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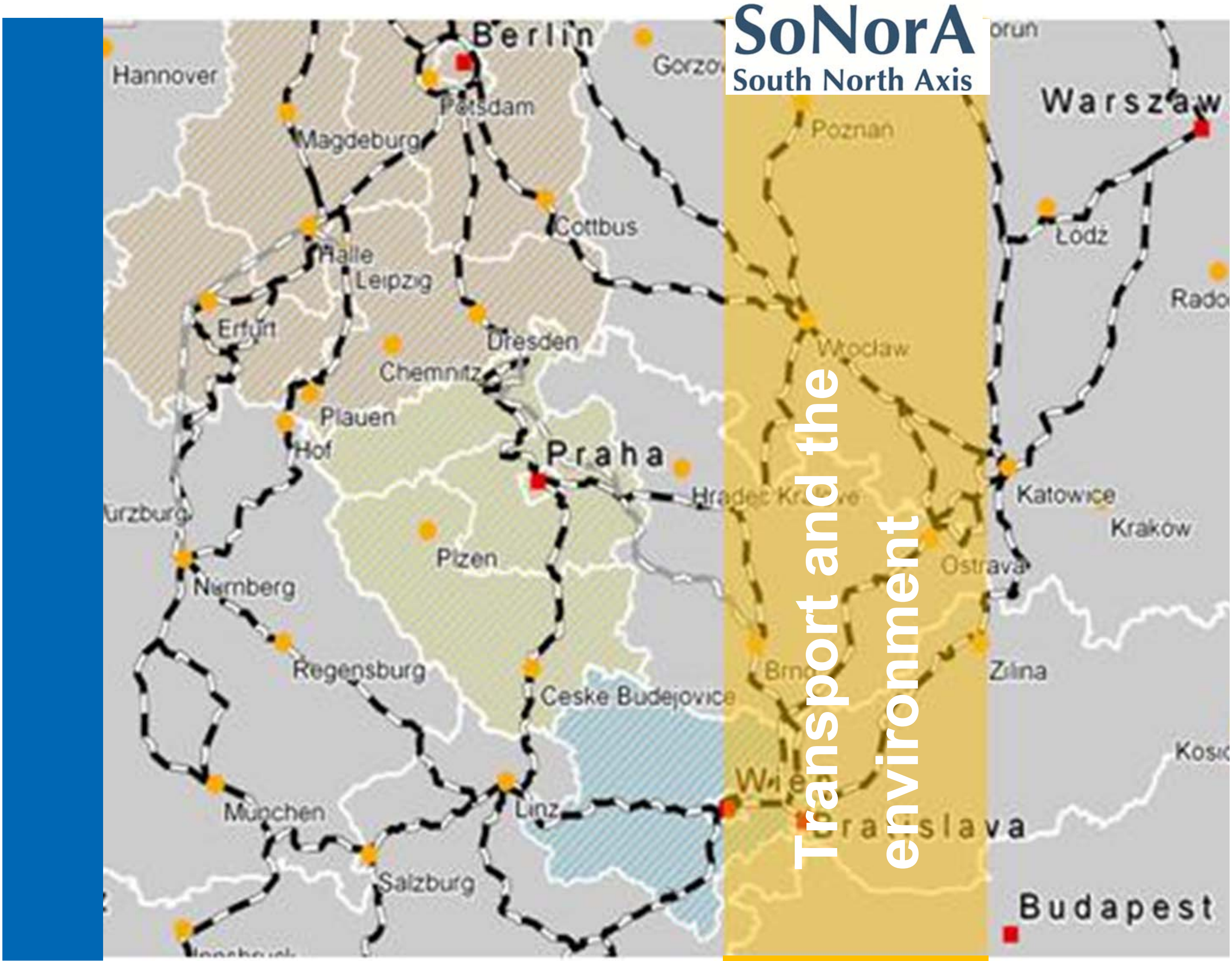
SoNorA
South North Axis

Transport and the environment



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Proceedings of the 8th SoNorA University Think Tank Conference

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Transport and the environment

Sustainable transport

Green corridors

Proceedings of the 8th SoNorA University Think Tank Conference (Szczecin)

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16th of June 2011

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INTRODUCTION

In February of 2009 the transnational cooperation project of the EU called SoNorA (South-North Axis) started to organize the "University Think Tank Conferences" and now it is a honour for us to present you the Proceedings of the 8th Conference, showing the successful cooperation between transport and spatial planning scientists from all over Central Europe and beyond.

The conference topics at the beginning were focusing on the transport infrastructure, the transport networks and core networks in Central Europe between the Adriatic and the Baltic Sea. In later conferences we put emphasis on interesting questions whether transport infrastructure has effects on regional development. Then, we organized conferences on topics about transport services like logistics and cargo and especially rail freight and inland waterway freight in Central Europe. After a rather specific topic on hinterland transport the 8th Conference now puts its attention on a more general but currently the most crucial point: Transport and its effect on the environment.

Not only the European Commission with its new White Paper on Transport is highlighting these important and mostly problematic effects of transport on the environment and the global and local climate. Many − but not many enough − national, regional and local governments are now having climate protection strategies and environmental programs and the transport has or should have a crucial part within these strategies.

Thus we selected this important theme as the topic for the probably last thematic conference before the general final conference. It also includes sustainable transport, which is not necessarily identical with environmentally friendly transport, as environmental sustainability includes social and economic sustainability. Green corridors are also specially high-lighted as they form a new concept of rail transport corridors with less impact on nature.

The papers in the beginning of this proceeding are dealing with possibilities to encourage environmentally friendly travel behaviour and the aspect of sustainable mobility in the new EU transport White Paper. Furthermore it is discussed whether the integration and improvement of transport infrastructure in the EU induces more consumers of transport services and thus leads to more environmental damage caused by mobility of goods and persons.

The second part of papers describes the concept of Green Corridors, firstly focusing on the so called SuperGreen project, then on the Swedish Green Corridor initiative. The next paper presents a transport model for the region around Vienna and Bratislava as a part of the south-north corridor. Finally the last paper deals with a project aiming on characterizing the accessibility of ports in the Scandinavian-Adriatic corridor.

SoNorA is a transnational cooperation project which aims to improve the infrastructure and services in the south-north orientation within Central Europe. An integral and important part of SoNorA is the University Think Tank as a network of transport scientists which has three main roles and tasks within the project:

Firstly, it aims on the creation and consolidation of a network of universities in Central Europe which are related to research and education in transport and/or spatial planning. These partners participate in SoNorA conferences, round-table discussions, the writing of scientific articles, and further research projects emerged out of SoNorA.

Closely related to point one, the second task of the Think Tank is to generate inputs for the whole project. The Think Tank gives methodological support to project partners and creates strategies and inputs for SoNorA. These scientific papers are presented on separate conferences during the regular SoNorA consortium meetings.

Thirdly, the Think Tank reviews the 24 core outputs of the project which are generated by the project partners. The core outputs will be presented to the Think Tank by the partners on the consortium meetings and then will undergo a scientific review process including ex-post-analysis and best-practice identification.

The Think Tank consists of transport researchers of different faculties and institutes of various Central European countries. As mentioned in the beginning the topics of the Think Tank conferences are the following:

No	Date	Place	Topic
1	Feb '09	Praha	Set-up of the SoNorA University Think Tank
2	Jun '09	Gdynia	Transport infrastructure between the Adriatic and the Baltic Sea; Transeuropean Networks of Transport in Central Europe; Simulation and modelling, forecasting and infrastructure
3	Nov '09	Potsdam	TEN-T core network; European and national railway policies
4	Feb '10	Portorož	Infrastructure and regional development; Infrastructure, transport and trade; Infrastructure and society
5	Jun '10	Erfurt	Railway logistics and rail cargo
6	Oct '10	České Budějovice	Future of rail freight; Future of inland waterway freight
7	Feb '11	Trieste	Harbour hinterland transports and connections
8	**Jun '11**	**Szczecin**	**Transport and the environment; Sustainable transport; Green corridors**
9	Oct '11	Bologna	Preparation final conference
10	Feb '12	Venezia	Final conference

The last SoNorA University Think Tank conference was held on the 17th of February 2011 in Trieste (Italy) and was focused on the topic: Harbour hinterland transports and connections.

The conference documented in this proceeding was held in Szczecin, Poland, on the 16th of June 2011. The main focus of this 8th SoNorA University Think Tank conference was about:

- Transport and the environment
- Sustainable transport
- Green corridors

Selected members of the Think Tank have written seven scientific papers on different aspects of these topics which were presented at the conference in Szczecin. The authors are from the Transport Research Laboratory (UK), the University of the West of England (UK), the Polis Network (BE), the Hungarian Academy of Sciences, the University of Gdansk (PL), the National Technical University of Athens (GR), the Swedish Transport Administration, the Slovak University of Technology and the Technical University of Applied Sciences Wildau (DE).

This is the seventh volume of a series of “Proceedings of the SoNorA Think Tank Conferences” where all accepted contributions of the authors are presented. It shall provide a basis for further discussions and continue a successful scientific network in the field of transport and spatial planning.

COMMUNICATING THE IMPACTS OF TRANSPORT CHOICES TO ENCOURAGE LOW CARBON TRAVEL BEHAVIOURS

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ABSTRACT

Transport, and particularly road transport, is a significant contributor to climate change. For climate change mitigation to become a reality transport needs to decarbonise. This is starting to be recognised at the political level, with strong targets for decarbonisation in the European Commission's White Paper on Transport published in March 2011, and with over 2,700 signatories to the Covenant of Mayors (which recognises transport as an important building block). However, political will needs to be followed by action; action which requires a radical change in travel behaviours.

This paper will present the context of, and findings from, the CATCH (Carbon Aware Travel CHoice) project. CATCH is a 30 month EU FP7 project (due for completion in early 2012) that is taking an innovative approach to increase awareness of the potential impact of current travel behaviours (in terms of CO_2 emissions, health, time, budget, community, safety and planning), indicate the impact of other more sustainable travelling choices, and demonstrate how that change could be realised on a city level. CATCH was commissioned in recognition of the fact that reducing greenhouse gas emissions from the transport sector is key to achieving climate targets and that doing so can also deliver a wide range of other environmental, social and economic 'co-benefits.'

CATCH recognises that reduction targets for the transport sector cannot be achieved by technological solutions alone. It is necessary to also foster the necessary behavioural change in modal choice and demand for travel. This creates a pressing need to communicate to citizens and transport professionals the possible impacts of their choices and policies on carbon emissions but also on other environmental, social and economic issues. CATCH is developing an interactive online 'knowledge platform' that will provide users with access to tools including a good practice database, data about the impacts of travel choices, and details of potential solutions to reduce emissions in urban transport. The audience of the platform consists of city stakeholders, who the CATCH project defines as: policy makers, planners, public transport operators, and the general public. The project is developing different tools for each type of audience.

The findings of in-depth literature reviews, focus groups and surveys conducted in the CATCH project have shown that information provision alone is unlikely to incite behavioural change but that it can 'nudge' people in the right direction. CATCH will therefore follow key principles about how to communicate messages relating to carbon reduction in mobility to help to 'nudge' behaviours. These

principles, which include focusing on the wider benefits for individuals and society to carbon reduction, will be incorporated in a set of interactive tools in the CATCH platform and will be introduced in this paper.

1 INTRODUCTION

The CATCH (Carbon Aware Travel CHoice) project is co-financed by the European Union under the 7th Framework Programme for Research. The aim of the project is to develop and promote a trusted 'knowledge platform' that is designed to encourage carbon friendly travel choices and in doing so contribute towards a reduction in CO_2 emissions from the transport sector.

The CATCH 'knowledge platform,' which will be described in this paper, will contain original research but also links to a far wider evidence base of research and best practices. The knowledge platform will be 'open,' enabling its users to add to, comment on, share and discuss its content. It is anticipated that the primary users will be decision-makers in cities, but its content will also be relevant to those working in the fields of transport, energy efficiency and climate change, on the regional and national level.

This paper will outline the pressing need to pursue climate change mitigation in the land transport sector on all levels from the local to the international. It will also highlight the role of behavioural change in achieving the emission reductions that are required to prevent a level of climate change that will exceed the capacity of people and the natural environment to adapt.

2 THE NEED FOR CLIMATE CHANGE MITIGATION

CATCH aims to increase awareness of the impact of travel behaviours on a range of different environmental, social and economic factors thereby encouraging users to think about the broader sustainability of their travel behaviours. The project was, however, specifically commissioned to encourage low carbon travel behaviours in recognition of the high and increasing level of CO_2 emissions being generated from the land transport sector.

Internationally, the transport sector consumes more energy than any other sector, and the International Energy Agency (IEA) forecasts that it will continue to do so [7]. Transport accounts for 23% of global energy related CO_2 emissions and it is predicted that they will grow by 50% by 2030 and by 80% by 2050 if current trends continue [8]. The picture on a European level is very similar. In the EU-27 the land transport sector is responsible for 19.3% of all GHG emissions, 98% of which are CO_2 emissions [2]. The only sector that emits a higher level of GHG emissions is 'energy production,' which is responsible for 31.1% of the EU-27's total emissions [2]. The rate of growth of emissions from the energy production sector, and indeed all other sectors of the economy, is, however declining while the share of emissions from the transport sector is increasing [9]. In the period 1990 to 2007 GHG emissions from the land transport sector increased by 28% and they are continuing to follow an upward trend [2] (see Figure 1 below).

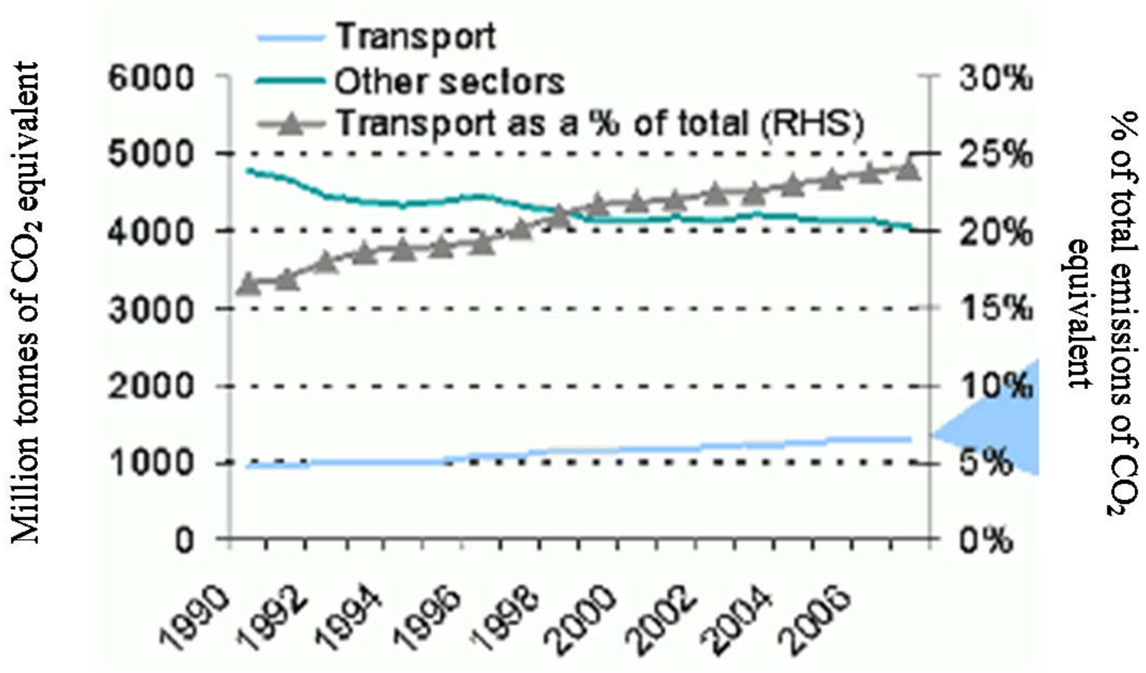

Figure 1: GHG emissions from the transport sector (including aviation and maritime) and all other sectors in the EU.

Road transport is responsible for 71.3% of EU GHG emissions from the transport sector [2] [9]. To control emissions from the transport sector there is therefore the need to manage demand for the private car. Figure 2 below shows that the private car dominates passenger transport across Europe and indicates that reducing emissions from this mode of transport should be a common goal.

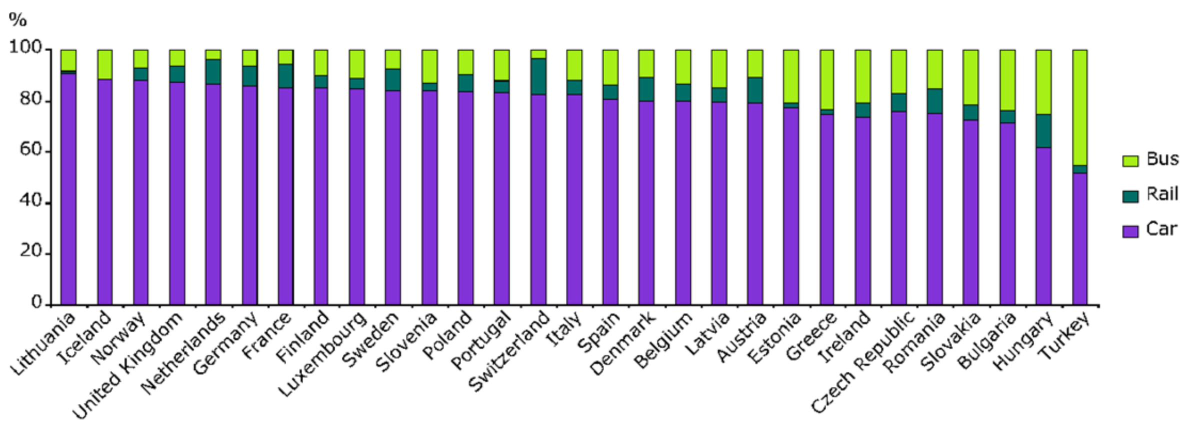

Figure 2: Passenger transport modal split in 2007. (EEA, 2010 [2])

3 CLIMATE CHANGE MITIGATION POLICY RESPONSES

In the land transport sector an increasingly popular approach to climate change mitigation is the 'Avoid, Shift, Improve' (ASI) strategic approach to CO_2 emission reduction [3]. The ASI strategy can control emissions from the transport sector by reducing the need to travel, shifting travel demand to lower carbon modes of transport, and enhancing the energy efficiency of all modes of transport (see Figure 3 below). In doing so, it can increase the efficiency and wider sustainability of the sector.

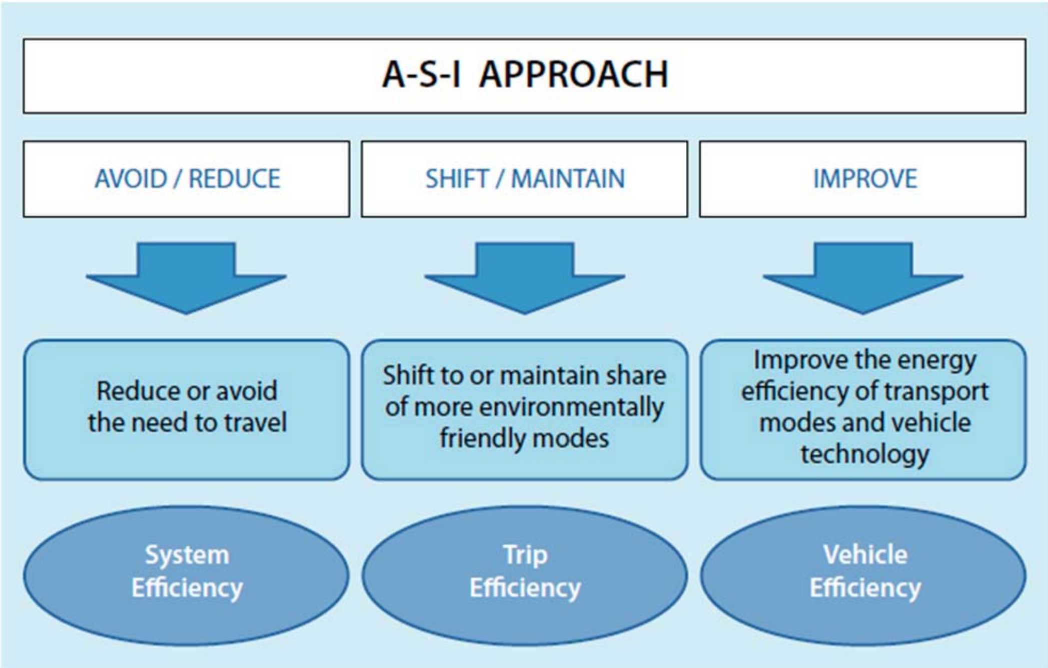

Figure 3: The Avoid, Shift, Improve climate change mitigation strategy applied to the transport sector. (GIZ (2011) [4])

The emphasis on each of the three pillars of the ASI approach will vary from strategy to strategy depending on context. The policies and measures that comprise the strategy will also vary to take into account the specific supply and demand characteristics of different transport systems. The interventions that can be used to manage demand do, however, often fall within five categories. These are as follows:

- Economic instruments
- Regulatory instruments
- Planning instruments
- Information instruments
- Technological instruments.

It is considered optimal to create a 'bundle' of measures from across these five categories. This can result in the adoption of an holistic approach to climate change mitigation that targets and integrates all modes of transport and that recognises the impact of land-use on travel demand. The bundling of different instruments can also lead to synergies with the introduction of one type of instrument reinforcing the impact, and offsetting the disadvantages, of another.

The CATCH knowledge platform can itself be regarded as an 'information' instrument as it will provide information to increase awareness of the impacts of different modes of transport and suggest how negative impacts can be reduced through modal choice and the adoption of alternative behaviours. It will also link to examples of where each of the other types of instrument that could comprise an ASI strategy have reduced CO_2 emissions across Europe.

The focus of the CATCH knowledge platform is on behavioural change, a type of policy which has tended to have a relatively low prominence in the past but which is increasingly being recognised as a vital component of any strategy that aims to control CO_2 emissions from the transport sector. There is, for example, an increasing amount of research that indicates that growth in demand for travel, and particularly for travel by private car, is increasing at approximately the same rate that average vehicle emissions are declining as a result of technological enhancements [2] [8] [9]. This adds weight to the contention that a bundle of policies is required to control CO_2 emissions from the transport sector, and that a proportion of these will need to focus on behavioural change so that the positive impact of energy efficiency improvements does not continue to be offset by increasing demand.

4 THE ROLE OF POLITICAL WILL

In order for transport climate change mitigation actions to become a reality there is the need for a mixture of both governmental and bottom-up grass roots initiatives [11]. Governmental intervention clearly requires political will: recognition of the problem, and action in transport climate change mitigation.

Climate change mitigation is moving up the political agenda in Europe. On the European level, the creation of a post for Commissioner on Climate Action (with the requisite Directorate General) in 2010 showed the willingness to engage with the issue of climate change at the top level. This is within the context of the Europe “20-20-20” targets set in 2007. These targets, to be achieved by 2020 in the EU, are: to reduce GHG emissions by at least 20% of 1990 levels; to generate 20% of energy from renewable resources; and to reduce primary energy use by 20%. This is also carried through in the Europe 2020 strategy of the European Commission which defines the ambitions of the Commission until 2020. Climate change mitigation actions can be seen in several other policy areas at European level: playing a key part in policies in energy, environment and transport.

At European level, DG Mobility and Transport (DG MOVE) of the European Commission recently released their White Paper on transport [9]. This White Paper recognises the need for climate change mitigation actions in the transport sector, with a target for a 60% reduction of CO_2 emissions from the transport sector by 2050. The White Paper includes actions for urban areas, with a target to have no conventionally-fuelled vehicles (i.e. fossil fuels) in cities by 2050 (with an interim target to halve the number by 2030). The White Paper and its targets are currently (June 2011) under discussion within the European Parliament [12] and the European Council [13].

There are several European initiatives that exist to promote low carbon mobility on the local level, particularly urban areas. The Covenant of Mayors Initiative is one that is particularly noteworthy. This initiative is a voluntary initiative which European Mayors can sign up to to commit their local authority to go beyond the “20-20-20” targets, and reduce their GHG emissions by more than the target set by the European Commission. In signing the Covenant, mayors commit to developing a sustainable energy action plan (SEAP) of which transport is one of the major building blocks. This non-mandatory EU initiative has over 2,700 signatories, showing the willingness of local politicians to engage in climate change mitigation actions.

The difference in approaches between EU countries is notable, as shown within the Council’s comments to the White Paper on Transport [13]. The UK’s carbon plan [16], for example, sets actions and deadlines for climate change mitigation over the next five years including department-specific actions for the Department for Transport, going beyond the EU

"20-20-20" targets. On the other hand, some countries are worried about EU ambitions in GHG emission reductions, and shy away from the targets set out in EU policy documents [13]. In Central and Eastern European countries, for example, there are indications that the political priority given to climate change is not as strong [14].

In parallel to political will, and as already mentioned previously, top-down policies must be accompanied by bottom-up actions. A mix of interventions is required: government intervention will not work without engagement from the general public, and grassroots actions will not be enough to tackle the scale of the problem without government intervention [11]. Effective communication plays a vital role in both communicating the need for government intervention and in engaging individuals to consider low carbon transport choices. The next section looks further at some key principles identified in the CATCH project on how best to communicate about low carbon mobility in order to help a move towards a low carbon transport system.

5 PRINCIPLES FOR EFFECTIVE COMMUNICATION

The CATCH knowledge platform will contain a range of information presented in various different formats. The information will reflect the results of the grounding research of the CATCH project, which found that simply providing access to information is not enough to motivate change. Research indicates that information can help to overcome a number of psychological barriers to behavioural change, but that to do so the way that information is presented must be carefully considered. It should reflect the way that individuals process information and an understanding of how information can lead to behavioural change. If this is effectively done then information can 'nudge' people to make small changes in their behaviour.

The grounding research comprised of a literature review, which encompassed models of behaviour to gain an insight into the decision making process of individuals, and also behavioural economics, to develop an understanding of how the presentation of information can impact the way that that information is interpreted. This review was supplemented by six focus groups with a broad spectrum of members of the general public, a survey with a sample size of 194 members of the general public, and interviews with transport practitioners. The findings from these research methods helped the CATCH team to understand how best to communicate transport and CO_2 related information to both the general public and transport practitioners – the two primary groups of end-user of the research. The findings of this research have been summarised here in five key principles for effective communication in the field, but for a more detailed and comprehensive overview see [5] and [6].

The first of the principles, which was found to be key to motivating change in both the general public and practitioners, is linking a reduction in CO_2 emissions to wider 'co-benefit' areas. Attitudes and beliefs affect choice, but most people's attitudes towards climate change are not sufficient to instigate a change in behaviour. If the CO_2 emission reduction associated with low carbon behaviours is linked to some of the other benefits of this behavioural change, such as those listed in Figure 4 below, then it may be enough to 'nudge' them towards considering making a change.

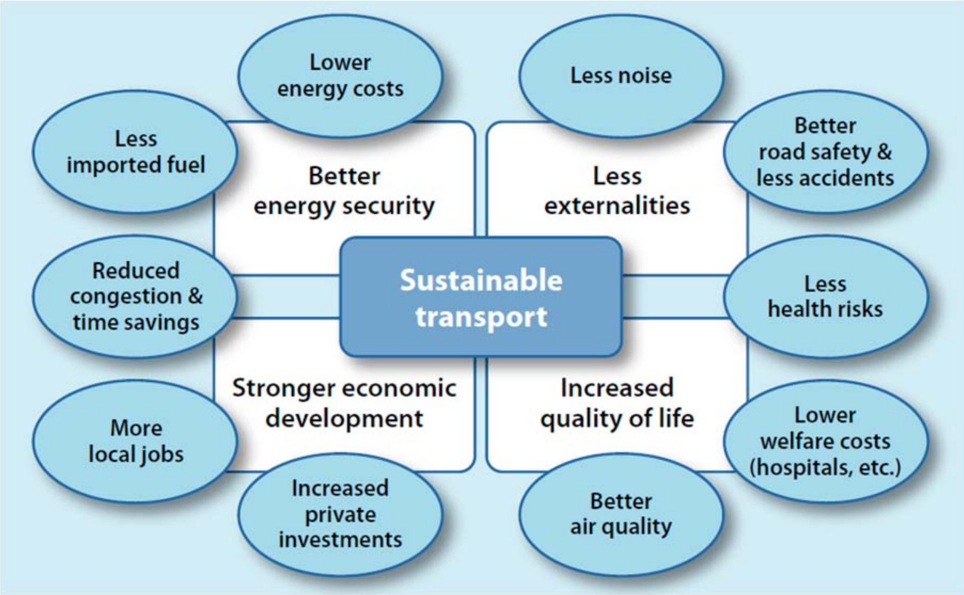

Figure 4: Selected ‘co-benefits’ of climate change mitigation activities in the land transport sector. (GIZ, 2011 [4])

This contention is based on theories of behavioural change such as the health model ‘transtheoretical model’ [15], which state that information should be tailored to motivate individuals through appropriate triggers – in this case ‘co-benefits’ of low carbon travel behaviours. This has implications both for the likelihood of members of the general public to consider changing their travel behaviours, and for the likelihood of decision-makers supporting associated policies and measures. Policy-makers will be hesitant to support single objective policies, particularly in the current economic climate, but linking climate change mitigation policies in the land transport sector to wider objectives both within and external to the transport sector could increase the chance of such policies being developed and maintained.

The CATCH knowledge platform will internalise this principle by collecting data on six co-benefits of climate change mitigation alongside data on CO_2 emissions. This data, and the way in which it is presented, will be interactive to enable users to explore the relationship between the different benefits of low carbon behaviour. A non-technical factsheet outlining the relationship between low carbon behaviours and each of the selected co-benefit areas will also be available from the knowledge platform. The six co-benefit areas, which were selected based on interaction with the end-users, are as follows: health, cost, time, safety, planning and community.

The second principle relates to the importance of the context of information presented. This can be seen to be linked with the previous principle but has far wider relevance, particularly in relation to the concepts of CO_2 emissions and climate change. These are both relatively new concepts, particularly in terms of the link with individual behaviours, and so hold less direct and obvious meaning to individuals. They vary considerably from concepts such as time and money, which people can instantly relate to and for which they have established reference points. ‘Carbon dioxide emissions’ is therefore a relatively abstract concept for many people and talking about CO_2 in the common format of grams per kilometres travelled, for example, is very difficult for people to interpret. This is not confined to members of the general public but extends also to transport professionals, many of whom are not instantly familiar with what constitutes a relatively ‘high’ or ‘low’ emission factor if presented as a mass. It stands to reason that information that cannot be interpreted will not motivate a change in behaviour or a change in support for certain policy measures.

The way that people perceive and interpret information is highly dependent on the context that it's presented in. The findings of the literature review highlighted the value in using images to make abstract concepts more concrete and easy to interpret. The findings of the surveys and focus groups conducted in the CATCH project did not, however, unequivocally support this contention as the use of a number of different equivalents for CO_2 did not elicit a positive response from participants. It was instead found that individuals sampled responded best to being presented CO_2 information in relation to a recommended level. The use of a recommended level conveys both a context by which to interpret the CO_2 amount and provides an *injunctive norm*. An injunctive norm describes what society approves or disapproves of [17]. This is a technique that will be applied to the CATCH knowledge platform, particularly in relation to interactive components where relatively large volumes of data will be accessible. It will enable users to compare the level of CO_2 emissions from their own city with a target, and also with other cities that can be selected on the basis of a number of characteristics, such as population size and GDP, to help individuals and practitioners to ensure that they are comparing with cities that have some similarities.

The concept of 'climate change' and how it is presented poses a similar challenge to that of CO_2 emissions – particularly for individuals who are under no obligation to change their behaviours. The international dimension of the concept and the large and diverse range of emission sources can make it difficult for people to internalise the concept and reflect on what it means for them and their behaviours. The CATCH knowledge platform will seek to make the concept more tangible and seemingly 'relevant' to them by focusing on the city level. Figure 5 below is a screenshot from the CATCH prototype and an entry point to city specific information – about CO_2 emissions and about performance in relation to co-benefits, both of which can be directly compared with other cities selected by the user. It also contains links to related discussion forums and details of policies that have been implemented elsewhere and that could be implemented in the user's city to effect positive change.

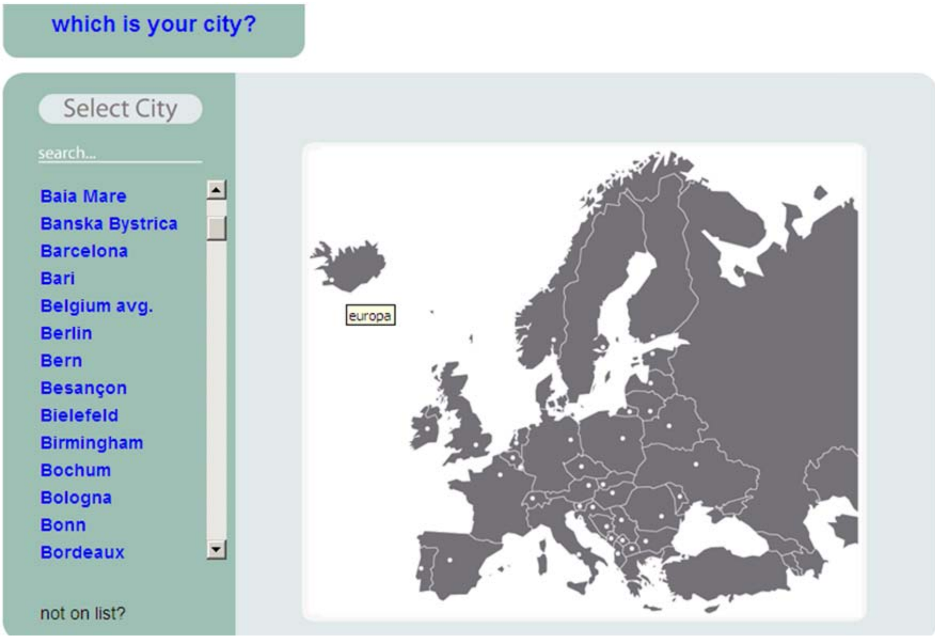

Figure 5: The CATCH knowledge platform enables users to select data on, and compare, their city and others

The third principle relates to the issue of 'loss framing,' which is essentially an issue of carefully considering semantics to 'frame' different outcomes. This technique can be applied to 'frame' the impact of low carbon transport behaviours in a certain way and in doing so 'nudge' people towards a specific choice. This relates to the fact that behavioural research has shown that people tend to feel and behave differently when information is presented in terms of gains and losses [18] and [19].

Research shows that presenting information as a 'loss' as opposed to a 'gain' can have twice the psychological impact on individuals, and therefore make them more likely to change their behaviours [19]. The wording of information can therefore have a direct impact on the interpretation of, and therefore response to, that information – a contention that was supported by the findings of the surveys conducted [18]. Figure 6 below gives an example of how information can be presented to highlight the negative difference between two different types of behaviours. This capitalises upon the fact that people will seek to avoid losses more than they will seek gains.

By car: 25 minutes
Cycling: you will save 5 minutes on your journey

Cycling: 20 minutes
By car: your journey will take you 5 minutes longer

Figure 6: An example of firstly 'gain' and secondly 'loss' framing.

The fourth principle relates to social norms, by which is meant 'how other people behave,' or at least how individuals perceive that other people behave. Behavioural research shows that the way that other people behave affects an individual's behaviour [20] and [21], and that individuals are motivated to take the socially optimal course of action. The impact of the behaviours of others on individual behaviours is said to be unconscious but its impact can be seen to be tangible [20]. It has, for example, been effective in reducing household energy use [20] and in improving rates of recycling [21]. The CATCH knowledge platform will therefore enable individuals to compare their behaviour, and that of their city, with others and highlight the best performing cities to both motivate and lead users to learn more. This is owing to the indication that information showing that others are performing better can encourage those who are performing less well to improve. In relation to cities data can be compared on the knowledge platform, and in respect to the behaviours of individuals there will be a number of 'testimonials' on the platform. These will highlight examples of how individuals are adopting more low carbon behaviours, and it is anticipated that the number of these posted on the knowledge platform will gradually increase with time. The same is expected for low carbon policies and measures implemented by practitioners – that the good practice database will significantly expand over time.

The fifth and last principle that will be covered in this paper is linking individuals with a wider social support network. Behavioural research has shown that social support, for example through social networks, is important in both facilitating and maintaining changes in behaviour. Linking back to the principles of loss framing and social norms individuals like to feel that they're involved in effecting socially approved changes that will prevent losses. The transport practitioner interviews conducted by CATCH also found that individual discussions were thought of as a desirable way of learning about new practices. The CATCH knowledge platform will aim to support this by hosting discussion forums where people can connect with each other, and also featuring links to popular social networking sites, such as Facebook and Twitter, to connect both individuals and practitioners to wider networks of people – both those who adopt low carbon behaviours and those who do not.

6 THE POTENTIAL IMPACT OF CATCH ON THE CITY LEVEL AND BEYOND

The EU White Paper states that urban transport is responsible for approximately a quarter of all CO_2 emissions from the transport sector [9]. This is the primary reason why CATCH focuses on the city level – it is the source of most CO_2 emissions from the transport sector. There are many other reasons why it is beneficial to focus on the city level. These include the fact that the higher population density and on average shorter trip lengths increases the viability of using low carbon modes for journeys. This in turn has resulted in public transport provision and facilities for non-motorised modes of transport being generally more developed in cities, which further increases the viability of adopting lower carbon travel behaviours. The negative impacts of private car use (such as congestion and poor air quality) also tend to be experienced more acutely, and a greater number of individuals exposed to them, on the city level. This can serve to increase the motivation of individual's in cities to consider changing their behaviours. As mentioned in the previous section concepts such as climate change and the impact of individual behaviours can also seem more concrete and tangible at a local level, further increasing the benefit of CATCH concentrating on this geographical scale.

The CATCH project is focused on the city level but the potential impacts and applications of the knowledge platform and associated research are not limited to the city level. This section briefly outlines some of the ways in which CATCH can contribute to low carbon travel behaviours on a larger scale.

The ultimate aim of CATCH is to increase awareness of the impacts of travel behaviours and suggest ways in which the carbon intensity of these behaviours could be reduced. If CATCH is successful in contributing towards an enhanced awareness of the relative impacts of different modes of transport on a city level, and if it results in any behavioural change, then it is unlikely that this awareness and any associated propensity to change travel behaviours will be limited to the urban level. An individual who decides to replace a private car journey with a rail journey on a city level, for example, may feel just as motivated to consider this modal shift on a regional or inter-urban journey. Similarly an individual's perception of public transport might improve if they increase their use of buses within a city, and as a result they might feel more inclined to consider coach travel over longer distances. This reflects the fact that the principles that the CATCH knowledge platform will be based on (as introduced above) will be rooted in broader behavioural change theories and concepts. They can therefore be taken and applied in a number of different contexts and by different stakeholders and have the same resonance. They could, for example, be used on a regional level to increase awareness of the benefits of sustainable green transport corridors. The relative sustainability of different modes of transport remains are the same regardless of whether a journey is conducted over a short or long distance.

The CATCH knowledge platform will provide links to best practice examples of transport provision on a city level, but these can support better integration between regional and city level transport. This could increase the viability of using low carbon modes of transport for relatively long distance journeys. Enhancing the interface between local bus services and regional rail services at railway stations could, for example, could patronage on both of these modes. Improving non-motorised transport networks to and around railway stations could have a similar effect. As with all elements of transport and climate change strategies increasing integration, enhancing communication and realising synergies within and between sectors should be pursued to increase the cost-effectiveness of interventions.

SUMMARY

CATCH will develop a knowledge platform that will increase the awareness of its users about some of the environmental, social and economic impacts of their travel behaviours. In doing so it will highlight opportunities for reducing the carbon intensity of travel behaviours and realising associated co-benefits. The grounding research that has been conducted has clearly shown that if users are to be encouraged to adopt more sustainable travel behaviours then information must be presented to them in a considered manner that is grounded in an understanding of how individuals process and respond to information.

The research conducted by CATCH has led to the identification of numerous opportunities for improving how CO_2 and climate change related information is communicated in the context of the land transport sector. The insights received from scientific research reviewed and interactions with user groups will be incorporated in the CATCH knowledge platform to help to ensure that it will be fit for purpose. It is also important, however, that the broader applications of these findings are recognised as incorporating an understanding of the psychological and cognitive factors that shape attitudes and behaviours into communications relating to transport and climate change could increase their effectiveness and better contribute to the sustainability of the sector.

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SUSTAINABLE MOBILITY AT THE EU LEVEL – AND THE NEW TRANSPORT WHITE PAPER

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ABSTRACT

The main messages of the paper in four points are the following: (1) The environmental target for 2050 (sixty percent emission decrease, oil dependence decrease) is a very progressive vision, clear target. (2) The tools to achieve these objectives are sometimes still contradictory in the White Paper. (3) There is no clear picture on the what-to-dos of the first ten years until 2020 (when probably a new White Paper will be issued); the back-casting is missing following the vision. (4) The Strategy chapter is not too much based on the 2050 vision but rather on the creation of a single European transport area. It was a relevant vision in the period of the EU-6s, '-9s, '-12s – but it is a question if it is still relevant for the EU-27s, or it is rather a myth, a dream.

1 INTRODUCTION

The paper discusses the relation of transport to sustainability, with special attention to the commitments in this respect made in the White Papers of EU transport policy – especially the last one that appeared on March 28, 2011. [1].

The first block of the paper (Antecedents and frameworks) briefly refers to the concept of sustainability and how it affects transport. (References are made to earlier summaries given by this author in greater detail.) The second block assesses the content of the new White Paper in terms of sustainability, considering in turn the elements of its situation assessment and system of goals and the objectives stated in its "Vision for a competitive and sustainable transport system". Here the paper points to some inconsistencies in the document and conclusions about sustainability that the author considers to be irreconcilable.

2 ANTECEDENTS AND FRAMEWORKS: SUSTAINABILITY, TRANSPORT, AND EU POLICY

2.1 Environmental criteria and sustainability

The term *environment* has been radically revalued in the last three decades, from a negligible side factor into a notable one, and then into *decisive* peripheral condition.

The path between the last two can be envisaged well through the three pillars commonly advanced as an explanation of sustainability. The great mission of the triple pillar model of *economy, society* and *environment* was to promote the two other factors alongside the economy, but the common exegesis, which accords the three equal importance, so that the objective would be that the aggregate of the three forms of capital should not decline, has been superseded as obsolete. It has to be seen that these are three interleaving systems with different time scales, and vital though the economy may be, its system is embedded in society and in the broader environment, so that it has to adjust to the limitations that these impose[1]. (*Figure 1 is author's figure based on Passet* [3])

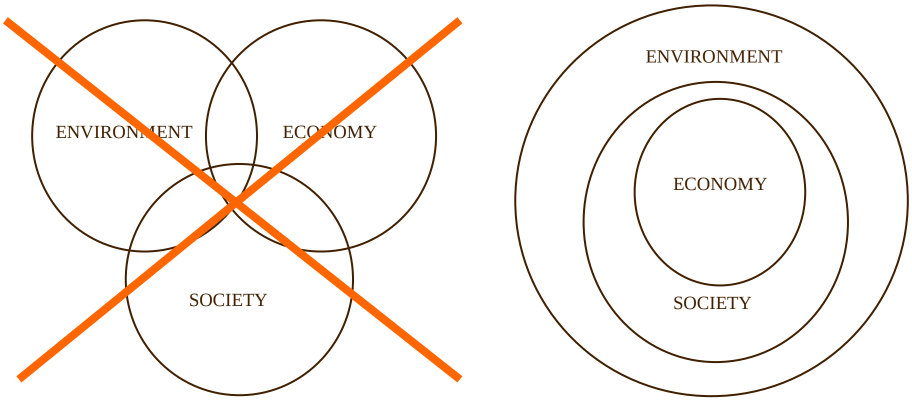

Figure 1: The three pillars of the sustainability are embedded into each other

Even more frequently than listing the three pillars as a definition of sustainable development, it is also customary, to cite the Brundtland report to the UN [4]: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The Brundtland definition actually underlines the dimension of *time* in sustainability, the need for *solidarity between generations*. When it is a question of transport, networks, and regional provisions, there comes a need to formulate a *spatial* aspect of sustainability alongside the temporal one, i. e. to complement the *inter-generational* relationship with obligations among contemporaries. Sustainability demands that the needs of those *in one place* are met without compromising the ability of *those in other places* to meet their own needs. "Other places" may be a wide range of distances away: from faraway islands in Oceania (if climate change is at stake, for example) to neighbouring districts, or to an adjacent street, to which traffic flows is diverted, or even a roadside stall or store where passing traffic makes conditions impossible.

2.2 Transport and sustainability

Those two ideas from the interpretation of sustainability suffice to draw attention to the main changes of outlook that the transport sector has had to face in the last couple of decades.

Transport can no longer be seen simply as a sector required to serve the economy's needs. It also has to operate with frames set by *society* and by the *environmental conditions*. The vision of the future held by autonomous transport specialists must be reshaped into a wider set of objectives, which helps to promote the *broader aims and scopes* of society. Exclusive heed to the sector's own efficiency criteria must give way to adjustment to programmes that promote *efficient development of the whole of society* (and within that, of course, offering an efficient transport solution). Transport that sets out to meet the needs of the moment (for which there is adequate transport expertise) has to be replaced by comprehensive thinking, in which a supply side integrated into the activities decisive to the formation of demand is *able to influence demands for transport*. Whereas the decisive role in improving the transport supply has been played hitherto by innovations and developments

[1] This is argued more detailed in Fleischer 2005. [2]

that improve the rolling stock, track and fuel − the *hardware factors of transport* − it is essential when influencing the demand side to expand this, and event to shift the emphasis onto innovations capable of renewing the regulation and organization of transport and onto the inter-sectoral system of relations − the *software factors of transport*.

The changes of outlook are modelled well, for instance, by those in the social expectations towards urban transport. Over the middle third of the 20th century, the accepted goal was to *adjust the city physically* to the increasing volume of road transport and to sacrifice all public spaces to that end. By this time it has become clear that the framework can only be sum of a liveable city (along with the district around it). Only then priorities can be set. The finite space available must allow for recreation, open spaces, pedestrian traffic, public transport, private transport, commerce, etc. and for the requisite proportions between these multiple functions. The transport objectives can only be set once this situation has been acknowledged, for transport that exceeds the framework available constitutes a *spatial pollution* that is as harmful to society as air pollution or noise pollution.

Also perceptible is the change in outlook on a global scale, augmented by climate change. The traditional transport strategies defined transport objectives, broken down into tasks, and if all went well, the aim at project level of alleviating and neutralizing some of the environmental damage caused. This was institutionalized as environmental impact assessments (EIAs), but still only at project level. Only the institutionalization of strategic environmental assessments (SEAs) could introduce such thinking into the making of policies, plans, and programmes. The EU environmental action programmes appeared more emphatically; the fifth, in 1992 [5], stated explicitly that environmental policy had to be integrated into the main policy branches (i. e. those causing most environmental damage): manufacturing, energy management, transport, agriculture, and tourism. The idea was to prepare sectoral strategies in these fields that would prioritize environmental criteria from the outset.

The experience in Hungary was a complete failure. The documents intended to form a basis for debate appeared in 1998, but the sectors targeted did not support them, seeing them as superfluous extensions of the environmental portfolio, irrespective of what they contained. The effort remained within the bounds of the state administration and failed inevitably to attract any public support. Meanwhile climate change was proving to be more readily communicable and understandable, so that it gathered public support and appeared as a peripheral condition in the framework of policies. At least seemingly, the many dimensions of the environmental goal system were being narrowed down to one, greenhouse gases, primarily the need to restrict carbon dioxide emissions. Yet it is clear from the climate models that limiting carbon dioxide emissions would reduce the climate effects at most after a long delay. It was not possible to conceive of averting climate change; there would certainly be some, to which humanity would have to adapt. The question of *adaptation*, however, again assigns a more active role to the sectors mentioned, for it was not a matter of keeping below a single technological ceiling, but of preparing comprehensive sectoral strategies, which would again call for broad knowledge of each. This was a big advance for the sectors, away from a relative losing position, while it also became appreciated by the public that combating climate change meant adjusting to an important external system of conditions, within which each sector had to draw up its plans.

This is more or less the field in which environmental policy and effects exert their influence over important sectors, including transport. This was the system of relations that awaited the new EU transport policy. Being presenting it, however, it is worth looking at another dimension: the relation of the earlier EU white papers to environmental policy at any time.

2.3 The environmental stances of EU transport policies before 2010

No common policy on transport appeared during the first thirty years of the European Communities, despite calls for one from the outset. Measures were taken on a number of matters to do with transport, but the aims behind them were not transport-related, but rather the demands of competition policy and elimination of distortions in that (market advantages).

The first EU common transport policy (CTP), which appeared in 1992 [6], was concerned first of all to introduce uniformity: harmonization of member-state regulations that were impeding flows and breaking up of national monopolies, and also the creation of a common infrastructural network (TEN-T).

This document was superseded by the 2001 White Paper [7]. This summed up the results in the previous period, concluding that most competitive-market objectives had been attained − consumer prices had eased, quality of service improved, technology spread, and closed transport markets (apart from rail) opened up, but overall disharmonies in transport had not been reduced: means of transport were expanding at unequal rates; road transport is still gaining market share. Development remained spatially unequal, with congestion at centres and scarcities in remote areas ubiquitous in the EU of that time. Moreover the report spoke of mounting health damage, worsening environmental figures, and shocking accident statistics.

The principles proclaimed in the 2001 White Paper, which rested on the evaluation of the situation and the EU environmental goals of the time, were a marked advance. It was newly realized that concentrating on transport links between countries would not suffice. There had to be harmonization in policy efforts, in depth and in outlook. The document went beyond the earlier approach by coming out firmly in favour of a policy change towards environmental and social sensitivity. An important part of this was firm support for breaking with the practice of increasing transport performance and lessening the growth in road transport.

The counter-attack by the road haulage industry obviously had much to do with the way the 2006 revision of the White Paper, Keep Europe Moving [8], distanced itself strongly from the original intention of moderating the aggregate growth of transport, including the response to the harmful consequences of road transport. Instead it described the development of international goods transport by road as commendable, making veiled damaging references to the environmental efforts by talking of “the efforts to achieve the goals of meeting growing mobility needs and strict environmental standards are beginning to show signs of friction”[2] [3]

In this context it is especially welcome to find that the 2011 White Paper returns, with even more precise goals stated, to a decisive commitment to taking the environmental frame conditions seriously. Essentially the policy focuses on bringing about a 60 per cent decline in carbon dioxide emissions over forty years. The new White Paper can also be seen as a framework document for devising a strategy to achieve that goal.

[2] Ib. id. [8] p.8.

[3] For a brief account of the EU transport policy in the period up to 2006, see Fleischer 2009 [9].

3 THE WHITE PAPER ON EU TRANSPORT POLICY 2011

3.1 The White Paper and its accompanying documents

The main document on transport policy is the 30-page White Paper (COM(2011) 144 final) [1], which makes its main points in 68 paragraphs, accompanied by an appendix of 40 initiatives. Three accompanying documents belong to this: a 170-page impact assessment [10], a nine-page summary of it [11], and the 127-page working document [12]. This paper deals with the White Paper itself, with a mention of some statements found only in accompanying documents.

The planned structure of the White Paper is best reflected in the three main titles of the more detailed working document [12], I. Current trends and future challenges: Growing out of oil; II. A vision for 2050: an integrated, sustainable and efficient mobility network; and III. Strategy: policies to steer change.

3.2 Few impact assessment lessons reach the White Paper

The White Paper devotes only one paragraph (1.12) to assessing the previous White Paper. This reports success in market opening, passenger rights, transport safety and security, building components of the Trans-European Transport Networks, and measures to enhance environmental performance. But it omits to report on how far the adopted measures had the extra-transport effects for which they were taken. Looking not at the present, but projecting present trends into the future, Point 1.13 states that in energy usage, emissions, and even cohesion, the changes will fall short of desirable and may not even be in the desirable direction. Those drawing up the document had the means of offering far-reaching conclusions from analysis of the accomplishment of earlier goals, so casting doubts on some of the transport tools set for achieving these.

The White Paper does indeed seek radical new solutions for carbon dioxide emissions, energy dependence, and congestion, but it ignores the likewise modest advances in cohesion and proposes relying on the same means employed so far. This presents a danger that the new White Paper may push for the accomplishment of expensive, wrongly proposed solutions that will again *fail to gain the social and economic objectives* seen to be desirable.

3.3 Focus objectives: emission cuts and a uniform European network

The White Paper derives its main objectives from some important Union documents. One is the EU 2020 Strategy [13], from which the White Paper draws its sustainability goals. The other basic document is the Maastricht Treaty of 1992 [14], to which only the impact assessment refers explicitly ([10], paragraphs 90-93). This is the source for the objectives concerning the uniform Europe, fulfilment of the single market, and the free movement of goods.

The reference base of the overall policy objective of the document is that a sustainable transport system is considered to be as a key to the attainment of the goals of the EU 2020 strategy − smart, sustainable and inclusive growth. This calls for radical change compared with present practice. Among the economically, socially and environmentally undesirable effects to be averted are congestion, oil-dependency, accidents, emissions of greenhouse gases and other pollutants, noise, and fragmentation of territory. Three specific transport policy goals for achieving the overall objective are mentioned: to reduce transport-related carbon dioxide emissions by 60 per cent by 2050, to reduce oil dependency substantially, and to erect barriers to increasing congestion.

The detailed impact assessment sees it as important to augment these with assistance in promoting the real sustainability goals of the transport system: better accessibility, equity, good service quality, efficient provision, and paid social costs ([10], paragraph 105). The study here draws polite attention to the fact that the policy objectives derived in slightly technocratic language from the documents, had been thrust forward before the pan-social tasks of transport to be thought out by common sense, which betrays that the vision for transport is not aimed sufficiently at integration into the ideas for the future of society as a whole.

The present writer's greater problems concern the other, implicit reference to the Maastricht Treaty and the aims derived from them. The question is whether in 2011 the EU-27s can follow blindly a paradigm that starts out from 1992: whether the transport White Paper should be aiming at a uniform and homogenous Europe, whereas it is increasingly clear that there are several patterns in regions that vary widely in development level, with various problems to be solved. With small differences in development level it is possible to equalize by linking the regions, but with large differences this is at best questionable; indeed the differences may be perpetuated or actually increase. (The way strong linkage may heighten development differences appears similarly in the role played by the common currency.)

If strong linkage of regions at different development levels exceeds the rate at which they can catch up (in their economies, societies, internal cooperation, systems of institutions, local systems of ties, etc.), the improving external links fail to exert the expected beneficial effect, – just as the common currency system has not proved to be a catch-up panacea either.

The problem is not the catch-up objective, but application of the earlier tools to regions with two, three or fourfold differences of development level. What seems to be needed is an intermediate step of deepening relations among groups of countries at similar or close economic and social levels and establishing the transport links within macro-regions accordingly, *rather than promoting an abstract, theoretical uniform system*. Unfortunately the present concept of a macro-region works against that. Designating a non-homogenous region such as the EU Danube Region for an area from Baden-Wurttemberg to Ukraine undermines the potential utility of the concept for the EU.

There is a similar danger in putting forward a transport White Paper that bases its strategy on a formal unit, a vision with no reality behind it. We should be reinterpreting the cohesion strategy and combating such formal uniformity instead of promoting them with the prospects of euro-subsidies (with our neighbours or the Visegrád Group). The need is to adjust the revised transport policy to the realities.

3.4 The impact assessment examined three scenarios for attaining the emission-reduction goal

The White Paper contains just one single scenario, projecting forward unchanged conditions (thus concluding to the need for a radical decrease in emissions), whereas the impact assessment kept necessary to present scenarios to achieve the target of a 60 per cent reduction. One scenario concentrates on technological methods of influencing the emission parameters of vehicles (referred to above as supply-side and hardware intervention). Another scenario focuses on policy for mobility management and the pricing of carbon dioxide emissions (demand-side and transport software intervention). The third scenario combines the two.

One very important conclusion of the analysis is that *the desired results cannot be achieved simply by focusing on technology*. (There is a rich literature on this, pointing out that technological improvements have significant rebound effects: the surplus traffic grows contributed by the cheaper, more comfortable, freer transport cancels out the specific advantages obtained, or much of them.) The impact assessment rejects this scenario, and of the other two, supports on environmental grounds the pure supply-side scenario and on social and economic grounds the mixed solution.

3.5 The integrated transport model of the White Paper creates effective range-based groups

It is significant that the White Paper thinks in terms of an integrated transport model, not of sub-sectors or of passenger/goods/infrastructure segments, but of long-distance, medium-distance, and urban transport spheres. (It is worth noting that Hungary in the 2007 Transport Operative Programme and its reference framework document [15], [16] used categories of a similar type, distinguishing the priorities as (a) international accessibility of the country and its regions; (b) mutual and internal accessibility of that regions; and (c/d) urban and commuter traffic/goods hubs.) This makes a good starting point for the consequences of which are worth applying throughout the White Paper. (Subsections 2.2, 2.3 and 2.4 of the document followed this division, but inconsistently: the subject-matter does not always match the subtitle.) The EU White Paper is also weakened by unclearly defined categories. Medium distance is sometimes 300 km and sometimes 600-800 km; the category 'urban' should consequently refer to cities and their attraction areas.

Having adjusted for the inconsistencies, it is more to the point to look at spatial rather than distance categories. The shorter distances the White Paper distinguished should be sorted as urban/conurbation, the longer as extra-EU, intercontinental and global, while the medium journeys of 300–800 km could be classed as a macro-regional spatial segment.

The above transport segments provide a chance to present the forecast for greenhouse-gas emissions ([12], p. 18) by that categories. Here the boundary between medium and long distances is set at 500 km, but by long distance is also meant the extra-EU relations (sea and air cargo).

The percentages in the table below represent proportions of the total emissions in the Union. Importantly, 23 per cent of the emissions come from urban/metropolitan traffic, 56 per cent from macro-regional, and 21 per cent from intercontinental. Passenger transport accounts for 60 per cent and goods transport for 40. Road transport is responsible for 70 per cent. (The figures are somewhat (1-2%) distorted because EU statistics label the emissions from power stations under energy, not transport.)

Greenhouse-gas emissions SEC(2011) 391 final p. 18.		**Urban, metropolitan**	**Macro-regional (<500 km)**	**Global, inter-continental**
Passenger		**17.00%**	**33.00%**	**10.00%**
	in which road:	16.00%	29.00%	0 %
Goods		**6.00%**	**23.00%**	**11.00%**
	in which road:	6.00%	19.00%	0.00%

Table 1: Greenhouse-gas emissions by different modes and ranges (based on [12])

It is worth looking at the proportions of the total emissions emitted by the individual categories, since the 60 per cent aggregate reduction measures of the White Paper should be aggregated from these segments. Later (after the next table) it can be compared to what extent the declared measures reflect those proportions.

Medium distance is covered under Point 24: “Freight shipments over short and medium distances (below some 300 km) will to a considerable extent remain on trucks,” which also implies that 300 km is the upper limit for medium distance. However, Point 26 states, “The challenge is to ensure structural change to enable rail to […] take a significantly greater proportion of medium and long distance freight.” Point 28, in its discussion of air transport (in the wrong place, in the long distance bloc) notes, “In other cases, (high speed) rail should absorb much medium distance traffic,” which must imply journeys of 600–800 km. In all events, the content and tasks of the medium category must be put more precisely for successful measures to be taken in reducing sharply the 56 percentage point share of emissions in this field.

3.6 The White Paper gives three main development strands: vehicle and fuel technology, multimodal chain and modal shift, and information systems and others

The second part of Point 19 designates three strands of development. This is important because Point 2.5 later groups accordingly into blocs the *ten development goals* for emission reductions stated there. Intervention in vehicle and fuel technology is the first, innovations for the multi-modal chains and modal changes are the second, and information systems, traffic management and market-compatible economic methods to facilitate more efficient infrastructure use are the third.

Of these, the first is technology for development of transport hardware, the second is also supply-side, but has to do with organization technology, and the third is technology that is applied partly on demand-side, partly on supply-side, thrust together with demand-side price intervention. It seems as if the White Paper is out of kilter with the intervention scenarios analysed in the impact assessment. The assessment too came out in favour of a mixed system, but with more restrained use of supply-side technologies and with emphasis on the importance of demand-side intervention. The White Paper not only omits this, but states explicitly in Point 18: “Curbing mobility is not an option.” This runs counter to Point 31 of the White Paper, which talks of lowering urban traffic volumes with demand management and land use planning. Point 19 also proposes that transport users pay the full costs of transport, that is a mean of curbing mobility (indispensable mobility, excess mobility, unjustified mobility, uneconomic mobility).

3.7 Ten goals for a competitive, resource-efficient system: the foundations shake

In *Table 2* the ten goals of the White Paper are controlled trying to fit them to the categories given by the main development strands on the one side and by the distant ranges of the transport on the other.

Many inadequacies can be diagnosed and comments added looking through the goals and also the empty boxes in the table. Here the paper just presents the table itself, as a potential tool for helping to create a consistent system of goals offering also a feedback to the shaping of the main strands.

Ten goals to achieve 60 % GHG emission reduction target	Urban + suburban	Macro-regional (medium 300-800 km)	Global and intercontinental
Vehicle and fuel	(1) Phase out conventionally fuelled cars in cities		(2) Reduce maritime emissions with 40%, low-carbon fuel planes achieve 40% share in fleet
Multimodal chains and modal shift		(3) 30% of >300km road fright at another mode by 2030; 50% by 2050; (4) 3x more h-s rail 2030, medium dis. Rail by 2050	*(5? TEN-T) core netw. by 2030; >capacity by 2050* (6) rail provision of air-ports and ports by 2050
IT systems traff. management,		(8) Multimodal inform. Management payment sys	(7) Transport manag. syst. for air, land, water by 2020 + Galileo
safety	(9) 0 fatalit.by 2050	(9) 0 fatalities by 2050	(9) 0 fatalities by 2050
market tools	(10) User / polluter pays; h.ful subs.= 0	(10) User / polluter pays, harmful subsidies = 0	(10) User / polluter pays, harmful subsidies = 0

Table 2: Ten goals to achieve the 60 per-cent GHG emission reduction target sorted by the three main development strands and by three transport ranges

3.8 The Strategy chapter of the White Paper doesn't couple policies to the objectives of the Future Vision chapter to steer changes, instead urge traditional solutions (contradicting sustainability targets) to the single European transport area goal hardly dealt with as objective

The Strategy chapter of the White Paper begins to set up general objectives, as if it weren't the task of the previous chapter to fix the objectives, and weren't the task of this chapter to break the fixed goals to policies. "The objective for the next decade is to create a genuine Single European Transport Area by eliminating all residual barriers between modes and national systems, easing the process of integration and facilitating the emergence of multinational and multimodal operators." ([1] Point 34, p. 10.).

Even more troubling, that the further part of the same paragraph offers a secondary position, practically subordinates *social, environmental, security* etc. points to these newly declared operative and economic objective, contradicting by that to the normal sustainability logic, that would subordinate economy to the environmental, social, security frames. “A higher degree of convergence and enforcement of social, safety, security and environmental rules, minimum service standards and users’ rights must be an integral part of this strategy, in order to avoid tensions and distortions.” ([1] Point 34, p. 10.)

Out of the formal problems another special problem is, that (as it was mentioned above) the idea of the uniform Europe of the 27s needs further support before just accepted as the starting point of the transport objective for the next decade.

“A Single European Transport Area should ease the movements of citizens and freight, reduce costs and enhance the sustainability of European transport.” ([1] Point 36, p. 11.) In a sustainable logic it seems to be a quite absurd statement, that by easing the continent-long transport, the European society would move towards the direction of the sustainability, comparing to another situation, when the co-operation field would link densely those producers and consumers who are in a smaller distance to each other. (Naturally, if *sustainability of European transport* means but the sustaining of forwarders and road-builders, then the statement quoted can be true.) Long-distance links are necessary, but not for getting the great volume everyday commodities but to supplement those abilities that are missing from making prosperous and stable the small-distance and local co-operations.

“A further integration of the road freight market will render road transport more efficient and competitive.” ([1] Point 36, p. 11.) Whether relative to whom the White Paper wants to make the road transport more competitive in this chapter by all-Europe integration, – forgetting that in the previous chapter it was suggested to shift all fright to rail of ship longer than 300 km?

“…large divergences in terms of transport infrastructure remain between eastern and western parts of the EU, which need to be tackled. The European continent needs to be united also in terms of infrastructure.” ([1] Point 51, p. 14.) Whether in which measured unit should be equalised just the transport infrastructure of the western and eastern part of Europe in the next decade? In capacity? In the use of the capacity? In pavement carrying capacity? In tariffs? In safety indicators? In carbon dioxide emissions per road-km? In other indicators?

In 2021 possibly a new White Paper will be issued for the transport. The Strategy offers very scarce information about what should be done until that based of the future vision of the new White Paper.

4 CONCLUSIONS

This paper underlines two important features of sustainability: the economic system must be embedded into the social and the environmental ones, and beyond the temporal interconnections of sustainability, the spatial ones are also significant. For the transport sector it is a substantial consequence that the sector has to serve the environmental, social, safety and security goals, a sector policy can’t be built up the other way round.

The 2001 European transport White Paper took seriously the environmental requirements and focused on braking traffic growth, especially road traffic growth. The review of the paper in 2006 let those goals eliminating. Compared to that the new White Paper seems to bring a progressive and explicit environmental frame as *it schedules 60 % decrease of CO_2 emissions, or to phase out the traditional cars from cities by the horizon*

2050. The document couples ten development goals to the environmental objectives, but the composition of these goals poorly reflect the warning of the impact assessment to avoid a too technically centred direction. Back-casting of the 2050 vision is missing from the document, and what is more, the indicator values are sometimes unfounded, uncontrollable, incalculable ones. A section of greater value in the document is the *distinction of the spatial segments of the integrated traffic* that approach can get an important role in future strategies after a more thorough processing.

The future vision block is still the more elaborated part of the document. The Strategy chapter that should broke the objectives to more operative tools is based on another goal structure instead: intending to adjust environmental and social requirements to the creation of *the single European transport area*. This objective wasn't fit into the goal-hierarchy of the document, it wasn't harmonised with the sustainability conditions, and it was not even confirmed apart from a reference in the Impact Assessment to the Maastricht Treaty. The cause of the problem can be lead back to the fact that the political background of the uniformity question of the EU was not maintained, revised, or adjusted to the real situation since, – so the transport attendance of that general objective couldn't be elaborated better either.

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IS INTEGRATION OF TRANSPORT INFRASTRUCTURE POSITIVELY IMPACTING ENVIRONMENTAL SUSTAINABILITY?

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ABSTRACT

One of the major goals of the EU transport policy is the creation of integrated transport systems with different modes cooperating and creating seamless travel/transport opportunities. It concerns both passenger and freight transport sectors and is especially visible in the context of Trans-European corridors development. The general background of the analysis is the strategy and policy development at the EU level in the context of transport integration, including especially interconnectivity issues.

The objectives of transport integration could be achieved by facilitating cooperation between service providers, the creation of multimodal transport chains and infrastructure investments - especially introducing intelligent transport solutions. While on the one hand this could lead to considerable savings in environment through optimised transport links, on the other hand it is likely that better transport solutions attract more transport users both in cargo and passenger transport. Overall savings result from reduced congestion, lower energy consumption during optimised transport processes and the introduction of new technical solutions which in general are characterised by lower emissions (new energy saving vehicles, more efficient engines, etc.).

At the same time more attractive transport links are likely to produce more consumers of transport services. They create more demand for transport and as a result increased emission levels. In the paper those contradictory effects are taken into consideration.

The tools for improving interconnectivity of different modes are discussed. The solutions which are particularly likely to produce positive effects on transport integration are:

- New infrastructure (new rail lines, new motorways, dedicated links) and better interchanges (improved railway stations, cargo depots, container terminals nod switch points etc.),
- New ITS elements and modernised procedures introduced into transport system (reduced congestion, green waves in cities, direct access to other mode e.g rail-road, ship-rail).

1 TRANSPORT INTERCONNECTIVITY IN THE EU TRANSPORT POLICY

The European Commission has put forward the concept of interconnectivity in several policy documents. The policy objectives have been addressed by the EU through an array of measures, including for instance regulations, funding, standardisation, research or the exchange of best practice.

In 1995 a Task Force on transport intermodality was created with the main goal of developing a consistent intermodal research and technological effort at a European level. Central tenet of its work was to elaborate a transport system that could work as an integrated door-to-door operation by encouraging the development of new approaches and concepts for improving both passenger and freight intermodal transport operations [14].

A breakthrough in setting the course of the European transport policy occurred in 2001 with the release of the White paper on transport [6]. Interconnectivity and intermodality are viewed as priority aspects for easing travelling conditions and modal transfers, as travellers encounter serious impediments when using different modes of transport for single journeys, namely when the latter involves several transport companies or different means of transport. Moreover, the White paper also concludes that transferring from one mode to another can be complicated by inadequate infrastructure. Within this framework, the White paper identified a number of key issues to be addressed, such as:

- Integrated ticketing, e.g. encouraging the introduction of integrated systems between modes of transport (air - coach - ferry - public transport - car parks), which may also ensure a greater transparency of fares;
- Baggage handling, e.g. making easier the possibility to check in luggage directly in a station without holding it during transfers to / from the airports;
- Continuity of journeys, which requires integration in land-use and transport planning.

These three key issues are very important because they inspired all policy and legislation efforts over the first decade of 2000. Later, both the Mid-term review of the White paper [10] and the Communication "A sustainable future for transport" [1] have stressed the need to further encouraging and coordinating actions and investments for making the EU transport systems more cooperative, co-modal and to ensure a better interconnection.

A more holistic approach to the achievement of a single, interconnected and efficient transport system has been lined up by the EC in the new White paper on transport policy [13] , released in March 2011. Specifically for the issue related to interconnectivity, in the staff working document accompanying the White Paper, the EC stresses that "*The modal mix has to be better adapted to the particular needs of each journey and, in the case of passengers, to the overall travel experience. This will only be possible in a system that is highly integrated, and that is based on a continuous and ubiquitous exchange of information. The use of information technology to optimise all aspects of personal travel and freight transport is likely to become one of the most distinctive traits of future transport systems*"[5].

Consistently with the strategic and policy approach developed over the last decade, the new White paper not only affirms that the completion of a TEN-T high quality and capacity network remains a high priority in the EU transport agenda, but it further recognises the importance of achieving a greater interconnection of the modal networks and modes [14].

2 BETTER INTERCHANGES AND INFRASTRUCTURE IMPROVEMENTS

New infrastructure development in the context of improving transport system integration includes those solutions which seek to address the problem of inadequate infrastructure for the link between an interchange (such as an airport) and the centre of the city which it serves. One could identify such new infrastructure as railway, motorway or ferry links, or in passenger sector: Maglev, dedicated high speed railway links, metro, tram, park and ride facilities, guided bus link, segregated bus lanes, in-road bus lanes, cycle path link.

The problems which can be solved in this case refers firstly to lack (or inadequate capacity) of connecting links (rail, road, etc.) or to absence /inadequacy of local/regional connection service. The main limitations which can be recognised concerning this kind of solutions can be costs of building and maintaining infrastructure and operation costs of services [3]. As example Maglev link to connect major interchanges to city centres can be mentioned. Maglev is faster, quieter and smoother than wheeled trains, but the cost of building a Maglev system is extremely high.

In the cases where a bus or coach service between city centre and interchange is, or would be, hampered by congestion, construction of a tram link (light rail running on the road, either mixed in with normal traffic or on segregated tracks) from major interchange to city centre could be suggested. Many cities have tram networks which serve their airports e.g. Bremen, Erfurt, Newcastle. Similar links are planned, or under construction, in Edinburgh or Alicante.

The same kind of thinking is used in the case of a combination of heavy rail track and urban tram track to allow trams to link major interchanges to city centres. TramTrain operation involves both track-sharing light rail/heavy rail and dual- or multi-mode operation (Heavy rail voltage / Light rail voltage). The track-sharing sections may also include main line heavy rail infrastructure. Usually infrastructure (tracks and stations) is owned by the railway infrastructure owners (DB Netz, RFF, Prorail, Network Rail etc.) and track access and station use charges apply for the light rail operator. TrainTram-operation is reversing the tram-train idea; direct access from the region to city centres is not achieved by bringing the tramway out onto the railway, but by bringing heavy rail vehicles onto the urban tramway or onto a tramway-like alignment. The heavy rail vehicles being used under urban conditions follow tramway regulations. The first and still best known system exists in Karlsruhe, but this and many variants of the original system have been introduced for instance in Saarbrücken, Heilbronn, Kassel, Chemnitz and Geneva and a host of further systems are under consideration or already under construction.

Another very demanding problem in creating integrated transport chains is the question of quick and seamless switching from one mode of transport to another. The solutions which allow for improved interchanges are as follows:

- solutions speeding transhipment operations,
- better technical equipment allowing for more rapid operations.
- more universal transport equipment allowing for compatibility with various types of vehicles,
- better organization of transport process,
- increased use of intermodal and multimodal transport chains,
- integrated services at local transport nodes,
- moving services outside the transport hubs,
- more storage space at cargo hubs.

All the solutions above aim at actions oriented at speeding up of transhipment and cargo processing operations at interconnection points between different modes. This requires more compatible cargo vessels, widespread use of containers and unification of operation procedures. The concept is best served by development of logistic centres. A logistic centre could be described as a facility with specific infrastructure and organisation in which logistic services connected with receiving, storage and distribution of goods are provided [7]. The logistic centre is the most advanced response to the problem of lack of modern warehousing space in the outskirts of major urban areas, more frequent use of intermodal transport and containerization. The concept of a logistic centre is also a response to the demand for ecological transport. The LC concept started in Europe with the creation of logistic centres outside Verona and Bologna in 1970s, followed by 1980's logistic centres of Bremen. In Germany the idea has been to some degree institutionalized by implementation of LC construction programme in the mid 1990's. In other European countries like for instance the CEE group of states, the concept is also being introduced in the 1990's.

Logistic centres use is however limited to most urbanized areas due to required conditions of high services demand and infrastructure constraints.

A more typical situation in Europe is when interchange occurs in focal points of the network, especially on connections between two modes or in freight hubs which do not have all the logistic centre potential. There are usually three kinds of those vital switch points in transport systems: sea-road, sea-rail and road-rail, though they can also be sea-road-rail. This is because the three main freight transport modes each have their own separate advantages concerning price, barriers and distribution. With the growth of containerization, intermodal freight transport has become more efficient, often making multiple legs cheaper than through services—increasing the use of hubs. But this could be rationalized only under the condition that interchange is efficient, quick and straightforward.

A good solution for improving interchange efficiency is for example better equipment allowing for faster cargo movement form one mode of transport to another. More and more modern cranes, platforms and other stationary devices reduce waiting times for cargos to be moved from one vessel to another. Combined with widespread use of containers this revolution which started in 1950's allowed for unprecedented rise in the international trade. The impact which it has on transport – environment relation is twofold. Firstly it certainly made transport less costly and consuming less energy per unit. But at the same time it allowed for increase in volume of goods transported to the degree when emission reduction gains from efficiency improvement are fully cannibalized by increase in total throughput.

Another useful technique is equipping interchange points with additional warehouses or cargo depots. This solution allows for storage of cargos in crucial points over the network. Limited processing capabilities of most frequently used interchanges prevent seamless movement of goods. Additional cargo space allows for optimization of transport schedules as they are no longer dependant on arrival/departure times of different vehicles (cars, trains etc.). The idea is mostly useful at vital node points between rail-road modes, rail/road – seaport and less frequently rail/road and air mode.

Gains in efficiency could be also found in existing multimodal transports. For example lo-lo and ro-ro services could be improved. This solution is oriented mainly at seaports and calls for optimisation of use of lift-on lift-off machinery. New piers are most likely necessary.

Introduction of better ro-ro services calls for new types of ships capable of direct transport of vehicles or even trains. With the building of the 8000 CEU car carrier Faust in June 2007 the car carriers entered a new era called the LCTC (Large Car & Truck Carrier). There are also innovative new technology concepts being introduced in this area – for instance the car carrier Auriga Leader, built in 2008 with a capacity of 6200 cars, is the world's first partially solar powered ship. Use of solar energy has significant impact on emissions reduction but it is limited to regions with sufficient sunlight and in most cases it is still considered secondary and supportive system on board.

There is also room for improvement in regard to optimization of transport process organisation. Paperwork burden accompanying forwarding and multimodal transport has already been largely reduced due to the widespread use of trade terms (e.g. Incoterms, Combiterms), but still transhipment usually requires additional arrangements. The idea of using only one binding contract must be more easily accepted. This also requires organisational change – integration of accompanying services in one (hub) point. For example insurance, duty, safety and security controls should be conducted at the same time. This solution requires better coordination between different services and often coordination between private companies and authorities responsible for different control activities. Opposite solution would be to move all those additional services outside interchange. Duty or safety checks could be conducted for instance at the origin point of integrated transport chain.

This allows for time savings on processing at interchange points reducing congestion at those vital junctions, reduces need for warehousing and allows for optimisation of just in time deliveries as waiting times of border duty/safety checks are eliminated (and those activities are often unpredictable in regard to timing).

Further improvements could be sought by more widespread use of unified transport systems or unified vehicles. Use of multimodal or intermodal transport methods might in the future replace majority of current transport procedures.

While introducing all those improvements at interchanges one important question should be asked – whether they are indeed environmentally friendly solutions? Solutions improving interchanges between modes contribute to more seamless transport, they reduce congestion and waiting times thus emissions are certainly reduced in each separate transport process. However this positive environmental impact is offset by increase in volume of transport. Easier interchange means cheaper transport and this in turn results in attracting new loads to the transport system. The overall increase in transport we witnessed with first wave of interchange improvements which occurred with introduction of containers suggests that possibly we may rather expect overall growth in emissions if further improvements in interchanges efficiency are introduced.

3 IMPACT OF NEW ITS ELEMENTS AND MODERNISED PROCEDURES INTRODUCED INTO TRANSPORT SYSTEM

The opportunity to improve interconnectivity between different modes in modern transport system is offered by research leading to creation of Intelligent Transport Systems. ITS is often defined as actions oriented at adding modern information and communications technology to existing transport infrastructure in order to improve transport operations. Especially to improve safety and reduce vehicle wear, transportation times, and fuel consumption. The main contribution of ITS is that it provides a transport system with a variety of different technological improvements (ICT, IT, automation and measuring) but is not limited to technical sublime only. ITS means also new management techniques used in transportation to increase safety and security of transport processes, protect the natural environment and improve efficiency of the whole sector. The use of Intelligent Transport Systems (ITS) is global however certain system development level has to be achieved as precondition for introduction of ITS. The main ITS innovation is the integration of existing technologies to create new services. ITS can be applied in every transport mode (road, rail, air, water) and services can be used by both passenger and freight transport. Specific ITS solutions could be used at various levels, those could be actions in the field of:

- telematics,
- wireless communication,
- video/radio detection technologies,
- satellite navigation,
- electronic toll/data collection.

Thanks to telematics (ICT networks, traffic control systems, electronic location of vehicles and cargo, electronic exchange of documents) operations accompanying transport processes can be optimised with resulting time savings.

Wireless communication allows for better synchronisation of arrivals and departures at vital transport nodes. For example road vehicles boarding ferries could be warned about delay early enough to get redirected to different parking lots and thus reduce congestion at the ferry terminal. Cargo loadings for aircrafts could be postponed in case of flight cancellation and cost of loading/unloading avoided, etc.

Satellite navigation is slowly becoming standard in all branches of transport. It is especially useful at heavily congested transport nodes. Information provided by navigation systems allow for easy change of possible interchange node if original node is overloaded. Moreover it seems that it is not possible to achieve the goals of sustainable development of transport in Europe today without widespread use of satellite navigation due to its impact on route choice decisions. Satellite positioning is longest in operation with maritime sector allowing for optimal sea route choice, but as it finds its way to road transport improves the effectiveness of fleet management by transport companies (both in passenger and cargo transport), forwarding and logistics companies. Those technologies are applicable for a range of uses: vehicle and shipment tracking, route analysis and planning, facilities and depot management, routing and scheduling [11].

It has to be added that satellite navigation is directly included in the EU transport policy development among instruments like building trans-European transport networks, where the TEN network includes project for Galileo and managing the effects of globalisation, where one of the objectives is to achieve independence in terms of satellite navigation by developing Europe's own system Galileo [2]. However, using a satellite navigation system is possible, or even essential for the implementation of other objectives of EU transport policy, such as improving road safety or adopting the principles for effective charging for transport [12].

As it is presented at the table applications of the satellite navigation has an important impact on many areas of the EU transport policy. It also affects positively the integration of transport systems, more efficient interchanges and much more safe transport both in passenger and freight sectors.

Another ITS measure is that video detection technology could be used to prepare electronic cargo lists by simply scanning containers. Video detection also allows a reduced need of manual checks by border police or other law enforcement agencies. Even more promising is the use of RFID technology. Radio-frequency identification uses communication through the transmitting of radio waves in order to transfer data between a reader and an electronic tag attached to an object, for the purpose of identification and tracking. Latest RFID capable devices do not need a physical contact between scanner and items. This in turn allows the simultaneous reading of many tags and doing this over some distance which results in major time savings on transhipment operations at interchange point. Similar applications are offered by various electronic data collection facilities – counting stations, ticket vending machines, electronic toll collectors etc.

Different solutions are those which allow for traffic optimisation. Typical example of this kind of solution is automated lighting regulation which diverts vehicles at ports or at rail stations which offer intermodal services. Whenever a free slot for loading/unloading is available awaiting trucks are signalled using different lights. Those systems are also widely used in case of motorways – at toll collection points etc.

Areas of the EU transport policy	Application of satellite navigation	Areas of application of satellite navigation
Development of intermodal transport	Wide-ranging	• freight tracking, • current information for clients
Building trans-European networks	Wide-ranging	• traffic management, • construction of the European satellite navigation system Galileo
Improving road safety	Wide-ranging	• intelligent transport system, • current information about road incidents, • improving performance of emergency services
Fair and efficient pricing in transport, internalisation of external costs	Wide-ranging	• electronic toll collection system, • ability to diversify charges depending on various factors including external costs
Respecting the rights and obligations of users of transport systems (e.g. reimbursement and compensation for delays, accidents etc., harmonisation of procedures, improving passenger information)	Wide-ranging	In-vehicle passenger information (about transfers, current location, tourist attractions) and passenger information at the stations, stops or terminals (e.g. about actual arrival time)
Developing quality urban transport (promoting “clean” public transport, supporting practical solutions)	Wide-ranging	• vehicle tracking, • fleet management
Research and technology focused on environmentally friendly and effective development of transport (e.g. new traffic management instruments, improving technical standards of vehicles)	Wide-ranging	Intelligent transport system
Managing the effects of globalisation	Wide-ranging	Construction of the European navigation system Galileo
Controlling the growth of air transport (e.g. harmonisation, reducing noise and emissions, improving safety)	Supporting	Improving safety, including airport safety, by using satellite navigation also in ground operations
Promoting sea and inland waterway transport (e.g. the concept of sea motorways, improving safety at sea, technical and social harmonisation, improving seaport effectiveness, developing inland waterways information system)	Supporting	improving safety, waterway information systems, hydrographic control, supporting search and rescue systems (e.g. sar)
Improving quality in the road transport sector (e.g. standardisation of professional training of drivers, harmonisation of working conditions)	Limited	Improving drivers' working conditions, including safety
Revitalising the railway (e.g. liberalising international and national rail cargo markets, opening of international passenger markets, improving safety and interoperability, improving the quality of passenger services)	Limited	Current information for passengers, facilitating service quality improvements

Table 1: Applications of satellite navigation supporting the goals of the European transport policy (Source: Own study (M.Bąk))

The development of modern information technologies is to a high degree dependent on the integration of various IT systems and the use of current data interchange standards. These modern technologies applied in transport include Electronic Data Interchange (EDI), the Internet, Value-added Networks (VAN), Logistics Information Systems, Points of Sale (POS), Electronic Ordering Systems (EOS), Internet telephony VOIP, and enterprise information portals [4]. Intermodal transport systems still do not fully make use of those potentials. The solutions introduced in intermodal transport chains are more oriented at improvement of transhipment than at new inventions eliminating the need of transhipment. There are some experimental solutions like the concept of road-rail vehicles, dedicated road-rail buses, dual-mode vehicles but they have not been introduced on large scale yet although there have been some research projects into it [15]. For example the dual road vehicle is a vehicle that can run on conventional road surfaces or a dedicated track. A working example of this type of solution is road-rail DMV developed by the JR Hokkaido Railway Company [9]. Another dual service vehicle is the tram-train system of Karlsruhe [8]. But both systems serve as an example rather than a rule.

Interchange ITS use in intermodal transport aims at elimination of the faults and weaknesses of traditionally understood intermodal systems. To summarize their application - they include the development of new technologies of transport means operation, new ways of cargo handling, new design concepts of loading units and new communication techniques between entities in the integrated systems.. The most promising in terms of ease of adoption innovation occur at interchanges and terminals, which are highly absorptive of information and IT systems, leading to a reduction in operational time and costs in transport processes.

ITS and technology in general could significantly improve environmental friendliness of interchangeable transport. All solutions aim at reduction of tasks handled at switch points and thus reduce energy and fuel consumption. Furthermore by saving time in transport processes they reduce total emissions involved. Nevertheless important questions have to be raised. Firstly although ITS solutions really reduce environmental impact they should not be regarded as environment cost free. There is environmental cost for example associated with launching to orbit all satellites necessary for guidance systems. Secondly it is perceived that ITS solutions while facilitating interchange operations may attract additional transport services to most important interchange points. Therefore congestion savings will be short-lived and even more vehicles, ships and planes will concentrate in focal points, in other words we risk that major nodes (like the port of Rotterdam) will become even larger. Thirdly the technology used in support of transport is not necessarily energy saver. New electronic devices, lighting or communication require energy. If they are installed in vehicles fuel consumption must rise to compensate for increased energy demand. On the scale of single unit it is not significant but considering whole transport system figures grows.

4 CONCLUSIONS

It is obvious that EU transport policy goals cannot be achieved without integrated transport systems including transport infrastructure integration and good interconnection between transport modes both in passenger and freight sectors. New policy developments and documents confirm that these issues are treated seriously and significant attention is put on the problems of improving integration and identifying instruments and solutions allowing achieving the general objectives. It is clear that some implemented solutions would improve transport efficiency but at the same time they can influence negatively transport sustainability. Additionally more generally speaking it has to be noticed that the majority of new solutions generating new transport demand is risky from the environmental point of view since more traffic means in many case higher external transport costs. The implementation process needs to evaluate the conditions and impacts in order to choose the best option for specific situation/market/region, etc. In the paper some solutions which are important for better interconnectivity were identified. Especially organisational instruments and ITS solutions seem to have a significant and positive impact both on transport efficiency and sustainability. New technology implementation like satellite navigation which is useful in many areas of transport systems integration is inevitable future of the transport development in Europe.

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GREEN CORRIDORS IN FREIGHT LOGISTICS: HOW CONDUCIVE IS THE OPERATIONAL AND REGULATORY ENVIRONMENT IN EUROPE

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ABSTRACT

"Green corridors" in freight transportation is a concept introduced in 2007 as an action of the "Freight Transport Logistics Action Plan" of the European Commission. It pursues a corridor approach in developing integrated, efficient and environmentally friendly transportation of freight between major hubs and by relative long distances. The EU-financed SuperGreen project aims at assisting the European Commission in further defining and developing this concept. A central activity of the project is the development of a corridor benchmarking methodology using a set of Key Performance Indicators (KPIs) that are suitable for monitoring the sustainable development goals of the European Union and cover environmental, technical, economical, social and spatial planning aspects. The purpose of this paper is to present the KPIs that have been selected for benchmarking a set of project corridors and to use them for assessing the potential effects that recent changes in the European operational and regulatory environment may have on green corridor development.

1 INTRODUCTION

What is really a green corridor? In a strict sense, a precise definition of the term is still elusive, and in fact one of the most important contributions of ongoing research on the topic would be to develop an explicit and workable definition of the term.

According to the "Freight Transport Logistics Action Plan" of the European Commission [4], which introduced the concept, "... industry will be encouraged along these corridors to rely on co-modality and on advanced technology in order to accommodate rising traffic volumes, while promoting environmental sustainability and energy efficiency. Green transport corridors will … be equipped with adequate transhipment facilities at strategic locations … and with supply points initially for bio-fuels and, later, for other forms of green propulsion. Green corridors could be used to experiment with environmentally-friendly, innovative transport units, and with advanced Intelligent Transport Systems (ITS) applications… Fair and non-discriminatory access to corridors and transhipment facilities should be ensured in accordance with the rules of the Treaty."

The EU-financed SuperGreen project aims at assisting the European Commission in further defining green corridors through a corridor benchmarking exercise using Key Performance Indicators (KPIs). More details about the project can be found at: http://www.supergreenproject.eu.

The purpose of this paper is to present the KPIs selected for corridor benchmarking and use them for assessing the potential effects that recent changes in the European operational and regulatory environment may have on green corridor development. The paper is based on the work performed under the SuperGreen project, as this has been reported in [5], [7], [8] and [9].

2 THE SUPERGREEN KPIs

2.1 The project

SuperGreen is a Coordination and Support Action, in the context of the European Commission's 7th Framework Programme of Research and Technological Development. The objectives of the SuperGreen project concern supporting the development of sustainable transport networks by fulfilling requirements covering environmental, technical, economical, social and spatial planning aspects. This will be achieved by:

- giving overall support and recommendations on green corridors to EU's Freight Transport Logistics Action Plan,
- conducting a programme of networking activities between stakeholders (public and private),
- providing a schematic for overall benchmarking of green corridors based on selected KPIs,
- delivering policy recommendations at a European level for the further development of green corridors, and
- providing the Commission with recommendations concerning new calls for R&D proposals to support development of green corridors.

Project work is organised in 7 work packages. The most relevant one to the present paper is the package concerning corridor benchmarking. It involves: the selection of corridors; definition of the benchmarking methodology and indicators; identification of changes in the operational and regulatory environment that may enhance or hamper green corridor development; the actual corridor benchmarking; and definition of areas for improvement. It is noted that the benchmarking of corridors in relation to green technologies and smart Information and Communication Technology (ICT) applications comprises the subject of different work packages and will not be covered here.

2.2 The KPIs

No corridor benchmarking exercise was identified in the literature surveyed by the project. The closest case concerns benchmarking of transport chains and was studied by the BE Logic project [6]. Based on this experience, the project developed a methodology that consisted of decomposing the corridor under examination into transport chains, benchmarking these chains using a set of KPIs, and then aggregating the chain-level KPIs to corridor-level ones using proper weights for the averaging.

Following an internal round of compilation, categorisation and filtering, the project suggested an initial set of KPIs. They were grouped in five KPI areas (efficiency, service quality, environmental sustainability, infrastructural sufficiency, and social issues). Stakeholder feedback on the proposed methodology and KPIs was solicited during four regional workshops organised by the project, and a special meeting of the project's Advisory Committee. The KPIs that resulted from this process are listed below:

- relative transport cost (to the user) in €/ton-km;
- CO_2-eq emissions in g/ton-km;
- SO_x emissions in g/1000 ton-km;
- transport time in hours;
- reliability (on-time delivery) in % of shipments delivered within acceptable window; and
- frequency of service in number of services per year.

3 EFFECTS OF OPERATIONAL AND REGULATORY CHANGES

Aiming at identifying factors that might promote or hinder green corridor development, the SuperGreen project undertook an extensive literature survey that resulted in approximately 80 changes in the operational and regulatory environment. These changes were grouped in 7 themes (Business environment, Trends in logistics, Operations, Public policies, International regulations, Infrastructure development, and Technology development) and their effects on green corridor development were assessed through the use of the SuperGreen KPIs. The results, which are based on the content of the reviewed documents and the professional expertise of the reviewers, are summarised in Tables 1 to 7 below. These results were presented by theme in a project workshop and formed the basis for discussions with the stakeholders. The tables incorporate all feedback received from stakeholders.

In these tables, the direction and level of significance of the effects of each change are depicted through symbols, which have the following meaning:

+	Moderate increase
++	Significant increase
+++	Very significant increase
-	Moderate decrease
--	Significant decrease
---	Very significant decrease
+ / -	Two different forces work in opposite directions
(+)	Potential effects
+ (-)	Moderate increase but potential decrease under specific conditions.

No symbol means that no effects are expected.

In order to avoid confusion, the definitions of the KPIs used in the analysis are those of the previous section, with the exception of emission KPIs, which are defined in absolute (mass) rather than relative (mass/ton-km) terms. The above symbols should be considered in conjunction with the KPI definitions. As an example, it is mentioned that the symbol '+' in the CO_2-eq column signifies a moderate increase in greenhouse gas (GHG) emissions and not a positive development in this respect.

It is also noted that in assessing the effects of a particular change, this change is considered independently from all other factors, which are kept unchanged. As an example it is mentioned that in projecting significant increase ('++') of CO_2-eq emissions due to EU enlargement (Table 1), the capacity of transport infrastructure is kept at today's level, which does not need to be the case in reality. In most cases this assumption places more emphasis on the short term effects of a change.

Space limitations do not allow justification of the assessments contained in the tables; this can be found in [8]. Instead, we will focus on the following three important issues.

The first one concerns the liberalisation of transport operations. Following the efficiency gains achieved by the market opening in air transport, which have resulted in a significant reduction of user costs, the European Commission has set the liberalisation of road and rail transport operations as one of its main objectives. With the so-called Third Railway Package for rail and Regulation No 1072/2009 for road haulage, the legal framework of market opening is almost complete. Some issues such as opening up competition in the provision of intermodal terminal and port services, as well as existing differences in taxation and subsidies still need to be addressed. More effort is needed, however, in enforcing the competition rules [2].

No.	Change	Cost	Time	Reliability	Frequency	CO_2-eq.	SO_x
1	Population size	+ / -	-	+		-	-
2	Ageing population	+ / -					
3	Net migration to the EU	-					
4	Increasing mobility of workers	-					
5	Urbanisation and city sprawl	++ / --	++ / --		++	++ / --	++ / --
6	Increasing individualisation	+	-	+	+	+	+
7	Proliferation of electronic business	+ / -	-	+	+	+ / -	+ / -
8	Increasing economic activity	++	+		+	++	++
9	Globalisation	+				+	+
10	Technological convergence (productivity)	+				+	+
11	EU enlargement	++ / --	+	-		++	++
12	EU integration	++	+	-	+	++	++
13	Increasing scarcity of fossil fuels	+++	-		-	-	-
14	Increasing social and environmental consciousness					--	--

Table 1: Effects of changes in business environment

No.	Change	Cost	Time	Reliability	Frequency	CO_2-eq.	SO_x
1	Spatial concentration of production and inventory	++	+		++	++	++
2	Wider sourcing of supplies and wider distribution of goods	++	+		++	++	++
3	Supply chain integration	+ / --	--	++		--	--
4	Information sharing	+ / -	-	++			
5	Improving responsiveness to customer requirements (agility/adaptability)	+	-	++	++	+	+
6	Increasing direct deliveries	+	-	+	+	+	+
7	Increasing transport emissions					++	++
8	Reverse logistics	+ / -	+			+	+
9	Containerisation	---	---	++	++	+	+
10	Hub & spoke system	--	++		+	+ / --	+ / --

Table 2: Effects of trends in logistics

No.	Change	Cost	Time	Reliability	Frequency	CO_2-eq.	SO_x
1	Optimise fleet and terminal operations	--	-	+	+	--	--
2	Slow steaming	--	++		--	--	--
3	Eco driving	-	+			-	-
4	Introduce a container pool system	-				-	-
5	Introduce combined transport solutions	-	-	+		-	-
6	Introduce the Life Cycle Cost (LCC) methodology in decision-making	-				-	-
7	Enhanced training on environmental transport	-	-	+		-	-

Table 3: Effects of changes in operations

No.	Change	Cost	Time	Reliability	Frequency	CO_2-eq.	SO_x
1	Liberalise transport operations	-- (-)	-- (-)	++ (+)	++	-- (-)	-- (-)
2	Internalise external costs	++				--	--
3	Set energy consumption/ emission/noise standards & other regulatory measures	+				--	--
4	Tighten up and harmonise safety standards	+		+			
5	Tighten up security standards	+ / -	+	+			
6	Standardise transport units and vehicles	+ / --	--	++		- (+)	
7	Harmonise infrastructure (interoperability)	+ / --	--	++		--	--
8	Harmonise rules and enforcement	-		+		-	-
9	Standardise liability and documentation for multi-modal transport	-				(-)	(-)
10	Simplify administration	--	--				
11	Create freight-oriented corridors	-	---	+++		(--)	(--)
12	Develop green corridors	-		++		--	--
13	Employ a spectrum of instruments to fund infrastructure and other actions	-- (-)	-- (-)	++ (+)		-- (-)	-- (-)
14	Bring ICT applications to market (ITS, ERTMS, RIS, e-maritime, e-freight, e-customs)	--	--	++		--	--
15	Enhance education and training	-	-	+		-	-
16	Ensure satisfactory working conditions	-		+		-	-
17	Support research & development	--	-	+		---	---
18	Educate, inform and involve the greater public in transport policies (incl. labelling)	-	-	+		-	-
19	Monitor and publish service quality indicators	-	--	++		-	-
20	Promote international cooperation with EU neighbouring countries	(-)	(-)	(+)			
21	Green public procurement					-	-

Table 4: Effects of changes in public policies

No.	Change	Cost	Time	Reliability	Frequency	CO_2-eq.	SO_x
1	Support fair international trade	-		+		-	-
2	Adopt EEDI	+	+		-	- (+)	- (+)
3	Internalise the external costs of GHG emissions from ships	+				-	-
4	Strengthen restrictions on NOx and SOx	++				(+)	- (+)
5	Establish a mandatory Polar Code	--	--	+	++	--	--
6	Enhance international security	+ / - (++)	+ (++)	+			
7	Establish global standards for ICT applications in shipping	--	--	++		--	--
8	Establish global standards for IWT-engines	-				--	--
9	Upgrade EU status in IMO	(+)				(-)	(-)

Table 5: Effects of changes in international regulations

No.	Change	Cost	Time	Reliability	Frequency	CO_2-eq.	SO_x
1	Increasing congestion	+	+	-		+	+
2	Upgrade existing infrastructure	-- (-)	-- (-)	++ (+)		-- (-)	-- (-)
3	Expand infrastructure	-- (-)	-- (-)	++ (+)	+	-- (-)	-- (-)
4	Create a core network of high EU added value	-- (-)	-- (-)	++ (+)	+	-- (-)	-- (-)
5	Promote intermodal freight villages (including urban distribution centres)	--	--	++	+	--	--
6	Construct dedicated freight rail lines	- (+)	---	+++	+++	--	--
7	Create dedicated parking areas for trucks with appropriate security levels			+			
8	Designate unloading places for delivery vehicles in dense urban areas	-	-			-	-
9	Reduced public expenditures on transport infrastructure	+	+	-		+	+
10	Ensure adequate public and private funds	-- (-)	-- (-)	++ (+)		-- (-)	-- (-)
11	Adopt common methodologies in project appraisal	-	-	+		-	-

Table 6: Effects of changes in infrastructure development

No.	Change	Cost	Time	Reliability	Frequency	CO_2-eq.	SO_x
1	Develop ICT solutions for vehicles/vessels and infrastructure	--	--	++		--	--
2	Reduce forces on vehicles/ vessels	--				--	--
3	Increase efficiency of propulsion systems	--				--	--
4	Use alternative fuels	+				---	---
5	Improve after-treatment of exhaust gases of existing and new generation fuels	+				--	--
6	Improve environmental performance of auxiliary systems	+				-	-
7	Vehicle/vessel capacity optimisation	--				--	--
8	Develop more efficient cargo handling and transport technologies	--	++			--	--
9	Optimise vehicle and infrastructure characteristics in relation to noise generation	+					
10	Develop new methods for structural assessment of existing infrastructure	-				-	-
11	Enhance training on environmental transport	-	-	+		-	-

Table 7: Effects of changes in technology development

The effects of liberalisation are significant reduction of user costs, transport time and emissions, and significant increase of reliability and frequency of service (refer to Table 4). These gains are achieved basically through better utilisation of infrastructure and vehicles/vessels (higher load factors and lower empty trip factors) and more intensive use of ICT applications. It is noted, however, that the lower transport costs will have a positive impact on transport demand, and for most KPIs the above gains will be mitigated but not reversed.

The internalisation of transport related external costs, an issue that was raised in the 1990s and gained momentum in the last four years with numerous studies and policy papers, is the second one. Prices reflecting all costs – internal and external – convey the right signal to economic actors, who have economic incentives to use safer, more silent and environmentally-friendly vehicles or transport modes and, to plan their trips according to expected traffic conditions, leading to efficiency gains (seen from the welfare economics point of view). The principle applies to all modes. In all cases, it is suggested that revenues generated by internalisation should be used by Member States for making transport more sustainable through projects such as research and development on cleaner and more energy efficient vehicles, mitigating the effect of transport pollution or providing alternative infrastructure capacity for users [3].

The expected effects of externality internalisation are significant gains in terms of emissions, at the expense of increased user costs (refer to Table 4). The role of ICT applications is crucial in making the internalisation possible and in reducing the operating and management costs of the relevant schemes.

It is recommended that the Commission assesses the possibility of including the fair and non-discriminatory access requirement, and the internalisation of external costs as prerequisites for labelling a particular corridor as "green". In this way, green corridors, in addition to being a field for experimenting with environmentally-friendly, innovative transport units, and with advanced ITS applications, can become a laboratory for transport policies, too.

The third point of interest concerns the creation of freight-oriented corridors, as they have been introduced by Regulation No. 913/2010 [1]. The regulation designates 9 European corridors as initial freight corridors, where sufficient priority is given to international freight trains. In addition, it makes it mandatory for each Member State (excluding Cyprus and Malta) to participate in the establishment of at least one freight corridor.

The effects of the freight-oriented corridors on cargoes already transported by rail are very significant improvements in terms of speed and reliability (Table 4). Improvements are also expected in terms of costs through better coordination. If the scheme succeeds to attract road cargoes, significant gains in emissions will also materialise.

Four valuable lessons can be drawn from Regulation No 913/2010. Firstly, the Regulation separates the criteria for establishing a freight-oriented corridor from the indicators monitored after its establishment. In fact, while the establishment criteria are defined by the Regulation, the indicators to be monitored are left for the corridor's management to decide with only broad directions given. This is a logic that can be followed for the green corridors, too.

Secondly, one of the establishment criteria is the definition of a freight-oriented corridor: "A corridor crossing the territory of at least three Member States or of two Member States if the distance between the terminals served by the freight corridor is greater than 500 km." Although there is no need to expand this definition to the green corridors, it certainly provides a guideline to this end.

Thirdly, in recognition of the multiplicity of entities involved, the Regulation sets up a detailed governance structure, including representatives of the Member State authorities, Infrastructure Managers, Railway Undertakings and terminal owners / managers. To simplify communication with applicants and other interested parties, the establishment of a one-stop-shop is foreseen. Both the international governance structure and the one-stop-shop provided for by the Regulation can become features of the green corridor governance, with minor adjustments where needed.

Fourthly, the Regulation prescribes a number of implementation measures including:

a) a market study,
b) an implementation plan describing the characteristics of the freight corridor, including:
   - bottlenecks,
   - the programme of measures necessary for creating the freight corridor, and
   - the objectives for the freight corridor, in particular in terms of service quality and its capacity,
c) an investment plan including financial requirements and sources of finance,
d) a deployment plan relating to the interoperable systems along the freight corridor,
e) a performance monitoring mechanism,
f) a user satisfaction survey, and
g) the requirement to update all the above periodically.

All these requirements tie very well with the green corridor concept and should be retained.

4 CONCLUSIONS

The operational and regulatory environment in the EU is rather conducive to green corridor development, in the sense that all identified barriers have been adequately addressed by EU policies. Of particular importance are the administrative barriers addressed by the Freight Transport Logistics Action Plan. In general, the legal framework is pretty much in place. Special attention should be given to the enforcement of existing legislation.

The effectiveness of transport policy is enhanced by employing packages of complementary instruments. Very important is the role of technology (in particular commercially viable alternative fuels) for the long run, and of ICT applications for the immediate future. The significance of educating, informing and involving the greater public in transport policies is a precondition for their effectiveness.

Over-regulating is an issue that should not be overlooked, since improvements in one aspect might create problems in another. Three such cases were identified by SuperGreen, all concerning maritime transport and non-EU institutions. The first one is the Energy Efficiency Design Index (EEDI) formula of the International Maritime Organisation (IMO), which if adopted, might lead to the construction of underpowered ships which, in their attempt to go faster or just maintain speed in bad weather, might emit disproportionately more CO_2. The second one concerns the U.S. suggested requirement for 100% scanning of U.S.-bound containers, which can create bottlenecks and have significant adverse effects on transport time and costs through reduced port throughput capacity. The third one is the IMO's suggestion to reduce the maximum sulphur content of fuel oil burnt by ships from 1% to 0.1% as from 1 January 2015 in the Sulphur Emission Control Areas (SECAs) which, if applied, could lead to a 'back-shift' from short sea shipping to road transport with effects opposite to those intended.

Given the fact that the European Commission has acknowledged this last danger of over-regulation, policy action towards provision of financial instruments aimed at avoiding such 'back-shift' was proposed during the project workshop. A possibility worth assessing is the amendment of the new Marco Polo programme to include such schemes.

The corridor approach is an effective way to address the fragmented nature of European transport networks, especially in the rail sector. The green corridor concept is by far more complicated than the recently introduced freight-oriented corridors, which can be viewed as a subset of the green ones. Nevertheless, valuable lessons can be drawn from Regulation No 913/2010 in relation to:

- separation of the criteria establishing a freight-oriented corridor from the indicators monitored after its establishment,
- the definition of a freight-oriented corridor,
- the detailed governance structure fostering international cooperation among a multiplicity of actors involved, and the introduction of a one-stop-shop for communication with third parties,
- the implementation measures foreseen, including a market study, an implementation plan, an investment plan, a deployment plan relating to the interoperable systems, a performance monitoring mechanism, and a user satisfaction survey, all updated periodically.

In relation to the criteria for labelling a particular corridor as “green”, it is suggested that the Commission assesses the possibility of including as prerequisites:

- the fair and non-discriminatory access requirement of the Freight Transport Logistics Action Plan, and
- the internalisation of external costs, which for the time being remains voluntary.

In this way, green corridors in addition to being a field for experimenting with innovative transport technologies and advanced ICT applications, can become a field for experimenting with EU transport policies, too. This is in line with the core network concept proposed for the new TEN-T guidelines, which by placing emphasis on the European added value of the transport networks and their integration, in a way that combines efficiency targets with the sustainable development goals of the EU, basically extends the green corridor concept across all Europe.

Another conclusion concerns the role of intermodal terminals and freight villages in the development of green corridors. The shift of competition from among individual enterprises to among supply chains necessitates optimising performance at the chain level and this is impossible without nodes permitting the effective and efficient modal interconnection.

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THE SWEDISH GREEN CORRIDOR INITIATIVE – HISTORY, CURRENT SITUATION AND THOUGHTS ABOUT THE FUTURE

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ABSTRACT

Green corridors aim at strengthening the logistics industry's competitiveness and create sustainable solutions. Green corridors will enable large-scale and long-term transport solutions through sufficient and attractive infrastructure and supportive regulatory framework. Green corridors are, of course, to a large extent about the green, environmental, perspective. However, the concept does not foresee the other parts of the concept of sustainability such as the need for an economic rationale motivating the corridor and the operations within the corridor. In 2010 the Swedish Maritime Administration, Trafikverket (the Swedish Transport Administration) and VINNOVA received a governmental commission to strengthen the work of green corridors.

This paper describes the concept of green corridors, its fundamental ideas and the way forward. Focus is on the Swedish initiative within green corridors. The work carried out in Sweden has been one of the key drivers for developing the idea of green corridors. The paper takes the reader from the very beginning through the current work and into some thoughts and plans for the future.

1 INTRODUCTION

There is a challenge for the logistics sector and the society to achieve long-term sustainability since transports are a part of the problem but also a part of the solution. One way of accepting the challenge is to develop trans-national transportation corridors. Such corridors would increase competitiveness and contribute to a sustainable Europe.

Green corridors is a European Commission initiative aiming at strengthening the logistics industry´s competitiveness and create sustainable solutions. Green corridors will enable large-scale and long-term transport solutions through sufficient and attractive infrastructure and supportive regulatory framework. The concept is not mode-specific neither is it devoted only to intermodal solutions. It is important to develop green corridors for a number of reasons. Among these we find environmental reasons (emissions, noise etc), competitiveness of the manufacturing industry, better use of money spent on infrastructure, and to cope with the expected increasing freight movement across Europe and globally.

The basic idea behind the green corridor concept is to provide a more sustainable transport solution based on economies of scale in infrastructure as well as operations. The infrastructure should be characterized by using innovative solutions and demonstrate/test new techniques and ideas that will result in greener transport solutions. Using the vocabulary from the field of logistics time and place utility is of highest importance. The attractiveness of the infrastructure and the offered services must be high to strengthen its relative importance. The benefits for the operators and transport buyers will be safer, more reliable transports and the benefits to the society will be greener and more cost efficient building and maintenance of the infrastructural resources.

2 HISTORY

Green corridors as a concept stem from an initiative of the European Commission (in Freight Transport Logistics Action Plan (FTLAP), 2007 [2]). According to the FTLAP green corridors will "*reflect an integrated transport concept where short sea shipping, rail, inland waterways and road complement each other to enable the choice of environmentally friendly transport*". The plan also stresses the importance of "*adequate transhipment facilities at strategic locations*" and supply points for bio-fuels. The EU has continued to support the concept of green corridors both through financial means (funding projects) and through other forms of encouragements to speed up the shift towards greener and more efficient logistic solutions.

Green corridors should enable large-scale and long-term transport solutions through a sufficient and attractive infrastructure combined with a supportive regulatory framework.

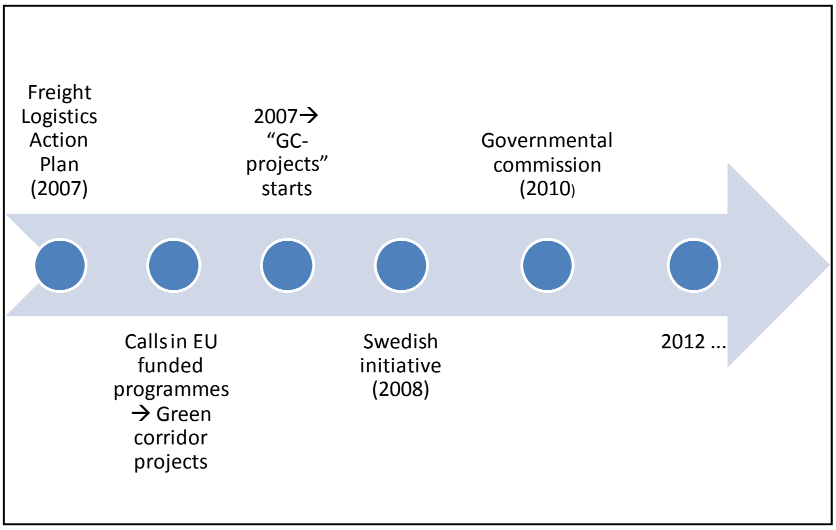

Figure 1: The Green corridor development

One essential pillar in green corridors is the concept of co-modality. The concept was introduced in the mid-term review of the EU white paper Time to Decide [4]. It was defined as: "*the efficient use of different modes on their own and in combination will result in an optimal and sustainable utilisation of resources".* The concept of co-modality is important to the green corridors in order to stress the fact that the logistic solution chosen by the market can, and should, be a decision made by the shippers/forwarders etc. In the green corridors the consequences of the choice can be clearer. Since the wealth of the society depends on freight transports and we in the foreseeable future will need all four transport modes it is important to stimulate that a green development occurs for uni- as well as multimodal freight transport solutions. The concept of co-modality has been and still is very important when it comes to green corridors. The concept takes us one step further to be able to focus on the consequences of the transport/logistics systems and not focus on either modal or intermodal issues. Co-modality gives room for improvements and demands in an intermodal as well as in a unimodal set up. This concept thus take us beyond the "old" thinking were transport modes often were described as competitors and forming a new thinking where the consequences of the transport movement is put in focus. This "new" way of thinking focuses the time and place utility created by the transport solution as well as the negative consequences for individuals as well as the society as a whole. Put simply, the consequences of the transport movement matters not the modes as such!

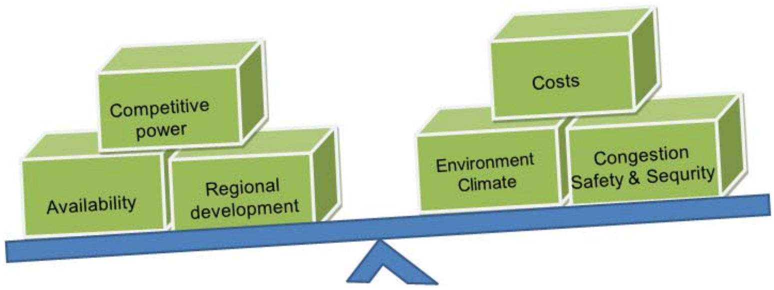

Figure 2: The Effects Seesaw

Another essential pillar of the green corridors is the understanding that transportation, as being a major sub-function of logistics, creates time and place utility of goods. Some underlying phenomena make this time and place utility possible. Among these we find aspects such as the infrastructure, the information system, the efficiency of the transport mode and the load carriers but also the demands of the customers and the terminal function.

3 CURRENT

In parallel with the Swedish National Initiative to Green Corridors (in short the Swedish Initiative), which will be further described below, several other projects, some financed from the EU and others with national funding, were started in 2008/2009. One of the most influential and largest (regarding ambition as well as number of partners representing different countries) projects was the "Supergreen[4]". The aim of Supergreen is to "*promote the development of European freight logistics in an environmentally friendly manner*". The project is multimodal and has a broad European coverage. The abbreviation Supergreen stands for Supporting EU's Freight Transport Logistics Action Plan on Green Corridors Issues. It is a broad and ambitious project looking into a wide range of green corridor-relevant issues. The project takes on a holistic approach to create "win-win" solutions for parties involved in the corridors. Supergreen will evaluate a series of corridors throughout Europe

The number of projects that in one way or the other relate to the concept of green corridors is huge. The reason is, to a large extent, that the concept of green corridor cover environmental and economic perspectives – areas which most "modern" projects have been focusing their efforts for many years (before "inventing" the green corridor concept). However, some large and influential projects dealing with green corridors in one way or the other, besides the Swedish Initiative, are:

- Batco[5] - the "*main objective is the sustainable and harmonised advancement of the Baltic-Adriatic transport axis and its competitiveness*".
- East West Transport Corridor II – aiming at developing "*efficient, safe and environmentally friendly handling of the increasing amount of goods going east-west in the south Baltic region*"

[4] www.supergreenproject.org. Date 2011-05-31.
[5] www.baltic-adriatic.eu/ Date 2011-05-31.

- NECL II[6] – "*aims to develop and promote the east-west Midnordic Green Transport Corridor as a cost-effective and environmentally friendly transport route*"
- Scandria[7] - focusing on developing a green and innovative transport corridor from Scandinavia to the Adriatic Sea.
- SoNorA[8] - aims at developing accessibility in the South-North direction
- TransBaltic[9] - focus on the Baltic Sea Region and aims to "*provide regional level incentives for the creation of a comprehensive multimodal transport system*".
- Transitects[10] – focuses mainly on the railway and intermodal traffic in the Alpine corridors
- Öresund EcoMobility[11] - aims to increase knowledge and innovation within climate friendly transport in the Öresund region.

The list could, of course, be extended further. However, it does neither claim to be complete nor to bring forward the "most important" projects. In the list above no unimodal projects are listed. However, this does not mean that unimodal projects could not be green corridor projects. In Sweden there are several such projects that could be classified as green corridor projects. Two of them, both dealing only with road freight issues, are a) Green freight road corridors (a project involving Volvo, Scania and Trafikverket) and b) KNEG (Climate Neutral Freight Transportation) in which a large number of companies, researchers, organisations and public authorities have joined forces to work towards a shared goal: to reduce the climate impact of goods transport on Swedish roads (www.kneg.org).

The Swedish National Initiative

The Swedish initiative began as a response to the EU Commissions idea presented in the Freight Logistic Action Plan in 2007. In 2008 the Swedish initiative started to work more operative using working groups in different fields.

In the beginning of the Swedish initiative a broad group of people started to discuss the phenomena and what the core of the concept was. This group consisted of people representing the Ministry of Enterprise, Energy and Communications, the administrations, the industry/shippers, academics, and the transport industry including terminal owners etc. Two of the most avid supporters for the concept were Stefan Back (then representing the Swedish International Freight Association) and Jerker Sjögren (then representing the Ministry of Enterprise, Energy and Communications). Around them a core group of about 30 persons representing were active. The broad collaboration between different type of actors involved in the logistic chain (and the presumptions for the function of the logistic chain) has been, and still is, one of the strengths in the initiative. Trafikverket was one of the most active partners during the early years 2008-2010.

Description of the concept

Neither the term "green" nor the term "corridor" is simple to define. This is also clear when looking at different green corridor projects and initiatives in Europe One consequence of the fact that there is no simple and clear definition is that there is a huge spread in different projects characterizing themselves, or being characterized by others, as green corridor projects.

[6] www.midnordictc.net/ Date 2011-06-01
[7] www.scandriaproject.eu/ Date 2011-05-31.
[8] www.sonoraproject.eu/ Date 2011-05-31
[9] www.transbaltic.eu/ Date 2011-06-01
[10] www.transitects.org/ Date 2011-06-01
[11] www.oresund.org/ 2011-04-30

In Sweden this lack of common understanding of the concept was intensively discussed in during the first year of the initiative. Therefore, one of the most important activities carried out in the beginning was to describe the concept to set the playground. After discussing different alternatives it was decided that a green corridor is characterized by:

• *sustainable logistics solutions with documented reductions of environmental and climate impact, high safety, high quality and strong efficiency,*

• *integrated logistics concepts with optimal utilization of all transport modes, so called co-modality,*

• *harmonised regulations with openness for all actors,*

• *a concentration of national and international freight traffic on relatively long transport routes,*

• *efficient and strategically placed trans-shipment points, as well as an adapted, supportive infrastructure, and*

• *a platform for development and demonstration of innovative logistics solutions, including information systems, collaborative models and technology.*

This description of the green corridor concept has later on been widely accepted among projects dealing with green corridors, representatives of the European commission, and among politicians in just a few years. One recent initiative to describe and develop the field was taken by the project Interreg-project East West Transport Corridor. In short the report concluded that there seem to be a broad approval of the Swedish definition of the concept.

Another important area in forming the Swedish initiative was the mapping and description of 30-40 national and international projects and initiatives that took place. This mapping was, even though it could be characterized as “quick and dirty” a first step towards a deeper understanding of the concepts of green corridors.

The Governmental Commission

In 2010 the Swedish Government decided to take the initiative one step further giving the commission to Trafikverket (the Swedish Transport Administration), the Swedish Maritime Administration, and VINNOVA (the Swedish Governmental Agency for Innovation Systems). This commission, running until 2012, took the Swedish initiative into a second phase. The commission states that the three administrations mainly should provide administrative support in the form of secretarial tasks for the development of green corridors. The administrations are also supposed to be actively participate in working groups; interact with stakeholders, organizations, businesses and others in strengthen the work of green corridors. Furthermore, the administrations should assist the Ministry of Enterprise, Energy and Communications in developing green corridors in a national as well as an international context.

The activities within the Swedish initiative is influenced by the trinity of technology, corridors and business models – all supported by policies and regulations. This is described in the figure below. The idea is that green corridors projects/initiatives could be divided into three main categories that interact and complement each other. These categories promote the view of logistics/transports as a system of integrated services and properties aiming at increased efficiency and a reducing negative ecologic impact. A project can be composed of a mix of the different project categories or one specific project category.

The three parts are:

Corridors (links and nodes): A corridor project is a geographic sub-corridor of the defined main European Green corridors or a corridor that support those. It is based on the needs of an efficient transport infrastructure, both in a physical and/or communicative aspect. A corridor project promotes collaboration between transport modes and optimal use of respectively transport mode including transport nodes (hubs, cross docks etc). It can be both a national and cross-border corridor.

Transport techniques: Projects related to transport techniques encompasses features and properties of various types of equipment used in transport operation. The main focus is on the different transport modes, transport/load units and transfer/reloading of goods between different modes. Examples are techniques related to trucks, trailers, railway engines, rail wagons, ships, port handling, containers, packaging, cranes, stackers etc.

Transport/logistics solutions: Refers to complete solutions which integrate different partners and stakeholders who mutually form a business case promoting efficiency and decreased ecologic impact.

It is in general terms a complete freight logistic/transport setup that fulfil a product owner delivery demand and is often connected with a new business model.

The underlying and supporting policies and regulations are important in order to take the green corridors from theory to reality.

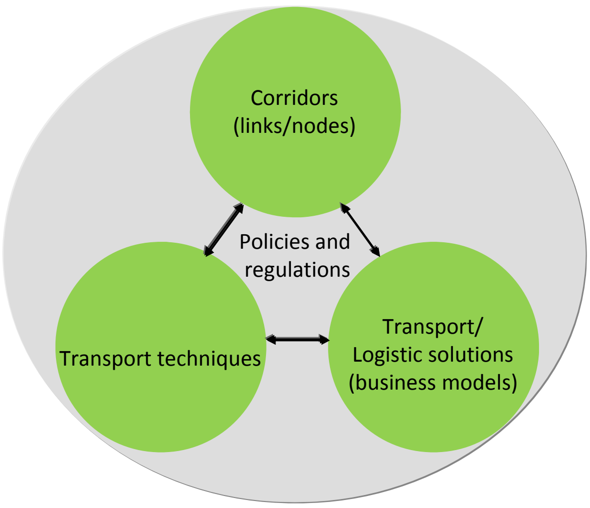

Figure 3: The three pillars and the underlying field of policies and regulations

Recently, Trafikverket has launched a Freight Transport Strategy. This document clearly points out the importance of working with the green corridor area and the concept of co-modality. The strategy is built up around the challenges identified by the STA.

To be able to take the concept of green corridors from being a good idea towards having a real impact on the infrastructure and the operations the Swedish initiative focuses mainly on two freight transport corridors. These are the corridor stretching from Oslo to Rotterdam and the second goes between Narvik and Naples. The efforts are, for practical reasons, concentrated on the former corridor. Furthermore, main focus is on the parts of the corridors that are on Swedish soil, simply because of the fact that this part of the corridor is where we are most likely to have a direct influence.

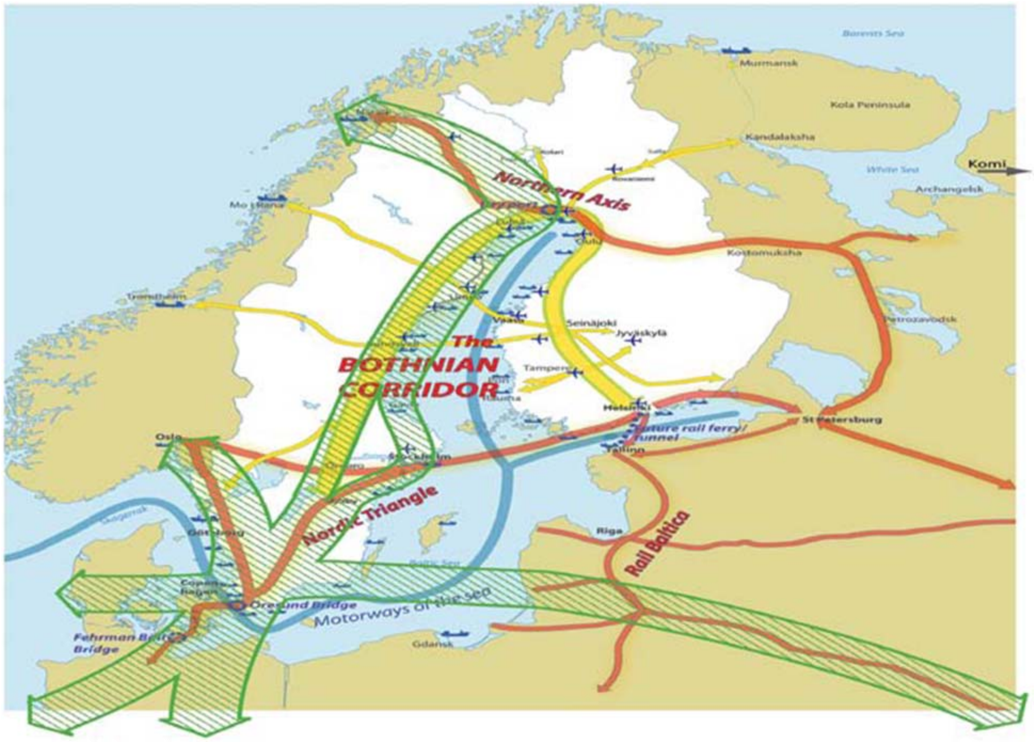

Figure 4: Main Swedish corridors

It must be understood that many projects, demonstrations etc. of different kinds take place outside of the specified green corridors (as described by, for instance, the Swedish Initiative or Supergreen). Development, wherever it occurs, applicable to green corridor idea should, of course, be used to move towards greener and greener logistic solutions in the whole network. For this reason the Swedish Initiative has high ambitions to follow and cooperate with other corridors/initiatives in order to develop the field of green corridor together. Then we might reach our common goal of implemented, efficient, and sustainable co-modal corridors, links, and networks with green characteristics!

4 FUTURE

The recently published White Paper "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" (2011), which currently is circulated for comments/considerations, only mentions green corridors as a facilitator for modal shift. However, the paper says that "*The EU needs specially developed freight corridors optimised in terms of energy use and emissions, minimising environmental impacts, but also attractive for their reliability, limited congestion and low operating and administrative costs.*" Multimodal freight corridors are more in focus in the paper which seems to have dropped the concept of co-modality.

To take the green corridors from a vision to reality we work intensively in a so called triple-helix setting with developing the corridors from an operational as well as from an infrastructure perspective. The work is especially intensive within Sweden but also in an international context.

To make the concept of green corridors more down to earth we are currently focusing three areas. These are:

- Demonstration day – on September the 22nd we are planning a demonstration day in Gothenburg. Focus will be on projects that are close to the market. This will help us spreading information about what is being done and to speed up the development. The ambition is that the demonstration day will be a tradition so that we will arrange one similar day in 2012. The idea then is to make it international since many initiatives related to green corridors end in 2012.

- Criteria manual – in an earlier report we described criteria for green corridors. Focus there was on energy, CO2, SOx, and NOx. The manual aim to be the next step describing how to measure these criteria. This is done using case studies and the manual, which will be ready in September 2011, will consist of 6-8 such cases. In the cases real transport chains will be described focusing on "complex" chains, i.e. chains involving terminals or different modes used in combination.
- Mapping of projects – to know what has been done, what is being done and where the "white spots" are from a knowledge perspective an earlier mapping of green corridor relevant projects is now being updated and broadened and deepened. Today the mapping consist of about 150 projects related to green corridors.

Many ongoing initiatives and projects regarding green corridors end in 2012. Among those we find, for instance, Super Green, Scandria, EWTCII, TransBaltic, and the Swedish green corridor governmental commission. The fact that so many important projects end during the same year gives a unique platform and an important knowledge base to draw future national and international strategies on. There is a common challenge for us to collaborate internationally but also across disciplines to use this opportunity to take the concept from words to actions with real results.

Looking beyond 2012, when the Swedish Initiative as well as many other GC-projects has come to an end, we are positive that a lot of development must continue to form greener logistics. This calls for long-term challenges in the field of green corridors/networks/logistics that must be dealt with in areas such as regulations, techniques, behaviour and building/maintaining infrastructure. Sweden is likely to keep having high ambitions in this field.

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THE CORRIDOR FOR ENVIRONMENTALLY FRIENDLY AND SUSTAINABLE MOBILITY

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ABSTRACT

Despite the efforts made in new EU member states, the current situation is characteristic with disorderly development in the field of transportation and an uncoordinated approach to dealing with traffic supply and demand. Serious problems in the road network functioning and capacity in both urban and rural areas are mainly caused by persistent growth of road transport. The resulting situation affects the territorial availability of human activities and causes an increase in traffic accidents, environmental devastation, and impairment of overall quality of life.

An open and economically prosperous European area requires a steady and safe movement of people and loads. It, however, requires unification of procedures for acquisition and evaluation of data on traffic, coordination in planning and designing of traffic infrastructure, as well as management and control of traffic processes in the territory, aimed at optimization of traffic supply and demand.

These issues are covered by the project of Austrian-Slovak bilateral cooperation named "Traffic model AT_SK" (“VKM ATSK”) [15] that is being prepared within cooperation between the University of Technology Vienna in Austria and the Slovak University of Technology Bratislava in Slovakia. The project is aimed at creation of multimodal transport model for the cross-border area of eastern Austria and western Slovakia, which formed a united area, many times a fragmented one, in the past stages of development.

The long-term goal of the project is to create and unify methodology of modelling of demand for multimodal transport at national and international level. The project has the ambition of gradually covering the entire territory of the central European cross-border region CENTROPE [16] and, in the following periods, also other neighbouring countries situated in northern-southern corridor in the Baltic-Adriatic axis. The approach could result in gradual formation of compatible traffic system of environmentally friendly and sustainable mobility for higher quality of life in this attractive, northern-southern, central European traffic corridor. The article presents the development of time-space traffic variations in given area and describes current conditions of the project and its ambitions for the future.

1 INTRODUCTION

The nature created extraordinary conditions for settlement in the location where the Danube river breaks the barrier formed by two European continental massifs, the Alps and the Carpathians. From the ancient times, various interests were „battling“ and the history was „kneaded“ in this area where two trans-European routes – the eastern-western Eurasian Silk Road and the northern-southern Baltic-Adriatic Amber Road – cross each-other. From the territorial point of view, the process resulted in current varied composition of tolerant inhabitants of various nationalities living in neighbouring countries. Distinct geographic conditions in this area have always acted in mutually opposite ways. Joining the territory on the one hand, but dividing it on the other hand, the conditions also were considerably influencing formation and functioning of traffic system.

A typical example of such a development is the cross-border region created by the capitals of Austria and Slovakia, Vienna and Bratislava, with their respective subregions. Balancing the territorial aspects in this area was an extraordinarily dynamic process, especially in the fundamental period of social and economic changes in the European continent in the last decade of the past century [1,2,3,4]. There occurred literally laboratory conditions for examination of time-space variations of traffic in the short period of time, especially with respect to previously strictly separated border areas of the countries with different social and economic structures.

An analysis of the development of the processes indicated radical change of traffic links in the territory and a necessity of compatibility of the traffic system as irreversible condition of sustainable development of mobility of people and loads in the future. Especially links between new EU member states, which still lack a system of management of traffic processes in their contact areas, showed to be most sensitive.

These issues were discussed in the 11th International Scientific Conference MOBILITA '11, held in May 2011 in Bratislava in the Slovak Republic. The discussion resulted in requirements for networking the scientific capacities of traffic experts of CE countries and gradual formation of multimodal transport model aimed at environmentally friendly and sustainable mobility of people and loads in this area.

2 TIME-SPACE VARIATIONS IN THE CENTRAL EUROPEAN TERRITORY

In the previous century, the European continent passed through radical territorial, economic, political and social metamorphoses. The most significant changes mainly occurred in the last decade of the century, when demolition of the “Iron Curtain” led to disintegration of the block of countries with centrally controlled economy and when many new states were created in the CE territory. On contrary, the same period in the market-economy countries of the western Europe was characterized by increasing integration efforts. So, paradoxically, there were two opposite tendencies: On the one hand, the countries of the former Eastern Bloc responded to the strict centralism of their past with decentralization associated with intense economic and political instability; on the other hand, individual countries of the western Europe with big economic potentials were getting integrated in one unit. These two seemingly contradictory tendencies of spatial, economic and social metamorphoses have drastic impacts to the development of spatial changes of inter-regional traffic relations with respect to a structure of settlement in the contact area of the former impervious iron curtain.

It was mainly a matter of the renewal of natural historic family, cultural, and economic relations that was reflected in change of overall volume of cross-border traffic, redirecting the traffic relations in the territory, and redistribution of modal split in the territory.

The change can be best documented through time and space changes in the volume of cross-border traffic in the territory of former Czechoslovakia and, in particular, using an example of the city of Bratislava, the capital of Slovakia, which is in extraordinary position with respect to background areas of Slovakia due to its extremely eccentric position.

In the previous period, Bratislava was the only border crossing from Slovakia to the “West”. Both the shortest for summer tourism of eastern Germans and the important traffic connection of the eastern block between the North Sea and the Black Sea alongside the iron curtain were leading through the city.

Based on a large-scale survey [1] in the years 1989-1991(1992) and an analysis of time-space changes in modal split and in overall volume of cross-border traffic in then Czechoslovakia, it can be concluded that the biggest changes occurred in the characteristics of road transport. The road transport very flexibly and promptly reacted to incentives from new origins and destinations in the contact area alongside the iron curtain in former Czechoslovakia. Very significant effects were, in particular, caused by spatial changes in the volume of cross-border traffic with very rapid increase in the volume of road transport in the Czech Republic, invoked by opening the borders with Austria and Germany, with which the Czech Republic had always very close historical, economic and cultural links (figure 1).

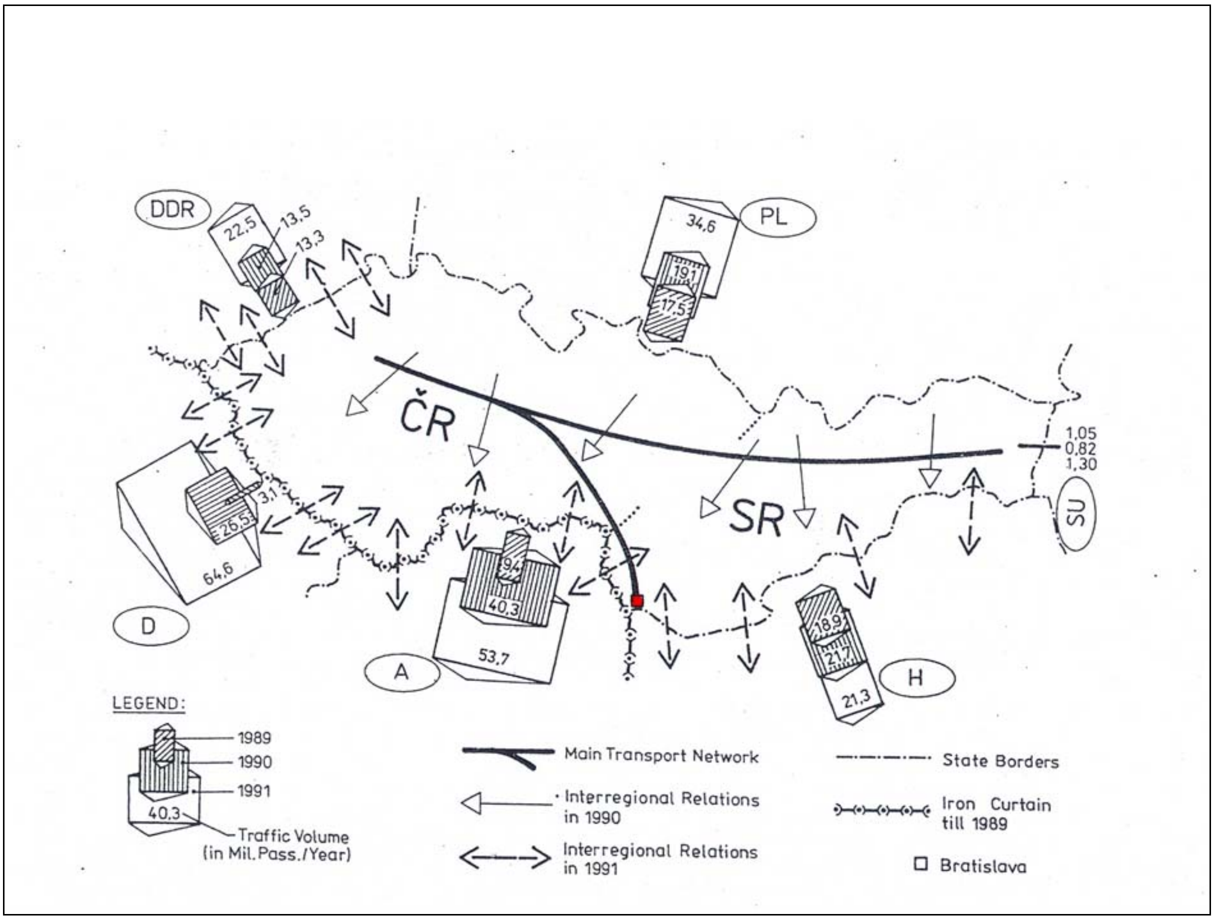

Figure 1: Territorial changes in cross-border traffic in former Czechoslovakia [1]

However, the cross-border transport in Slovakia in a very same period increased only slightly, stagnated, or even fell, mainly in mass types of railway, water and air transport (figure 2). It is obviously caused by effects of previous development, where requirements for fast industrialization of Slovakia in the post-war period accelerated process of urbanisation of the country. The development not only caused changes in the structure of settlement, but in particular if influenced relations between individual settlements in the country as well as relations exceeding the boundaries of Slovakia.

In addition to traditional historic relations, a strong attractor for radical changes in development and huge increase in volume of cross-border transport in the Czech Republic was the high economic potential in neighbouring countries - Germany and Austria (figure 2). The attractor is only functional in Slovakia in border territory of Bratislava region in direction to Austria (figure 3). Significant changes can be also seen in the modal split with gradually decreasing volumes of railway, air and water transportation.

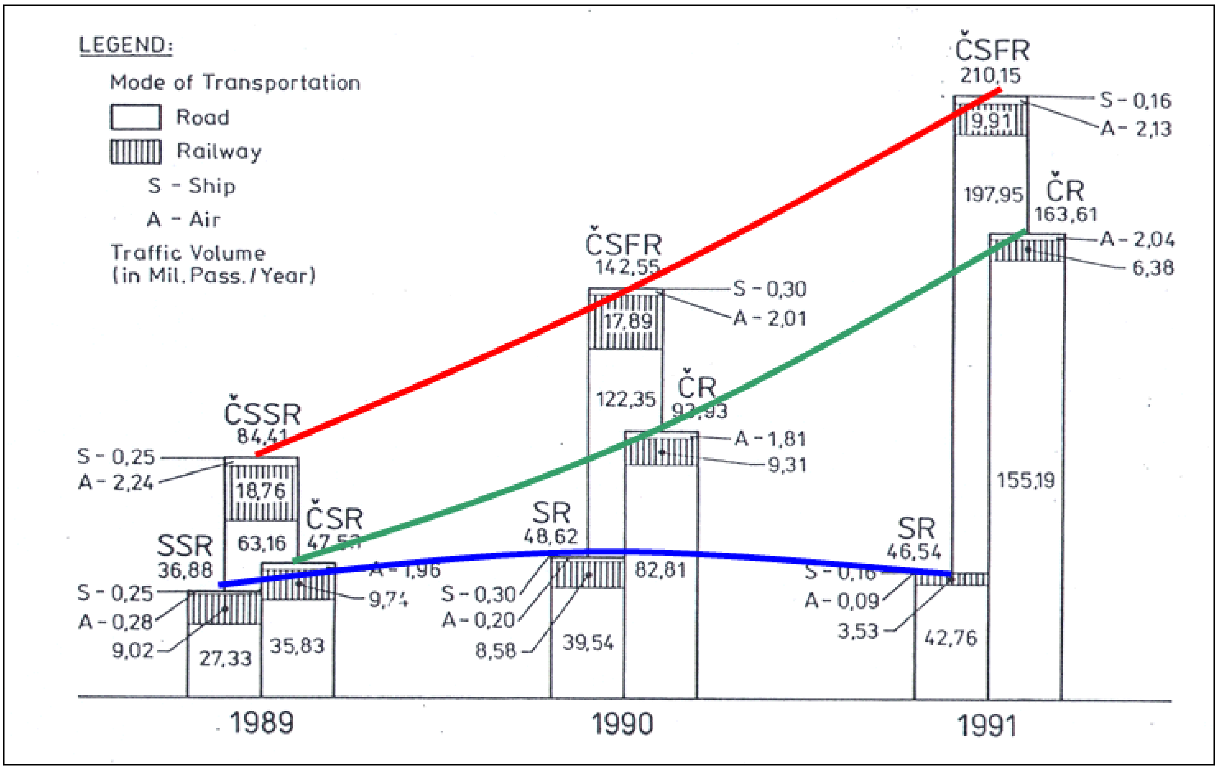

Figure 2: Changes in cross-border Modal-split in former Slovak and Czech Republic [1]

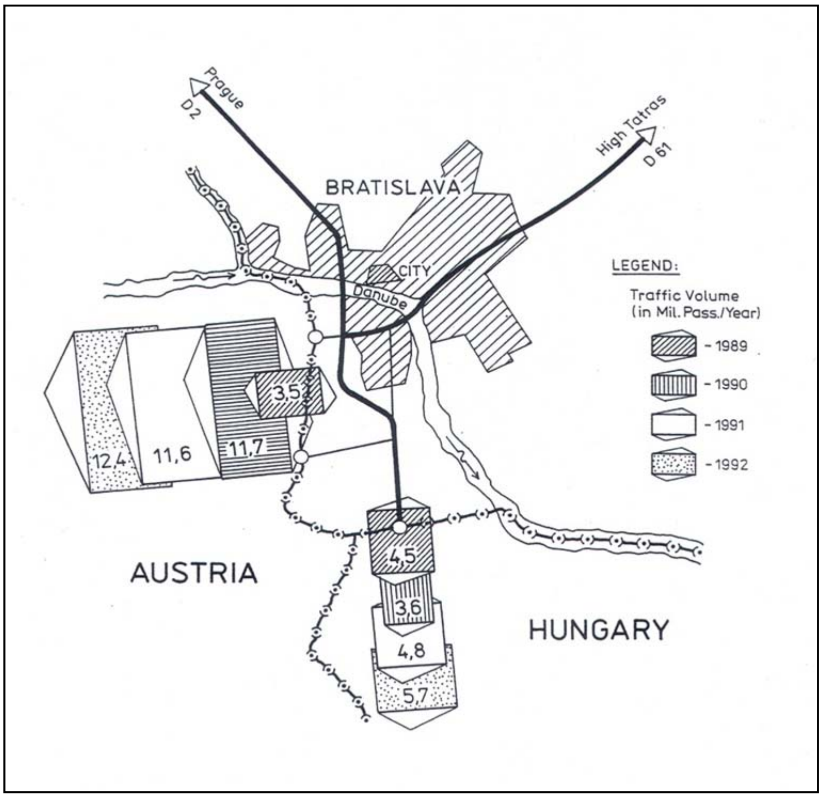

Figure 3: Territorial changes in cross-border traffic in Bratislava [1]

Given radical territorial changes in traffic relations had stimulated a creation of a new conception of traffic system in individual countries of central Europe, which even gradually transformed itself to requirements for preparation of trans-European conception of solution of compatibility of traffic system in given territory.

3 VISION OF THE CROSS-BORDER CENTRAL EUROPEAN REGION

An idea of formation of common region in the central Danube basin is very old. It is based on an excellent potential for traffic interconnection of the territory, advantageous conditions for further development of settlement, capital concentration, high-quality infrastructure and modern technologies as well as an available capacity of qualified labour force in the area, which represent the primary condition of productive cooperation in the cross-border territory. A study prepared by the Institute Empirica [2] depicts vision of Europe in 2018, where “many qualified engineers and researchers leave in mass... ... previously flourishing industrial territories of western Europe... , where the unemployment rate now attacks 50 percent, and moves to the east. They aim to a new, European Silicon Valley near Bratislava..." Although the study is very encouraging and reflects an extraordinary nature of this area, the reality is more prosaic.

Proximity of both capitals and their eccentric position with respect to their respective subregions creates a mirror model for advantageous association of the characteristics, indicating, at the same time, further possibilities of development of mutual economic, social and cultural relations, especially between the capitals and their subregions that overlap each other. The incentives, however, require new methods of management of mobility of people, loads and information, and sophisticated traffic system, which will assure conditions for protection and use of existing unique natural localities, natural parks and biocorridors in accordance with interests of further sustainable development of human activities in this unique multinational region of central Europe.

From the view of developmental opportunities, the region of Bratislava has a surplus of educated and skilled inhabitants as well as good technical and traffic infrastructure. Along with considerable economic potential and a high level of technologies, research and services of the big region of Vienna, above characteristics create very suitable conditions for further favourable development of the territory. However, reaching the goal requires an establishment of compatible transport network that represents the first precondition of smooth mobility of people and loads in the territory.

4 PROJECT OF INTERCONNECTION OF THE CROSS-BORDER CENTRAL EUROPEAN REGION

Possibilities of interconnection of the two attractive territories are covered by the project „VKM Transport model“[3] that is being prepared within the Program of cross-border cooperation Slovak Republic – Republic of Austria for the period of the years 2009-2012. The project focuses on creation of demand transport model for compatible network in the cross-border territory of eastern Austria and western Slovakia. The first step is the creation of the demand transport model for core territory of the CENTROPE region containing following areas:

- Great Area of Vienna,
- Lower Austria,
- Burgenland,

- The Self-Governmental Region of Bratislava (BSK), and
- The Self-Governmental Region of Trnava (TSK).

In the next period, the project is to cover the entire territory of the CENTROPE region[16], including southern Moravia and western Hungary (figure 4).

Figure 4: CENTROPE region [16]

Existing transport network is under pressure of considerable volumes of road transportation, which are even increased by new activities developed in the attractive territory of CENTROPE. Specific proximity of Bratislava and Vienna and open Schengen Area causes a necessity of analysis of current situation in transport and a need for determination of prospective demands of cross-border traffic that is constantly growing. The „VKM ATSK“ [15] project is intended for creation of an uniform demand transport model for the model cross-border Austrian-Slovak region. It will enable to model variations of relocation relations in continuous transport network. The main incentive for preparation of the task was the variety of basic documents, the unavailability of input data and the difference between approaches taken by the parties with respect to solution of traffic issues on both sides of the cross-border territory. The draft project [15] results from long-term cooperation between the Institute of Transport Sciences (Institut für Verkehrswissenschaften) of the TU Wien and the Department of Transportation Engineering, Faculty of Construction, STU in Bratislava. The project team includes following researchers from the Vienna University of Technology (AT project coordinator: Ao.Univ.Prof Mag Dr Günter Emberger), and from the Slovak University of Technology in Bratislava (SK: author of this paper). The project team is supported by the so-called Advisory Board that meets twice a year. The Board compromises of representatives of both Slovak and Austrian Ministry of Transportation (the BMVIT and the MDVRR), representatives of the Vienna City Council (MA 18), Lower Austria, Burgenland and VOR (Verkehrsverbund Ost-Region), ÖBB (Österreichische Bundesbahnen), ASFINAG (Autobahnen-und-Schnellstraßen Finanzierungs-Aktiengesellschaft), representatives of the Bratislava City Council, BID (Bratislavská integrovaná doprava – Integrated Transport Bratislava), NDS (Národná diaľničná spoločnosť, a.s.) as well as representatives of the Region of Vienna and the Region of Bratislava. The members of the Advisory Board regularly express their objections to prepared parts or provide proposals for a further solution of the project. After completion of the project, its results will be available to the members of the Advisory Board free of charge.

The project will run from October 2009 to September 2012. 85% of the project funds originate from ERDF (the European Fund of Regional Development) within the program of Slovak-Austrian cross-border cooperation for the years 2007-2013 ("Creating the Future"). Remaining 15% are co-funded from national public sources.

Long-term goals of the project also include broader scientific-research cooperation and an involvement of other institutions from neighbouring countries into the creation and use of a functional demand transport model for current as well as prospective transport demands of successfully developing CENTROPE region.

A serious problem in solution of transport demands in the cross-border area is system discontinuance of the transport system, which causes:

-lack of adequate information about the current state of traffic,

-difficulties in operational management and regulation of traffic,

-impaired coordination of both acute and prospective requirements for functionality of the transport system, and problems in dealing with risky traffic situations in the case of natural disasters, or, as the case may be, unforeseen emergencies.

Addressing these questions requires organizational, functional and infrastructural interconnection in the uniform system of passenger and freight transport that will enable to satisfy growing demand for individual and mass transport by an offer of high quality transport network and interconnected transport infrastructure in this metropolitan border region. To solve this difficult task, existing "independent" national models, separately prepared for the Austrian territory and for the Slovak territory, had to be assessed in the first stage of the solution process. Based on the analysis of available national models, following activities have been performed to the date:

-national areas were merged into a single cross-border model of the territory,

-the territory was divided into traffic zones (2-5000 inhabitants),

-input zoning and planning, traffic, and demographic data for individual traffic zones were processed,

-a single transport network for road and mass transport in the model territory of the project was created,

-missing or defective connectors were added/replaced

-system of connection of border crossings and public transport routes was added.

It completed the process of gathering and modification of input data and joining of the networks by comparison of existing demand models. Also the first draft of VISEVA model prepared using PTV VISUM/VISEM software was completed and calibrated.

This created the conditions for modelling variant traffic situations and optimum solution of an offer of available transport system in the cross-border region CENTROPE (figure 5). The figure 5 shows possible further extension of the project (grey) „VKM ATSK“ into the regions of Western Transdanubia in Hungary, parts of Styria in Austria and the South Moravian Region in the Czech Republic [11, 15].

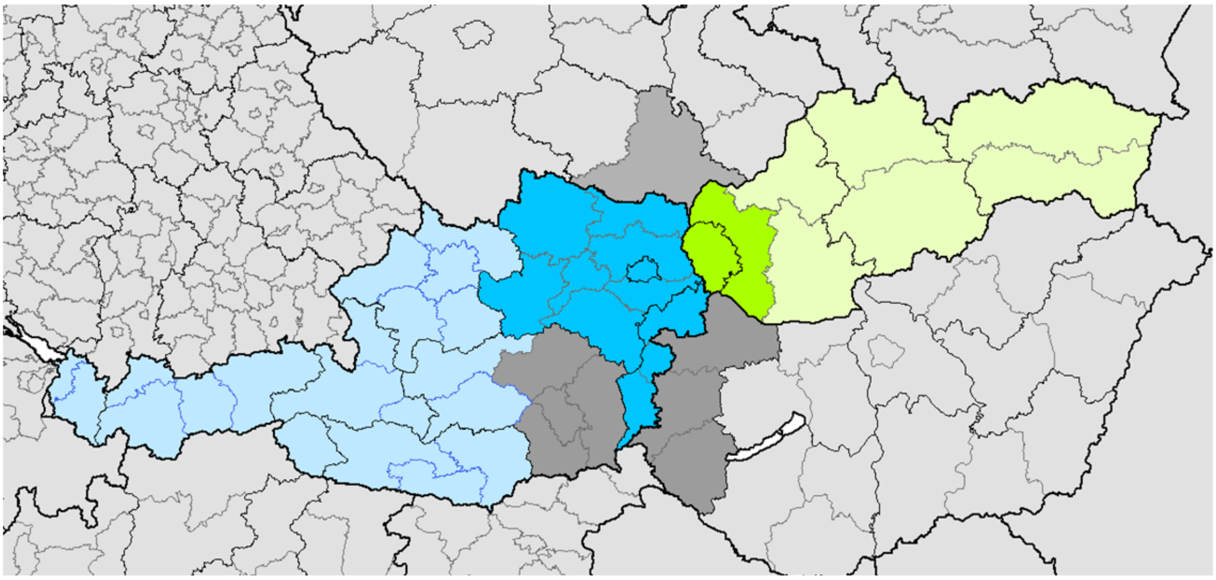

Figure 5: Project area of the Transport model AT-SK" [15]

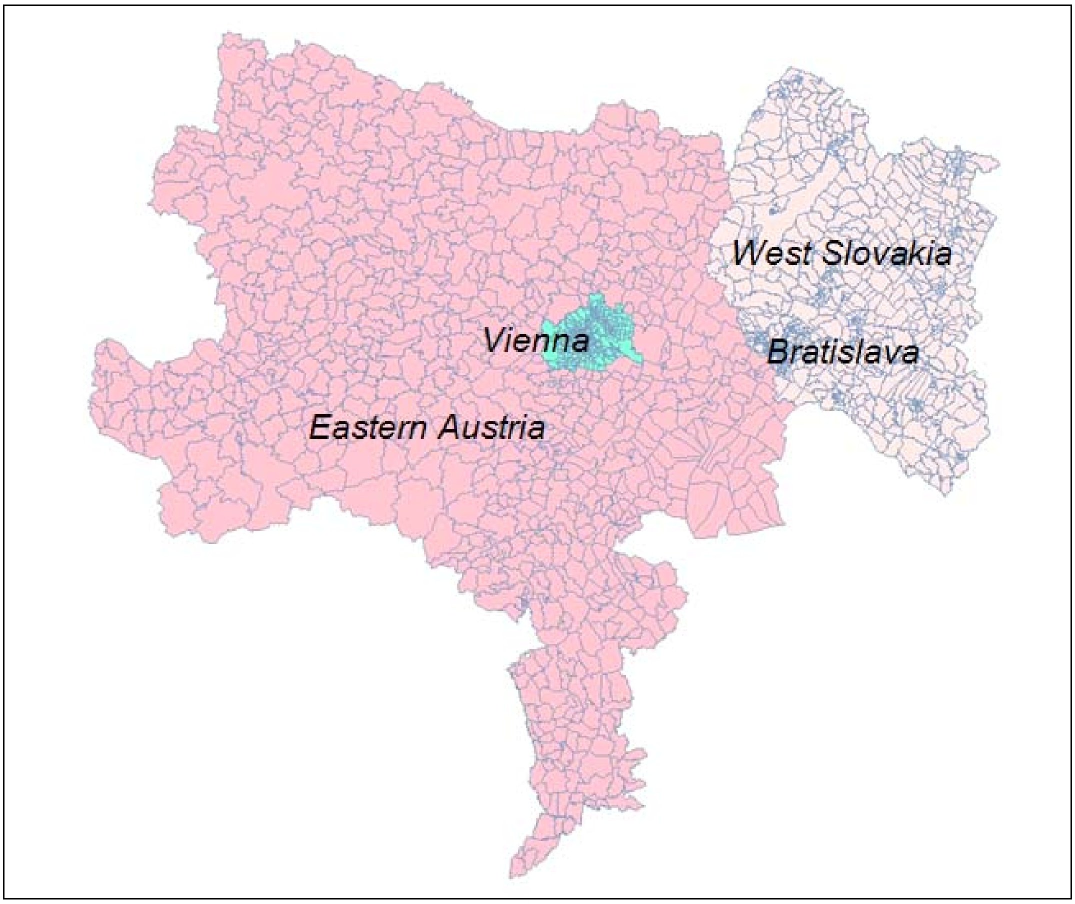

Figure 6: The zones in the interconnected model "VKM ATSK" [15]

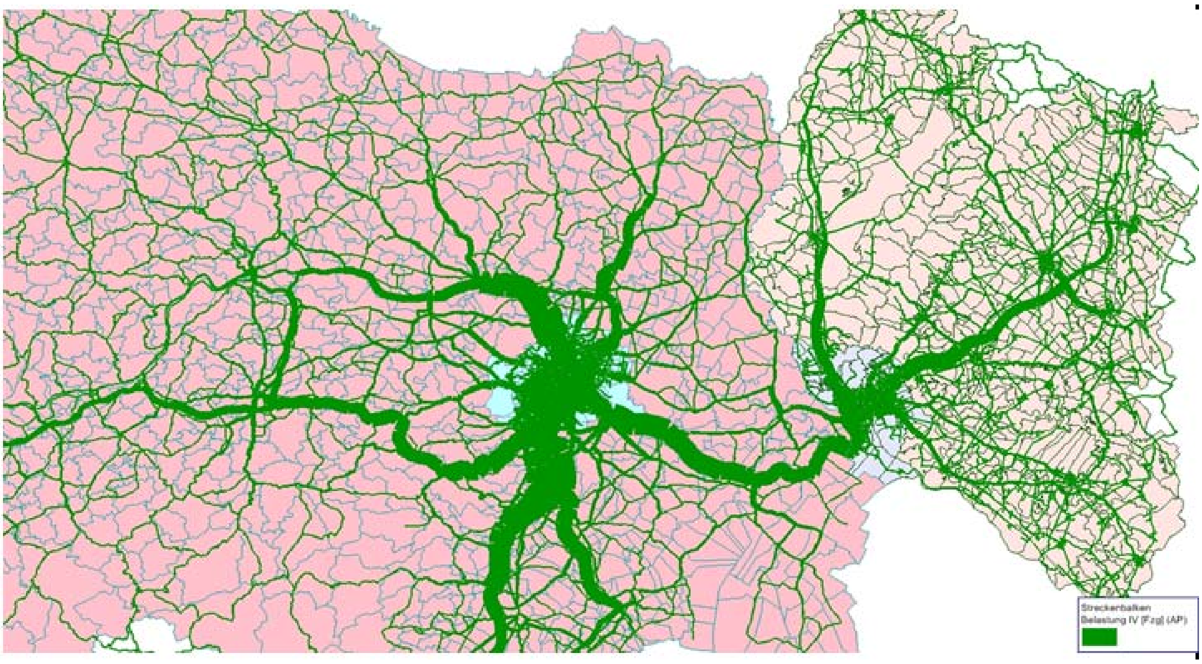

Figure 7: The detail of „VKM ATSK“ network model loaded by inner passenger car traffic [15]

5 PROSPECTS OF „VKM ATSK“ PROJECT

The project aims at creation of a single cross-border demand transport model, which will be an effective tool to support:

- organizational,
- regulatory, and
- planning processes

in the field of management and development of traffic infrastructure in the CENTROPE region and, as the case may be, in other neighbouring countries.

Summary results of the project, processed to the date, were discussed at the last meeting of the Advisory Board of the experts involved in the project and subsequently presented to a wide range of experts and scientists from the Central Europe at the 11th International Scientific Conference MOBILITA '11, held in May 2011 in Bratislava in the Slovak Republic. Possibilities of extension of the project into other countries in the Adriatic - Baltic axis [5, 9, 10, 11, 12, 14] were also presented and discussed at the conference. Gradual supplementation of the model with cross-border regions of Slovenia and, maybe, Croatia on the south side and the Czech Republic and Poland on the northern side, could ensure smooth management of traffic processes in this important northern-southern CE transport corridor (figure 8) in the future.

At the same time, internal regions of individual countries could be added according to uniform methodology, thus enabling creation of compact models at the national level. This transnational system of management of the supply and demand processes in transport could serve in the future as a guarantee of environmentally friendly and sustainable mobility in this sensitive CE area, whose backbone is the connection of the northern-southern Baltic-Adriatic route to the important trans-European eastern-western multimodal corridors. It would create opportunities for a vital interconnection of two major CE cross-border regions - CENTROPE with about 5.5 million inhabitants and the cross-border region of Ostrava (CZ) - Katowice (PL) - Žilina (SK) with approximately the same demographic and economic potential.

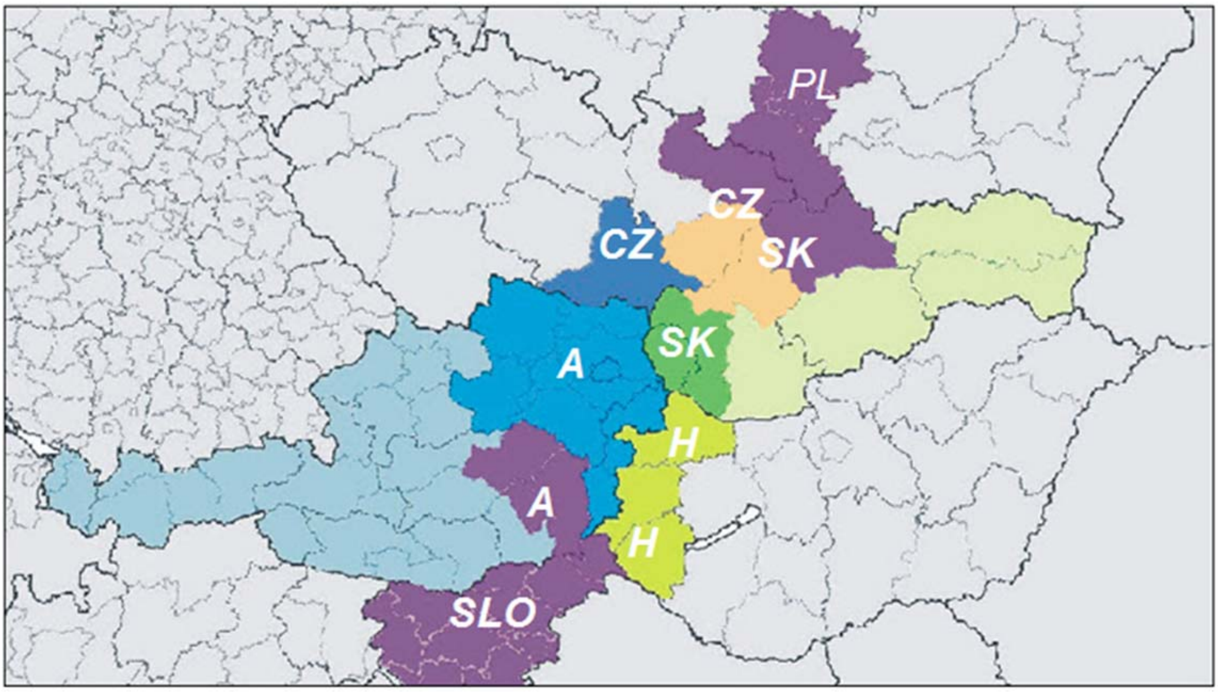

Figure 8: The possible extension of the „VKM ATSK“ to the North-South Corridor

6 CONCLUSIONS

The area of Central Europe plays a key role from the view of continental European economic links. It represents a highly sensitive issue with regards to functioning of the European transport system. Therefore, assurance of compatibility of transport infrastructure and coordination of management of traffic process is a very important factor of functionality and prosperity of an integrating Europe. Development of territorial transformations in previous period pointed to the direct effects of these changes on direction and magnitude of transport relations in the area. For the reason, modelling of traffic processes is essential for effective use of available transport system and forecasting of prospective transport demands in the future period [13]. It is also very important to redistribute transport demands among effective and environmentally friendly modes of transport in order of preventing from environmental devastation by flexible but aggressive road transport, which penetrates into all open spaces that are not clearly functionally defined and managed in a coordinated manner.

From this perspective, the "VKM ATSK transport model" project represents the first step for creating an effective tool with a uniform methodology of collection and use of traffic data for modelling multi-modal transport in cross-border regions of an integrating Europe [15]. Another advantage is that the project enables to network prominent experts in transport, thus creating the conditions for synergic use of knowledge for creation of an efficient transport system.

Multimodal transport model for the CENTROPE territory is an incentive for creation of appropriate conditions for environmentally sound and sustainable mobility in the corridor of the northern-southern Baltic-Adriatic connection in the future period.

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BENCHMARKING ACCESSIBILITY OF PORTS AND INLAND TERMINALS IN THE SCANDRIA CORRIDOR

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ABSTRACT

Accessibility has been defined as the possibility to reach potential locations to carry out commercial or private actions or “as some measure of spatial separation of human activities” [8]. To evaluate the positioning of intermodal nodes within the SCANDRIA corridor and their connectivity to the existing infrastructure, the study at hand was conducted. This also bears significance for the SoNorA area, as the German SCANDRIA nodes are also part of the SoNorA area and the Scandinavian nodes of the SCANDRIA corridor constitute a logical extension of the SoNorA transport system. Also the accessibility of selected nodes (such as the port of Szczecin or Lübeck) – which can be seen as a complement or as components of competing corridors to the SCANDRIA corridor, as well as to the SoNorA region – was examined. The INTERIM tool, developed in the INTERREG CADSES project INTERIM [4], was used to analyse the number of other intermodal nodes (including seaports) and of regional centres (operationalized by the number of centres and by population size) accessible within a time frame of 3 hours and within a cost frame of 100 € per TEU. Analyses were based on existing infrastructure, but not on the quality of the infrastructure, its available capacity or on existing services.

In a first step the nodes (segmented into ports and inland terminals) were analyzed for the number of other intermodal nodes, regional centres and size of regional centres accessible within the given time and cost frame. In a second step nodes were evaluated by a weighed score, comprising of the number of nodes accessible and of the population size in regional centres within a given time and a given cost frame. This cumulated score was then used to benchmark the nodes in comparison to one another. The results emphasizes that the location of the ports of Rostock and Szczecin within the SCANDRIA corridor and SoNorA area make these ports ideal candidates for transport chains, supplying the SCANDRIA corridors regions as well as those of the SoNorA area, as far as the routing of existing infrastructure is concerned. It also underlines the strategic importance of locations of the inland nodes around Berlin, especially Großbeeren, Westhafen, Brandenburg and Wustermark.

1 INTRODUCTION

SCANDRIA is a co-operation of 19 partners from Germany, Denmark, Sweden, Finland and Norway willing to develop a green and innovative transport corridor. The SCANDRIA region includes the states of Brandenburg and Mecklenburg-Vorpommern in Germany, Denmark and the southern parts of Sweden, Finland and Norway (compare Figure 1). In order to determine the strategic quality of locations of intermodal transport nodes (inland terminals as well as ports), the accessibility of these nodes was examined. A possibility to assess the accessibility of transport nodes (ports or inland intermodal transport terminals) within the SCANDRIA region is to compare the different nodes with one another, based on an indicator. One way to achieve this is a benchmark analysis.

It can be assumed, that transport time and transport costs are among the most important criteria for a shipper, when making a decision which transport path to use, and these two dimensions are also very common when comparing transport processes. But time and costs to reach a node alone are obviously not very adequate to determine the importance of a transport node. A transport node could have very low accessibility costs and be reached in relative short time, but this could be of no or very little significance if it was located in a very remote location and if it did not have a function, like supplying a region with goods or serving as a gateway to a region.

So transport nodes have been benchmarked, in this study, in regard to the costs and time to reach other accessible nodes and accessible regional centres[12] within the SCANDRIA region. This also means, that nodes, regional centres and population in regional centres were not included, if they were outside the SCANDRIA region. Benchmark values were ascertained by the number of regional centres and nodes accessible within a given time frame of three hours and a given cost budget of 100 € for the transport of one TEU and by the population living in the (under this assumptions) accessible regional centres. This numbers might appear arbitrary, but it can be argued that if a large number of regional centres can be reached within a given time- or cost frame, an even larger number could be reached tendentially in any larger time or cost frame. Therefore a given time frame of three hours or a given cost frame of 100 € already is a part of any longer travel time or any necessary larger transport budget and thereby an indicator for the total travel time or transport budget needed for any longer distances from the benchmarked node on.

If a cluster of nodes (such as in Hamburg, with four large terminals or the Berlin area with five nodes) can be reached in a given time or cost frame, the benchmark value would be distorted, if each node in that cluster would be counted as one accessible node. For this reason the following clusters have been counted as only one node:

Berlin-Capital-Region, consisting of the nodes:

- Velten
- Wustermark
- Berlin Westhafen
- Freienbrink
- Großbeeren
- Königs-Wusterhausen

Hamburg, consisting of the nodes:

- HHLA Container Terminal Altenwerder (CTA)
- HHLA Container Terminal Burchardkai
- HHLA Container Terminal Tollerort
- Eurogate Containerterminal Hamburg

(The Container-Terminal Tollerort has not been considered in the study at hand, as it was inoperative at the time this study was conducted (June 2010)).

Göteborg, consisting of the nodes:

- Port of Göteborg
- Göteborg Railö Terminal

[12]Within the scope of this work a regional centre was defined as a municipality with a least 100.000 inhabitants.

Stockholm, consisting of the nodes:

- Port of Stockholm
- Stockholm Artsa

Fredericia, consisting of the nodes:

- Fredericia Port
- Fredericia Inland Terminal

These Clusters are marked with a red bubble on the map (see Figure 1Figure).

Figure1: ports and terminals in the SCANDRIA region (red bubbles: clustered nodes for this study, source: own depiction)

All calculations were made with the INTERIM-Tool, which was developed within the INTERREG CADES project INTERIM ([4]) and calculates costs and travel time, based on the existing infrastructure. The Terminals in Hamburg can serve as sea-terminals (interface between sea-ship and landmode-transport), as well as they can serve as inland-terminals (interface between different land-transport-modes). Within the scope of this study they have been analysed in their function as inland-terminals, as they might constitute a competition for the SCANDRIA inland Terminals in this function. The port of Hamburg has not been benchmarked, as it is a North-Sea port and therefore unlikely to be a competition to any of the SCANDRIA ports. Low Benchmark values for a port or inland terminal could be constituted by a far location from any other nodes or regional centres or the infrastructure could be inadequate to enable transport in the given time- or cost-frame. Due to non-available data, not all ports and terminals shown in the map have been analysed in regard to their accessibility.

2 METHODOLOGY

Accessibility has been defined as the possibility to reach potential locations in order to carry out commercial or private actions or “as some measure of spatial separation of human activities” ([8]). Accessibility is - in the context of general mobility - a construct to measure and compare different geographical locations, transport modes and network structures. Mobility stresses the availability of transport options – accessibility includes the structure of settlements in a given region. To analyse the degree of accessibility, information about the underlying transport network, geographical constraints, available transport modes, costs and the distribution of potential locations is needed. The location problem is essential, especially for freight transport, because freight cannot act like a person selecting one destination from a group of potential locations for one purpose (e.g. one hospital out of 3 in the neighbourhood).

The first approach to cover problems of freight transport was presented by von Thünen ([10]). He analysed the interaction between a given location and the costs to produce and transport products to the location. He found out that some distance groups exist (Thünen’s circles) around the location which are optimal for different product groups in terms of costs. In the following decades the accessibility of people moved more into the focus of science due to the dramatic development of new transport modes, extension of road and rail networks and new and faster vehicles. Nowadays freight transport or logistics are very seldom reflected in the landscape of accessibility and if they are, usually in restricted research areas like ports, container flows and top-down analyses ([7] pp. 297–313., [1] pp. 85–115, [3] , pp. 171–184., [9]). A lot of indicators have been proposed to analyse accessibility of people of which some can be used for freight transport as well. The fact has to be considered, that the elements of freight transport are quite different from elements of public or private transport (of people). The following table summarises the differences between some modes of transport.

mode / elements	Car	public transport	bicycle/walking	Freight
time	walking to parking place in vehicle travel time congestion time finding a parking place walking to destination	hidden waiting time travel time of access/egress mode waiting time at station in vehicle travel time transfer time	travel time bicycle parking	loading transport documents transport time (diff. modes) transhipment waiting at ramp, unloading
costs	fixed costs fuel costs maintenance costs parking costs road-pricing costs	costs of tickets/fares	fixed costs maintenance costs	driver costs depreciation fuel and maintenance rail/road use pricing insurance
effort	level of (dis)comfort physical effort reliability stress accident risk information status	level of (dis)comfort physical effort reliability stress accident risk social safety information status	level of (dis)comfort physical effort social safety	quality of transport supply chain / network administration energy consumption reliability accident and theft risks tracking and tracing value added services

Table 1: Differences between personal and freight transport ([12], last column: own depiction).

2.1 Indicators to measure accessibility

Network based measures are the most simple group of indicators. They can be easily derived from physical characteristics of network segments or parts of a network, such as length, density per square-kilometer, permitted and technical possible velocity, average congestion time, number of exits to locations, ratio between different transport modes, etc. Using these measures different regions/locations can be compared, concerning the quality/performance of the given networks and identify disparities.

Distance based measures can be used to calculate different values from a given point X to other points Y_i in terms of distance, time and other efforts. Typical indicators are air distance, real length of the way, time used to reach Y_i from X. With a high number of Y_i and a defined exclusion criterion (e.g. not more than 10 min.) it is possible to calculate catchment areas. Also different transport modes can be compared using distance based measures.

Contour measures consider the accessibility of a group of locations X_i concerning the reachability of activity potentials Y_i with a given transport system and normally with a given budget of resources. The best known indicator is the isochrones map.

Potential measures use distance-decay functions to calculate the reduced interaction between locations with high distances or other resistances. So the question can be answered how entities react on different efforts to come from X to Y. Typical functions are the negative exponential function, log sum functions and modified Gauss functions.

Inverse balancing measures include additionally competition elements to constrain restricted resources e.g. working places and workers.

Space-time path measures are complex scripts of the movement of people using an x-y graph for distances and directions. The z-dimension shows the time used for the movement and for activities in a specific location. The so called „Time Geography“ was established by Hägerstrand [13].

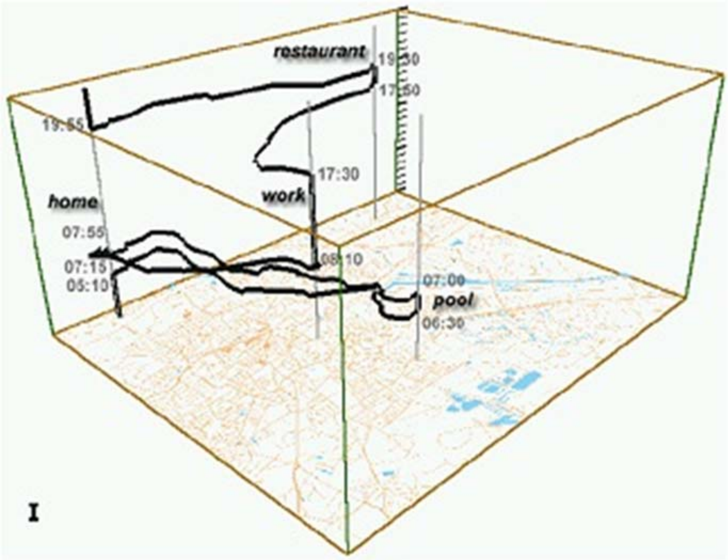

Figure 2: Example space-time path graph ([5])

2.2 Suitability of accessibility measures for freight transport

In the following table data and practicability of accessibility measures have been compared. The most practical indicator group for freight at the moment is the indicator group "distance based measures" in which one starting point X is given and different destinations/activity potentials Y_i are included to compare values like distances, time needed, costs and energy consumptions. The results can be visualised in maps or graphs. Changing the starting location X advantages and disadvantages of different locations can be compared in a direct way.

Indicator group	**Needed data**	**Practicability for freight**
Network based	Information about network segments	Yes, but the information gained is not freight specific
Distance based	Information about network segments Set of potential locations	Yes
Contour	Information about network segments Set of potential locations Set of starting locations	Yes, but all transport relations in a given area are needed.
Potential	Information about network segments Set of potential locations Set of starting locations Distance-decay functions	Distance-decay functions are not available for freight
Inverse balancing	Information about network segments Set of potential locations Set of starting locations Distance-decay functions Constraint functions	Distance-decay and constraint functions are not available for freight
Space-time path	Information about movements included	Not suitable for freight

Table 2: Comparison of accessibility measures.

2.3 The INTERIM Tool

The INTERIM tool was further developed in the INTERREG CADES project INTERIM. It is a trip chain generator for intermodal freight (containers, swap bodies and trailers) in the first line. It can calculate a trip chain from X to Y using and combining different transport modes: rail, road, inland waterway and short sea shipping/ferries. Additionally, intermodal terminals serve as nodes connecting the different networks (modes of transport). As such it is a route planning tools. Secondly, an accessibility measure from the indicator group "distance based measures" was implemented in the tool.

Route planning tools in general consist of an infrastructure network database and a routing algorithm. A number of routing algorithms to calculate the shortest path in networks have been developed during the last century. The A*-Algorithm is a particularly fast method but it needs a heuristic guess about the distances between the nodes. A faster clone of the A*-algorithm is the D* which can be used in high dynamic surroundings, like internet router communities. The algorithm of Dijkstra provides the shortest path from node x to node y if the values of the network segments are not negative. Also, no heuristic is necessary to use the algorithm.

Other algorithms to calculate shortest paths are the Bellman-Ford-algorithm, which is able to calculate paths under consideration of negative network segment values, and the algorithm of Floyd-Warshall, which provides additionally the shortest paths between all pairs of nodes. A new algorithm with a self-learning approach is the so called ant-way-algorithm. Taking into account the specifics of transport networks (usually no negative values of network segments are to be expected) and the aims of the tool (only the routing of the path with the minimised value is interesting and not the knowledge of all paths) the Dijkstra-algorithm was selected for implementation.

The Dijkstra-algorithm describes a solution for a directed, weighted graph G:

$G = (N, S)$ with nodes N
$N (G) = \{n_i \mid i = 1,\ldots,n\}$, segments S
$S (G) = \{s_{ij} = <n_i, n_j> \text{ and } n_i, n_j \in N(G)\}$ and not negative weights for all s_{ij}.

It has to be considered that the nodes nij do not have the ability to represent geometrical information. But for the representation of intermodal terminals as interfaces between different transport networks the consideration of information is needed e.g. for distances to cover, transhipment times, costs and energy consumption inside the terminal. This kind of information is essential for the calculation and comparison of different transport alternatives or paths in the network. Therefore, the nodes were replaced by a defined group of internal segments in the algorithm.

Basing on the routing application the INTERIM tool has been developed with the following functions:

- Basic Function: GIS (Geographical Information System) based generation and display of intermodal transport routes on the basis of underlayed networks (road, rail, inland waterway, transhipment terminals) and according to defined criteria and transport requirements

- Alternative Routes Function: Calculation and comparison of route-alternatives by criteria: distance, time, costs and energy consumption
- Via-Point Function: Possibility to define up to 2 via-points for the source-destination relation in order to prefer specific transport corridors or transhipment terminals
- Information Function: Presentation of information (contacts, service portfolio) of suitable logistics service providers (e.g. special provider for inland navigation) and transhipment terminals for each part of the generated transport chains

The INTERIM tool was implemented for the geographical zone of continental Europe and the islands. The networks for the routing include 10,000 rail segments (only freight) and 700 inland waterway segments. Network section delimiters are junctions, crossings, intermodal terminals, and changing points of segment characteristics (e.g. gauge or number of tracks). For the road network a classified part of the NAVTEC net (research support license) is integrated. Furthermore, 600 intermodal terminals and ports with intermodal capabilities are included.

The INTERIM tool has also a function “accessibility of a location” which provides selected intermodal terminal iso-curves on a map for a given value regarding time, distance, costs and energy consumption. The maps visualise how far an intermodal unit (container, swap body, trailer) can be transport in all directions with a given resource (time, cost, energy). It has to be mentioned that the paths in all directions are calculated as intermodal trip chains. That means that along one specific path the mode of transport can change if a terminal for transhipment is available. Furthermore all intermodal terminals in the map are marked with stars which are inside the iso-curve. The following graph gives an impression of such a map.

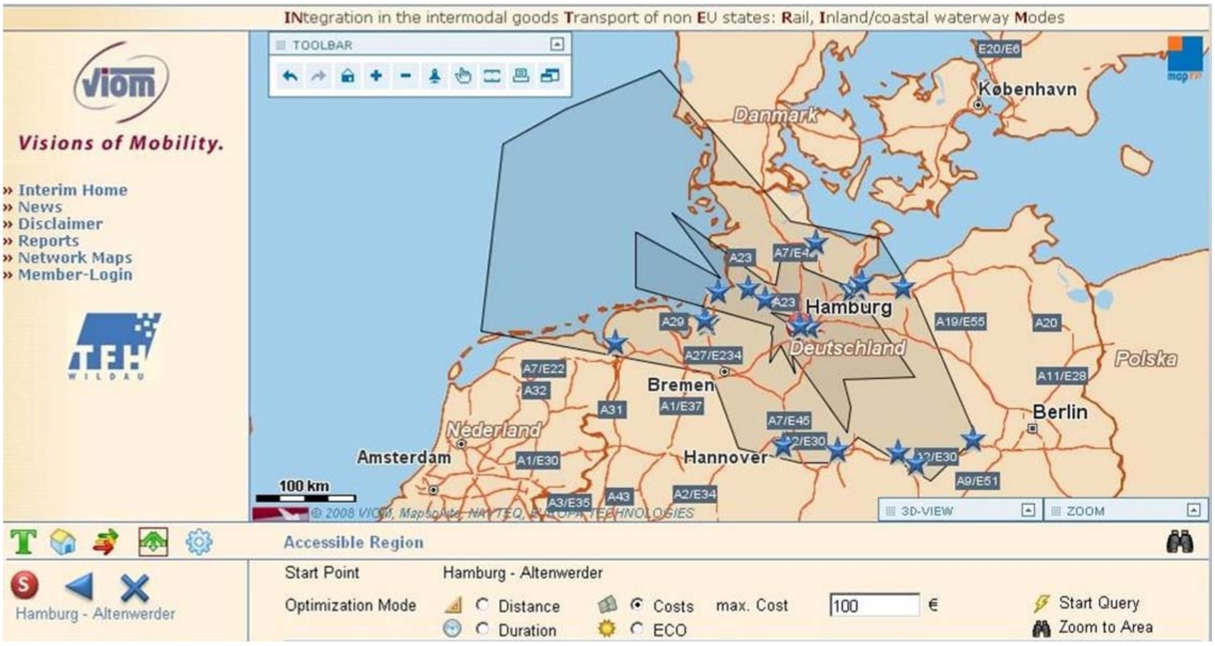

Figure 3: Accessibility map of the intermodal terminal Hamburg Altenwerder

For the following benchmarks the INTERIM tool was used as a calculation basis. Population data were taken from the Europeans Unions Commission statistical online databank “EUROSTAT” ([2]).

3 PORTS

The ports of Swinoujscie, Szczecin, Kiel and Lübeck are not part of the SCANDRIA corridor but have been benchmarked anyway, as they could be competing with SCANDRIA ports, for supply regions in the SCANDRIA corridor or offer a way to bypass SCANDRIA ports.

3.1 Costs

Most ports have a larger accessible area - in terms of cost- on the sea side, than on the land side, as sea-transport is usually cheaper than land transport. Table 3 and 4 in the appendix show the number of accessible transport nodes with a transport budget of 100 € per TEU. Transport nodes can consist of ports, as well as of intermodal inland terminals. Red bars represent nodes that are not located within the SCANDRIA corridor.

The ports of Swinoujscie and Szczecin are within the 100 € range of the Cluster of inland terminals in the Berlin-Brandenburg region, as well as in the range to ports in South Sweden and the Öresund Region of Denmark. In terms of cost these ports, though not part of the SCANDRIA region, could have a significant importance for the Baltic-sea-link of the corridor. Especially as Rostock has a similar access to the Baltic ports, but access to the terminals in Berlin-Brandenburg is slightly more costly, so that the Polish port actually provides a better link from Scandinavia to the Berlin-Region. The advantage of Szczecin is however merely theoretical as this benchmarking analysis does not encompass the actual infrastructural capacity and organizational factors. The rail connection between Berlin and Szczecin is insufficient to handle larger volumes of regular rail traffic: Only one track exists on the segment Passow and Szczecin Gumience, the line is not electrified and even passenger trains only reach an average traveling speed of 60 km/h ([6]).

The majority of Nodes in Germany accessible from the ports of Kiel and Lübeck in the given cost frame, are outside the SCANDRIA corridor (mostly in Northwestern Germany) and none are in the Berlin-Brandenburg-Region. Other accessible nodes from these ports are mainly in south Sweden and the Öresund region. Within the given cost frame, the north-eastern part of the Baltic Sea and the Gulf of Finland are accessible from the ports of Pori, Helsinki and Hanko. Within the cost frame only Denmark and northern Schleswig Holstein are accessible from Fredericia. In an eastern direction the accessible area only stretches to Fyn. The 100 € range of Fredericia is rather small, compared to other Danish ports like Aalborg. Table 3 and 4 also show the number of accessible regional centres with a transport budget of 100 € per TEU. The average number of nodes that can be reached within the given cost frame from a port, is much larger than the numbers of nodes reached from an inland terminal within the same cost frame. This is due to the much lower costs of sea transport that enables a longer range with the 100€ budget per TEU. The same reasoning is applicable to the finding, that also the number of regional centres within the 100 € range of a port is larger than the number of regional centres within the 100 € range of an inland terminal.

Within the given cost frame a large number of regional centres along the Swedish West coast and the Danish East coast can be reached from the ports of Varberg, Aalborg and Göteborg. The regional centres in South Sweden and the Öresund region, are within the 100 € range of the ports of Szczecin and Swinoujscie as well as Rostock and the Berlin-Brandenburg area, one more time implicating a significant importance of these two ports for the Baltic sea link in terms of transport costs. Lübeck and Kiel: The Öresund Region, South Sweden and parts of the Danish East-Coast, are within the 100 € range of these two ports, but opposed to Szczecin and Swinoujscie, the Berlin-Brandenburg Region is not within the given cost frame. Mostly Sjaelland and Fyn and the north-eastern part of the Danish Main-Land are within the given cost frame of the port of Helsingborg. Hanko has a larger accessible sea area than Helsinki, but a smaller accessible land area than the latter, within the cost frame of 100 €.

Oskarshamn and Visby are located too far from any SCANDRIA regional centres, to reach them within the given cost frame. Table 3 and 4 show the total population of all accessible regional centres with a transport budget of 100 € per TEU: More than half of the population in the accessible region of the ports of Szczecin and Swinoujscie (within the given cost frame) live in the Berlin-Capital region. A majority also lives in the Öresund region, implicating a possible significant importance for the supply of goods from the Öresund Region to the Berlin-Capital region and vice versa. The majority of the population in the SCANDRIA regional centres within the given cost frame of the ports of Kiel and Lübeck, live in the Öresund Region. Again the ports of Varberg, Aalborg and Göteborg have access to a large number of regional centres along the Swedish West coast and the Danish East coast within the given cost frame, due to the low costs of sea transport.

3.2 Time

Not surprisingly most ports have a larger accessible area within a given time frame on the land side and a smaller one on the sea side, as land transport modes are usually faster than ships. A large number of inland terminals in West and South Sweden can be reached on the land way from the port of Helsingborg and Malmö. The Öresund Bridge also enables short transport times to Sjaelland. Most of South Sweden (SE22 in the NUTS 2 Nomenclature) can be reached on the land way from the port of Ahus, and by that also a large number of nodes in this region.

Nearly all nodes in the Oslo og Akerhus region are accessible from the port of Drammen by land transport. Though a number of northern German nodes are within reach of the ports of Wismar and Lübeck, the majority of these nodes in Germany are outside the SCANDRIA corridor (Hamburg, eastern part of Lower Saxony, Schleswig Holstein and only two in Mecklenburg-Vorpommern). The ports of Oskasrhamn, Visby and Aalborg are all located to far from any other nodes, to have them within their three hours range. The ports of Ystad, Trelleborg, Malmö, Helsingborg and Ahus all have access to the south Swedish land transport network and cover the regional centres in the Öresund region. The only SCANDRIA regional centre accessible within three hours from the ports of Szczecin, Wismar, Rostock and Lübeck is the Berlin-capital Region comprising of Berlin and Potsdam. Turku, Pori and Naantalin are all within three hours range of Turku. Visby, Oskarshamn, Karlshamn, Göteborg, Swinoujscie and Kiel are outside the three hours range of any SCANDRIA regional centre.

The average number of nodes and regional centres, accessible within the given time frame from a port, is smaller than the number of centres and nodes accessible from an inland terminal. This is partly explainable through the fact, that a lot of inland terminals have a distribution function for a regional centre, thus are located closer to a regional centre. But it also reflects the slower transport speed of ships. Land transport modes are faster, thereby expanding the landside range of nodes. Berlin and Potsdam are accessible within 3 hours from the ports of Szczecin and Rostock, with more than 3.5 million inhabitants combined. Ystad, Trelleborg, Malmö, Helsingborg and Ahus are within the three hors range of the regional centres Helsingborg, Kobenhavn, Lund and Malmö with a combined population of more than two million.

4 INLAND TERMINALS

4.1 Costs

A large number of nodes in northern Germany are accessible within the 100 € range from the terminals in Hamburg, of which only Wismar and Brandenburg are located in the SCANDRIA corridor. Göteborg terminal has access to about the same nodes as Göteborg port by forwarding freight through the Port of Göteborg, just as Lappeenrenta, has access to a number of Baltic sea ports via the Port of Helsinki, due to the low cost of sea transport. The terminals in the Berlin Brandenburg-Region (Berlin-Westhafen, Großbeeren, Schwedt, Brandenburg, Velten, Eisenhüttenstadt, Wustermark and Frankfurt (Oder)), are mostly within the range of terminals along the river Oder and in Lower Saxony. The Göteborg terminal has access to the same regional centres as the Port of Göteborg, due to its easy access to the port, just as Lappeenrenta, has access to a number of Baltic sea ports via the Port of Helsinki, due to the low cost of sea transport, enlarging the 100 € range of these two terminals significantly in terms of cost. As already noticed above, the average number of nodes and regional centres that can be reached within the given cost frame from a port, is much larger than the numbers of nodes reached from an inland terminal due to the much lower costs of sea transport. All Terminals in the Berlin-Brandenburg area (Wustermark, Großbeeren, Freienbrink, Frankfurt (Oder), Eisenhüttenstadt, Velten, Schwedt, Brandenburg and Berlin Westhafen) have access to the capital region of Berlin which is the largest regional centre in the SCANDRIA corridor.

4.2 Time

Table 3 and 4 show the numbers of nodes, number of regional centres and the population of regional centres within the 3 hours range of the terminals assessed, as well as the number of nodes that can be reached within 3 hours transport time from a terminal. Table 3 and 4 also show the number of accessible regional centres within 3 hours transport time. Eskilstuna has the centres of Västeras, Uppsala, Stockholm, Linkoping and Örebro in its three hours range, while Taastrup lies in the Öresund region and has the regional centres on Sjaelland and in South Sweden within its three hours range. Table 3 and 4 show the total population living in the regional centres that are accessible within three hours transport time from the assessed terminals. The nine terminals in Table 3 and 4 with the highest population numbers do have the Berlin capital region in their 3 hours range and also have a supply function for this region.

5 SCORING ANALYSIS OF TRANSPORT NODES

5.1 Procedure of a Scoring Analysis

Different accessibility criteria were benchmarked in the preceding section. The more detailed information provided by such an approach however, comes with the cost of less clarity, about the accessibility of a node compared to other nodes. To compile one value for each node, the different values researched shown in Table 3 and 4 shall be combined in a scoring analysis: Each value resulting from the different accessibility criteria will be weighted, than all weighted values will be added to one score:

$$S = \sum w_i * v_i$$

Whereby:

S: Total score

w_i: Weight of criteria i

v_i: Value of criteria i

The criteria are:

- Number of accessible nodes within a cost frame of 100 €.
- Total population in accessible regional centres within a cost frame of 100 €.
- Number of accessible nodes within a time frame of three hours.
- Total population in accessible regional centres within a time frame of three hours.

The value of the weights depends on how important one believes a criterion is. It is quite possible, that a shipper will favour lower costs over time or vice versa. Also it is not obvious if the number of nodes within the range of a node or the number of inhabitants in a regional canter constitute a higher importance of a node. According to Occam's razor, that one should follow the theory with the smallest number of new assumptions; the weights on level shall all have the same value (compare Figure 4 for weight values).

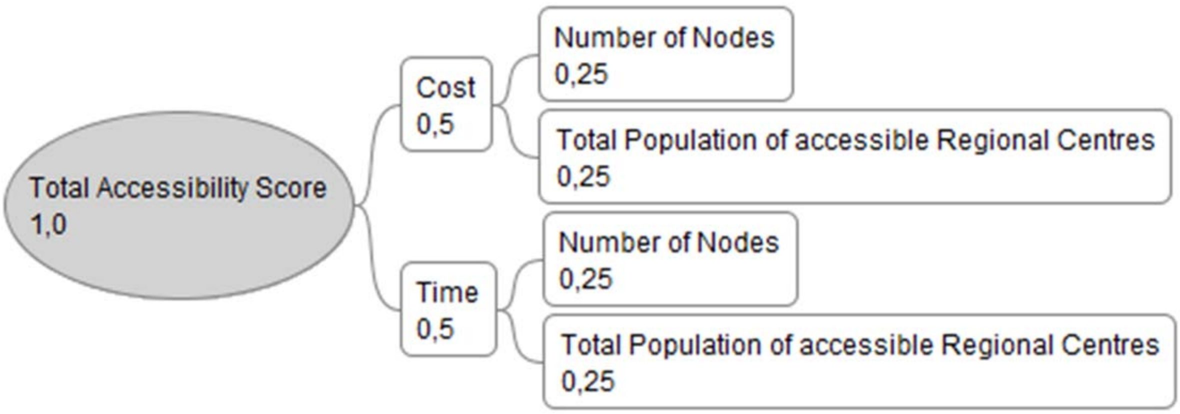

Figure 4: Weight values for considered criteria.

The values of the criteria cannot be directly weighed and added, as the different values have different dimensions. Therefore all values are being normalized to values from 0 to 100, 0 representing the smallest and 100 representing the largest value.

5.2 Scoring Analysis of Ports

The left column in Table 5 shows the total score of all analysed ports for the four accessibility criteria (accessible nodes and accessible population in regional centres within a cost range of 100 € and a time range of three hours).

The port of Szczecin scores high, as it has a large population in the regional centres of Berlin and Brandenburg within its analysed range. Rostock has the same centres within its time range, but not within its cost range, but therefore scores above average in the number of accessible nodes. Helsingborg, Malmö and Aalborg all score high in the number of accessible nodes within three hours range and still above average in all other criteria. Visby, Oscarshamn and Fredericia score below average in all criteria. In the case of Visby and

Oscarshamn, the reason can be found in their rather remote location, while Fredericia has a generally smaller time and cost range than most other ports.

5.3 Scoring Analysis of Inland Terminals

The right column in Table 5 shows the total score of all analysed inland terminals for the four accessibility criteria (accessible nodes and accessible population in regional centres within a cost range of 100 € and a time range of three hours). The Terminals in the Berlin Brandenburg area all score far above average, due to the large regional centres of Berlin and Potsdam within their immediate cost and time range. They also have a large number of transport nodes within the cost and time frame set for this analysis, in Lower Saxony and along the Polish-German border. The large number of nodes can be partly explained by the very high population density in Lower Saxony and in the Berlin area.

Borlänge, Insjön, Tampere and Jonköping all score far below average, due to their location, which sets other nodes as well as regional centres outside their range. Interestingly, the Inland Terminals score a little bit higher in the average overall score (green bar), than the ports.

6 CONCLUSIONS

One of the most noticeable findings is the very strong positioning of Swinoujscie and Szczecin according to the pathway of their infrastructure. This stands in sharp contrast to the actual transshipment volumes in these ports (about 7 million tons in Swinoujscie and Szczecin each in 2009) as opposed to Rostock (17 million tons) [11], which scores with a very similar accessibility in this study.

Naturally the pathway of the infrastructure alone only has a partial influence in the total accessibility of a port from the view of a shipper or forwarder. Quality of infrastructure and existing services are of similar importance. (As already mentioned the quality of the transport infrastructure - especially the rail infrastructure - to Rostock is better.) Also traditionally grown business relations may overcompensate for lower potential on the infrastructure side, for example if large transport volumes overcompensate the additional costs of a less favorable infrastructure through the economy of scales.

However, this study shows the potential of ports and inland terminals according to their geographical position. Analysis as the one at hand can therefore deliver important input information for policymakers to decide on the possible impact of infrastructure investments, as they give a quantitative expression of what would be possible. When compared with the costs of the infrastructure investments policymakers can use such analysis to find the best benefit for a given budget in a region.

In future studies, the quality of the infrastructure could be incorporated by underlying the computer tool with information about certain quality aspects of the infrastructure (for example, the maximum possible speed on a certain track-segment). An accessibility study could also incorporate the effects of existing services, if they are fed into the tool. This feature has actually already been realized in the INTERIM tools successor, the SoNorA tool.

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APPENDIX

Terminal	Number of accessible Nodes within 3 hours in the SCANDRIA region	Number of accessible Nodes with a budget of 100 € in the SCANDRIA region	Number of accessible regional centers within 3 hours in the SCANDRIA region	Number of accessible regional centers with a budget of 100 € in the SCANDRIA region	Total population of accessible regional centers within 3 hours in the SCANDRIA region	Total population of accessible regional centers with a budget of 100 € in the SCANDRIA region
Älmhult	3	2	1	2	127,000	420,909
Average	6	6	2	2	1435645	1642686
Berlin Westhafen	13	12	2	2	3,584,792	3,584,792
Borlänge	1	1	0	1	0	134,000
Brandenburg	10	9	2	2	3,584,792	3,584,792
Eisenhüttenstadt	6	8	3	3	3,686,792	3,686,792
Eskilstuna	5	0	5	2	1,335,000	324,000
Frankfurt (Oder)	6	1	3	3	3,686,792	3,686,792
Fredericia	1	0	2	2	487,929	487,929
Freienbrink	12	4	2	3	3,584,792	3,686,792
Göteborg	1	13	0	10	0	3,542,071
Großbeeren	15	10	3	3	3,686,792	3,686,792
Hallsberg	2	1	3	2	362,000	228,000
Hamar	1	1	2	2	697,800	697,800
Hamburg-Altenwerder	11	13	0	0	0	0
Hamburg-Billwerder	12	13	1	0	200,465	0
Hamburg-Eurokai	12	12	1	0	200,465	0
Insjön	2	1	0	0	0	0
Jonköping	2	2	0	0	0	0
Lahti	4	0	3	3	1,636,000	1,636,000
Lappeenranta	2	12	0	6	0	2,694,000
Schwedt	4	9	2	2	3,584,792	3,584,792
Skien	3	7	1	3	111,000	867,092
Stockholm-Artsa	2	1	3	2	409,000	324,000
Taastrup	4	4	5	5	1,866,265	1,866,265
Tampere	2	1	1	0	196,000	0
Ujscie	3	3	0	0	0	0
Velten	10	8	2	2	3,584,792	3,584,792
Wustermark	12	6	2	3	3,584,792	3,686,792

Table 3: Different Benchmark values for **intermodal terminals** in the SCANDRIA region, within a 100 € per TEU cost-range and a 3 hours time-range.

Port	Number of accessible Nodes within 3 hours in the SCANDRIA region	Number of accessible Nodes with a budget of 100 € in the SCANDRIA region	Number of accessible regional centers within 3 hours in the SCANDRIA region	Number of accessible regional centers with a budget of 100 € in the SCANDRIA region	Total population of accessible regional centers within 3 hours in the SCANDRIA region	Total population of accessible regional centers with a budget of 100 € in the SCANDRIA region
Aalborg	0	9	1	0	300,000	3,372,779
Ahus	6	10	4	0	1,678,336	1,878,801
Average	3	8	2	1	873843	1855406
Drammen	6	8	2	1	697,800	867,092
Fredericia	2	0	2	2	487,929	187,929
Göteborg	1	11	0	3	0	3,033,357
Hanko	1	2	3	3	1,636,000	1,813,000
Helsingborg	7	10	4	3	1,678,336	2,335,557
Helsinki	1	2	3	3	1,636,000	1,636,000
Karlshamn	2	9	0	3	0	1,678,336
Kiel	5	11	0	3	0	2,239,730
Kotka	3	5	3	3	1,636,000	1,636,000
Larvik	3	8	1	3	111,000	867,092
Lübeck	6	15	1	4	200,465	2,066,730
Moss	3	9	4	4	1,678,336	1,978,336
Naantalin	2	8	2	4	697,800	867,092
Norrköping	2	4	1	5	177,000	1,636,000
Oskarshamn	0	6	3	5	1,020,281	1,020,281
Oslo	4	1	0	5	0	0
Pori	2	10	2	5	697,800	1,375,806
Rostock	4	2	1	6	177,000	177,000
Stockholm	1	12	1	6	3,431,675	1,866,265
Swinoujscie	1	3	3	6	409,000	324,000
Szczecin	3	16	0	6	0	5,651,522
Trelleborg	5	14	1	7	3,431,675	5,651,522
Turku	2	10	4	7	1,678,336	2,178,801
Varberg	2	4	1	8	240,000	1,636,000
Visby	0	10	2	8	635,714	4,050,785
Wismar	6	2	0	9	0	0
Ystad	5	6	1	9	200,465	1,569,633
Malmö	7	8	4	11	1,678,336	2,066,730

Table 4: Different Benchmark values for **ports** in the SCANDRIA region, within a 100 € per TEU cost-range and a 3 hours time-range.

Port	Cumulated score
Aalborg	31.17
Ahus	57.59
Average	37.24
Drammen	42.85
Fredericia	11.53
Göteborg	34.18
Hanko	26.63
Helsingborg	63.18
Helsinki	25.85
Karlshamn	28.63
Kiel	44.95
Kotka	37.68
Larvik	27.86
Lübeck	55.47
Malmö	60.04
Moss	32.13
Naantalin	21.92
Norrköping	28.46
Oskarshamn	1.56
Oslo	41.08
Pori	12.34
Rostock	66.29
Stockholm	12.67
Swinoujscie	53.57
Szczecin	82.59
Trelleborg	55.35
Turku	22.38
Varberg	45.32
Visby	3.13
Wismar	39.21
Ystad	51.73

Terminal	Cumulated score
Älmhult	12.56
Average	41.03
Berlin Westhafen	93.36
Borlänge	4.50
Brandenburg	82.59
Eisenhüttenstadt	75.38
Eskilstuna	19.58
Frankfurt (Oder)	61.92
Fredericia	8.28
Freienbrink	77.00
Göteborg	50.69
Großbeeren	94.23
Hallsberg	9.26
Hamar	13.05
Hamburg-Altenwerder	43.33
Hamburg-Billwerder	46.36
Hamburg-Eurokai	44.44
Insjön	5.26
Jonköping	7.18
Lahti	28.85
Lappeenranta	44.68
Schwedt	72.59
Skien	25.09
Stockholm-Artsa	10.23
Taastrup	39.67
Tampere	6.59
Ujsice	10.77
Velten	80.67
Wustermark	80.85

Table 5: Results of the scoring analysis

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