch delegation (Shipping Inspection) of the working group transport of dangerous goods, Central Commission for the Navigation on the Rhine (CCNR), was searching for solution to increase cargo tank sizes in the inland navigation industry. Ing. K. den Braven was employed at Shipping Inspection and started discussing with Ir. A.W. Vredeveldt (employed at TNO) about the possibilities of a crashworthy hull.

TNO would organize crash tests to valid their computer calculations. The Dutch government would support these crash tests because they needed this validity for the regulations. Crash tests are very unique and expensive. A Japanese consortium was asked to take part in the crash tests, mainly to split the costs of the crash tests. This Japanese consortium would also like to test a more crashworthy construction.

DSNS was searching for constructions that were able to resists extreme loads, ir. J.W.L. Ludolphy thought about an Y-Shaped hull. Chemgas asked DSNS to find a solution to increase their cargo tank size. The solution was to increase the energy absorbance of the hull, as a consequence the risks reduces. With the Y-Shaped hull the energy absorbance, in case of a collision, before penetrating the tank is higher than at a conventional hull. Ir. J.W.L. Ludoplhy (employed at DSNS) found in the inland tanker industry an application for the Y-Shaped hull.

Ing. K. den Braven (Shipping Inspection) was searching for a crashworthy construction. Ir. A.W. Vredeveldt (TNO) promoted the crashworthy constructions developed by Ir. J.W.L. Ludolphy (DSNS). Chemgas was searching for a crashworthy construction and discussed the possibilities with Ir. J.W.L. Ludolphy. Ir. A.W. Vredeveldt would perform crash tests on the Y-Shaped hull.

Development

Ir. J.W.L. Ludoplhy developed the Y-Shaped hull, employed at DSNS. Ir. J.W.L. Ludolphy passed away after the crash tests. At DSNS the development of the Y-Shaped hull proceeded with ir. J. Broekhuijsen, he did get help from the University of Helsinki and M2I materials. The crash tests are part of the development process, the evaluation of the Y-Shaped hull. The crash tests are performed by TNO, DSNS produced a part of an Y-Shaped hull to be tested. The Dutch government (Rijkswaterstaat) allocate a location to perform the crash tests.

TNO and DSNS together developed a risk based design approach to demonstrate equivalence between a conventional hull (and 380m³ cargo tanks) and a Y-Shaped hull (bigger cargo tanks). They discussed this risk based design approach with the CCNR.

The second crash tests, using the Y-Shaped hull, were performed to demonstrate the members of CCNR and the Dutch government (shipping inspection) the performance of the Y-Shaped hull. The developers intended to speed up the approval of CCNR for

Chemgas to sail with an increased cargo tank size. Chemgas had to invest in this crash test. DSNS and Chemgas together designed the pushed gas barges with an Y-Shaped hull.

The development of an Y-Shaped hull implemented in type C tankers is performed by DSNS and Rensen-Driessen Shipbuilding. TNO was involved to proceed with the development of the risk based design approach, they standardized it, as a consequence it could be implemented in the ADNR (rules of CCNR for the transport of dangerous goods). G.C.M. Deen Shipping was launching customer for a type C tanker with an Y-Shaped hull and bigger cargo tanks, mts. Apollo.

Implementation

Chemgas, DSNS and TNO tried to receive approval for the building of two pushed gas barges at CCNR with help of the Dutch Government (shipping inspection).

G.C.M. Deen Shipping, DSNS, TNO and the Dutch government (shipping inspection) tried to receive approval for the building of a type C tanker with an Y-Shaped hull and bigger cargo tanks.

Rensen-Driessen Shipbuilding together with G.C.M. Deen Shipping was licensed by DSNS to implement the Y-Shaped hull in the inland tanker (except gas tankers) industry. Chemgas was licensed by DSNS to implement the Y-Shaped hull in the gas tanker industry. Two partnerships were developed: one between Chemgas and DSNS and one between Rensen-Driessen Shipbuilding, G.C.M. Deen Shipping and DSNS.

Adoption rate and spread of the innovation

The patent originates from 1996, ir. J.W.L. Ludolphy started developing the Y-Shaped hull before 1996. The Y-Shaped hull was initially developed to be implemented in the naval industry. The Dutch and American navy studied the possibilities of implementing the Y-Shaped hull in naval vessels. These studies were finalised in 2004. But implementing the Y-Shaped hull in advanced vessels like naval vessels seems too complicated. As a consequence the Y-Shaped hull is not implemented in any naval application.

Chemgas asked DSNS to develop a crashworthy hull to increase the tank size. TNO was developing a crash test and was supposed to perform the crash test in 1998. The Dutch delegation of CCNR was searching for a solution to increase the cargo tank size. In 2000 a second crash test was performed in attendance of all the regulators. This crash test was performed to speed up the approval of increased cargo tanks sizes in vessel of Chemgas. So Chemgas adopted the Y-Shaped hull very soon after the first crash test. In 2002 Chemgas built two pushed gas barges with bigger tanks, approved by CCNR. In 2004 Chemgas build two gas tankers with an Y-Shaped hull without bigger tanks.

During this period G.C.M. Deen Shipping asked Rensen-Driessen Shipbuilding to build a type C tanker with an Y-Shaped hull. Together with DSNS they started developing this tanker. At the same time the approval by CCNR was asked to standardize the method for demonstrating equivalence between a conventional hull ($380m^3$ cargo tanks) and a Y-Shaped hull and bigger cargo tanks. The approval of a standardize method was finalized in 2005, the approval for the tanker of G.C.M. Deen was given in 2007. In 2007 another vessel with an Y-Shaped hull was build and since then the numbers are rising. Since 2002, including the mentioned vessels, 24 inland tankers/pushed barges are built or being built. The Y-Shaped hull is only attractive in inland tankers bigger than 4000 ton cargo capacity because of the investment savings.

Finally the building of alternative constructions using a risk based design approach and the standardized demonstration of equivalence is implemented by CCNR in ADNR 2009 chapter 9.3.

Success factors during the innovation process

Demonstrate advantages

The Y-Shaped hull is developed to improve safety of the inland tanker industry. The image of a company dealing with safety as one of the highest priorities will improve. As a consequence companies are willing to participate in the innovation process or willing to implement the innovation.

The Dutch delegation of the working group transport of dangerous goods and the Dutch government (Shipping Inspection) were enthusiastic about the project, they believed that this could be a real improvement of safety in the inland tanker industry. As a consequence they were willing to assist the participants of the Y-Shaped hull.

Cooperation

During the entire innovation process the cooperation between the participants in this innovation went well, mainly because DSNS searched for the right partners in the innovation process. After internal discussion they deliberately choose their partners.

Industry research organisation

TNO is an independent, non-profit research organisation with a well-developed image. They believed that the Y-Shaped hull was an improvement for the safety of inland tankers. They were willing to promote the innovation and assist in the innovation process when necessary. CCNR had to approve the bigger cargo tanks, they had to be convinced by the Dutch delegation of the working group transport of dangerous goods. TNO assisted the Dutch delegation in convincing the CCNR about the increased safety.

Dissemination during the entire innovation process

During the development process of the Y-Shaped hull the innovation has been disseminated through the inland tanker industry due to the crash tests. Dissemination throughout the entire innovation process ensures the confidence of the innovation. Everyone interested in the innovation is able to observe the innovation process and the evidence required to demonstrate equivalence.

Initiation

Common interest

TNO intended to perform crash tests to valid their computer calculations. This was a unique opportunity to perform real scale crash tests with new constructions. TNO was interested in these new constructions because they were able to valid the calculations related to the conventional hull and the new constructions. There was a common interest between DSNS, TNO, Chemgas and the Dutch delegation of the working group transport of dangerous goods to find a solution to increase the cargo tank size by use of crashworthy hull.

Time to develop new ideas

At DSNS ir. J.W.L. Ludolphy received time and money to develop new ideas. If a company would like to be innovative the employees need time to develop new ideas.

Development

Disseminate to attract investors

TNO was able to perform crash tests in the Netherland. The Dutch government was very interested in the project because of the regulations and the validity of the computer calculation (about the performance of a hull in case of a collision), as a consequence they subsidized the crash tests. The validity of the computer calculations (about the performance of a hull in case of a collision) was important for all users of the software. More users of software were willing to invest in the first crash tests.

Subsidy

DSNS used a law in the Netherlands that promotes development and research work. This law includes that part of the wages related to research paid by the company is compensated.

Proof of concept

During the crash tests it was clear that the performance of the Y-Shaped hull was extraordinary. The "proof of the concept" was at the evaluation of the prototype, early in the development process. As a consequence there was stimulation to proceed with the development and finally implementation.

Launching customer

Chemgas was since the beginning of the idea about a more crashworthy hull very interested in the development. They were willing to cooperate with the development of the idea and implement the Y-Shaped hull, the so called launching costumer. Immediately after the start of the innovation process it was clear that there was request for a practical application of the Y-Shaped hull.

Implementation

Demonstrate advantages and find launching customer

The launching customers were stimulated to take part in the innovation process by means of two advantages. The first advantage is taking part in the innovation process related to a safety matter, this improves the image of the participant. The second advantage is commitment of DSNS with the launching costumers. The launching costumers take part in the patent fee, they receive a part of the fee for every vessel sold with an Y-Shaped hull.

Chemgas immediately implemented the Y-Shaped hull in 2002 in two pushed gas barges. In these barges bigger cargo tanks were implemented, approved by CCNR. With the possibility to increase the cargo size and demonstrate the economic advantages of the Y-Shaped hull.

Chemgas was the launching costumer for the Y-Shaped hull related to gas tankers. The launching costumer for the other type of tankers was G.C.M. Deen Shipping, he demonstrated the advantages of an Y-Shaped hull and bigger cargo tanks to the entire inland tanker industry.

Dissemination through launching customers

Two companies were launching costumer of the Y-Shaped hull, these two companies are medium and major players in the inland tanker industry. As a consequence they are an example for the entire inland tanker industry. If they were willing to implement an Y-Shaped hull than it will offer great advantages.

Policy contribution and intervention

Management intervention

Management of DSNS did intervene with the innovation process. When the inventor, ir. J.W.L. Ludolphy, passed away the management doubted to continue with the development of the Y-Shaped hull. This doubt rose because of the uncertainty about the payback of the investment. A high investment until then was needed, but no money was earned with the innovation. The market that could be reached with the innovation was unclear and for that reason the management considered attracting another participant for the marketing and sales. For this reason Rensen-Driessen shipbuilding was contacted to sell the Y-Shaped hull. They searched for a partner that was well known in the inland navigation industry, a ship builder. DSNS had no intention of putting the innovation in the inland navigation market by itself. Rensen-Driessen Shipbuilding was the right partner according to the management of DSNS, they offered them a partnership. A contract was signed between these two partners, including an agreement about the patent fee. Rensen-Driessen should receive a certain percentage of the patent fee when a vessel with an Y-Shaped hull was being sold. After the start of this partnership DSNS and Rensen-Driessen Shipbuilding started assessing the potential market to implement the Y-Shaped hull, with this assessment and the known costs they performed a cost-benefit analysis.

Dutch government

Support

The Dutch delegation of the working group transport of dangerous goods is employed by the Dutch government (shipping inspection). They supported the Y-Shaped hull since the crash tests in 1998 and were willing to promote and assist in demonstrating the equivalence at CCNR.

Subsidy

Without the financial support of the government the development of the Y-Shaped hull did probably not proceed after the crash tests in 1998, according to ir. J. Broekhuijsen. Agentschap NL (former Senter Novem) did support the development of Y-Shaped hull within the innovation trajectory Cleanest Ship. The crash tests are financially supported by the Dutch government, management of waterways (Rijkswaterstaat). DSNS used the WBSO (Wet bevordering Speur- en Ontwikkelingswerk). The WBSO is a Dutch law and is called “a fiscal stimulation rule”, this indicates that part of the wages for technological research is compensated. All these financial support is applied for by an external party, which is specialized in financial support applications (subsidy).

Support and subsidy

The Dutch government, management of waterways (Rijkswaterstaat), supported the crash tests financially and practically. A location for the crash tests was pointed out by the Dutch government and the crash tests equipment could stay there until the crash tests were finished.

Central Commission for the Navigation on the Rhine

Development contribution

The specialists (BAM, PTB and Germanischer Lloyd) of the German members of the working group transport of dangerous goods assisted in the development of evidence to demonstrate equivalence. They contributed to development of the risk based design approach. This German delegation was very dedicated to the approval of bigger cargo tanks.

Intervention

CCNR approved to increase the cargo tank size if the developer is able to demonstrate equivalence. CCNR told developers of the innovation that they could demonstrate equivalence until 1000m³. Above 1000m³ cargo tanks they were not able to approve the risk based design approach of the inland tanker.

Barriers

The innovation process

Cooperation
In the innovation process partners are working together to develop the Y-Shaped. The sizes of the different partners working together is varying. With the varying size of the company the responsibility structure varies as well. As a consequence not every partner was equally flexible. For example DSNS is a huge company and owns a research department, these people were involved in the development of the Y-Shaped hull. Another example is G.C.M. Deen Shipping, a company with four people in their office, the director of the company was involved in the development of the vessel. As a consequence the director is able to decide very fast, while the people involved from DSNS cannot decide everything at the same speed. An example of this barrier follows below.

At the time of building the mts Apollo, DSNS was still simulating all the possible collisions of the vessel. They found out that one possible collision resulted in penetration of the cargo tank. DSNS requested to stop building the vessel. Mr. G.C.M. Deen rejected to stop building the vessel and told DSNS to find a solution, they found a solution. They told Mr. Deen to increase the deck thickness from 14 mm to 18 mm. Mr. Deen contacted the ship yard in China and told them to increase the deck thickness from 14 to 18 mm, even if the deck was already constructed.

Initiation
No barriers are observed in the initiation process.

Development
Common property
On one hand the Y-Shaped hull is patented, as a consequence everyone implementing an Y-Shaped hull has to pay license fee to the patent keeper. On the other hand the development of a risk based design approach was required to receive approval for the bigger cargo tanks. This risk based design approach is implemented in ADNR and for this reason everyone is able to use this approach. Everyone who uses the approach is able to install larger cargo tanks if they demonstrate equivalence. A ship owner does not need an Y-Shaped hull to demonstrate equivalence, there are other manners to increase the energy absorbance in case of a collision (e.g. bigger clearance between cargo tank and outer hull). Everyone who cooperated with the development of a risk based design approach invested time and money to do so, while everyone is able to use this approach.

Regulations
To evaluate the Y-Shaped hull and other crashworthy construction a crash test was required. Deliberately collide with another vessels is by definition illegal, as a consequence TNO had to apply for approval of the crash tests with the Dutch government (Rijkswaterstaat). Because of the fact that TNO is a non-profit and independent organization the Dutch government did approve the crash tests. The Dutch government thought that the crash tests were a contribution for the safety in the inland shipping industry.

Regulators involved in an innovation process have to be willing to cooperate. The innovation will never be a success if there is someone in this responsibility structure bureaucratic. Most employees of the regulatory bodies are not technical educated, therefore it will be hard to objectively assess a technical innovation. As a consequence they often cover the safety with the conventional proved rules.

Market
DSNS tried to develop the Y-Shaped hull for the naval industry. The implementation of the Y-Shaped hull in the naval industry was expected to be a difficult process. As a consequence DSNS decided to implement the Y-Shaped hull in a commercial application, the inland tanker industry, to find and solve all the problems during the implementation. To implement the Y-Shaped hull in the inland tanker industry DSNS required knowledge of the inland tanker market, for this reason they offered Rensen-Driessen shipbuilding a partnership.

In this industry there are many ship owners. Ship owners who do own one vessel and make a living with that vessel, these ship owners are most of the time quite conventional. They are not willing to invest in new technologies if there is a risk of losing money. As a consequence it is quite hard to find motivated ship owners willing to cooperate to develop and promote an innovation.

Two ship owners were willing to invest time and money in the development of the Y-Shaped hull, because they would have the opportunity to increase the cargo tank size.

Investment for the development
The investment needed to develop and implement the patent was high.

On one hand to apply for a patent requires a large investment. DSNS intended to apply for a patent in entire Europe. It is not possible to apply for a patent that is valid in all European countries, in every country you need to apply for a patent separately. This includes a novelty study in every country, every year the patent keeper has to pay patent fee in all the different countries. These cost increase every year and with every country involved. For this reason DSNS had to consider in which country they applied for a patent and in which country it was not necessary to apply for a patent. At the start of the innovation it was unclear if the investment repaid itself, it was unclear whether they could sell any license. As a consequence they took quite a big risk in applying for a patent in a lot of the European countries.

On the other hand the investment after the crash test until the implementation of the Y-Shaped hull in inland tanker vessels was high. They first needed to develop the Y-Shaped hull for one application and after that they needed to develop the Y-Shaped hull for other ship types. For the investment to develop the Y-Shaped hull they received subsidy and private investments.

Investment for the second crash test
The regulations mentioned in ADNR are in force since 1972. The members of the working group were not willing to change any of these regulations, for them there was no incentive to change the regulations because there were no problems with the regulations. The regulations were based on the inland tankers of 1972, while the inland tankers are modified since 1972. The second crash test, needed to convince the regulatory organizations about the potential of this innovation and to approve larger cargo tanks for the tankers of Chemgas, needed a second investment.

Because of the fact that Chemgas would like the approval for their vessels they decided to invest the required amount of money to demonstrate the energy absorbed by the Y-Shaped hull. Chemgas was willing to take the risk because ir. J.W.L. Ludolphy and ir. A.W. Vredeveldt did believe that the Y-Shaped hull was able to absorb more energy than a conventional hull and they convinced Chemgas. Chemgas had to invest 600.000,- Dutch guilders, around 270.000 Euro.

If the CCNR approved larger cargo tanks for two tankers of Chemgas, Chemgas would be able to save on the investment. These savings would be higher than the investment required performing the crash tests. The implementation of the Y-Shaped hull in the Chemgas 20 and 21 is financed by Chemgas. Chemgas did not perform a cost-benefit analyses, they needed larger cargo tanks no matter what.

Communication

During the demonstration of equivalence at CCNR the German delegation was at first conservative. They required evidence and a well-developed demonstration of equivalence between the conventional hull with cargo tank sizes of 380m³ and the Y-Shaped hull with bigger cargo tank sizes. But they were willing to assist in developing this evidence and developing the risk based design approach. As a consequence TNO, ir. A.W. Vredeveldt, had to cooperate with PNB and BAM, both German research facilities. At the start the cooperation was very difficult, they did not understand each other very well. The employees of PNB and BAM did not speak English very well. Ir. A.W. Vredeveldt thought about trying to speak German. Technical discussions were most of the time still performed in English, but the Germans appreciated the fact that he tried to speak German. Since then the German delegation tried to assist in proving the equivalence. TNO, DSNS with assistance of the German delegation found a method to proof equivalence and develop a risk based design approach.

Implementation

CCNR

When someone develops an idea that needs approval of CCNR to be implemented you will first need to go to your own national government, member of the CCNR working group. You will need to show your innovation to them and if they do believe the innovation contributes to an improved inland navigation industry they propose the innovation at the CCNR working group. As an inventor you are not able to directly inform CCNR about your innovation. In the working groups of CCNR every state member has to deliver a delegation of people from their country. These members are most of the time nautical specialist, economists, jurists, etc., most of them are not technical educated. As a consequence if there is a new proposal, that does not meet the regulation, they will tend to disapprove the proposal. If they do consider approving the innovation they need to demonstrate the innovation to technical specialists in their country. The members of the CCNR working group transport of dangerous goods have to be unanimous when the decide on regulation.

The proposal of the country to the CCNR needs approval or disapproval, as a consequence there will be discussion before everyone agrees on their unanimous decision. The developer of the innovation will never know how long it will take for CCNR to decide on the innovation. The mts. Apollo was almost finished when the approval of CCNR was given, this is a big risk for the ship-owner. If it took any more time to decide that the mts. Apollo was able to install bigger cargo tanks then the vessel was not able to sail, and therefore not able to earn money. You will never know the duration of the decision process at CCNR.

During the development of the Y-Shaped hull with bigger cargo tanks the developers needed to show equivalence. If they demonstrated this equivalence every member in the working group transport of dangerous goods had to approve the use of an Y-Shaped hull and bigger cargo tanks. The equivalence demonstration has been a long and difficult process. Finally the developers of the Y-Shaped hull were able to show equivalence using a risk based design approach.

Approval of a proposed concept by CCNR is a long and difficult process. When there is a practical application of the concept the members of the working groups are able to observe the concept in real life, this will probably speed up the decision making process at CCNR. There were two practical applications at the time of the decision making process, Chemgas and G.C.M. Deen Shipping.

There is still one regulatory barrier that is not abolished. Every time a ship owner decides to implement an Y-Shaped hull he has to apply for larger cargo tanks. To apply for these larger tanks he has to demonstrate equivalence between the reference tanker and the new designed tanker. As a consequence the design costs for a vessel with larger cargo tanks are higher.

Summarized the main barrier of the innovation process was the implementation of the modernized rules by CCNR. This barrier is overcome by three methods: practical applications, crash tests and a risk based design approach to demonstrate equivalence.

Launching costumers and subsidy
Chemgas applied for subsidy to invest in the crash tests. At the time of the crash tests Chemgas did not exactly know what they would do with this innovation, they did not exactly know the purpose, besides safety, of this innovation. As a consequence they did not receive any subsidy. They privately invested in the crash tests and the implementation of the Y-Shaped hull.

Deen shipping applied for subsidy during the implementation of the Y-Shaped hull in their first vessel. They did not receive any subsidy because they intended to earn profit with the innovation. As a consequence they had to privately invest in the implementation.

The risk for the launching costumers of no approval, while they invested time and money in the development and implementation, is high. This risk has to be compensated by someone. DSNS decided to compensate this risk, they agreed to split the profit of the patent fee with the launching customers.

Lessons to be learned and recommendations
The analysis of this innovation process is performed in different steps: the first step was identification of key players and their relationships, second step was description of the adoption process, third step was the identification of success factors, fourth step was identification of policy contribution and intervention and the last step was the identification of barriers and how they are abolished.

With the lessons to be learned from this innovation process we will conclude this analysis. The lessons learned are directly related to the described innovation process and the analysis of the innovation process.

Lessons to be learned from success factors
Cooperation

The main success factor of this innovation process is cooperation between firms involved in the innovation process. The lesson learned from this success factor is to involve other parties in the innovation, do not try to keep the innovation internally. Protect the innovation by means of a patent and disseminate the innovation.

The main reason for attracting other parties to assist in the development and implementation process is knowledge. Every firm is specialised in a specific area, by using these specialisation the innovation process will have a high chance of being successful.

Cooperate with independent organisation
If an innovation process is supported by an independent, non-profit, research organisations people are convinced that the results of tests are valid. As a consequence the results of evaluation of the prototype will be adopted earlier.

Cooperate with regulatory bodies
If the implementation of an innovation requires a modification of the rules try to drag the regulatory bodies early in the development process. Demonstrate the advantages of the innovation to them and convince them about supporting the innovation.

Publish the results of the innovation process
Results achieved during the innovation process should be disseminated. People interested in the innovation will be convinced about the advantages of the innovation if the results and how they were achieved are published.

Demonstrate advantages
Try to demonstrate the advantages during the innovation process. Try to find advantages that will contribute to the industry, like safety. If safety is the main advantage of an innovation, but it is not obligated to implement the innovation by the regulatory bodies, try to find a convincing advantage besides safety.

A launching costumer in the innovation process is able to speed up the adoption of the innovation by demonstrating the advantages of the innovation. Try to find launching customers by offering them advantages over other adopters. A launching customer always takes a risk by implementing the innovation, this risk has to be compensated.

Focus on several industries
An innovative idea developed in an industry does not by definition have to be implemented in that industry. An innovative idea can evaluate to be more applicable in other industries. An innovative company is not supposed to focus on one industry, if they developed an innovation applicable for other industries try to implement it in another industry.

Subsidy
Try to attract an external party to apply for subsidy. They can assist in where and for what you are able to attract public money. Make sure that part of investment is public and part of it is private. If the risk of developing an innovation is divided between the government and the industry both will be motivated to successfully finalize the innovation.

Innovative company
If a company likes to be innovative, for whatever reason (e.g. competition), make sure that employees are offered time and money to think about new ideas and

develop these ideas. A quote from one of the interviews was “Be ready and take the chance if it is there” (ir. A.W. Vredeveldt). Be ready to develop new ideas and take the chance if someone is able to offer it.

E.g. in the innovation process of the Y-Shaped hull the chance was offered to perform crash tests. It is very unique to perform real scale crash tests. DSNS was only able to take part in the crash tests because crashworthy structures are something they dealt with for already a long time.

Lessons to be learned from policy contribution and intervention

Policy intervention

During the development of an innovation it might become clear that you will need some modification of rules to be able to implement the innovation. For this reason you need to inform the authorities early in the development process. As a consequence you will be able to discuss with the authorities what you will need to do to get approval to modify the regulations. The regulatory bodies are able to intervene with the process or they are able assist in the process. As an innovative company you are able to influence the cooperation with the regulatory bodies.

E.g. CCNR almost did not intervene with the innovation process because they could discuss their needs with the developing companies. CCNR made sure that the developing companies showed equivalence on the way they demanded it. The equivalence is demonstrated with a risk based design approach by DSNS, TNO and assistance of CCNR.

Knowledge about regulation

If it becomes clear that regulations need to be modified to implement the innovation make sure that you have knowledge about these regulations.

E.g. in the innovation process the developing parties would like to increase the cargo tank size of inland tankers. The regulations already approved an alternative design of a vessel if you were able to show equivalence. A bigger cargo tank size was not allowed, therefore regulations needed to be modified.

Knowledge about subsidy

If a company is developing an innovation and would like to attract investors, private or public, the company needs to make sure that they know where and how to apply for subsidy. For this reason it might be wise to attract an external party how applies for the subsidies.

Management intervention

The management of an innovative company needs to observe and financially control the innovation process. As a consequence the management should monitor the costs of the development process and know what the benefits will be. A management team should not intervene with the technical development and trust their engineers in knowing how to develop an innovation. The management should support the employees involved in the innovation process.

When the company management is not able to predict the benefits or they are not able to perform a market assessment, they should attract another partner who is able to do so.

Lessons to be learned from barriers

Communication barriers

A company developing an innovation with international partners needs to ensure that communication will not lead to any problems. Predict during the development process in which languages the partners will communicate and make sure that employees involved in the innovation process are able to communicate in that language. They do not have to communicate fluently in that language, but trying to communicate in that language will be appreciated by the partner. As a consequence the cooperation will improve.

European patent

If a company likes to patent their innovation in Europe they have to apply for a patent in every single country. A patent for the EU could reduce the invested money and time to apply for a European patent.

CCNR

In the description of this innovation process it was clear that the method of applying for approval is not very effective and that the decision making process at CCNR takes quite a long time. For this reason there are some recommendations related to CCNR.

Technical educated people are able to objectively assess an innovation. In the working group transport of dangerous goods most employees are not technical educated. As a consequence they disapprove an innovation because it does not comply with the rules or the proposed innovation has to be assessed by specialists in their own country. If specialists assess the innovation it will take a long time before the assessment is finished. First of all the proposal has to be demonstrated to the specialist, than he has to assess it, questions will rise and he passes them on to the working group, they discuss the questions, etc. If employees in the working group are able to assess the innovation it will speed up the decision making process.

CCNR could implement a deadline in the decision making process. The developer of the innovation will ask for approval of the innovation and does not have any indication how long the decision making process will take. Not knowing how long the decision making process will take is a big risk for the developer. CCNR could give the developer an indication of when the decision making process will finish or they implement a deadline.

The decision making process takes a long time for many reasons, one of them is the unanimous in the decision of all the members. The working group transport of dangerous goods only meets once in half a year, as a consequence they can only decide once half a year. If someone is ill or not able to read a proposal because of the language than the decision has to be postponed. If the working group does decide based on a majority of votes the decision making process will take less time.

Testing of hypotheses

- That the removal of barriers (of various types) to the spread of innovation is one mechanism to speed up and extend innovations through the sectors.

The main barrier during the innovation process of the Y-Shaped hull has been the approval of CCNR to implement bigger cargo tanks when using an Y-Shaped hull. Without the approval, the Y-Shaped hull would only have safety advantages, with the approval the cargo tank size can be increased. The increase of cargo tank sizes results in economic and safety advantages. The Y-Shaped hull was only going to be adopted with the approval of CCNR to increase the cargo tank size.

During the development of the risk based design approach, to demonstrate equivalence between a conventional hull and the Y-Shaped hull with an increased tank size, TNO had to communicate with the German delegation of CCNR. Switching from English to German was the start of a successful cooperation.

- That the existence of adoption and implementation barriers, however, is not a *sufficient* explanation as to the speed or extent of the spread of innovations through the sectors.

To answer this hypothesis we will need more data on other innovation processes.

- That the impact of support agencies external to the firms has a significant impact on the speed and extent of the spread of innovation through the sectors.

The support of the Dutch delegation of CCNR, member of the working group transport of dangerous good, was necessary to propose for the approved increased cargo tank size.

Support of all the actors involved in the innovation process was required to successful complete the innovation process.

- That the impact of types of support processes internal and external to companies on the speed and extent of the spread of innovations through the sectors.

To answer this hypothesis we will need more data on other innovation processes.

- That public financial support may be required to produce the optimum rate and extent of spread among the surface transport sectors examined.

Public financial support was required during the development of the Y-Shaped hull. Financial support was required to support DSNS in their research costs. Financial support was required to perform the crash tests, the evaluation of the Y-Shaped hull.

- That industry research associations represent useful mechanisms to assist the adoption and spread of innovations within sectors.

TNO is a research association, without their effort in performing crash tests the demonstration of the advantages of the Y-Shaped hull had not become clear. They assisted in collecting the evidence to demonstrate equivalence to CCNR. They took care of the adoption of the risk based design approach, required to approve the increased cargo tank size, related to the regulators.

- That linkages forged at EU level, e.g. the various EU research strategy groupings, lead to a more rapid pace of innovation.

N/A

- That the sharing of innovations with other firms in the transport chain is both a characteristic of a number of innovations and a factor in achieving the rapid spread of intermodal transport chain innovations.

This innovation is not about intermodal transport but the hypothesis is applicable on the innovation process of the Y-Shaped hull.

Sharing of the innovation with other firms is definitely a characteristic of this innovation. DSNS shared their innovation with the launching costumers and Rensen-Driessen Shipbuilding. Without sharing this innovation DSNS had to put the innovation in the market by itself. They did not have any connection with the inland navigation sector, as a consequence they attracted partners who do have a connection with the inland navigation sector. Developing these partnerships resulted in a rapid spread of the innovation.

- That the provision of independent information on the positive impacts of innovations on the volume and socio-economic, cost-effectiveness of freight transport across the EU may enhance the adoption and spread of innovations across the sector.

N/A

Templates
The key success factor template is filled out with numbers, 1 is of minor importance and 5 is of big importance. If the key success factor was not present we should leave the cell empty.

Category of factor	Sub-category	Initiation (ranked 1-5)	Development/ Spread (1-5)	Implementation (1-5)
Technological	knowledge and expertise available	5	5	5
	availability of technologies	3	3	3
	compliance with standards	1	1	5
Administrative and legal	legislative guidelines	1	5	5
	Adm. partners available	-	-	-
	(lack of) clarity about division of responsibilities	1	3	3
Political and process-related	support, relay in local, regional assemblies	3	5	5
	the role of interests groups	1	2	2
	cross boundaries effects	-	-	-
Socio-cultural and psychological	incentives, motivation, spirit of entrepreneurship	5	5	5
	involvement in the project on the part of the stakeholders	1	5	5
	link universities/research/innovation	5	5	5

Economic and financial	net benefits for actors	5	5	5
	revenues for actors	1	3	5
	availability of subsidies	1	5	1

The barrier template should be filled out using numbers, 1 is of minor importance and 5 is of big importance. If the barrier is not present we should leave the cell empty.

Category of barrier	Sub-category	Initiation (ranked 1-5)	Development/Spread (1-5)	Implementation (1-5)
Available information (knowledge)	Lack of information on information	-	-	-
	Lack of information on markets	2	4	1
	Lack of qualified personnel	1	3	3
Technical	Lack of interoperability	1	1	1
	Lack of lack of standardisation and certification	-	-	-
	Difficult adaptation to a new technology	1	5	5
Legal and regulatory	Legislation, regulations, taxation	1	5	5
	Administrative barriers	1	5	5
	Weakness of property rights	5	1	1
Financial and economic	High costs (too high costs)	1	3	3
	Lack of funds within the enterprise and subsidies from outside	-	2	3
	Lack of competition in the market	-	-	-
Cultural and societal	Scarce acceptability	2	3	5
	Scarce attitude of personnel towards change	-	2	5
	Inability to devote staff to innovation activity	-	-	-
Decision making	Lack of cooperation among partners (public, private,…)	1	1	2
	Fragmentation of decision levels	-	-	3
	Lack of Vision and Policy Growth	1	3	-

Analysis of innovation process Automatic Identification System

Introduction
Information and Communication Technology (ICT) in the maritime sector is used by all kinds of equipment. ICT applications in the inland navigation industry are (arbitrarily and incomplete):

- Stability (e.g. cargo planning software)
- Administration (e.g. cost price calculation software)
- Communication (e.g. River Information Services)
- Electronic reporting (e.g. inland shipping information and communication system, BICS)
- Dangerous goods (e.g. dangerous goods regulation software)
- Track and trace (e.g. Automatic Identification System)
- Information exchange (e.g. River Information Services)
- Internet
- Logistical (e.g. fleet planning software)
- Navigation (e.g. inland Electronis Chart Display System (ECDIS)
- Process security (e.g. fuel consumption software)
- System management and security (e.g. anti-virus software)
- Freight mediation programs (e.g. bargelink, platform used by shippers and transportation companies)
- Environmental circumstances (e.g. River Information Services)
- Etc.

Because of this inexhaustible list an assessment of the innovation process of ICT in general is impossible in a reasonable time frame. As a consequence the Technical University of Delft decided to limit this assessment and study the innovation process of River Information Services (RIS).

Extensive information exchange between all the actors in the supply chain is required these days. This information is needed to perform accurate planning and optimize the resource allocation. Using communication and information technologies nowadays is crucial to increase the operational efficiency and safety in the supply chain. River Information Service (RIS) can provide this required information. RIS uses several other IT applications like:

- Internet
- Inland ECDIS
- Inland Electronic Navigational Charts (IENC)
- Electronic ship reporting system
- Vessel track and Trace (like AIS)
- Radio Detection and Ranging (Radar systems)
- Voyage planning applications
- Fuel consumption optimization programs.

An innovation process assessment of RIS will be too extensive in a reasonable time frame as well, as a consequence this should be limited, eventually we decided to assess the innovation process of Automatic Identification System (AIS), track and trace system.

Innovation process

Initiation period
The initiation period of Inland AIS is a rather long period because it is developed and implemented by merchant shipping and it is part of another system called RIS.

Generate ideas

Since the mid 80's experiments have been executed to determine the added value of radio transponders in shipping. These experiments were commissioned by the Dutch government. TNO had built ARIS (Automatic Reporting and Identification System) to demonstrate the use of radio transponders in the maritime industry. Following , the international Maritime Organization (IMO) started arguing about the systems because they were developing Digital Selective Calling (DSC). DSC is part of the Global Maritime Distress and Safety System (GMDSS). DSC is used to send standardized distress messages and communicate ships to ships, ships-shore and shore-ships by VHF, MF and HF. DSC and emergency traffic have to operate both using VHF channel 70, therefore the transponder capacity is significantly limited. Because of this limited capacity the industry desired to dedicate one channel for transponder functions. Transponder functions like: dynamic messages of vessels (speed, heading, rate of turn, etc), static messages of vessels (call sign, name IMO number, etc), voyage information of vessel (like destination, estimated time of arrival, dangerous goods, etc.), security messages, data messages, etc. These desired functions required a new communication device, therefore Automatic Identification System (AIS) was developed, figure 1. Since 2000 IMO started to revise the Safety Of Lives At Sea (SOLAS) chapter V regulations, this included the implementation of AIS in merchant shipping. All merchant vessels of 300 GT (Gross Tonnage) and bigger are obligated by IMO to use an AIS, these regulations have been adopted by the Dutch government, Dutch flagged merchant vessel are obligated to use AIS.

"*The AIS information transmitted by a ship is of three different types:*

- *fixed or static information, which is entered into the AIS on installation and need only to be changed if the ship changes its name or undergoes a major conversion form one ship type to another;*
- *dynamic information, which, apart from navigational status information, is automatically updated from the ship sensors connected to AIS; and*
- *voyage-related information, which might need to be manually entered and updated during the voyage."* (IMO, 2001)

AIS demonstrated a significant contribution to the safety of merchant shipping. Because of the ship-ship communication officers of watch are able to use AIS to avoid collision and use AIS as navigational aid (providing information about position, status, tidal and current data, and weather conditions). Shore-ship communication enables vessel traffic service (VTS) to send messages related to navigational warnings, traffic management information and port management information. AIS can be used for automatic electronic reporting. Search and Rescue operation can be assisted by AIS. It supports voyage planning and monitoring, dangerous goods can be tracked and traffic situations can be monitored. The use of all these AIS applications will result in a safer maritime environment. The AIS is fully developed to be used in merchant shipping.

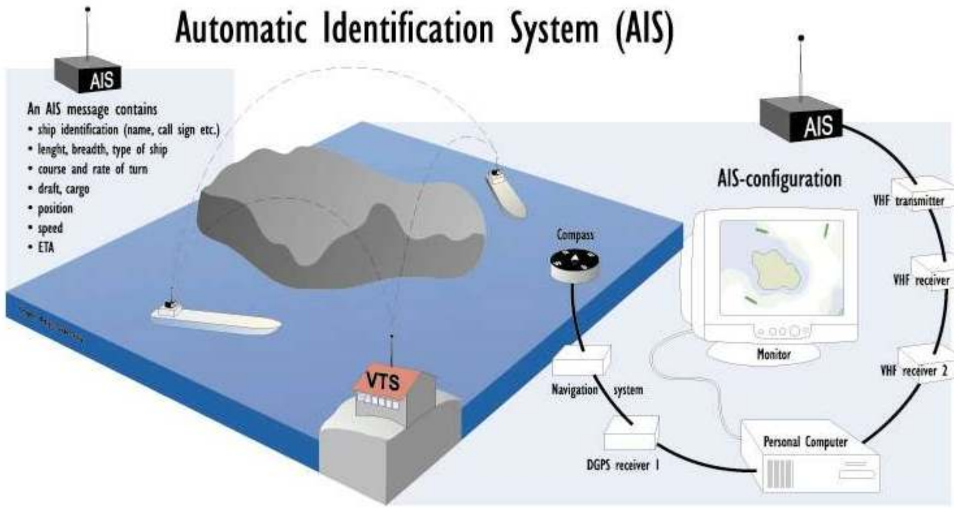

Figure 1: Automatic Identification System (www.shinemicro.com)

The transportation of cargo on the Dutch road infrastructure could be problematic in the near future. An alternative transport modality could be used to solve these problems, this could be the inland navigation industry. *"Regrettably, in most of the potential intermodal transport chains identified, the inland waterway transport component often stays the weak link for different reasons. This weakness constitutes a major handicap, which affects the reliability of this transportation mode and slows down the "transfer of cargo" towards the waterways"* (Ndiaye et al. 2006). A competitive transport modality using the inland navigation industry should be more reliable, faster and safer. To achieve this improvement in the inland navigation industry information technology is crucial. Therefore River Information Services (RIS) should be developed. The aim of RIS is to ensure, by using efficient and reliable information exchange, a safer, smoother and easier to plan inland navigation industry.

Many project in the past and current projects have been initiated to develop RIS in Europe. European projects are e.g.: COMPRIS (Consortium Operational Management Platform River Information Services), SPIN (Strategies for the promotion of Inland Navigation), IRIS (Implementation of River Information Services in Europe), RISING (River Information Services for Transport&Logistics) etc. Many national initiatives have been initiated as well e.g: Pilot project Corridor 895 (Dutch), STIS and RIS (Flanders), etc.

Shocks

INCARNATION (Identification of Administrative and organisational barriers and the assessment of informational and organisational requirements and functionalities of an efficient inland navigation information system with special regard to transport capacity and goods flow, safety of traffic and transport of dangerous goods) is the first European project related to the development of RIS executed in the 4th framework of EC transport. The amount of transported cargo will keep increasing, as a consequence more cargo capacity is required. Road transport deals with extensive exhaust and noise pollution, an increase in road transport is unacceptable according to society. Besides these negative aspects there is a significant overload observed in the European road infrastructure, as a consequence traffic congestion keeps increasing. A goal of European countries is to shift cargo from road to inland waterways because of these negative effects. The use of inland waterways can be increased by increasing the safety, efficiency and reliability of this industry.

"INCARNATION aims to enhance both navigation safety and the reliability of waterborne transport" (Glansdorp, C., Blaauw, H., 2001). These goals should be achieved by developing some kind of River Information Services and development and demonstration of a traffic situation monitoring system on board of inland vessels. It was argued that River Information Services should at least include monitoring of traffic situations on board, to receive environmental conditions information on board and to supply cargo information to stakeholders.

Vessels using European inland waterways mainly use RADAR to monitor the local traffic situation. The use of RADAR on inland waterways is limited, sometimes it is not possible to monitor a traffic situation on the other side of bridge or bends. The range of a RADAR is limited as well. Governments ensure safe passages on local dangerous situations by use of VTS centres, they regulate traffic using VHF communication. When a skipper is able to monitor the local traffic by himself, a VTS centre does not have to provide the required information, therefore VHF communication can be reduced and the skipper will not be distracted by VHF communication.

INDRIS

INDRIS (Inland Navigation Demonstrator for River Information Services) is a European project initiated in 1998 and based on INCARNATION. The project is initiated to develop standards about information exchange in the inland navigation industry. These standards were required in an early stage of the development of RIS to avoid the use of different communication systems. Data communication is mostly performed between ships and shore and vice versa. As a consequence standards for this kind of communication were required. The project should be finalized by experiments to demonstrate the application and profitability of RIS. Governmental departments of European members were involved in the project, besides industrial members.

The project was initiated by defining the core functions of RIS. Tactical traffic information and tactical traffic image (TTI) are core functions. This information is able to support users in decisions about navigation, traffic management and calamity avoidance. The traffic situation is continuously monitored and will be updated and displayed on the bridge of vessels.

VTS centres are located along rivers to provide traffic situation information to skippers about dangerous situations, they use RADAR stations and information provided by vessels to monitor the current traffic situation. The information provided by vessels and provided to vessels will be communicated by use of VHF. An automatic identification system (AIS) can be used to improve the TTI services of a VTS. Using DGPS will enable the possibility to continuously transmit vessel information (about position, identification, depth, width, etc.), therefore report to a VTS, by use of VHF, is not necessary anymore. This will improve the safety of inland shipping because skippers are able to focus on their main job instead of communicating. If the identification and position of nearby located vessels is provided to a skipper he will be able to effectively communicate and avoid collisions. The main advantages of a TTI system is: vessels are visible that were not visible with a conventional RADAR and more efficient communication ships-ships, ships-shore and shore-ships is possible.

One part of a TTI system is proposed to be AIS, AIS is already used in merchant shipping and could be implemented in the inland navigation industry as well. Using an AIS system enables the following:

- AIS transponders transmit information to shore stations and other transponders. Therefore position and identification of vessels are known without the use of a VTS.
- Without AIS a skipper needed to contact a VTS to identify a vessel are call a vessel by using its position. Calling a vessel using its name enables the possibility to effectively communicate about navigational matters.
- AIS is able to transmit more information besides position and identification. In case of calamity information about a vessel carrying dangerous cargo can increase the quality of fighting a calamity.

Using AIS as part of RIS will improve the efficiency of inland navigation.

The second core function is Strategic Traffic Image (STI) and will assist users in traffic and fleet management decisions. Monitoring large regions enables waterway managers to anticipate on expected traffic situations. When a large amount of vessels are entering a waterway, that does not own enough capacity to deal with these vessels, they are able to pull this amount of vessels apart to ensure a smooth throughput and avoid calamities. Shippers are able to track and trace vessels and monitor available cargo capacity in a certain region. Therefore they are able to efficiently use the inland fleet. VTS centres do not have to communicate with skippers, they do monitor the traffic situation and anticipate to future problems. Their role could change from providing required traffic information to handling traffic planning and monitor traffic safety.

The third core function is strategic information and will assist users in planning transport activities. Estimated time of arrivals and required time of arrivals can easily be communicated by using RIS. Skippers can easily update their required time of arrival when they notice current problems on their route. Terminals can transmit required time of arrivals to skippers because of limited cargo handling capacity. They both are able to minimize their transportation costs: a skipper is able to adjust speed and save fuel and a terminal is able to optimal use its cargo handling equipment. Authorities are able to use ETA's of vessels to optimal plan lock cycles and inform skippers about a RTA, therefore the skipper is able to adjust the speed and save fuel.

The fourth core function is a Fairway Information System (FIS) and informs users about the current situation on a waterway. The system will supply the following information:

- notices to skippers, current, current and predicted water depths,
- current waterway constraints,
- integrate this kind of information to electronic charts.

FIS includes all the traditional information used to safe navigate on inland waterways.

The development of data and communication standards are the main objective of this project. Because INNOSUTRA is concerned with the development of AIS we will focus on the development of standards related to AIS. An AIS transponder system seems suitable to handle all the dynamic information, it is already a proven and adopted system by IMO and the IMO members in merchant shipping, as a consequence it is believed to be suitable for inland navigation as well. However, AIS should be modified to use in the inland navigation industry.

Development period

Evaluation of ideas

INCARNATION has been initiated to determine functions provided by RIS and develop a tactical traffic image (TTI) on board of vessels. The participants discussed the possibilities how to develop a TTI and thought some existing systems would be suitable, shore radar and DGPS. They decided to develop these two separate systems and compare the use of them.

Design and Development of innovation (INCARNATION)

Both systems are existing, but they should be modified to make them suitable for use in the INCARNATION system. The first method is developed by HITT (Holland Institute of Traffic Technology, the Netherlands). A shore RADAR station is strategically located and able to transmit signals to vessels. This RADAR station is able to observe traffic in a certain area and monitor the traffic situation. The monitored traffic situation is transmitted and presented on a screen on the bridge of vessels. The system is able to monitor traffic in a certain region, therefore skippers are not limited to bridges, mountains or bends. On the other hand the system is not able to provide static information about the vessel, like vessel identification. While this could significantly improve the safety of inland shipping, an identified vessel can be called for by a skipper in order to avoid collisions. The second methodology uses Differential Global Positioning System (DGPS) and is developed by DASA (Daimler Benz Aerospace AG, Germany). Vessels equipped with DGPS will transmit DGPS information and other relevant information (like vessel identification, depth, dangerous cargo etc.) to a central shore station. The shore station will receive all DGPS and relevant data of vessels and is therefore able to integrate this information in a TTI. The TTI will be transmitted to vessels in a certain area and the skipper is able to observe the TTI on a screen. Every vessel displayed in the integrated traffic monitor screen needs to carry a DGPS system. While not every vessel will carry a DGPS and therefore the integrated traffic situation is not complete.

The HITT method is not able to display vessel identification and the DASA method is not able to observe all vessels. Therefore project participants in INCARNATION decided to combine both systems and experiment with it. Full RADAR coverage and vessels identification (if provided) can be transmitted to vessels. This will significantly improve the safety of inland shipping. The system has been tested in 1997 in the Netherlands.

HITT supplied a shore-ship connection to transmit RADAR information from a VTS station to a vessel. To display this information on board software was required, this software was available. The software has been tested by HITT to ensure the desired compatibility. After these tests it was clear that HITT had to develop integration software between the RADAR and transponder/DGPS of DASA.

A DGPS work package was initiated to develop a DGPS system able to transmit/receive GPS information. The development has been extended because it had to receive shore RADAR images as well. The participants required that the communication systems had to be compatible with the IMO requirements used in the merchant shipping AIS. Compatibility was desired to enable communication between inland and merchant vessels.

Based on these requirements DASA decided to develop Automatic Identification and data Management System (AIMS 7100). This system uses VHF to transmit/receive information. Every vessel using this system will be equipped with a mobile transmit/receive unit (MTU). MTU will automatically transmit navigational, positional and voyage information. The system is compatible with merchant shipping AIS. All system users in a certain range will be displayed on board of every vessel. The following services can be provided:

- weather circumstances,

- waiting time at locks,
- integrating information of shore RADAR systems, if HITT systems are installed,
- the main function is a current tactical traffic image.

This system enables the possibility to transmit TTI used by a VTS centre. “This enables the possibility to look around the corner” (DASA, 1998).

Evaluation of prototype (INCARNATION)

The INCARNATION system developed by HITT and DASA called AIMS 7100 was tested in 1997 using the Dutch inland waterways (nearby Rotterdam). The traffic intensity on these waterways is quite high and therefore the system could be well tested. A VTS centre and four demonstration vessels were used in this demonstration. The DASA system and the HITT system were installed. The shore RADAR information and the dynamic information provided by AIMS was integrated and displayed on a screen on board of the vessel.

The project was finalized by assessing the developed system. Eventually six methods were assessed:

- only shore RADAR (HITT),
- only transponder using DGPS (DASA),
- INCARNATION system, shore RADAR combined with a transponder using DGPS,
- Vessel Traffic Service (VTS) communicating with vessels in a certain area,
- on board RADAR,
- INCARNATION system and VTS communications.

These systems were compared focusing on the following criteria: traffic safety, traffic efficiency, quality and content of provided information, governmental financial support to implement and entrepreneurial financial support. Skippers, VTS personnel and Policy makers were invited to execute the system assessment. The assessment demonstrated that the sixth situation (INCARNATION and VTS) was believed to be the most profitable situation.

After the assessment project participants were supposed to carry out an overall assessment about the RIS system. Cost benefit analysis demonstrated small benefits using RIS. The benefits of using RIS on board of a vessel depended on the adoption rate of RIS, if every actor adopts the system the benefits would be huge. The costs to implement the required equipment on board are low, as a consequence benefits can be achieved by a small investment. This investment includes purchasing: AIS transponders, ECDIS and a computer. This equipment will improve the safety of inland navigation. Integrating AIS into an ECDIS display will require some study. In this proposition the project consortium recommends the use of AIS and inland ECDIS. They did not propose the use of INCARNATION system (Shore Radar and AIMS displayed on board). The use of that system was believed to be too expensive, the shore RADAR needs expensive modifications to be able to send TTI data to vessels.

These finding should be used to develop data standards, communication standards and more demonstration activities in entire Europe. A follow-up project was required, INDRIS.

Redesign and production (INDRIS)

INCARNATION proposed to install Inland AIS on board of inland vessels. AIS seemed suitable to use in the inland navigation industry because AIS is already developed to use in merchant shipping and proved to be advantageous. An extensive development period to develop Inland AIS would not be necessary. Therefore the participants of INDRIS evaluated the merchant shipping AIS.

AIS used in merchant shipping is a system able to operate independently at sea. The system is able to transmit/receive AIS messages on a regular basis without interference of some kind of management. The system uses the SOTDMA principal to be able to do this, the explanation of this system follows. A so called Time Division Multiple Access (TDMA) divides the time in short periods (time slots), a time slot is assigned to every user in which he will be able to transmit. The allocation and synchronisation of all users is executed by a central manager. This system is used in GSM (Global System for Mobile communication). At sea there is no central manager able to allocate time slot and synchronise all users, merchant vessels at sea cannot be reached by VHF all the time. As a consequence the system uses GPS to synchronise time on board of all users. A GPS receiver is part of the AIS system, it is used to synchronise time between users and allocate time slots to transmit information. AIS receivers will listen to the allocation of time slots and it will choose a not used time slot to transmit messages. The system is kept stable because every message also transmits the next timeslot that will be used. Using this system every AIS receiver is able to look into future reserved time slots, a central management is not necessary. The system is called Self Organized TDMA (SOTDMA). At full sea the system will operate in the “autonomous mode”, an independent operating system without any interference. The system can also operate in the so called “assigned mode”, in which an authorized user is able to allocate timeslots. The authorized user is able e.g. to change frequencies to transmit position messages and keep another frequency clean for emergency transmission. In this mode the authorized user is able to reserve timeslots and transmit periodic messaged (like weather circumstances or navigational messages). The third and last mode is “polling mode” in which one user can ask another user to transmit a message.

The AIS transponder used in merchant shipping is developed for this specific industry, as a consequence it should be modified for inland waterways. The following problems were discussed during INDRIS:

- Maritime areas differ from inland waterway areas. The traffic density is much higher on inland waterways, as a consequence the AIS can be overloaded. The overloading issue will become critical if it is used with a shore based AIS network. This shore based AIS network will integrate conventional RADAR plots into the AIS network. Overloading will therefore result in an empty AIS display, this is unacceptable according to the participants.
- IMO compatible AIS transponders can be used in the inland navigation waterway as well, as a consequence the inland and merchant AIS are compatible. In combined areas, like harbours, inland and merchant vessels are therefore able to communicate with each other. In 1998, the initiation of this project, IMO did not yet formalise a standard AIS.
- The purchase price of an IMO compatible AIS is high, therefore no authorities decided to obligate the use of AIS (yet).

The merchant shipping AIS is going to be used in demonstrators. The AIS messages used in merchant shipping will be adjusted to meet the inland navigation requirements.

Evaluation of prototype INDRIS

Demonstrations have been executed in 1999 and 2000 by users to test defined RIS functions. Four demonstrators have been executed:

- Danube demonstrator (Austria) is been initiated by the Austriam ministery of transport. The main function was to demonstrate a tactical traffic image on board of vessels by using AIS, DGPS and Inland Ecdis.
- Seine demonstrator (France). The main function of this demonstration was to demonstrate commercial advantages using RIS. The required commercial information was communicated by use of GSM and internet. Cargo owner and shipping companies communicated to adjust the cargo capacity to the supplied cargo.
- Flemish demonstrator (Belgium). The main function of this demonstrator was to demonstrate the use of strategic information and fairway information services.
- Rhine-Scheldt demonstrator (Netherlands, Germany and Belgium). 30 Vessels were equipped with GSM, computers and a DGPS transponder. They were able to display a tactical traffic image, provide strategic information and use fairway information services.

Users of the demonstrators were very satisfied by the system, they believed after using the system that RIS will contribute to the safety and efficiency of inland shipping. Some skippers even continued using the demonstrator of the Rhine-Scheldt. The project concluded with a positive C/B (Cost/Benefit) analysis.

The project concluded, related to AIS, that merchant shipping AIS can be used in the inland navigation industry:

- *"AIS transponders according to the IMO standards can be applied in inland navigation, thus contributing to safe navigation. They are particularly useful in areas of mixed traffic with maritime and inland navigation as well in areas with high shipping densities and areas with special navigational difficulties such as rivers in mountainous stretches like the Danube.*
- *Standard IMO AIS transponders are still non-existent: every supplier has its own specific peculiarities; these should be changed to the actual standards as agreed in IMO. A test bed such as the German test bed will help identifying loopholes in the standards and contribute to a general application of AIS transponders."* (INDRIS, 2000-2001).

Parallel to the INDRIS project IMO developed standards to use an AIS transponder in merchant shipping, these standards have been adopted by IMO on 29 November of 2001.

Redesign and production (COMPRIS)

An European follow up project (5th framework) of INDRIS was initiated in 2002 COMPRIS (Consortium Operational Management Platform River Information Services) and lasted until 2005. The project should contribute to the implementation strategy of RIS and create a full scale test environment, the first large scale implementation of RIS. Therefore the development and implementation phase do overlap each other at this point.

Implementation period

Impact of Inland AIS

Inland AIS enables the possibility to fast, reliable and efficient exchange information without necessary interferences of people. The impact of implementing Inland AIS is different for actors in the inland shipping industry. By means of Inland AIS the position and identification of a vessel will be transmitted, using VHF, to actors participating in inland navigation. The message of an Inland AIS can be enhanced by course/speed of the vessel, carriage of dangerous cargo, destination, ship dimensions, ETA, etc. This possibility will be used in the near future when privacy of skippers can be guaranteed by governments. The flow of inland vessels can be smoothened by using AIS, according to pilot project participants.

Inland AIS messages will contain vessel identification and vessel position. With this information the main goal of implementing AIS is improving the safety of Inland shipping. VTS centres are able to use the information and improve traffic control. Safety for the entire shipping industry will be improved, an inland vessel equipped with AIS, sailing in an ocean port will be recognized by merchant vessels. They are able to effectively communicate about each other's intentions and agree on navigational measures.

Privacy of skippers is the main reason to limit the content of an AIS message. The privacy of a skipper is believed to be reduced by the use of Inland AIS, shippers are able to accurately follow their cargo.

Inland skippers

With the use of RADAR a skipper is only able to observe every plot the RADAR is able to observe. RADAR is not able to look around a bend, mountain or bridge. AIS information is transmitted by VHF and as a consequence will be transmitted and received on a wider range even if there are bridges, bends, mountains etc. With an Inland AIS a skipper is able "to look around the corner" and on a wider range. An Inland AIS will support the navigation.

All vessels equipped with an AIS transponder (inland and merchant) are able to transmit and receive AIS information between ship-ship, ship-shore and shore-ship. If an inland skipper will integrate AIS information with an Inland ECDIS or RADAR he is able to add the vessels identification to a vessel plot. The AIS information can also be displayed without integration of any other system. Because identification of inland vessels will be transmitted/received communication will be more effectively. Identification of vessels before the implementation of Inland AIS was not provided to each other, therefore it was difficult to reach another skipper. The position of another vessel relative to your own vessel was only displayed by RADAR, therefore to call another vessel the skipper needed to mention a position or recognizable point passed by the vessel that he would like to contact. It took a lot of effort and concentration to contact another vessel and agree on navigational measures to avoid collisions. With the Inland AIS the identification of a vessel is known and a skipper can directly call the identified vessel and communicate with him. The inland navigation industry is an international sector, therefore many languages are spoken, if messages are standardized a lot of information does not have to be communicated personally, therefore miscommunications will be avoided.

Without an Inland AIS a skipper is obligated to update VTS centres, he has to call them to provide his position and identification. Without this obligation the skipper is able to focus on his main task: safe navigation.

Traffic management

Traffic management required Inland AIS to execute management tasks: traffic management, traffic safety and support of calamity management. In ports and near waterways transponders will be located. These transponders will be connected to computer systems owned by VTS centres. Received information can be integrated in shore RADAR, therefore every plot is labelled with identification and possible additional information. Traffic managers are able to adjust the behaviour of AIS transponders to improve safety, e.g. they can adjust the time between two position transmissions. By use of Inland AIS they are able to monitor traffic intensity on a wider range and they are able to anticipate on expected traffic intensities. Calamity management can be more efficient if the exact position of vessels and their identification are known.

Vessels will be automatically identified when they enter a certain VTS centre area, therefore the work load of VTS centre employees will decrease and they will be able to focus on their main task, ensure safe navigation. On the long term governments are able to reduce the amount of manned VTS-centres, because vessels were automatically provided with required information to perform safe navigation.

Lock and bridge management are interested in Inland AIS. If they know ETA's and destinations of vessel they are able to monitor the traffic intensity and the amount of traffic heading for their bridge/lock. As a consequence they can ask skippers to adjust their speed and arrive at a desired time at the bridge/lock. Therefore managers can smoothen the passing traffic at bridges and locks. Informed VTS about lock and bridge planning enables the possibility to ask skipper to adjust vessel's speed and meet a desired ETA. Information about ETA's and destination enables the possibility to manage the mooring location more efficient.

Logistical actor

Shippers are able to track and trace their cargo if they desire to. They are able to efficient plan the transport of their cargo. They could identify which inland vessels are nearby and searching for cargo.

Inland navigation industry

Inland AIS is part of RIS. If the system will be enhanced in the near future the sector will be able to operate more efficient, therefore the sector is able to attract more freight. A cargo shift is aimed for by governments to reduce the road infrastructure overload and the environmental impact of cargo transportation. RIS will contribute to a cargo shift between road and inland waterways.

Dissemination

The development projects related to RIS are mainly initiated by European project consortiums. Therefore EC governmental members were informed about the development of RIS. RIS, a harmonized river information service is able to improve the competitive position of inland shipping compared to other transport modalities, as a consequence the road infrastructure overload will reduce and the environmental impact will reduce. It is a strategy of many governments to support the cargo shift from road to inland waterways. After a few projects, the EC defined guidelines that have been adopted by many governments and river authorities. As a consequence many national projects have been initiated to observe the added value of RIS and the possibilities of implementation.

At the adoption period of RIS guidelines by governments, many articles have been published about RIS and AIS. Because of the potential huge impact of RIS, and therefore AIS, newspapers and the industry kept following the development of RIS. AIS is part of RIS and will significantly improve the safety of inland navigation. The Dutch government would like to implement an AIS installation in vessels using the Dutch inland waterways. Therefore the initiated three pilot projects and disseminated the outcomes of these pilot projects. They initiated a funding program to implement AIS on a large scale and they extensively disseminated that they would initiate a funding program.

The amount of authorities, currently and expected in the near future, obligating the use of AIS are cooperating to an extensive dissemination of Inland AIS. Many articles have been published about the policy involvement in the development and implementation of Inland AIS, therefore skippers believe that it will be obligated in the near future to use Inland AIS.

Companies noticed the funding program and anticipated on it. In the Netherland companies do provide and install an AIS installation for a price equal to the governmental funding. Inland skippers did notice these advantageous developments and started implementing it.

In general the dissemination of RIS is immense. All the project participants of past project believed that RIS will be advantageous and therefore they extensively disseminated the generated knowledge in their own country. The amount of participants and governments made it possible to extensively disseminate the knowledge about RIS and AIS.

Adoption

Regulatory authorities

In 1998, based on results from several research projects and various applications, the EU officially defined the concept of River Information Services (RIS) (European Commission, 2005).

During the pan-European Conference on Inland Waterway Transport in Rotterdam in September 2001, the European Ministers of Transport declared that River Information Services should be up and running on the main European rivers within five years. (EC, 2001) EC published a white paper in September 2001: “Transport policy for 2010: time to decide”. In this paper EC proposed to shift cargo from road to inland waterways to decrease the road congestion in Europe and supports the development of efficient navigational aids and communication systems.

Guidelines related to RIS have been published by PIANC (Permanent International Association for Navigation Congresses) in 2002.

CCNR (Central Commission for Navigation on the Rhine) adjusted the guidelines of PIANC. They adopted and published the guidelines in 2004: “guidelines and recommendations for River information Services”. In 2007 CCNR adopted guidelines for tracking and tracing.

A RIS framework is adopted by European council and parliament in 2005. In 2006 the RIS guidelines have been adopted by the European Commission. In 2007 the Dutch government implemented the European guidelines in their national law. These guidelines include guidelines for the use of AIS.

Some regulatory authorities obligate inland vessels to install AIS e.g.: the port of Antwerp (obligated 1st of January 2012), Donau (obligated), Rhine (probably around 2013), etc.

Dutch inland shipping industry

Many national and European projects have been initiated to promote RIS, AIS included. As a consequence we will limit our innovation process description to the adoption of AIS in the Netherlands.

In 2006 support of shipping entrepreneurs to implement AIS has been monitored by BTB (Dutch Bureau Telematics Inland Shipping) commissioned by the Dutch ministry of waterway management. BTB approached 646 inland skippers and 147 skippers did participate in a questionnaire. Many inland skippers did believe Inland AIS contributes to the safety of inland navigation and believe it complements the current navigation equipment. The possibility to directly call a skipper and the possibility that transmitted information can be used in case of a calamity are the main added values of the system according to skippers. Skippers rejecting the use of AIS are above average age (>50 years), reasons to reject are:

- insignificant trust in technique,
- skippers will lose concentration because of the improved safety,
- privacy is affected,
- disbelieve of advantages,
- skipper does not need it, their professionalism is sufficient
- inland navigation is safe,
- current technique is sufficient,
- using AIS does not provide information on actions of other skippers,
- governments wants to reduce the cost of VTS centres.

More than 80% of the questioned skippers are willing to implement AIS equipment if the government will cover the costs. More than 70% of the questioned skippers did not object the use of position and identity information by authorities and skippers, 60% does object public use of this information. This numbers are demonstrated by figure 2.

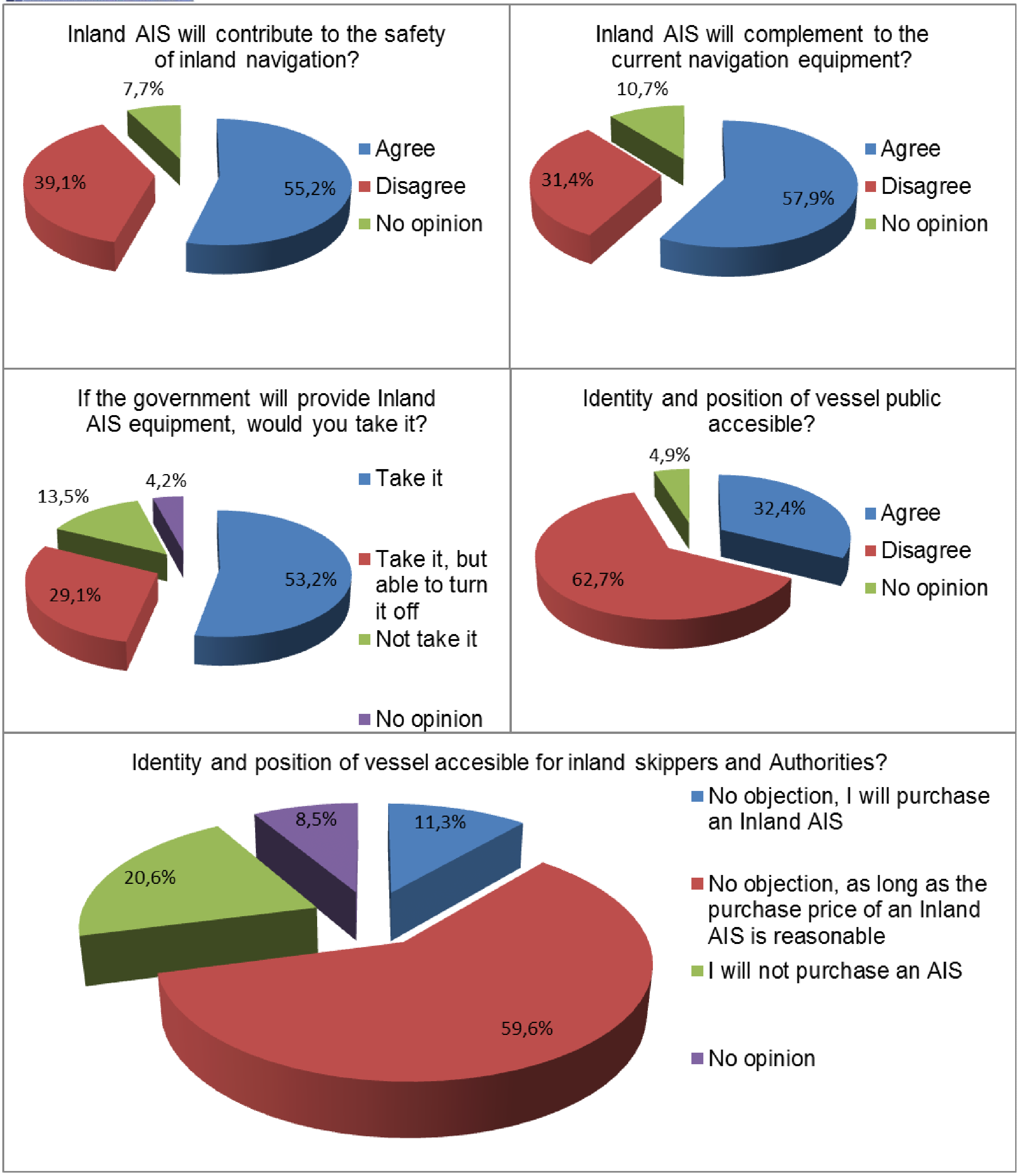

Figure 2: Support monitor (BTB, 2007)

The Dutch government agreed a covenant about tracking and tracing, executed by AIS, used in RIS in 2006 with Dutch inland shipping associations. The ministry of waterway management, Royal Schuttevaer, Binnenvaart bureau (Inland shipping office), CBRB (central bureau for Rhine and inland shipping), and tug- and push tug owners association Rhine and Ijssel participated in composing the covenant. According to the Dutch government implementation of Inland AIS is unavoidable to improve: quality of traffic control, fighting a calamity and logistical service. The industrial association does respect the governmental opinion, crucial to them in this covenant is:

- governmental funding is provided during the period of voluntary implementation of Inland AIS, the funding rates have to be determined.
- a transmitted AIS message is limited to the position and identification of the vessel.

The industrial associations are willing to support voluntary implementation of Inland AIS if the government is able to meet these demands

As a consequence of this covenant the Dutch government developed a funding program to implement Inland AIS. The funding program is initiated on the 1st of January in 2009 and will end at 31st of December 2012. The funding can be applied for by every Dutch registered inland vessel above 20 metres or below 20 metres and professionally used, or every European Union registered vessel, except German registered vessels, using Dutch inland waterways more than ones a year for at least the last three years. The installed Inland AIS has to meet the RIS guidelines adopted by the Dutch government. € 2100 per inland vessel is funded by the Dutch government until the maximum amount of funding of 14,7 M€ is provided. As a consequence maximum 7000 vessels are able to receive funding to implement an Inland AIS. The funding program will be managed by Agentschap NL. The private investment to purchase an AIS installation is believed to be around € 500. If a skipper decides to use this funding program he will be obligated to keep the Inland AIS turned on.

Implementation

The first project related to the implementation of RIS and therefore AIS was COMPRIS initiated in 2002. We will again limit our focus on the activities related to AIS in this project. Work package 4 of this project included the development of Inland AIS.

In this project different configurations are implemented and tested, two configurations use Inland AIS:

- Tracking and Tracing, tested by a test team
- Concept of ship borne applications, tested by a test team.

The ship borne test team believed the AIS is suitable to use for navigational purposes (e.g. collision avoidance). The tracking and tracing team concluded that Inland AIS does contribute to more efficient and safer inland shipping. Transmitted AIS information was correctly integrated with on board/on shore RADAR tracks and displayed on the Inland ECDIS. A different transponder type is used in inland navigation compared to merchant navigation, however both types are able to transmit and receive correct information to each other. Therefore AIS is reliable to create a tactical traffic image on board of vessels and it is reliable to create a strategic traffic image used by VTS centres. The strategic traffic information is able to monitor the traffic situation in entire Europe and transmit it to other VTS centres. As a consequence of these positive extensive tests finalized in 2005 Inland AIS can be implemented in the inland navigation industry.

National European authorities and river authorities have adopted and implemented the European guidelines established in 2005. Therefore if an AIS transponder is implemented it should be a transponder according to the developed guidelines. The first transponder is certified in October 2008. Saab adjusted the software of a merchant shipping transponder to meet CCNR guidelines.

Because of the amount of projects related to the implementation of RIS (and therefore AIS) we will limit to the initiation of Dutch projects. Three pilot projects were initiated in 2009, 1000 vessels should participate and were installed with an Inland AIS. All the projects have been initiated with support of the ministry of waterway management, they supported the projects to demonstrate and enhance the possibilities of Inland AIS. On the other hand they supported the projects to find out if large scale implementation of Inland AIS on Dutch Waterways is possible.

The province of Southern Holland, Dutch ministry of waterway management and HTM (Haagse Tramweg Maatschappij, public transport company) initiated a pilot project with thirty vessels during the second half of 2009. The project was executed at a bridge (Hoornbrug) where different transport modalities meet: road transport, public transport and inland shipping. The pilot aimed to smoothen the traffic flow at the bridge, when does it open and when does it close, which timeslots will optimize the traffic flow. An advising system about the most suitable opening times of the bridge was developed. ETA to the bridge of public transport and inland vessels are calculated using Inland AIS information. It was able to accurate calculate ETA's of inland vessels (using Inland AIS) but it was not able to accurate calculate ETA's of public transport (using another system). As a consequence inland skippers believed the system was suitable to optimize the flow of traffic at the bridge, on the other hand public transport drivers did not believe the system was suitable. HTM will improve their information providing system, as a consequence the advising system will be able to accurately calculate ETA's of public transport. An advantage for Inland skippers using the system is that they are informed when they will be able to pass the bridge, they can adjust their speed with this information.

The port of Rotterdam, Dutch ministry of waterway management and Radio Holland initiated a pilot project with 75 vessels. The objective of the pilot project was to shorten waiting times for mooring at Tweede Maasvlakte. The pilot project was finalized at the end of 2009. The project demonstrated that Inland AIS is suitable to improve safety and a smooth traffic flow of vessels, if all vessels turn on their Inland AIS. If a vessel is heading for Rotterdam it will be recognized by port authorities, when mooring locations are available the vessel can proceed. If mooring locations are not available the authorities are able to inform the skipper, and he is able to adjust the speed of the vessel.

The 1st of October 2009 Corridor 895 is initiated by BTB and the Dutch ministry of waterway management. 895 Participants will receive an Inland AIS transponder and the installation of it for free, if they are able to demonstrate that they are actively using the ARA (Amsterdam, Rotterdam and Antwerp) ports or the Rhine corridor. Until the 31st of January 2010 inland entrepreneurs are able to subscribe and apply for participation. The pilot project has been initiated to evaluate user experiences and demonstrate possibilities using Inland AIS. One of the main experiences is until now: AIS is a useful complement to other navigational equipment but not suitable to use for navigation. In this pilot, users are able to communicate about the Inland AIS, many technical problems have been solved. Users, specialists and the ministry of waterway management still cooperate to solve user problems. Structural mentioned problems are or will be studied in the near future.

After finishing these pilot projects the Dutch government aimed at implementing Inland AIS at a larger scale, using funding for 7000 vessels without an Inland AIS transponder. Until the 31st of December 2012, skippers are able to apply for funding and install an Inland AIS. Some companies in the Netherlands are able to supply and install an Inland AIS installation for a price equal to the governmental funding. At this moment many authorities (e.g. CCNR, Port of Rotterdam) consider an obligatory implementation of Inland AIS. Some authorities already obligated the use of Inland AIS (e.g. Port of Antwerp, Port of Gent, Via Donau). The ministry of waterway management aims for full AIS coverage in the Netherlands before 2014.

Analysis of the innovation process

Key actors and their relationships

The development of RIS (and AIS) is executed by many international actors. Therefore we will limit to Dutch development of AIS. The development and implementation of Inland AIS is mainly influenced by governmental bodies and industrial associations.

TNO (Applied Scientific Research) is a Dutch research institution and was commissioned by Dutch government to develop a system which should demonstrate advantages using a vessel transponder. They developed ARIS (Automatic Reporting and Identification System). This system demonstrated functioning and the added value of a transponder system. The International Maritime Organization (IMO) used this information to start discussing the possibilities of a transponder system. In 2000 they published IMO AIS guidelines. In 2000 IMO started revising SOLAS regulations, this included the obligated implementation of AIS starting in 2002. IMO (International Maritime Organization) implemented and adopted AIS in their regulations. Every merchant vessel is obligated to use AIS since 2007.

European Commission supported many international initiatives related to AIS since 90’s. These international initiatives were initiated by mainly CCNR member states: Dutch, German, French and Belgian participants (ministries, universities, research institutes and industrial members). The Dutch ministry of waterways management did coordinate some of these projects. In 1998 they defined RIS and believed that it could improve the competitive position of the inland navigation industry. In 2001 they published a white paper and publically called for the development of RIS around 2005. Guidelines to use AIS were developed and adopted by them based on INDRIS. The first European implementation project was initiated in 2002, 43 participants were involved. 11 Dutch, German, Belgian and French participants were already involved in former European projects and 32 additional participants were attracted, also pan-European, the total amount of participants consisted of:

- 10 Dutch
- 5 German
- 5 Belgian
- 5 Austrian
- 4 Hungarian
- 4 Slovakia
- 3 Bulgarian
- 2 French
- 2 Romanian
- 2 Ukrainian
- 1 Swedish

CCNR adopted and adjusted European RIS guidelines in 2004. They will try to obligate the use of Inland AIS on the Rhine before 2013. In 2008 the first AIS installation is certified, SAAB (participant in COMPRIS) did develop an Inland AIS installation meeting the CCNR guidelines.

Dutch ministry of waterway management was involved in many international projects developing RIS. They adopted the European Commission guidelines and would like to start implementing RIS. They decided to initiate the implementation of RIS by implementing AIS first. Support of the Dutch industrial association (cooperating in research projects) was required to voluntary implement AIS. Therefore they did agree a covenant with the industrial organization. After this covenant they initiated some pilot projects and a funding program managed by Agentschap NL.

Dutch industrial association were involved in COMRIS, in this project they were able to observe advantages by carrying an Inland AIS. They represent inland skippers and they did support the implementation of AIS if the government would purpose a covenant. They agreed on the content of the covenant and supported the implementation of AIS.

Province of Zuid-Holland (the Netherlands) initiated together with HTM (public transport in the Hague) and ministry of waterway management a pilot project with thirty skippers. They all implemented an Inland AIS. Port of Rotterdam (cooperated in all European projects) and ministry of waterway management initiated a pilot project in the port of Rotterdam, 75 inland vessels were equipped with an Inland AIS. Port of Antwerp, Port of Rotterdam (cooperated in all the European projects) and Port of Amsterdam cooperated with the Dutch ministry of waterway management to implement 895 Inland AIS installations to execute a pilot project.

Inland skippers participated in pilot projects, they adopted and implemented the Inland AIS.

Adoption rate and spread of the innovation

Around 1985 first experiments using a transponder system on vessels have been executed. These experiments are executed in the Netherland by TNO commissioned by the Dutch ministry of waterway management. Since then the Dutch ministry of waterway management participated in many European and national projects, they coordinated and initiated many projects.

Since the 90's many European projects about RIS and AIS have been initiated. In 1998 the European Commission defined the concept of RIS and supported the development of RIS. They aimed for a pan-European implementation of RIS by 2005. In 2002 a major pan-European project (COMPRIS) was initiated, 43 participants of 11 (pan-) European countries participated in the project. Industrial members, governments, industrial research organizations and universities participated and believed that the concept would strengthen the competitive position of European inland navigation. Many national spin-off projects have been initiated since COMPRIS was finalized.

IMO started to use the Dutch experiments and adopted AIS guidelines in 2000. They implemented these guidelines in SOLAS chapter 5 and obligated all merchant vessels above 300GT to install AIS. The Dutch government implemented the IMO regulations in their own legislation and extended the use of it. Dutch regulations obligate all merchant vessels to implement AIS. The support of the Dutch government using AIS to increase the safety in shipping is very clear.

In 2002 the European commission adopted Inland AIS guidelines developed by PIANC, IMO guidelines have been adjusted to fit the inland navigation industry. CCNR adjusted and adopted AIS guidelines in 2004. They will try to obligate the use of Inland AIS before 2013. The use of Inland AIS is obligated on the Austrian part of the Donau. In the following years the port of Antwerp and Gent will obligate the use of Inland AIS as well.

In 2006 the Dutch government agreed a covenant with Dutch inland skipper associations about the use of AIS. They were willing to voluntary implement AIS to improve the safety of inland navigation on certain terms. These terms were related to the privacy assurance of Dutch inland skippers and funding of implementing Inland AIS. All European Union skippers are able to apply for funding on certain terms, except German flagged vessels. The German government initiated an equal funding program. In the covenant they agreed that position and vessel identification will be transmitted, more information can be transmitted if a skipper is willing to transmit more information.

The Dutch government adopted the AIS guidelines in 2007, initiated a funding program desired by a covenant and initiated pilot projects. Skippers applying for funding and the pilot projects are obligated to use the Inland AIS and continuously transmit the position and vessel identification.

At this moment, during INNOSUTRA, around 2500 Dutch skippers using Dutch inland waterways applied for governmental funding (Agentschap NL, 2011), the amount of funding is limited to 7000 vessels. 1000 skippers did already apply for the installation of AIS during pilot projects in the Netherlands, as a consequence around 3500 inland vessels using Dutch inland waterways are equipped with an AIS installation. The German government, the Dutch government and the Belgium government initiated funding programs which will end respectively on 31st of December 2012, 31st of December 2010 and 31st of December 2011. Dutch funding can be applied for by 7000 skippers, German funding is not limited and the Belgian funding is limited to 750 vessels. As a consequence everyone willing to implement an AIS installation is able to install one without a major investment.

The Dutch inland fleet consists of 7000 vessels, 3500 Dutch flagged vessels did apply for funding, thus 50% of the Dutch inland fleet adopted and implemented the Inland AIS.

Success factors during the innovation process

Initiation

Incentive (safety)
AIS is used to track and trace vessels. The vessel identification and its position will be transmitted and received by other vessels and VTS centres. The merchant shipping industry effectively uses AIS, they demonstrated that AIS significantly improved the safety of merchant shipping. Communication between ships will be improved, if a position of a certain vessel and its identification are known officers of watch are relatively easy able to call another vessel and agree on navigation matters (avoid a collision). Vessels can use AIS to automatically report if they enter a certain VTS area. An effective and efficient communication device contributes to the safety of shipping, an officer on watch is not distracted by communication and is able to focus on his main job: navigate safely. Because standardized communication is possible without extensive interferences of humans the probability of miscommunications will significantly reduce. VTS centres can use AIS to transmit navigational messages like: weather circumstances, navigational warnings, traffic management information, etc. Vessels can automatically report if they carry

dangerous goods, in case of calamity it is easier to effectively fight the calamity because vessel characteristics (size, crew, dangerous goods, etc.) are known.

The merchant AIS demonstrated a significant safety improvement, therefore the inland navigation industry was willing to monitor the added value of AIS in the inland navigation industry.

A compatible Inland AIS with a merchant shipping AIS will improve safety in mixed areas, like ocean ports.

Incentive (cargo shift from road to inland waterways)
AIS is supposed to be part of RIS. RIS is developed to improve the information exchange in the inland navigation industry. If information exchange will be more extensive and accurate the inland navigation industry will be more reliable, safer and faster. The competitive position of the industry will be improved compared to other transport modalities. Especially a cargo shift from road to inland waterways is desired by community and the inland navigation entrepreneurs. A more competitive industry will establish the cargo shift from road to inland waterways.

The shift of cargo will reduce the overload on the European road infrastructure and reduce the environmental impact of cargo transport. The reduction of overloaded road infrastructures will reduce congestion and therefore the road transport sector will be more efficient. The use of inland vessels instead of road trucks will reduce the environmental impact of transportation.

Incentive (logistical actors)
There are commercial advantages using RIS. If the inland navigation industry is more efficient and logistical actors can be provided by required inland navigation information they are able to improve the entire supply chain service. E.g. port management is able to track the amount of vessels heading for their port, they are able to monitor the required cargo handling capacity when all vessels will enter their port. If there is not sufficient cargo handling capacity they are able to call a skipper and request an alternative time of arrival. The skipper can adjust the speed of the vessel, saving fuel, and the terminal is able to efficiently use the cargo handling capacity. Saving fuel and the optimized use of cargo handling capacity will decrease the transportation costs.

Incentive (governmental)
Safety of transportation, reduction of road infrastructure overload, reduction of the environmental impact and a more efficient supply chain in Europe is desired by all European governments. These goals can be achieved by implementing RIS and therefore implementing AIS in the inland navigation industry.

Inland AIS is able to transmit information required for safe navigation. RIS will improve the quality of information exchange in the inland navigation industry even further. All the required information is provided by the inland skippers using RIS, as a consequence the role of VTS centres can change. Eventually governments are able to reduce the amount of manned VTS centres and the amount of employees.

Complementary concept
AIS is used in RIS to track and trace vessels. RIS is an information exchange technology with many advantages for all logistical actors. AIS is complementary to current navigational aids and complementary to the entire RIS concept.

Governmental initiative and industrial initiative
Because of the incentives to initiate the development of Inland AIS many industrial members, regulatory bodies and governments were willing to participate. Because of the governmental involvement the projects were mainly funded by national and European governments. Both governments and industrial members were willing to cover the risk of developing an Inland AIS because the advantages of using the system are clearly demonstrated by the merchant shipping industry.

Industrial research organization
Many industrial research organizations were involved before the initiation of projects related to Inland AIS. TNO is a Dutch research organization involved at the initiation of transponders in the shipping industry. TNO is a well-developed research institution with a reliable image. They disseminated their generated knowledge and industrial members were convinced to participate because a well-developed research institution is willing to participate.

After this project IMO was willing to implement transponders in the merchant shipping industry to improve the safety of merchant shipping.

European standardization
Effectively communicate between ship-ship, shore-ship and ship-shore is one of the main incentives implement RIS. AIS is part of RIS and used for tracking and tracing of vessels. To be able to effectively communicate a standardized system should be used in entire Europe, as a consequence the European Commission was involved to ensure a standardized system for Europe.

EC involvement in projects enables the possibility to apply for funding and attract European participants.

Technical
AIS is already developed and implemented in the merchant shipping fleet. The development of Inland AIS contains the modification of AIS to meet the inland navigation requirements. A shore infrastructure to use Inland AIS has to be developed. VTS centres should be able to use the AIS information as well, this is the main technical challenge during the development phase of Inland AIS. Therefore the development of Inland AIS is quite limited. It is just a developed concept used in another.

Cooperation and project coordination
Most European projects are coordinated by the Dutch ministry of waterway management. They believed the development of Inland AIS would contribute to strengthen the inland navigation industry and were willing to keep coordinating initiated projects. They were not supposed to develop Inland AIS, they were supposed to coordinate the project. They own sufficient resources (time/money) to attract participants and keep them involved. AIS is obligated in merchant shipping by IMO, as a consequence many participants believed that Inland AIS will be obligated in Inland shipping as well. If Inland AIS will be obligated it will be implemented in many vessels, therefore project participation can be quite profitable.

Development

Industrial requirement
In cooperation with industrial members during INDRIS the desired core functions of RIS were defined. One of these core functions was to develop a tactical traffic image. To create a tactical traffic image a tracking and tracing system was required. To meet

this requirement merchant shipping AIS or a similar system could be used. Development of a tracking and tracing system was desired by actors in the inland navigation industry, therefore they supported the development of Inland AIS.

Economic and environment (demonstrate advantages)
Merchant shipping did demonstrate an improved safety using AIS. The system had to be modified to increase the safety in inland navigation as well.

Extensive and many pilot projects have been initiated during the development of Inland AIS. INCARNATION tested DGPS and shore RADAR systems. INDRIS initiated four pilot projects. And national initiatives initiated other national pilot projects. These tests demonstrated that Inland AIS contributes to improve navigational safety. Inland AIS can be used as a navigational aid to observe vessels that could not be observed by RADAR and to identify vessels, enabling a more efficient communication between vessels and between vessels and shore.

The advantages of Inland AIS have been extensively demonstrated during the development process. Therefore the projects were extensively supported and adoption of the concept was easier.

Support
Improved safety in inland navigation is of high priority to regulatory bodies. After the first demonstrations of improved safety during the development of Inland AIS regulatory authorities supported and participated in the development of Inland AIS.

PIANC, CCNR, EC and national governments supported the development and aimed at implementing Inland AIS in entire Europe as one of the first steps to implement the RIS concept.

Demonstrated advantages of the concept ensured a much wider support, European industrial members did support the development of Inland AIS. Industrial members were willing to implement prototype concepts, there was immense amount of potential adopters willing to act as launching costumer.

Standard development
European standardization is required, demonstrated by the next example:

“In the eighties ships had to be equipped with at least three different mobile phones to make calls on the Rhine between Rotterdam and Basle” (INDRIS, 2000).

INCARNATION was followed by INDRIS, INDRIS was supposed to develop RIS guidelines. Guidelines for tracking and tracing have been developed. The first guidelines developed were related to DGPS and shore RADAR instead of Inland AIS. The project concluded that the INCARNATION system was too expensive and Inland AIS should be developed. A follow-up project COMPRIS developed guidelines for Inland AIS. Eventually these guidelines have been adopted by the European Commission, PIANC, adjusted and implemented by CCNR and adopted by national governments in their legislation. In 2007 standardized guidelines have been adopted by the Dutch government.

Implementation of well-developed concept
Participants of COMPRIS, HITT and DASA, tried to develop a concept suitable for tracking and tracing. This concept used shore RADAR and DGPS to create a tactical traffic image. Vessels equipped with DGPS will transmit the required information to a

shore station. The shore RADAR is used to observe all traffic in a certain region. Shore RADAR is able to observe all traffic but not able to identify vessels. A DGPS system is able to identify vessels but if vessels are not equipped with DGPS they will not be observed. As a consequence participants decided to combine these two systems and use it to create a tactical traffic image. The concept is successfully tested. A disadvantage of the system is incompatibility with the merchant AIS system and the costs of modifying a shore RADAR to transmit the tactical traffic image are relative high.

The project participants did propose another concept because of the negative effects of the first concept. Despite the well-functioning system they believed a more suitable aid to track and trace could be Inland AIS.

Merchant AIS has been modified to meet inland navigational requirements and still be compatible with merchant AIS. After the projects participants decided that a modified merchant AIS will be suitable to use despite all the resources used to develop other systems. They would only implement a well-developed and functional concept.

Prototype evaluation (including cost benefit analysis)
All potential users of Inland AIS evaluated the prototypes. Requirements of all actors were tried to be met by developing an Inland AIS. Shippers, logistical service providers, VTS centres, regulatory authorities, developers and skippers (associations) were involved. As a consequence the main requirements were met:

- Dutch skipper associations required a limited transmission of only position and vessel identification,
- Dutch skipper associations required some kind of funding if Inland AIS would be implemented,
- Dutch skipper associations required a voluntary implementation of Inland AIS,
- Dutch government required to implement Inland AIS to improve safety and support the VTS centres (maybe reduce employees in the near future at VTS centres),
- logistical service providers and shippers are able to agree about which information they will exchange.

Extensive evaluations ensured meeting the requirements, therefore skippers were willing to participate in pilot projects and implement Inland AIS.

During the evaluation cost benefit analysis have been executed, in these assessments it was clear that shore RADAR and DGPS was too expensive. It was clear that Inland AIS would not require a huge investment while it would significantly improve safety.

Cooperation (realistic consortium in pilot projects)
Project consortiums have been deliberately considered. Participants owning the required knowledge were attracted to achieve objectives of different projects.

In past projects consortiums were quite large, many participants were willing to participate in the development of RIS and they were willing to participate in the development of Inland AIS. The required knowledge was available and they were willing to intensively cooperate because of great potential impact of RIS.

Despite the effort to develop some kind of tracking and tracing system by shore RADAR and DGPS participants were realistic about the advantages and disadvantages of the system. They were realistic about the potential impact of the concept and decided to propose and develop another concept, Inland AIS.

Available resources
European projects were all initiated in the European Union framework program for research and technological development. All projects were partly funded by the European Union. Many national governments and regulatory bodies were involved in European projects, they partly funded the projects. All participants in European projects would benefit to develop Inland AIS, therefore they were willing to fund the project as well.

In the Netherlands three national pilot projects have been initiated by the ministry of waterway management, regulatory bodies and industrial members. As a consequence funding these projects was no problem.

The available resources were sufficient in different project, national and European. As a consequence there was a small risk to participate in these projects. Because of the small risk and the great potential impact of RIS and AIS participants were willing to participate.

Implementation

Economic and environment (demonstrate advantages)
During the development process of Inland AIS advantages have been demonstrated by launching costumers. It is demonstrated that the concept significantly improves the safety of inland navigation by creating a tactical traffic image. Skippers are able to “look aroud the corner” and they are able to identify other traffic, enabling a more efficient and effective communication. Skippers are not reluctant to implement a concept that improves safety of the inland navigation industry.

Regulatory authorities are not reluctant to use Inland AIS because it will improve the quality of traffic control. They are able to control the traffic more effective and efficient. They can create a tactical traffic image (to improve safety on a short term) and strategic traffic image (to manage traffic intensity on the long run and manage locks and bridges).

It is possible to exchange more information by Inland AIS, but skippers are not willing to extensively exchange information at the moment, because they believe it will limit their privacy. If privacy is guaranteed they will be willing to exchange more information like destination, ETA, heading, speed, etc. Lock operators, bridge operators and port managements are able to optimize their operations using this information. Shippers and logistical service providers are able to use this information to track and trace their cargo and observe available transport capacity.

If advantages of a concept are demonstrated and the concept is functional then the risk of implementing a dysfunctional concept is very small.

EC adoption
Demonstrated advantages of the concept were observed by the EC. A strategy of the EC is to reduce the road infrastructure overload and the environmental impact of cargo transportation. RIS is able to improve the competitive position of inland navigation compared to road transport, as a consequence a cargo shift could be realized. The EC publically supported the development of RIS because of these reasons.

They did adopt RIS and AIS guidelines developed in European projects, by PIANC, and disseminated the guideline adoption.

Regulatory adoption (CCNR adoption)
Improved safety of navigation on the Rhine is of importance to CCNR. Therefore the adjusted and adopted the guidelines developed by PIANC in 2004. They even aim for an obligated use of Inland AIS on the Rhine, to improve the navigational safety, by 2013.

Governmental adoption (Dutch legislation)
In 2007 the Dutch government adopted the RIS guidelines established in 2004. They aim at full AIS coverage of the Netherlands by 2014. A shore Inland AIS infrastructure should be developed because VTS centres require the transmitted vessel information.

Industrial adoption and implementation
Dutch Inland skipper did participate in an adoption monitoring project. BTB questioned inland skippers about the impact of Inland AIS and industrial requirements to implement Inland AIS. They observed a positive attitude towards Inland AIS if funding was available to implement Inland AIS.

Industrial members did participate in European projects, after the establishment of AIS guidelines they started to develop an Inland AIS meeting these guidelines. The first Inland AIS has been certified in 2008.

Governmental funding
The Dutch government is willing to invest in the inland navigation industry to improve the service of the industry and the safety in inland navigation. A cargo shift from road to inland waterways is aimed for to reduce the road infrastructure overload and environmental impact of cargo transportation.

Because Inland AIS demonstrated a significant improvement of safety in the inland navigation industry the Dutch government is willing to fund the implementation of Inland AIS. On the long term they could be able, because of the extensive information exchange, to reduce the amount of VTS centres and the amount of employees employed by VTS centres. The Dutch government provided 1000 Inland AIS transponders and the installation of them for free. They will fund 7000 Inland AIS transponders to be installed in vessels. € 2100 is available for everyone applying for Inland AIS funding. As a consequence the required private investment is nil.

Industrial association
Industrial associations were attracted to participate in European and national projects. Eventually they were able to make agreements about the Inland AIS with the Dutch government. They did agree in a covenant that voluntary implementation of Inland AIS will be supported by the industrial associations on certain terms. These terms were composed by industrial members, skippers. If these requirements were honoured inland skippers were willing to adopt and implement Inland AIS.

Policy contribution and intervention

Policy contribution
The initiation and development projects have been executed by the EC, ministries and industrial members. They all funded the projects.

In 2001 EC members publically called for the implementation of RIS and therefore AIS. They supported the implementation of Inland AIS because it would improve the competitive position of inland navigation. The system should be established to reduce the road infrastructure overload and environmental impact. They adopted guidelines developed by PIANC in 2002. These guidelines were adjusted and adopted by CCNR in 2004. The Dutch government adopted the guidelines in 2007.

The Dutch government aimed to implement Inland AIS in the Dutch inland fleet to improve the inland navigation industry. Inland AIS was not obligated but voluntary implemented by Dutch skippers if it was governmental funded. Dutch national projects were initiated and funded by the Dutch ministry of waterway management. They implemented Inland AIS in 1000 Dutch vessels and demonstrated advantages of the concept. After that they initiated a funding program to implement Inland AIS.

The entire innovation process of Inland AIS is influence by political members, European and national governments publically supported, participated and adopted the innovation. The development of Inland AIS is policy initiative.

Policy intervention

The European commission interfered with the development of Inland AIS and asked for general guidelines to use Inland AIS. They asked for these guidelines rather early in the development process because they were afraid that different systems would be implemented.

The Dutch ministry of waterway management interfered with the development and implementation process. They monitored the adoption of Inland AIS by inland skippers and asked for industrial requirements to implement Inland AIS. The implementation of Inland AIS in the Netherlands is policy initiative, pilot projects and a funding program were initiated by the ministry of waterway management.

Barriers

Initiation

Competitive position barrier (of inland navigation industry)

The competitive position of the inland navigation industry compared to road transport is rather weak. Information exchange in the inland navigation industry is not efficient, therefore the industry is not transparent. If the industry was transparent, actors could be able to efficiently operate and use the inland navigation industry. Therefore information exchange in this sector should be improved. There are many different information exchange technologies used in the inland navigation industry. For example on the Rhine between Rotterdam and Basle three different mobile phones are required to be able to communicate (back in the 80's). A European standardized information exchange system should be developed. RIS was believed to be a suitable system, AIS is used in RIS to track and trace vessels.

A new communication system implementing instead of current systems require a big change in the industry, this change is a great barrier. By demonstrating the advantages of using RIS and AIS people were convinced about the profitability of the system. A system like RIS is not going to be implemented at once, but will be implemented step-by-step.

Road transport barrier
The overload of the road infrastructure and the environmental impact of the road transport are big issues in European countries. A cargo shift of road to inland waterways is desired to reduce these problems. Therefore EC and national governments supported initiatives to improve the competitive position of the inland navigation industry.

The overload and environmental impact is a huge barrier to the transportation industry, this barrier could be removed to shift cargo from road to inland waterways.

Compatibility barrier
Merchant AIS was desired in the inland navigation industry to track and trace vessels. Merchant AIS seemed not suitable to use in the inland navigation industry, therefore an Inland AIS should be developed to track and trace vessels and create a tactical traffic image. European and national projects have been initiated to develop an Inland AIS compatible with merchant AIS, so it could be used in mixed areas.

Development

Support barrier (Industrial requirements)
Implementing RIS in the inland navigation industry will only succeed if industrial members support the implementation. Industrial requirements were unknown at the initiation of projects related to the development of RIS, therefore industrial participants were attracted and they developed the core functions that RIS should provide. Tracking and tracing (therefore a tactical traffic image) was one of these core functions, this is provided by Inland AIS.

In the Netherlands a large amount of skippers was attracted to participate in pilot projects related to Inland AIS. They could mention their requirements and discuss user experiences. Therefore the system could be developed with support of the industrial members.

Investment barrier
The development of RIS included the development of a tracking and tracing system. The first idea was to use shore RADAR in combination with DGPS. The system was tested and seemed to function. After a cost benefit assessment it was clear that modification needed to implement the system would require a high investment. Therefore this system was terminated and another system was proposed, Inland AIS.

Standardization barrier
Communication devices are used in the inland navigation industry. Many regional regulatory authorities, national governments and European governments are involved in the inland navigation industry. Every country has their own requirements and legislation, therefore many different systems are used in the inland navigation industry to communicate. A European standardized information exchange will contribute to the safety and efficiency of the industry. All actors in the inland navigation industry should implement an equal system to ensure a smooth communication between all actors. Tracking and tracing is one of the core function of RIS. Therefore Inland AIS guidelines should be developed. On the other hand industrial members will probably not develop an Inland AIS without standards, because they do not know the legislative requirement that should be met.

Guidelines for merchant AIS were developed and adopted by IMO. These guidelines were adopted in 1998, but could still be changed because it was not obligated to use AIS in merchant shipping. Therefore Inland AIS guidelines could not be developed, both transponders had to be compatible to each other to operate in mixed areas (inland and merchant traffic). Inland AIS is based on merchant AIS, therefore these guidelines had to be implemented in IMO legislation to ensure the guidelines would not be changed anymore. In 2000 these guidelines were implemented in SOLAS. Therefore Inland AIS guidelines could be developed since then.

To develop European guidelines, which will be adopted by all European countries, European participants have to support the development. Many (pan-) European participants were attracted to develop Inland AIS, they were able to observe concept advantages, discuss industrial requirement and eventually support the development of Inland AIS.

Support barrier
European support of Inland AIS guidelines was required, every national government is not obligated to adopt EC guidelines in their own legislation. Therefore advantages should be demonstrated in all European countries. As a consequence the European projects initiated many demonstration projects in Europe. Actors using AIS in the future would be able to use and observe the system. Many actors did attend pilot projects and concluded that Inland AIS would improve efficiency and safety of the inland navigation industry. Governments could be able in the future, if RIS is developed, to reduce amount of manned VTS centres, therefore they will save money on the traffic management. Governments supported the development of RIS (and Inland AIS) because it was demonstrated that RIS would improve safety of inland navigation, competitive position of the inland navigation and reduce the traffic management costs.

Technical barrier
The amount of instruments used in RIS cannot be implemented at once without some kind of integration. Integrating these systems required a certain approach to be able to implement the entire system. All these instruments have to be integrated in one system. Therefore a test environment was required. To optimal use Inland AIS it has to be integrated with other navigational aids. Integration of RADAR, Inland ECDIS and Inland AIS seemed quite a challenge but was solved in European projects.

Efficient use of Inland AIS requires a shore AIS infrastructure. VTS centres require the information transmitted by vessels, they need to know positions and identification of vessels to optimal manage inland navigation traffic. The AIS infrastructure is developed in some European and national projects.

Implementation

Cultural barrier
If RIS would be implemented at once it requires a major change, as a consequence RIS is implemented step-by-step. One of the first steps is the implementation of Inland AIS.

The cultural barriers in the inland navigation industry are extensively described in former innovation process analysis. Inland navigation industry actors are reluctant to implement an innovation because of the risk of implementing a dysfunctional innovation. The main barrier to implement Inland AIS is the affected privacy of inland skippers.

To overcome implementation barriers the Dutch government agreed on a covenant with the Dutch shipping associations. They agreed to only transmit position and vessel identification to reduce the privacy affects. And they agreed to fund Inland AIS implementation of 8000 inland vessels (1000 test vessels received and installed an AIS installation for free and 7000 vessels will receive € 2100 to install Inland AIS), the Dutch inland fleet consists of 7000 vessels.

Legislation barrier
Inland AIS could be advantageous to use in the inland navigation industry if every vessel uses it. The Dutch government and skipper associations agreed to implement Inland AIS on voluntary basis. Therefore not everyone will carry Inland AIS and as a consequence not every vessel can be identified.

Because of the risk that not every vessel will carry Inland AIS some regulatory authorities are considering to obligate the use of Inland AIS (e.g. Donau, port of Antwerp, port of Gent, Rhine). It is believed that governments will obligate the use of Inland AIS in the following years.

Education barrier
Inland skippers believe that Inland AIS is a navigational aid which can be advantageous for navigational matters. They mentioned that they do require some kind of education to optimal use Inland AIS. This type of education is not provided (yet), although the use and functioning of Inland AIS installations is taught at inland navigational education.

Lessons to be learned and recommendations

Lessons to be learned from success factors

Incentive (common interest)
The main incentives to develop Inland AIS are: improvement of safety, improvement of the efficiency of inland navigations and VTS centres cost reductions. These improvements should be met to achieve a cargo shift towards inland navigation. The cargo shift is required to reduce overload of European road infrastructure and reduce the environmental impact of transportation. It is demonstrated to all stakeholders that they will benefit by implementing Inland AIS. Therefore there is a common interest to develop Inland AIS, this common interest is required to create wide support.

Initiative (governmental and industrial)
Governments and industrial members will benefit by implementing Inland AIS, as a consequence they did initiate projects together. They both have to adopt and implement the concept, therefore they try to develop a concept that will meet their requirements. Industrial members willing to initiate a project are willing to invest in a concept, they will be dedicated to develop a successful concept and implement it. Governments willing to initiate a project are willing to invest in the concept, they will be dedicated to the development of a successful concept and will implement it as well.

Inland AIS should be implemented by inland skippers and governments, they both initiated and developed the concept. The development of the concept was supported by research institutions, scientific members should assist in the development and not initiate it. Participants willing to adopt a concept will try to meet their requirements, therefore they should initiate and develop a concept. Projects should be initiated by participants who will adopt and implement the concept.

Cooperation

Project coordination in European and Dutch projects is mainly executed by the Dutch ministry of waterway management. They were involved to coordinate the project and did not participate in the development of Inland AIS. Available resources (time and money) were sufficient to extensively coordinate projects. They were able to attract, stimulate and interest project participants. A ministry owns a wide industrial network, therefore they were easily able to attract the right partners with the required knowledge to execute an extensive project like RIS implementation. Dedicated project coordination with sufficient resources is required to keep participants interested and motivated to develop an innovation. If a government is willing to coordinate a project like RIS, and therefore AIS, they will be convinced about the potential advantages of the concept. There is a high change that Inland AIS will be obligated in the inland navigation industry, because it is obligated in merchant shipping. On top of that a ministry is going to execute project management. Therefore participants believed that Inland AIS would be implemented into legislation. Obligated Inland AIS in every vessel is profitable for developers of Inland AIS and the Inland AIS infrastructure, as a consequence many participants were willing to participate. Project coordination by a trustworthy member like a ministry will enable the possibility to attract and keep the right participants (stakeholders) interested

TNO is a Dutch industrial research organization, they did develop the first transponder system back in 1985 commissioned by the Dutch government. After that, AIS was developed and implemented in merchant shipping. A reliable research institute like TNO participated in some European and national projects, they were convinced about advantages using Inland AIS. Support of an industrial research organization strengthens the adoption process of an innovation. Inland skippers did mention: “we do believe innovations are advantageous, but we do not own sufficient knowledge to assess an innovation”. If a research institution is involved they will assess the innovation, this lowers the adoption barrier for inland skippers. On the other hand they are willing to participate in the development of Inland AIS, therefore they do believe the concept is advantageous. Support of industrial research organization enables the possibility to attract participants, keep stakeholders interested and convince stakeholders about the advantages of a concept.

A project consortium does invest resources to develop an innovation. In INCARNATION many resources were invested to develop a DGPS combined with shore RADAR to create a tactical traffic image. Because of these invested resources entrepreneurs will try to get paid-back for the investment. Some entrepreneurs will try to implement their concept, because of the invested resources, no matter what. In INCARNATION the concept has been assessed and it seemed that resources required to implement this concept were rather high. Implementing Inland AIS to track and trace vessels and create a tactical traffic image will lower the required investment. As a consequence follow-up projects did develop Inland AIS. Project consortiums need to be realistic, creative and flexible to adjust plans, find new solutions and develop new concepts in order to implement a well-developed concept in the market.

To implement efficient Inland AIS every vessel needs to carry an Inland AIS and every VTS centre has to be able to use Inland AIS information. Many national governments and regulatory authorities should be involved in developing Inland AIS to convince them about the advantages. The national governments and regulatory bodies need to adopt and implement Inland AIS. They maybe even implement Inland AIS into their legislation. Beforehand it was known that wide support of these members was required, as a consequence they were asked to participate in European projects. If regulatory authorities are needed to implement a concept, they should be convinced about the advantages of the concept, therefore they should be attracted early to participate in developing the concept.

Inland skipper need to implement Inland AIS, therefore they have to adopt Inland AIS. Dutch inland skippers associations were attracted into development projects. They were able to observe advantages of the concept by demonstrations and invite members to join the demonstrations as well. The industrial associations were able to monitor the industrial requirement of an Inland AIS installation and discuss the industrial requirement with project participants and governments/regulatory bodies. They were able to mediate between inland skippers and participants, they could change the concept to meet the industrial requirement. The Dutch government monitored the adoption of Inland AIS in 2006, they were able to use the information of this monitor to propose an agreement between Inland skippers and the Dutch government. The Dutch government made sure that industrial requirements were met if the inland skippers were willing to voluntary adopt Inland AIS. An industrial association can mediate about the industrial requirement between projects and potential implementers. If a project aims at a wide implementation of a concept they will need support of implementers, implementers will support if their requirements are met. Therefore industrial association should be involved in the development of concept to discuss industrial requirements and create a wide support.

Available resources
All projects related to Inland AIS were partly funded by the European Commission and national governments and partly funded by participants. Because of the amount of funding of governments the risk of participating in these projects was small, if the concept is not successful, participants would lose their rather small investment. If the concept would be successful, participants would benefit from implementing the concept. Because of the available resources and the potential impact of Inland AIS participants were willing to participate. Because of sufficient resources the project consortium could be creative and flexible.

Many companies own R&D departments, they reserve resources to develop and research new concepts. Companies do have resources to invest in projects. Available resources to develop a concept should be sufficient to a project consortium to be realistic, flexible and creative. If there are enough resources, project consortium can decide to try and find a new solution if another concept does not meet the industrial requirements.

Economic and environmental (demonstrate advantages)
The inland navigation industry is reluctant to implement innovations. They are not able to assess an innovation without observing the advantages of an innovation on full scale. As a consequence they need demonstrations and pilot projects to be convinced about a profitable innovation.

During the development process of Inland AIS many demonstrations have been executed. European wide support was aimed for, governments, regulatory authorities and logistical actors needed to be convinced about the advantages of Inland AIS before they would adopt and implement it. Therefore demonstrations have been executed at many locations. Stakeholders were invited to observe the functioning of the installation and mention their requirements. Demonstrations were executed by VTS centres and skippers, they could assess the system and discuss about their user experiences. Taken into account industrial requirements and user experiences the concept was redesigned and tested again.

Finally three pilot projects have been initiated in the Netherlands to assess the installation and collect user experiences. Small adjustments to the concept have been implemented until the installation did meet all the user requirements.

Demonstrations and pilot project in the inland navigation industry are required to develop: a well-developed concept without any uncertainties, a concept that meets all the user requirements and to achieve wide support (governmental and industrial).

Standardisation (European)
European strategy is to improve the information exchange between all European actors in the inland navigation industry. A standardized communication between these actors is required to improve the competitive position of the inland navigation industry.

Early in the development process, Inland AIS guidelines have been developed to ensure an equal system used in Europe. These guidelines were developed in former projects executed by international European consortiums. Therefore the European members did adopt the European developed Inland AIS guidelines and disseminated their guidelines by local demonstrations. In following national projects Inland AIS has been used that met these guidelines, therefore e.g. an initiated project in Austria uses an Inland AIS that meets the same requirement as an Inland AIS used in the Netherlands. Compatibility between all European systems is ensured with these guidelines. If concepts will be implemented without honouring these guidelines the system does malfunction. Without compatibility of all European systems skippers are still not able to identify each other and VTS centres are still not able to identify all vessels. As a consequence European RIS will never be implemented.

Guidelines of concepts are necessary if a wide support is required. Many actors are involved in the implementation of European wide concepts, without guidelines they will all develop another system. With these guidelines they will use the same equipment and it will be compatible in Europe.

Technical (implementation of well-developed concept)
The first developed tracking and tracing aid was DGPS and shore RADAR, ensuring compatibility of this system required a large investment. Participants decided to try and implement Inland AIS instead of DGPS and shore RADAR.

Inland AIS is complementary to merchant AIS, therefore the system functions in mixed areas. Inland AIS is complementary to the entire RIS system. Implementation of RIS at once requires a major change in the industry, therefore the system is implemented step-by-step, Inland AIS is one of the first steps. The concept is complementary to current navigational aids, it does contribute to the navigational safety and can be integrated with other navigational aids to create a tactical traffic image.

Implementing a well-developed concept strengthens support of the concept. If a concept is functioning user experiences are good, if a concept is dysfunctional user experiences are bad. This information, in case of a dysfunctional concept, will be disseminated and as a consequence no skipper is willing to implement the concept anymore. If developers still like to implement the innovation they need to modify the system and again convince everyone about the performance of the concept. This will require a big investment. Implementing a well-developed concept reduces the risk of implementation for users and will speed up the implementation of the concept.

Investment (financial support implementation)
Inland AIS is part of RIS, governments are aiming to implement RIS in the following years. Inland AIS is one of the first step to implement RIS, therefore government try to speed up the adoption and implementation of Inland AIS, they are willing to fund the implementation.

Lessons to be learned from policy contribution and intervention

Funding (projects)
The EC stimulates European research and development projects by initiating framework programmes. Project consortiums are able to apply for funding in these programmes, if they meet certain EC requirements. Without this funding program many international projects related to Inland AIS would not have been initiated because of the required resources. The EC needs to continue with these funding programmes to stimulate European research and development.

Initiative (project)
Improving the information exchange in the inland navigation industry strengthens the competitive position of this industry. An improvement of this competitive position is required to stimulate a cargo shift from road to inland waterways. This is required because of the European road infrastructure overload and the environmental impact of road transport. Many national and European governments aim to reduce the road infrastructure overload and environmental impact. Therefore an improvement of information exchange is required to enable: higher safety standards in inland navigation, improve the competitive position of inland navigation, improve the traffic management of VTS centres and reduce the traffic management costs. Because of these governmental and industrial advantages projects have been initiated by governments and industrial members. Especially the Dutch ministry of waterway management did initiate many international projects.

Inland AIS is going to be used by industrial members and governmental members, therefore governments initiated projects to be sure the concept would meet their requirements. On the other hand their public support of the concept ensured a wide support and participation. They were able to coordinate the project, attract participants and keep stakeholders interested.

Governmental support of a concept enables the possibility to apply for governmental funding, use governmental members to coordinate the project, find specialised participants and keep stakeholders involved and interested in the project. If a government would like to implement a certain concept they should participate in the development and publically support the implementation of the concept.

Support (EC, CCNR, national governments, etc)
Implementation of European standardized RIS, and Inland AIS, was aimed for by the EC. Therefore they supported European projects and publically supported the development of RIS. EU governmental members were attracted to participate in these European projects and in follow up projects Pan-European governmental members were attracted.

European wide dissemination of the EC strategy to implement a European standardized RIS was required. Therefore EC stimulated and funded demonstration projects in entire Europe. Observing these demonstrations by governments and regulatory bodies interested them to implement RIS, they publically supported the development of RIS as well. Inland AIS is part of RIS, so they did support the implementation of Inland AIS.

A concept requiring European wide support needs to be demonstrated in Europe to be supported. EC should fund and stimulate initiatives to demonstrate advantages if they require European wide support. If these demonstrations are finished and supported, they should attract European wide participants in development projects to enable them to mention user requirements. If user requirements are met they will probably adopt and implement the concept.

Standardisation
European standardisation was required to implement Inland AIS in Europe. Therefore at an early stage the EC asked for RIS and Inland AIS guidelines. These guidelines have been developed in European projects and implemented by PIANC. The guidelines have been disseminated to all European regulatory authorities and in 2004 finalized and updated guidelines were adopted by PIANC and CCNR.

European wide support was attracted and national governments implemented the guidelines in their legislation. Inland AIS can be developed by anyone but it has to meet the CCNR/PIANC guidelines, this will guarantee a European wide compatibility of Inland AIS.

Implementation of a European wide concept requires guidelines. The EC should ask for these guidelines early in the development process to ensure a European wide compatible concept.

Support and funding (governmental to implement)
The Dutch government aimed to voluntary implement Inland AIS in the entire Dutch inland navigational fleet. They should convince inland skippers about the advantages of the concept. Therefore they needed to monitor the inland skipper requirements to use Inland AIS and they needed to demonstrate the concept. The requirements were mainly related to privacy matters, the inland skippers were only willing to transmit their position and identification. They were willing to implement Inland AIS if implementation was funded by the Dutch government. These agreements were captured in a covenant between skippers associations and the Dutch government.

After monitoring user requirements the Dutch government initiated and funded three pilot projects. 1000 vessels were equipped with an Inland AIS, the main objectives of these experiments were: demonstration of advantages using Inland AIS and collect user experiences to modify the concept. After these experiments they made funding available for 7000 vessels.

The Dutch government would like to voluntary implement Inland AIS and was willing to provide the required resources to enable this voluntary implementation. If a government requires a certain concept by inland navigation entrepreneurs they should demonstrate the concept to attract industrial support and they should be willing to fund implementation.

Lessons to be learned from barriers

Cultural barriers
The cultural barriers at implementing Inland AIS in the inland navigation industry were: privacy and investment. Both barriers have been removed by agreements between skipping associations and the Dutch government in a covenant.

If cultural barriers in the inland navigation industry hamper the implementation of an innovation, they should be removed. These barriers should be removed by stakeholders trying to implement an innovation.

Competitive barriers
The competitive position of inland navigation is weak compared to road transport. As a consequence much cargo is transported by road, while this creates problems like: road infrastructure overload and an unacceptable level of environmental impact. To reduce these problems in the transportation industry, cargo needs to be shifted to the inland waterways. But the inland waterway transportation owns a weak competitive position. This competitive position should be strengthened before a cargo shift is possible.

To solve the problems in road transport, problems in the inland navigation industry should be solved. Actors need to deal with these problems one by one, first strengthen the competitive position, second demonstrate improvement in the industry, third try to create a cargo shift and the problems in the transportation industry will be reduced.

Financial barriers
A cost benefit analysis is executed at the end of INCARNATION, this analysis demonstrated the relative high investment needed to implement DGPS and shore RADAR compared to the implementation of Inland AIS. As a consequence the participants decided to propose Inland AIS instead of DGPS and shore RADAR.

Cost benefit analysis should be performed in any innovation process to demonstrate improvements of the industry using the concept and the costs of these improvements. Cost benefit analysis will demonstrate the potential impact of the concept. These analyses are a great incentive to decide on go/no go decisions.

Technical
Implementation of RIS requires a great change in the inland navigation industry. Implement an entire new information exchange devices requires: skipper education, supply of all the required devices, integration of all the required devices, etc. As a consequence industrial members and governments decided to implement Inland AIS first and implement the other services one by one. At this moment Inland AIS is implemented.

If a concept contains more than one innovation participants should implement these innovations one by one. Adoption and implementation of multiple innovations at once will be very hard, maybe even impossible. Especially the conservative inland navigation industry will not adopt such a big change, therefore implement one innovation at a time.

Templates

The type of policy analysis template is filled out with numbers, 1 is of minor importance and 5 is of big importance.

Type of policy analysis	Key points or not *(ranked 1–5)*	Level of government involved (and public/private partnership?)	Influence during the initiation period (ranked 1-5)	Influence during the development period (ranked 1-5)	Influence during the implementation /termination period (ranked 1-5)
Standardisation	4	European/state/private	2	5	3
Stimulation of R&D	2	European/state/private	3	2	1
Knowledge management	-	-	-	-	-
Infrastructure development	3	European/state/private	-	3	3
Regulation and planning	2	European/state	1	1	4
Legislation	4	European/state	1	3	5
Pilots and demonstrations	5	European/state/private	2	5	5
Networking	-	-	-	-	-
Financial resources and incentives	4	European/state/private	3	4	4
Niche management	-	-	-	-	-
National security/strategies issues	5	European/state/private	3	5	5
Environment issues	5	European/state/private	4	5	5

1) Comments on financial intervention:
- R&D is stimulated by funding and by R&D departments at participating companies
- Pilots and demonstrations have been funded by EC, national governments and participants.
- Financial resources have been provided by governments, a financial incentive to develop Inland AIS for governments has been demonstrated (traffic control costs reduction).

2) Policy/administrative intervention

- European standardisation of information exchange in the inland navigation industry is one of the main objectives of the initiated projects.
- European infrastructure to use Inland AIS should be developed.
- Planning and development of regulations about the development of Inland AIS is executed by governmental bodies.
- Guidelines have been adopted in national legislation.
- National strategies are: reduction of road infrastructure overload and environmental impact. Therefore they stimulate strengthening the inland navigation industrial competitive position.

The type of actors involved template is filled out with numbers, 1 is of minor importance and 5 is of big importance.

Type of actors involved	Key points or not (ranked 1 – 5)	Involved in which level of government involved (and public/private partnership?)	Influence during the initiation period	Influence during the development period	Influence during the implementation/termination period
State experts, State administration	3	State/European	1	4	4
Monitoring agents	-	-	-	-	-
R&D Agent	-	-	-	-	-
Regulator	3	State/European	-	2	4
Innovation agent	-				
Implementer	5	State/European/private	2	5	5
Developer	5	State/European/private	5	5	5
Lobby group	3	State/European/private	2	4	4
Inventors	-	-	-	-	-
Industrialists, VIP in Business	4	State/European/private	3	4	5
Politicians	3	State/European	1	3	3
International organization (or E.U.)	5	European	4	5	5

Comment: actors have been extensively described in the innovation process analysis, but some comments are:

- State experts and state administration was involved because of the governmental funding and the governmental participation in the development of Inland AIS.
- Regulators were involved because AIS guidelines were adjusted and adopted by them.
- Implementers were involved during the entire innovation process.
- Developers developed the concept.
- Lobby groups were used to disseminate advantages using Inland AIS.
- Members of the logistical industry were participating.
- Politicians were interested to achieve their strategies.
- EC, PIANC, CCNR and other international organizations were involved.

The key success factor template is filled out with numbers, 1 is of minor importance and 5 is of big importance. If the key success factor was not present we should leave the cell empty.

Category of factor	Sub-category	Initiation (ranked 1-5)	Development/Spread (1-5)	Implementation (1-5)
Technological	knowledge and expertise available	4	4	4
	availability of technologies	4	3	4
	compliance with standards	2	4	4
3Administrative and legal	legislative guidelines	1	4	4
	Adm. partners available	1	3	3
	(lack of) clarity about division of responsibilities	2	2	2
Political and process-related	support, relay in local, regional assemblies	4	4	4
	the role of interests groups	2	3	5
	cross boundaries effects	-	-	-
Socio-cultural and psychological	incentives, motivation, spirit of entrepreneurship	2	4	4
	involvement in the project on the part of the stakeholders	2	4	5
	link universities/research/ innovation	2	2	2
Economic and financial	net benefits for actors	2	4	5
	revenues for actors	1	3	2
	availability of subsidies	4	4	5

Comment: success factors have been extensively described in the innovation process analysis, but some comments are:

- Technological: AIS has been developed to use in merchant shipping, the system had to be modified and a shore infrastructure should be developed. Participants with the required expertise were attracted to execute the projects.
- Administrative: legislative guidelines have been developed and were important to create a standardized information exchange in the inland navigation industry.
- Political: all projects were governmental supported. Interest groups attended all projects.
- Cultural: clear incentives to initiate projects are mentioned, stakeholders were involved during the innovation process, as well as research institutions and industrial members.
- Economic: net benefits for actors are available, revenues for project participants are available and an incentive to participate. Subsidy is available.

The barrier template should be filled out using numbers, 1 is of minor importance and 5 is of big importance. If the barrier is not present we should leave the cell empty.

Category of barrier	Sub-category	Initiation (ranked 1-5)	Development/Spread (1-5)	Implementation (1-5)
Available information (knowledge)	Lack of information on information	-	-	-
	Lack of information on markets	-	-	-
	Lack of qualified personnel	-	-	-
Technical	Lack of interoperability	1	4	-
	Lack of standardisation and certification	3	4	-
	Difficult adaptation to a new technology	3	3	3
Legal and regulatory	Legislation, regulations, taxation	-	2	1
	Administrative barriers	-	-	-
	Weakness of property rights	-	-	-
Financial and economic	High costs (too high costs)	-	-	2
	Lack of funds within the enterprise and subsidies from outside	-	-	-
	Lack of competition in the market	-	-	-
-Cultural and societal	Scarce acceptability	1	4	2
	Scarce attitude of personnel towards change	1	4	2
	Inability to devote staff to innovation activity	-	-	-
Decision making	Lack of cooperation among partners (public, private,…)	-	-	-
	Fragmentation of decision levels	-	-	-
	Lack of Vision and Policy Growth	1	4	2

Comment: barriers have been extensively described in the innovation process analysis, some comment are:

- Information: available information was not a barrier.
- Technical: the main reasons to initiate the projects related to AIS are: interoperability between Inland AIS and other systems, and the need for a European standardized information exchange system. Adaption to a new technology seems a huge barrier in every innovation process related to the inland navigation.
- Legal: legislation had to be adjusted to adopt RIS guidelines, but this was not a huge barrier.

- Financial: inland skippers are reluctant to implement any innovation, because of the risk of implementing a dysfunctional concept. As a consequence they believe any costs related to the implementation of an innovation are too high.
- Cultural: the inland navigation industry has scarce acceptability towards a new innovation.
- Decision making: there is a lack of vision in the logistical industry about the possible advantages of RIS. As a consequence projects tried to demonstrate advantages by executing pilot projects.

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2.5. Intermodal

Introduction of the Superfast Ferry Line

INTRODUCTION

The present document corresponds to the analysis of the Innovation introduced by the company EPAT, which is known as the “introduction of the Superfast Ferry Line” for freight and passenger transport between Greece and Italy. This constitutes an innovation in the “intermodal sector”. During the 1st consultation (Antwerp, April 2010) it was advised within the wider topic of Short Sea Shipping, that cases of particular interest should be identified. The partner responsible for the specific topic (UAegean) decided to purse one case under WP4 and one under WP3.

The present Case focuses on the introduction of the Superfast Ferry Line between Greece and Italy, which is, in general, considered as a “success”.

The analysis is based on tacit knowledge within the UAegean team and findings from interviews conducted on:

- December 3rd, 2010, at company headquarters with senior staff involved in the initial endeavor
- …

The introduction of Superfast Ferry line(s) between Greece and Italy, are considered a best practice example of intermodal transport leading to modal shift. One additional, interesting element of the present case study is the fact that the case was repeated, which not always the case.

DESCRIPTION & BACKGROUND

BRIEF DESCRIPTION OF CASE STUDY

In 1995, Superfast Ferries, a new Greek company headed by father and son Pericles and Alexander Panagopoulos, introduced a pair of 27-knot Ropax ships on the 504nm Patras-Ancona route between Greece and Italy. Capable of carrying up to 120 trucks each, these ships were also able to complete a single trip in 20 hours, which meant a regular daily service could be maintained employing just two ships. Competitors on the route tended to use three slower ships (36 hour journey) to provide a daily service. Within a year of start-up, Superfast was carrying approximately 1,000 trucks a week. While part of the attractiveness of the fast sea route was due to the war in former Yugoslavia, which made the road journey problematic, virtually all traffic diverted from road has been retained since the Balkans conflict ended.

From this humble beginning Superfast developed very quickly, introducing a further six fast vessels into service, four 28-knot ships on the Adriatic, and two similar ships on the Baltic Sea between Hanko and Rostock, the latter service starting in 2001. Four vessels now operate the Patras-Ancona route all-year-round, providing an increased service frequency of twice daily in both directions (and via Igoumenitsa, daily). While Superfast services also offer passenger carrying capacity, all-year- round freight is regarded as the core market.

Figure 1: Current routes between
Greece (Patra – Igoumenitsa – Corfu) and Italy (Bari – Ancona)

A further four vessels were subsequently delivered to Superfast, helping to open up two further coastal long-distance ferry routes, between Sodertalje-Rostock and Rosyth-Zeebrugge. The former service was subsequently stopped after only a few months due to lack of support (and intense pressure on rates) from the heavily concentrated long-distance trucking sector in Sweden. While some of the earlier ships have since been sold to other operators, the Superfast Ferries focus on long-distance routes employing fast RoPax tonnage has been very successful and resulted in a major and sustained modal shift from road to sea.

Figure 2: SuperFast Ferry outside Patra Port

The attempt is known as an innovation in terms of technology: Introduction of fast ferry on the Greece – Italy route

However, the case study also presents the following innovations:

Managerial: The Panagopoulos family before engaging in the passeger – freight shipping industry were highly reputed enterpreuners in the Cruise Shipping Industry (Royal Cruise Lines - RCL). When they started the SuperFast Ferry Line they recruited their old staff (including crews). This represented, roughly, 70-80% of all employees and 12-13 people on the Board of Directors.

Cultural: As ship crews were trained to offer hotelier services, they provided similiar services on the SuperFast Ferry routes. This led to the upgrading of services provided on the Greece-Italy route.

Service quality is utmost importance in business culture. This is a totally new concept in a Short Sea Shipping Service.

Marketing: Special service package offered to truck drivers, therefore, securing their preference in terms of services rendered.

ICT Technology: The Company was the first to introduce an on-line booking system in 1995. This facilitated both users and in preparing the car and truck loading plan reducing ship loading time.

Organisational: Revitalisation of the old route Patra – Bari due to the ability to do the trip within the 24 hour limit

Business: Emphasis on «passenger logistics» by providing a bus service between Athens and Patra.

CHRONOLOGICAL DEVELOPMENT

1971 Pericles Panagopoulos (Entrepreneur) sets up his own cruise line company, Royal Cruise Lines (RCL). RCL is considered a very successful business in a growing industry.

Initiation Period

1989 P. Panagopoulos sells RCL to Denmark's Kloster Cruises, later known as Norwegian Cruise Lines for about USD 300 mio. This is considered a very visionary move, as following 1989 the Cruise line industry takes a downturn. This action, while common in the ocean shipping industry, is considered exceptional in the Cruise Line industry.

1990-91 P. Panagopoulos buys shares in various companies and company groups with diverse commercial activities. Most probably testing investment opportunities.

1991	Beginning of conflict in former Yugoslavia and the disruption of road transport through the Balkans region.
1992	P. Panagopoulos buys Attica Flour Mills and renames it to "Attica Enterprises". Today Superfast Ferries is owned 100% by "Attica Enterprises"

Development Period

Nov. 1993	The 1st order for two (2) SuperFast Ferries is placed at the German Schichau Seebeckwerft yard (SSW).
April 1995	SuperFast Ferry I delivered
June 1995	SuperFast Ferry II delivered
June 1995	The service Patra-Ancona-Patra is launched. The two ferries revolutionise the route by cutting the crossing time between Patra and Ancona by up to 40% (20 hours instead of 26 hours)
1996	Success is belong expectations.
June 1996	An order is placed for new car-passenger ferries, Superfast III and Superfast IV, at Kvaerner Masa-Yards in Turku, Finland with an option for two more vessels which was not pursued.
June 1996	Finnish bank loans were drawn.
April 1998	Delivery of Superfast III and Superfast IV
April 1998	SuperFast III and IV are deployed on the Patra -Ancona- Patra route.
April 1998	Superfast I and Superfast II launch a new route linking Patra and Igoumenitsa with Bari in southern Italy
July 1998	Order of four new Superfast car-passenger ferries at Howaldtswerke Deutsche Werft AG with an option for two more units. Option confirmed in March 1999.
1998-99	Success is confirmed. Numbers continue to rise. Revenues correspond to 55% to freight, 30-35% passengers and 10-15% onboard services.

Implementation – Dissemination Period

2000	End of upheaval in Balkan region.
March 2000	Order of two new Superfast car-passenger ferries at Flender Werft AG scheduled for delivery in March and May, 2002.
Sept. 2000	Superfast Ferries selected by Scottish Enterprise as the preferred bidder among 42 companies to run a direct ferry service from Rosyth in Fife, Scotland to continental Europe.
2001	Delivery of Superfast V and Superfast VI from Howaldtswerke Deutsche Werft AG in Kiel, Germany. Both ships are deployed in the Adriatic Sea routes.

The Adriatic Lines – continued and upgraded service

2002	Delivery of ultramodern car-passenger ferry Superfast XI, built at Flender Werft AG in Lubeck, Germany and deployment in the Adriatic Sea routes between the ports of Patras, Igoumenitsa and Ancona.
Oct. 2002	Delivery of ultramodern car-passenger ferry Superfast XII, built at Flender Werft AG in Lubeck, Germany. The delivery of Superfast XII marks the completion of the ambitious investment programme for twelve Superfast ferries, which began in 1993 with the order of Superfast I and Superfast II.
Sept. 2002	Superfast Ferries and Blue Star Ferries, are first Greek passenger ferry companies to receive ISO 14001 certification by ABS Quality Evaluations, a member of the international American Bureau of Shipping group.
2004	Attica Enterprises enters into an agreement with Atlantic Navigazione of Grimaldi Group, Napoli, for the acquisition by the latter of Superfast I. The ship is delivered to her new owners at the end of February, 2004. The sale of Superast I concludes the sale of the four first-generation vessels of Superfast Ferries. The Superfast Ferries fleet consists in 2004 of eight brand new car-passenger Superfast ferries built from 2001 onwards with an average age of less than three years.
2008	Delivery of new-built Ro-Pax vessel Superfast I from Grimaldi Holding S.p.A., of Genoa, Italy which was built at Nuovi Cantieri Apuania, Italy deployed in the Patras-Igoumenitsa-Bari route.
2009	Delivery of new-built Ro-Pax vessel Superfast II from Grimaldi Holding S.p.A., of Genoa, Italy which was built at Nuovi Cantieri Apuania, Italy in September 2009. Superfast II is deployed in the Patras-Igoumenitsa-Bari route.

The Baltic Line

2001	Superfast VII commences operations between the ports of Rostock, Germany and Hanko, Finland, marking the inauguration of Superfast Ferries' Baltic operations and is joined on the same route by sister vessel Superfast VIII in July.
Nov. 2005	In response to market demand and pursuing European network optimization, Superfast IX, until then on the North Sea route between Scotland and Belgium, joins Superfast VII and Superfast VIII in the Baltic Sea on the route between Rostock, Germany and Hanko, Finland.
April 2006	Superfast VII, Superfast VIII and Superfast IX, serving on the Rostock, Germany – Hanko, Finland route in the Baltic Sea are sold to to AS Tallink Grupp. The sold vessels retain their names and continue sailing under the Superfast livery until the end of 2007, following an agreement with AS Tallink Grupp.

The UK Rosyth Line

2001	The port of Zeebrugge in Belgium is selected by Superfast Ferries as the corresponding port on the new North Sea service out of Rosyth due to be launched in May, 2002.

2002 Delivery of Superfast IX and Superfast X from Howaldtswerke Deutsche Werft AG in Kiel, Germany.

2002 Launch of the new Superfast Ferries service between Rosyth, Scotland and Zeebrugge, Belgium. Newly built Superfast IX and Superfast X operate the route, the first direct ferry route between Scotland and the European continent.

2004 Superfast IX and Superfast X are voted as “Best” ferry overall among 15 ferries operating out of the UK by "Holiday Which?" magazine, the publication of the British Consumers' Association.

2004 Superfast Ferries voted “Best Ferry Operator” by the Scottish Passenger Agents’ Association (SPAA), the oldest travel trade association in the world, with 700 travel agents in Scotland voting for the award.

2005 The Superfast Ferries Scotland-Belgium service in the North Sea, is operated by Superfast X.

2005 Superfast Ferries is voted ‘Best Ferry Operator’ by the Scottish Passenger Agents’ Association for the second consecutive year, with approximately 700 associated travel agents in Scotland voting for the award. The Scottish Passenger Agents’ Association is the oldest travel trade association in the world, established in 1921.

Aug. 2006 Attica enters into an agreement to sell to Veolia Transport its ice-class vessel Superfast X trading between Scotland and Belgium for a total cash consideration of Euro 112mln. The delivery of Superfast X and final payment is to take place at the beginning of 2007

The Bass Straight Line

2002 Attica Enterprises enters into an agreement with the Government of Tasmania (Australia) and TT-Line Pty Ltd. of Tasmania for the sale of Superfast III and Superfast IV for service in the Bass Straight.

July 2003 Attica Enterprises enters into an agreement with the Government of Tasmania (Australia) and TT-Line Pty Ltd. of Tasmania for the acquisition by the latter of Superfast II for service between Sydney and Tasmania.

The UK Great Yarmouth Line

2002 Superfast Ferries emerges as a front runner in another international tender for the operation of a ferry route between Great Yarmouth in the United Kingdom and continental Europe.

The Piraeus – Crete Line

2008 Attica Group announces the launch of a new service to be operated by car-passenger ferry Superfast XII from Heraklion to Piraeus. Superfast XII brings Heraklion closer to Piraeus, making Crete an attractive weekend destination not only in the summer but also during the winter season.

KEY ACTORS

The Entrepreneurs/ Owners:

Pericles and Alexandros Panagopoulos, father and son, are the key actors, innovators, motivators and initiators of the application of this case study, which was replicated in the Baltic Sea, North Sea, the Bass Straight and recently on the Piraeus – Heraklion line (internal in Greece). The Owners may be considered charismatic in terms of envisioning market developments, leadership qualities, and demonstration of initiative.

Shipyards:

While shipyards could have been considered a positive influence on the case study, it was identified that their role was limited to providing the new built as in conventional shipyard building services. This is also evident by the fact that vessels were ordered in various shipyards.

Banks:

On the same note as shipyards, banks did not offer any additional support, possibly required in the case of new technology uptake. On the contrary, there is evidence that banks were hesitant to support the endeavor.

Ship Farers' Unions & Regulations

The Owners respected all laws and regulations concerning employment and working conditions. In contrast, interviews with company staff revealed high levels of company loyalty.

Ports Installations and Port Authorities:

The success of the SuperFast Ferry Case is the ability to make the journey within 24 hours. This also meant efficient planning of ship loading and unloading which required specific port installations. While requirements were meant by port Authorities in all visiting ports, the port of original origin is still (after 15 years of successful service) to provide adequate installations.

Government & Other Public Authorities

Government and other Public authorities did not provide any support in the development of the SuperFast Ferry Case.

Analysis

Initiation

The endeuvor of my be characterised as a pure enterpreunal activity, where a visionary enterpreneur identifies an opportunity for investment.

Factors supporting the endeuvor were the availability of own capital and the war in the Balkan region with posed difficulties (if not restricted) road transport through the Balkans.

However, the above factors could only be considred as supportive and not decisive, as there is no evidence that Banks would not fund the endeuvor and after the end of the war, there has been no drop in % of vessel loading.

The key concept was the ability to reduce the voyage to under 24 hours and, thus, securing the potential to offer:

- A daily service
- Voyage time comparable to road journey time
- Operation with two vessels on the lines instead of three required by competition.

Development

In the development phase, success was secured through the introduction to multiple innovations, which all supported/served the concept of seemless travel. As noted in section 2, the application included the following «innovations»:

Managerial: The Panagopoulos family before engaging in the passeger – freight shipping industry were highly reputed enterpreuners in the Cruise Shipping Industry (Royal Cruise Lines - RCL). When they started the SuperFast Ferry Line they recruited their old staff (including crews). This represented, roughly, 70-80% of all employees and 12-13 people on the Board of Directors.

Cultural: As ship crews were trained to offer hotelier services, they provided similiar services on the SuperFast Ferry routes. This led to the upgrading of services provided on the Greece-Italy route.

Service quality is utmost importance in business culture. This is a totally new concept in a Short Sea Shipping Service.

Marketing: Special service package offered to truck drivers, therefore, securing their preference in terms of services rendered.

ICT Technology: The Company was the first to introduce an on-line booking system in 1995. This facilitated both users and in preparing the car and truck loading plan reducing ship loading time.

Organisational: Revitalisation of the old route Patra – Bari due to the ability to do the trip within the 24 hour limit

Business: Emphasis on «passenger logistics» by providing a bus service between Athens and Patra.

These innovations concluded the image of the "new QUALITY product" initially introduced on the Patra- Ancona – Patra route, which was the busiest line and had significant competition by established shipping lines (ANEK and MINOAN Lines).

The establishment of the Patra- Igoumenitsa – Corfu – Bari route was contested by the Ventouris Lines.

However, Superfast Ferries did not take share from the market but actively pursued the increase of the market by achieving modal shift. Prior to the initiation of the routes systematic promotion was made of this advantages to forwarders, at the time looking for an alternative route through the Balkans.

The Patra – Brindisi – Patra was never actively pursued. Instead, marketing efforts were made to pick up traffic from this line.

Dissemination - Implementation

Dissemination – Implementation of this case is present on two levels.

The first consists of the replication of provided services by competitor shipping lines, which serve in the Adriatic routes. Therefore, many quality characteristics of the SuperFast Ferry are offered, today, by its competitors. However, true to its culture, the company continues to offer quality services by employing new vessels on the Adriatic routes.

The second replication of the innovation case was initiated by the Owners by providing services in the Baltic and North Sea or initiating the Bass Straight Line.

CONCLUSIONS

The SuperFast Ferry Case study demonstrates the case where innovation is pursued based on the identification of potential for positive surplus by the private sector.

At the same time, while technology offered the potential to apply a new concept, its multiple facet innovation support, especially with respect to quality may be considered a decisive factor. This is particularly valid in the case of achieving modal shift.

ANNEX I: Process description template

Process description template			Areas of attention based on previous research like MIRP in the initiation period are: the gestation period, shocks and triggers that initiated the development of an innovation, and the development of plans and budgets.	Areas of attention based on previous research like MIRP in the development period are; proliferation, setbacks, shifting performance criteria, fluid participation of personnel, top management involvement and roles, altering relationships and cooperation between innovation entrepreneurs.					Areas of att research lik process are; and early te
		Process	**Inititiation period**	**Development period**					**Im**
Key aspects	*Aspects to be considered*	*Sub process*	*Generate ideas*	*Evaluation of ideas*	*Design of innovation*	*Development of prototype*	*Evaluation of prototype*	*Redesign and production*	*Disseminati*
Managerial	*Decision making barriers*		None	Introduction of Technology (faster vessels), ICT, Managerial, Organisational and Cultural Innovation to achieve increase in market segment through modal shift					Other companie /competito followed suite.
	Intervention		N/A						
	Technical barriers		None						
	Support		None						
Organizational	*Actors involved*		Principally the Company Owners and Staff	Organisation oriented to the provision of quality services (background in Cruise Shipping) and this is pursued in the new company bringing into the case and through the case quality in Short Sea Shipping.					
	Cooperation between innovation entrepreneurs		YES, the Shipyards						
	Human resource		YES						
	Personnel involved in the innovation process		YES						
	Lack of knowledge/training of personnel		NO						
	Planning		YES						
	Experts support		YES						

	Lobbying	NO		
Economic and Financial	*Private investment*	YES, BANK LOAN		
	Public investment	NO		
	Cost benefit analysis	VERY PRELIMINARY		
	Investment appraisal	YES		
	Financial and commercial barriers	YES, COMMERCIAL BANKING SYSTEM		
Market	*Potential market*	YES, YUGOSLAVIA WAR		
	Dissemination of the innovation	N/A		
	Rate of spread	N/A		
	Reached market	N/A		
	Support	YES		
Governmental	*Subsidy*	NO	There was no support from the Greek Government or respective public Authorities. More specifically, to date and despite the company's success in securing flows through the Port of Patra, Port Authorities have provided minimum support in terms of infrastructure requirements.	
	Regulatory and legal barriers	COMPLIANCE(CREWING)		
	Intervention	N/A		
Cultural	*Cultural and societal barriers*	NO	New cultural concepts introduced to the SSS were accomplished through this case. Moreover, the change in culture and image was in favour of the endeavour.	
	Communication problems	NO		
	Environmental	NO		
	Sustainability	NO		

ANNEX II – POLICY INTERVENTION TEMPLATE

Policy Intervention

Type of policy analysis	Key points or not (ranked 1 – 5	Level of government involved (and public/private partnership ?)	Influence during the initiation period	Influence during the development period	Influence during the implementation/termination period
Standardisation	N/A				
Stimulation of R&D	N/A				
Knowledge management	N/A				
Infrastructure development	N/A				
Regulation and planning	N/A				
Legislation	N/A				
Pilots and demonstrations	N/A				
Networking	N/A				
Financial resources and incentives	N/A				
Niche management	N/A				
National security/strategies issues	N/A				
Environment issues	N/A				

Source : adapted from the methodology of Zuylen and Weber (2002)

Actors and their roles

Type of actors involved	Key points or not (ranked 1 – 5	Involved in which level of government involved (and public/private partnership?)	Influence during the initiation period	Influence during the development period	Influence during the implementation/ termination period
State experts, State administration	Port of Patra – 1	Port Authority	1	2	2
Monitoring agents	N/A				
R&D Agent	N/A				
Regulator	N/A				
Innovation agent	Owner – 5	NONE	5	5	5
Implementer	Owner – 5	NONE	5	5	5
Developer	Owner – 5	NONE	5	5	5
Lobby group	N/A				
Inventors	N/A				
Industrialists, VIP in Business	N/A				
Politicians	N/A				
International organization (or E.U.)	N/A				

Source: adapted from the methodology of Zuylen and Weber (2002)

Stress tests for transport innovation in an ex-ante / ex post perspective for future projects[37]

Indicators selected	Before Innovation (existing infrastructure)	Estimated results (forecast, planning, projected data) from experts / advisors/ planning agencies Of transport innovation	Real operation, up to date data	EVALUATION of IMPACTS of a 50 % traffic reduction	EVALUATION of IMPACTS of a 20 % traffic reduction	EVALUATION of IMPACTS of a 50 % traffic increase	EVALUATION of IMPACTS of a 20 % traffic increase
Level of traffic				- 50 %	- 20 %	+ 50 %	+ 20 %
Level of Demand							
Level of Subsidies							
Revenues from operations							
Return on investment							
Public/Private money invested							
Security issues, injuries, accident							
Extension needed, complementary infrastructure needed,							
Neighbourhood approval							
Public debate, opinion of politicians and experts							
project exported?							

[37] Awaiting permission from SuperFast Ferries to public data

ANNEX III- Factors contributing to the transport innovation

Category of factor	Sub-category	Initiation (ranked 1-5)	Development/ Spread (1-5)	Implementation (1-5)
Technological	knowledge and expertise available	5	5	5
	availability of technologies	5	5	5
	compliance with standards	5	5	5
Administrative and legal	legislative guidelines			
	Adm partners available			
	(lack of) clarity about division of responsibilities			
Political and process-related	support, relay in local, regional assemblies			
	the role of interests groups			
	cross boundaries effects			
Socio-cultural and psychological	incentives, motivation, spirit of entrepreneurship	5	5	5
	involvement in the project on the part of the stakeholders			
	link universities/research/innovation			
Economic and financial	net benefits for actors	5	5	5
	revenues for actors	5	5	5
	availability of subsidies			

Source: adapted from Banister (2004), and Van den Bergh et al. (2007)

ANNEX IV Barrier table

Category of barrier	Sub-category	Initiation (ranked 1-5)	Development/Spread (1-5)	Implementation (1-5)
Available information (knowledge)	Lack of information on information			
	Lack of information on markets			
	Lack of qualified personnel			
Technical	Lack of interoperability			
	Lack of lack of standardisation and certification			
	Difficult adaptation to a new technology			
Legal and regulatory	Legislation, regulations, taxation			
	Administrative barriers			
	Weakness of property rights			
Financial and economic	High costs (too high costs)			
	Lack of funds within the enterprise and subsidies from outside			
	Lack of competition in the market			
Cultural and societal	Scarce acceptability			
	Scarce attitude of personnel towards change			
	Inability to devote staff to innovation activity			
Decision making	Lack of cooperation among partners (public, private,…)			
	Fragmentation of decision levels			
	Lack of Vision and Policy Growth			

Source: adapted from Comtesse et al. 2002, and OECD 2005