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Mobility in a Globalised World

Jan Werner, Eric Sucky, Niels Biethahn, Gerd Grube
(Hrsg.)

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Das erfolgreiche Management sowohl unternehmensinterner als auch unternehmensübergreifender Wertschöpfungsprozesse, Wertschöpfungsketten und ganzer Wertschöpfungsnetzwerke basiert im Besonderen auf dem zielgerichteten Einsatz von bestehenden und weiterentwickelten Methoden und Konzepten des Produktions- und Logistikmanagements sowie des Operations Research, dem Einsatz von innovativen Informations- und Kommunikationstechnologien sowie theoretischen und praktischen Erkenntnissen des Kooperationsmanagements. Die Schriftenreihe dient der Veröffentlichung neuer Forschungsergebnisse auf den Gebieten Logistik und Supply Chain Management. Aufgenommen werden Publikationen, die einen Beitrag zum wissenschaftlichen Fortschritt in Logistik und Supply Chain Management liefern.

Mobility in a Globalised World

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Economics
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Editors

The term mobility has different meanings in the following science disciplines. In economics, mobility is the ability of an individual or a group to improve their economic status in relation to income and wealth within their lifetime or between generations. In information systems and computer science, mobility is used for the concept of mobile computing, in which a computer is transported by a person during normal use. Logistics creates by the design of logistics networks the infrastructure for the mobility of people and goods. Electric mobility is one of today's solutions from engineering perspective to reduce the need of energy resources and environmental impact. Moreover, for urban planning, mobility is the crunch question about how to optimize the different needs for mobility and how to link different transportation systems.

The conference "Mobility in a Globalised World" took place in Iserlohn, Germany, on September 14th – 15th, 2011. The aim of this conference was to provide an interdisciplinary forum for the exchange of ideas among practitioners, researchers, and government officials regarding the different modes of mobility in a globalised world, focusing on both domestic and international issues.

The proceedings at hand document the results of the presentations and pursuing discussions at the conference.

Jan Werner, Eric Sucky, Niels Biethahn, Gerd Grube (Eds.)

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Editors

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Prof. Dr. Ing. Gerd Grube

Aims and Methods of the Research Centre for Sustainable Freight and Passenger Mobility

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Abstract:
In 2010, an interdisciplinary research centre was founded at the University of Bamberg to examine the future of individual personal and freight transport. The aims and methods of this research centre are outlined in the following.

1 Background to the research centre's aims

Mobility is one of the fundamental pillars of a modern society. The average German citizen travels 3.4 routes per day, each route averaging 11.5km.[1] 87 percent of those interviewed in a study from 2005 said that mobility is part of their lifestyle and 93 percent agreed with the statement that mobility is an aspect of freedom.[2] According to recent studies, this seems set to continue and all signs point towards further growth of the total traffic volume. This is supported by factors including the continued strong world population growth and increasing income levels in many regions of the world.[3]

The increase in mobility is forecast to lead to many challenges, from the limited energy resources[4] and climate issues to the threat of gridlock on main transport routes. This scenario is leading to the awareness in some parts of society that mobility as we know it today cannot continue in its current form.

In order to be able to describe possible consequences, different trends and scenarios are discussed in the literature. The Institute for Mobility Research[5], initiated by BMW, has developed basic scenarios which take into account factors such as the exodus from rural areas, the consequences of demographic change and greater mobility among older people. The result is three scenarios which are in part highly contradictory. The first scenario describes similar automobile usage behaviour as in 2010 with a shift towards local public transport. Scenario two depicts how the transport performance could continue to increase as a result of continued globalisation and how this would only be possible with considerable investment in infrastructure. The third scenario outlines the case where the transport performance declines overall. These studies and scenarios show the industry's uncertainty and demonstrate the need for fundamental research which considers the link between society's desire for mobility and the principle of sustainability.

The conclusion includes various engine and mobility concepts which reduce CO_2 emissions. This holds significant consequences for automobile manufacturers and suppliers, as a study from 2009 describes.[6]

These studies show the importance and complexity of the mobility issue. In order to be able to research this topic holistically and from various perspectives, the Research Centre for Sustainable Freight and Passenger Mobility was founded in 2010 by Prof. Dr. Eric Sucky from the University of Bamberg and Prof. Dr. Gerd Grube, Dr. Niels Biethahn and Prof. Dr. Werner from the Business and Information Technology School in Iserlohn. It pursues the aim of investigating issues of future mobility in a scientific

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1 Belz, J. et al. (2010): p. 16 ff.

2 Cf. Federal Ministry of Transport, Building and Urban Development (2005).

3 Cf. Leschus et al. (2009), p.8,

4 Cf. Leschus et al. (2009), p.7, who point out that energy consumption by increasing traffic will contribute to the global energy consumption doubling by 2050.

5 Unattributed (2010)

6 Cf. Leschus et al. (2009), p. 63 ff.

and interdisciplinary manner. These mobility issues are examined with consideration of the pressures applied by time, cost and quality aspects.

2 Methods of the research centre

The Research Centre for Sustainable Freight and Passenger Mobility works towards the above-defined aims and conducts associated research projects in interdisciplinary research and development teams and, preferably, with the inclusion of commercial partners with practical experience.

The research centre's work is interdisciplinary, i.e. beyond the traditional divisions of scientific fields into business studies, engineering sciences and political economics. It addresses the necessity to deal with interrelated questions in a holistic manner. This is ensured by the leadership of the research centre consisting of representatives of the three faculties Business Studies (logistics in particular), Political Economics and Industrial Engineering. There is currently also active networking between representatives of various companies. There is therefore a first close linkage between suppliers, regional partners and representatives of the research centre.

As an example, one topic which was more closely investigated in 2011 in a project with external partners was the development of electro-mobility as part of car sharing concepts.

Literature:

Belz, J.; Follmer, R.; Gruschwitz, D. (2010): Report of Results MID 2008, Munich.

Federal Ministry of Transport, Building and Urban Development (2005): Demographic Change and Mobility, Report of Results, Berlin. 2005.

Leschus, L; Stiller, S.; Vöpel, H. (2009): „HWWI: Strategie 2030 – Mobilität"; Hamburg, 2009.

Unattributed (2010): Future of Mobility - Scenarios for the Year 2030 (2010): Second Update, (ifmo-studies), Institute for Mobility Research (Ed), Munich 2010.

Zielsetzung und Vorgehensweise der Forschungsstelle für nachhaltige Güter- und Personenmobilität

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Abstrakt:
Im Jahr 2010 wurde an der Universität Bamberg eine interdisziplinäre Forschungsstelle gegründet, die sich mit der Zukunft der individuellen Personen und Gütermobilität beschäftigt. Im Folgenden werden die Zielsetzungen sowie die Arbeitsweise der Forschungsstelle beleuchtet.

1 Hintergründe zur Zielsetzung der Forschungsstelle

Mobilität gehört zu den Grundsäulen einer modernen Gesellschaft. So legt ein Durchschnittsbürger in Deutschland pro Tage 3,4 Wege mit einer durchschnittlichen Wegelänge von 11,5 km zurück.[1] 87 Prozent der Befragten einer Studie aus dem Jahr 2005 gaben an, dass Mobilität zum Lebensstil gehört und wiederum 93 Prozent stimmten der Aussage zu, dass zur Freiheit Mobilität gehört.[2] Aktuellen Studien zufolge wird dies auch weiterhin so bleiben, so dass aller Voraussicht nach die Gesamtmenge des Verkehrs weiter zunehmen wird. Dies wird unter anderem mit einem weiterhin starken Bevölkerungswachstum und einem steigenden Einkommen in vielen Regionen der Welt begründet.[3]

Die Steigerung der Mobilität wiederum führt aller Voraussicht nach zu vielfältigen Herausforderungen, angefangen von Energieknappheit[4] über Klimaproblematik bis hin zu einer drohenden Verstopfung der Verkehrsadern. Vor dem Hintergrund entwickelt sich teilweise in der Gesellschaft ein Bewusstsein, dass die Mobilität in der Form, wie sie heute praktiziert wird, nicht weiterzuführen ist.

Um mögliche Folgen beschreiben zu können, werden unterschiedliche Trends und Szenarios in der Literatur diskutiert. So hat das von BMW initiierte Institut für Mobilitätsforschung[5] Basisszenarien entwickelt, welche unter anderem die Faktoren Landflucht, die Folgen des demographischen Wandels sowie mobilere Ältere berücksichtigt. Das Ergebnis sind drei teilweise sehr konträre Szenarios. Das erste Szenario beschreibt ein ähnliches Nutzungsverhalten von Autos wie im Jahr 2010 mit einer Verschiebung in Richtung des öffentlichen Nahverkehrs. Szenario zwei schildert, wie die Verkehrsleistung infolge steigender Globalisierung weiter zunimmt und dies nur durch hohe Investitionen in die Infrastruktur ermöglicht werden kann. Szenario drei skizziert wiederum ein Fall, dass die Verkehrsleistung insgesamt sinkt. Diese Studien und Szenarien zeigen die Unsicherheit der Branche und demonstrieren die Bedeutung der Grundlagenforschung, die sich mit der Verbindung des gesellschaftlichen Wunsches nach Mobilität mit dem Prinzip der Nachhaltigkeit beschäftigt.

Die Folge sind unter anderem verschiedenste Antriebs- und Mobilitätskonzepte, um die CO_2-Emissionen zu reduzieren. Dies wiederum hat tiefgreifende Folgen für die Automobilhersteller und die -zulieferer, wie eine Studie aus dem Jahr 2009 beschreibt.[6]

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1 Belz, J. et al. (2010): S. 16 ff.

2 Vgl. Bundesministerium für Verkehr, Bau- und Wohnungswesen (2005).

3 Vgl. Leschus et al. (2009), S.8,

4 Vgl. Leschus et al. (2009), S.7, die darauf hinweise, dass unter anderem der Energieverbrauch für den zunehmenden Verkehr dazu beitragen wird, dass der Energieverbrauch der Erde sich bis 2050 verdoppeln wird.

5 O. V. (2010)

6 Vgl. Leschus et al. (2009), S. 63 ff.

Die Studien zeigen die Bedeutung und die Komplexität des Themas Mobilität. Um dieses Thema ganzheitlich von verschiedenen Perspektiven aus zu erforschen, wurde im Jahr 2010 die Forschungsstelle für nachhaltige Güter- und Personenmobilität durch Prof. Dr. Eric Sucky von der Universität Bamberg und von Prof. Dr. Gerd Grube, Dr. Niels Biethahn sowie Prof. Dr. Jan Werner von der Hochschule BiTS in Iserlohn gegründet. Mit ihr wird das Ziel verfolgt, sich wissenschaftlich als interdisziplinäre Institution mit Fragestellungen der Mobilität in der Zukunft zu beschäftigen. Dabei werden diese Mobilitätsfragestellungen im Spannungsfeld von Zeit, Kosten und Qualität betrachtet.

2 Arbeitsweise der Forschungsstelle

Die Forschungsstelle für nachhaltige Güter- und Personenmobilität bearbeitet die obige Zielsetzungen und die damit verbundenen Forschungsprojekte in interdisziplinären Forschungs- und Entwicklungsteams und vorzugsweise unter Einbeziehung von Praxispartnern aus der Wirtschaft.

Die Forschungsstelle arbeitet interdisziplinär, d. h. jenseits der tradierten Einteilung der Wissenschaftsgebiete in Betriebswirtschaftslehre, Ingenieurwissenschaften und Volkswirtschaft. Sie stellt sich der Notwendigkeit, zusammen gehörende Fragen auch in einem ganzheitlichen Sinne zu behandeln. Sichergestellt wird das dadurch, dass sich die Leitung der Forschungsstelle aus Vertretern der drei Fakultäten Betriebswirtschaftslehre, insbesondere der Logistik, der Volkswirtschaftslehre sowie des Maschinenbaus zusammensetzt. Des Weiteren findet zurzeit eine aktive Vernetzung mit Vertretern verschiedener Unternehmen statt. So findet zurzeit eine erste engere Verknüpfung zwischen Zulieferern, regionalen Partnern und Vertretern der Forschungsstelle statt.

Ein Thema, welches dabei im Jahr 2011 genauer in einem Projekt zusammen mit externen Trägern beleuchtet wurde, war beispielsweise die Entwicklung von Nutzungsmöglichkeiten der Elektromobilität im Rahmen von Car-Sharing-Konzepten.

Literatur:

Belz, J.; Follmer, R.; Gruschwitz, D. (2010): Ergebnisbericht MID 2008, München.

Bundesministerium für Verkehr, Bau und Wohnungswesen (2005): Demografischer Wandel und Mobilität, Ergebnisbericht, Berlin. 2005.

Leschus, L; Stiller, S.; Vöpel, H. (2009): „HWWI: Strategie 2030 – Mobilität“; Hamburg, 2009.

o.V. (2010): Zukunft der Mobilität - Szenarien für das Jahr 2030 (2010): Zweite Fortschreibung, (ifmo-studien), Institut für Mobilitätsforschung (Hrsg), München 2010.

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Mobility in Economics

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The term mobility has different meanings in various science disciplines. In economics, mobility is the ability of an individual or a group to improve their economic status in relation to income and wealth within their lifetime or between generations. This definition, however, fails to describe all aspects of mobility in economics as it restricts itself to social economic mobility or labour mobility. The term can, of course, also refer to capital mobility or factor mobility. The free movement of goods, services, capital and persons within the European Union (the so-called "four freedoms"), for example, is a further key mobility issue in economics. Capital mobility and tax competition is of great significance to tax authorities and politicians in modern economies, especially given that there is a huge number of supporters [1] and adversaries [2] of tax competition in economic literature[3].

The respective contribution of this thematic section highlights these diverse aspects of mobility in the field of economics. The first contribution entitled *"The dynamics of labour mobility in Eastern Europe and Central Asia"* by Alessandra Bravi, Alisher Juraev and Aleksandra Janjic observes labour migration in the European and Central Asian contexts. This contribution focuses on the two main migration axes in the European Union and Russia and it describes the free movement of people and labour in the European Union and compares it to the migration policy in the Russia Federation.

In the second contribution *"Mobility of Top 500 Firms in the U.S., China and the Globe"* Qinghua Chen, Jinzhong Guo, Qi Xu and Yougui Wang use corporate size as an indicator of mobility within the economic system. Mobility is measured in this paper as the fluctuations of the top 500 companies as listed in China 500(CH500), Fortune 500 (US500) and Fortune Global 500(FG500).

"Relevance of oil prices for mobility today and in the next decades" by Andreas Seeliger is the third contribution and discusses the role of crude oil prices as an important

[1] See Tiebout, 1956.

[2] See Oates, 1972.

[3] See Wilson, 1996.

cost factor for individual and collective mobility. The author shows that alternative fuels such as gas, hydrogen or electricity are closely linked to developments on the oil market. Moreover, the paper focuses on a component analysis of end-user prices.

Finally, in the fourth contribution *"Revenues from National Resource Taxation – both a blessing and a curse"* Jan Werner emphasizes the fact there are 31 oil producing countries in the world where fiscal oil revenues account for more than 25 percent of total fiscal revenue. However, revenues from national resource taxation are not always a blessing. This paper therefore explains the Dutch disease and, with the National resource funds, presents an instrument for reducing the negative economic effects of the Dutch disease.

Each of these four contributions discusses important, yet very different aspects of mobility within economics.

References

Oates, W. (1972): Fiscal Federalism, 1.edition, New York, Harcourt Brace Jovanovic.

Tiebout, C. (1956): A Pure Theory of Local Expenditures in Journal of Political Economy, Volume 64, Issue 5, page 416-24.

Wilson, J. (1999): Theories of Tax Competition in National Tax Journal, Volume 52, page 269-304.

The dynamics of labour mobility in Eastern Europe and Central Asia

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Abstract
The following paper examines labour migration in the European and Central Asian contexts. Focusing on the two main migration axes in the European Union and Russia it describes the free movement of people and labour in the European Union and compares it to the migration policy in the Russia Federation. By illustrating the key push and pull factors that have influenced migration towards both EU and Russia poles this work explains the role played by movement restrictions in shaping both migration paths.

[1] The authors are very thankful to Alena Kachanovich for her help in preparing the paper.

[2] The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the view of UNDP and the Regional Bureau for Europe and CIS countries.

1 Introduction

Many of the world's largest migration flows during the last two decades have occurred between the developing and transition economies of Europe and Central Asia. With the collapse of the Soviet Union, many people passed from restricted external mobility to "freedom of movement" regulated by international law and national visa systems. The advent of new states and national borders also turned internal into external migration flows.

This paper focuses on migration flows from Eastern European[3] and Central Asian countries in the last decade. In particular it describes the biaxial trends that migration flows have followed in the region towards two main migration poles: Russia and the European Union (EU). The paper analyses the two different unions existing along these axis. On one side the Commonwealth of Independent States (CIS)[4] and on the other side the European Union. In the former, the migration policy focus in the past years has been on increasing control, barriers and internal border security. The latter represents an ongoing experiment to abolish internal borders and create a common labour market. The study shows that despite the differences in internal migration polices within the two unions, in both cases restrictions to regular migration has not prevented migration flows; on the contrary, they increased the incentives to irregular migration.

The argument is structured in six sections including a brief introduction (section 1) and conclusion (section 6). Section 2 explains labour migration in the European and Central Asian contexts and analyses the two main migration axes: towards the European Union and towards Russia. Section 3 describes the free movement of people and labour in the European Union and how it has been extended to Eastern European citizens from new EU member states after the accession. Section 4 gives an overview of the migration policy in the Russia and its impact on migrant workers from Central Asia, Belarus, Moldova and Ukraine. Finally, section 5 illustrates the key push and pull factors that have influenced migration towards both the EU and Russia poles and the role played by the restrictions in shaping those migration paths.

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[3] In this paper the United Nations Statistical office's definition for Eastern Europe is used. It includes: EU member states Czech Republic, Hungary, Poland, Slovakia, Romania and Bulgaria plus Belarus, Ukraine, Russia and Moldova.

[4] Commonwealth of Independent States (CIS) was created in December 1991. At present the CIS unites: Azerbaijan, Armenia, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Uzbekistan and Ukraine. In September 1993 the Heads of the CIS States signed an Agreement on the creation of Economic Union to form common economic space grounded on free movement of goods, services, labour force, capital; to elaborate coordinated monetary, tax, price, customs, external economic policy; to bring together methods of regulating economic activity and create favourable conditions for the development of direct production relations. Source: http://www.cisstat.com/eng/frame_about.htm.

2 Labour migration in the European and Central Asian contexts

This paper focuses on international labour migration defined by the International Organization for Migration (IOM) as the flow or movement of workers across national boundaries from their places of origin or home country (sending country) to the area of destinations or migrating country (receiving country). The flow of workers is often accompanied by a flow of money (or goods) in the opposite direction called remittances.

According to the IOM there are about 214 million international migrants in the world of which 80 million are migrant workers[5]. Over 22 million migrants are from Eastern Europe and Central Asian countries (World Bank 2010).

Looking closely at the migration top destinations , a biaxial pattern can be identified: one axis goes from most of the Eastern European countries (Czech Republic, Hungary, Poland, Slovakia, Romania and Bulgaria) to the "old EU members"[6]and another axis going from Central Asia and the non EU members of Eastern Europe (Belarus, Ukraine and Moldova) to Russia. Figure 1 reports the proportion of total number of emigrants per country living in Russia and the European Union in 2010. The preference for the two poles is very strong, in almost all countries more than half of the emigrants chose to live in the country top destination.

Kyrgyzstan 76%
Tajikistan 50%
Moldova 37%
Ukraine 56%
Belarus 54%

Russia

Bulgaria 45%
Romania 79%
Poland 49%
Hungary 54%
Czech Republic 54%[7]

EU

Figure 1: Proportion of total emigrants going to Russia and the EU (2010).

Source: UNDP calculations, World Bank data.

[5] A migrant worker is a person who is to be engaged, is engaged or has been engaged in a remunerated activity in a state of which he or she is not a national. (UN Convention, 2003). According to the ILO Migration for Employment Convention (Revised), 1949 (No.97) Art.11, Sec.1 a migrant worker is a person who migrates from one country to another with a view to being employed otherwise than on his own account and includes any person regularly admitted as a migrant for employment.

[6] EU member states which were part of the EU before May 1, 2004.

[7] Czechs living in Slovakia have not been counted.

2.1 First axis: Eastern European new member states to European Union

On 1 May 2004, eight former communist countries in Central and Eastern Europe (so called "A8" - Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia - plus the islands of Malta and Cyprus) acceded to the European Union. On 1 January 2007, Romania and Bulgaria became the newest members of the EU bringing the total number of member states to 27[8]. Out of these twelve countries, seven are Eastern European countries. They are analyzed in this paper.

The latest EUROSTAT data available show that about 3.2 million foreign migrants entered at least one of the member states of the union in 2009. About 43percent (1.4 million) came from one of the EU member states[9]. Romanians formed the largest group (384,000 persons; 27percent of the total immigrants from EU members) followed by Polish citizens (266,000 persons; about 19percent of the total) and Bulgarians (91,000 persons; about 7percent of the total). Romania[10], Poland[11] and Bulgaria alone represented about 53percent of the total migrants coming from the EU.

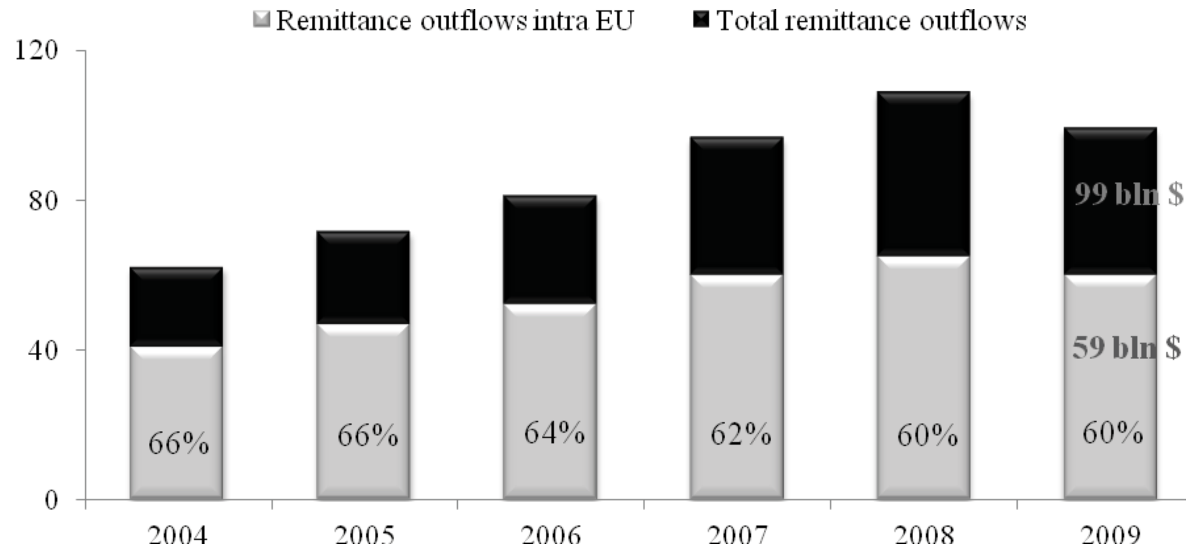

Chart 1: Remittance outflows EU (in billions of USD)
Source: EUROSTAT, exchange rate annual average OANDA.

[8] Goldin, Cameron and Balarajan, "Exceptional People" Princeton Univeristy Press 2011. (Chapter 5 page 134).

[9] EUROSTAT 2011.

[10] The main destinations for Romanian citizens in the EU were Italy and Spain. Italy received 46% of all Romanians migrating to another EU Member State in 2008 and Spain 19 %, EUROSTAT 2011.

[11] The main destination of Polish citizens in the EU was Germany, which received 45% of all Poles migrating to another EU Member State (about 120,000 persons), EUROSTAT 2011.

2.2 Second axis: Central Asia and the non EU members of Eastern Europe to Russia.

Remittances'[12] flows from the European Union towards EU countries also confirm these trends in 2008 about 60percent of the remittances sent form EU where sent to another EU member state (Chart 1).

According to the UNDP 2009 Human Development Report (HDR), Russia received more than 12 million immigrants from former Soviet states between 1992 and 2007 (Rosstat 2008), while the aggregated number of registered labour migrants employed in Russia during the same period was over 4 million (FMS 2008). About 36percent of Russian's foreign population comes from Central Asia and about 56percent from other Former Soviet Union countries including Eastern European countries (World Bank 2010). Some of these people are ethnic Russians who had returned to Russia after the collapse of the Soviet Union and did not obtain Russian citizenship (they are not working migrants as per IOM definition and therefore are not considered in this paper). However, if we compare the migration stock data for 1990, 2000 and 2010 we can see that people have continued to come from Russia even after the initial population resettlement. Some of these persons are ethnic Central Asian and Eastern European worker migrants from Belarus, Moldova and Ukraine (Table 1).

	Countries	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	total flows (*)
from Eastern Europe	Belarus	10,274	6,520	6,841	5,309	5,650	6,797	5,619	6,030	5,865	5,517	4,894	**69,316**
	Moldova	11,652	7,569	7,562	6,391	4,816	6,569	8,649	14,090	15,519	16,433	11,814	**111,064**
	Ukraine	74,748	36,503	36,806	23,418	17,699	30,760	32,721	51,492	49,064	45,920	27,508	**426,639**
from Central Asia	Kazakhstan	124,903	65,226	55,706	29,552	40,150	51,945	38,606	40,258	39,964	38,830	27,862	**553,002**
	Kyrgyzstan	15,536	10,740	13,139	6,948	9,511	15,592	15,669	24,731	24,014	23,265	20,901	**180,046**
	Tajikistan	11,043	6,742	5,967	5,346	3,339	4,717	6,523	17,309	20,717	27,028	18,188	**126,919**
	Turkmenistan	6,738	4,402	4,531	6,299	3,734	4,104	4,089	4,846	3,962	3,336	2,283	**48,324**
	Uzbekistan	40,810	24,873	24,951	21,457	14,948	30,436	37,126	52,802	43,518	42,539	24,100	**357,560**

(*) sum of all foreign migrants entered in Russia 2000-2010, does not consider the departures.

Table 1: International Migration to Russia flows by country of origin (persons).
Source: Russian Federal State Statistic Services.

Besides, there are millions of irregular migrants in Russia: estimates vary from 4 to 10 million, of which 90percent are unregistered labour migrants from various post-Soviet states[13].

Experts estimate there are between 600,000 and over one million Tajik migrants in Russia (392,000 according to the World Bank estimates 2010). Estimates of Kyrgyz migrants vary from 500,000 to over one million (478,000 according to the World Bank 2010). Uzbekistan's emigrant population is the largest in Central Asia in absolute numbers, over 2 millions. Roughly 60percent of Uzbek migrants work in Russia[14] (about 940,000 according to the World Bank 2010). Of all the Central Asian countries

[12] For the purpose of this papers we refer to remittances as the sum of two components as reported in the Balance of Payments, worker's remittances and compensation of employees.

[13] UNDP Human Development Report, 2009.

[14] Marat 2009.

Turkmenistan has the lowest number of emigrants working abroad, according to the World Bank 180,000 people from Turkmenistan are in Russia (2010)[15].

Once more the remittances figures confirm what indicated by the migration data and show that in 2010 about 85percent of remittances from Russia were sent to CIS countries.

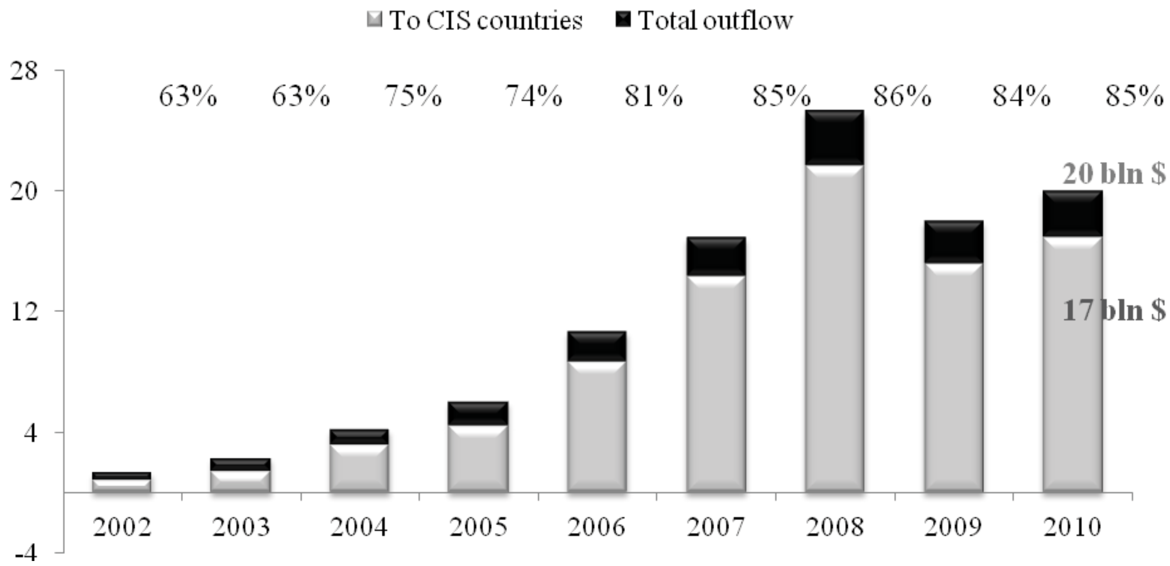

Chart 2: Remittance outflows Russia (in billions USD)

Source: Russia Central Bank.

2.3 Why are migrants following those migration axes?

It is not surprising that Russia and the EU are the most important migration poles in the region, as they are among the largest poles of attraction for migrants in the world. Russia is the second-largest migrant-receiving country in the world after the United States (followed by Germany, Italy and Spain). Among the EU member states in 2006 Spain, Germany and UK received more than half of all migrants[16] in the EU-27, respectively 840,000 in Spain, over 660,000 in Germany and nearly 530,000 in the UK[17].

There are historical, geographical and cultural reasons that can explain the direction of migration flows from Central Asian countries to Russia. Those factors in part also justify why migrants from Eastern European countries of Belarus, Ukraine and Moldova migrate mostly to Russia. Moreover these countries have special visa-free travel agreements with Russia as it was established among the countries of the Commonwealth of Independent States. The existence of a privileged mobility agreement seems to influence people's migration preferences. Also for the remaining Eastern European countries, EU membership seems to be a key factor in their decision

[15] Marat 2009.

[16] Migrants coming from everywhere in the world, including returning national citizens of the country.

[17] EUROSTAT, 2009.

to migrate and this is especially true for the newest member states, Bulgaria and Romania.

3 Migrating and moving within the European Union

The European Union is the largest example of free movement area and free labour zone. It is still in process: other countries in the region applied for accession and not all new member States are already fully benefiting of free movement- free labour privileges. This section will briefly describe what free movement of people mean in the context of the European Union and how it applies to the citizens of the Union.

According to the Treaty of Maastricht, European citizens have the right to travel, work[18] and live anywhere within the territory of the Union. The right to travel without visa in the European Union is further enhanced by the Schengen cooperation that allows citizens to cross internal borders without being subjected to border checks. Joining the Schengen area requires countries to fulfill pre conditions including applying the common set of Schengen rules[19]. Being EU member is not a *conditio sine qua non* to become part of the Schengen area; as a matter of fact three non members' states - Switzerland, Norway and Island - are part of the area. On the contrary Bulgaria and Romania[20] - EU member States - are not members of the Schengen area[21]. Citizens from Bulgaria and Romania can enter the EU with a valid passport; however their borders with other EU member states are not free of controls. Everyone entering the EU from these two countries needs to comply with the EU external visa policy. Currently there are 25 countries are member of the Schengen area. As mentioned above three of them are not in the Union, while the other 22 are EU member states[22] including the A8 Eastern European countries.

The right to work and live in any country of the Union increases EU citizen's chances to find a job outside their place of birth, and therefore facilitates internal migration. As it happened with Schengen membership, citizens from A8 countries and later Bulgaria and Romania were not granted these rights everywhere in the Union immediately after

[18] Any person who is a national of an EU country can work in the health, education and other public services anywhere in the Union, with the exception of activities covered by the prerogative of public authorities (the police, armed forces, foreign affairs, etc.). In addition the EU has passed a directive establishing a system of mutual recognition of higher education qualifications. This directive applies to all university courses lasting three years or more and is based on the principle of mutual confidence in the quality of national education and training systems.

[19] Schengen Rules include eliminating border controls with other Schengen members while simultaneously strengthening border controls with non-member states. States implementing the rules have to agree on a common policy on the temporary entry of persons (including the Schengen visa), harmonize external border controls, cross-border police and judicial co-operation with the common policy.

[20] The United Kingdom, Ireland and Cyprus are also not part of Schengen.

[21] Bulgaria and Romania which are part of the European Union are not yet members of the Schengen zone. On September 2011 due to the opposition of Finland and Netherlands, Schengen membership was denied to both countries.

their accession. At the time of the 2004 enlargement, 12 out of the 15 old EU member states restricted access to their labour markets for newly arriving citizens of new EU member states. During the 2004-2006 period Ireland, Sweden and the United Kingdom did not implement such restrictions. Only Sweden, however, fully applied European Community law, while the United Kingdom did so in practice, but safeguarded itself by requiring workers coming from new EU member states to register in the Workers Registration Scheme (WRS)[23]. Countries like Austria, Italy and the Netherlands offered labour permits on a quota base[24]. The main fear of European Union founder countries was that there would be an “invasion” of people from the new member states. Time proved this fear to be unfounded.

Official data show that the EU 2004 enlargement has led to increased legal migration from new member states (EU8) to Western Europe (EU15) but this increase was mostly temporary. The additional flow has been in the order of 200,000 to 300,000 people per year in line with earlier forecasts that had tried to assess the East-West migration potential during the first years after EU enlargement[25]. The EU enlargement has also led to de facto legalization of several hundred thousand EU8 citizens who were irregular residents of EU15 prior to enlargement. A certain proportion of them have meanwhile found regular employment.

For example, in the UK - where no labour quotas were in place - migration increased significantly in the immediate years after the enlargement. Between May 2004 and December 2008, almost one million citizens of A8 countries applied to work in the UK according to the Worker Registration Scheme (WRS). However, some of the people who registered between 2004 and 2006 in the WRS were already living in the UK and they used the WRS to legalize their status. Moreover, the flows of migrants arrived after the 2004 enlargement proved to be highly variable and not necessarily permanent (Chart 3).

23 According to the Worker Registration Scheme every worker coming from A8 countries who wanted to work in the United Kingdom had to apply for registration. The system was introduced in January 2004 and has been valid until May 1 2011. Now citizens of Czech Republic, Estonia, Lithuania, Latvia, Hungary, Poland, Slovakia, and Slovenia can live and work in the UK under the same rules as other citizens of other EU member states.

24 “Labour Markets Unbound? EU Enlargement, Transitional Measures and Labour Market Effects” by Kristof Tamas and Rainer Münz, 2006.

25 “Labour Markets Unbound? EU Enlargement, Transitional Measures and Labour Market Effects” by Kristof Tamas and Rainer Münz, 2006.

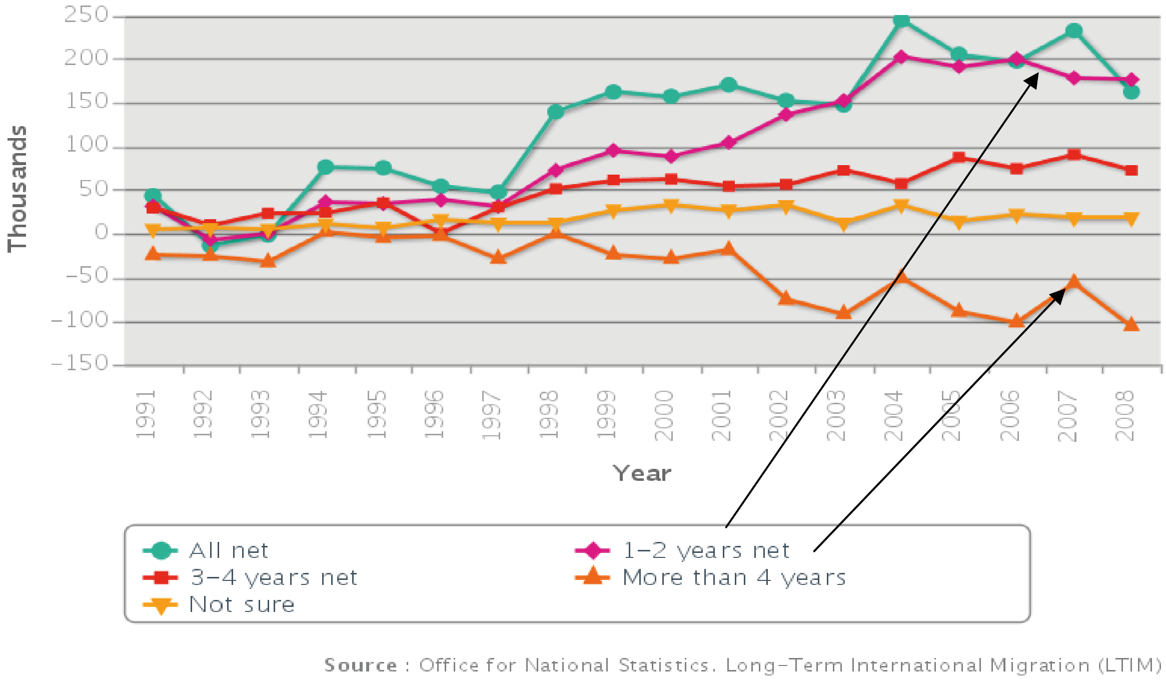

Chart 3[26]: Net migration by length of stay: 1991-2008

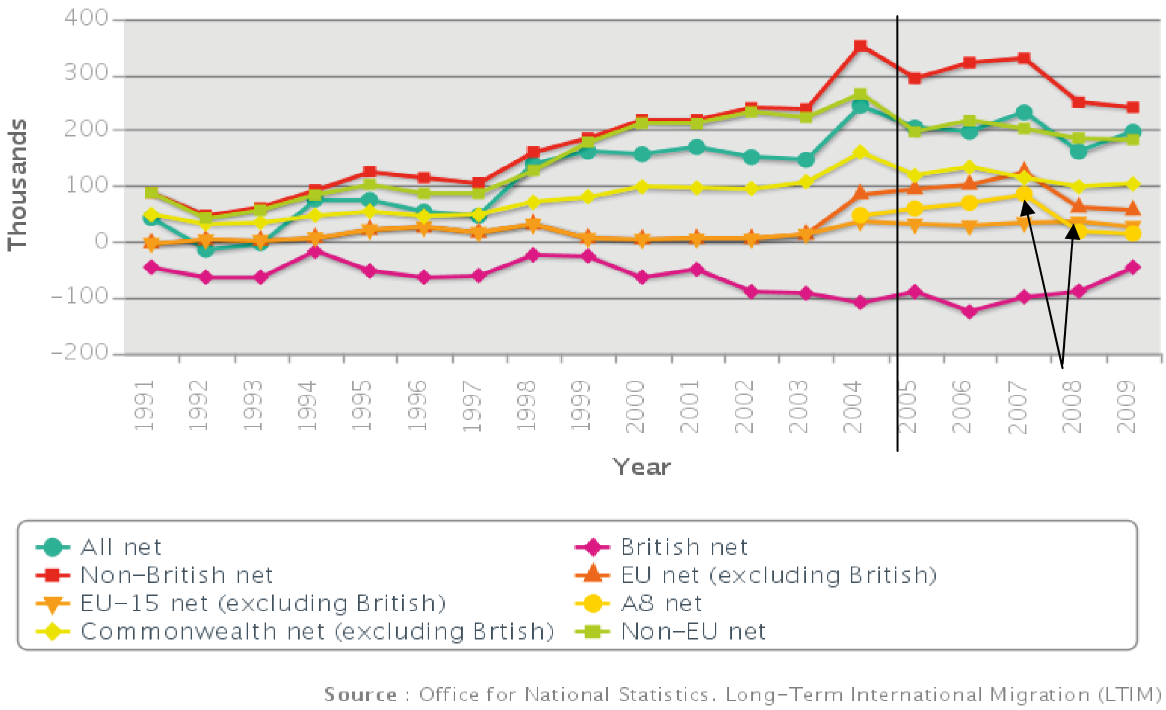

Chart 4[27]: Net migration by citizenship: 1991-2008

[26] Chart provided by www.migrationobservatory.ox.ac.uk.

[27] Chart provided by www.migrationobservatory.ox.ac.uk.

In 2008 net migration form A8 countries to Britain (the number of people arriving minus those leaving) fell for more than a third and in 2009 almost reached the balance (Chart 4).

Since May 2011- seven year after the accession - the latest measures have been removed for citizen from A8 countries and now the right to work in every country of the Union also applies to Eastern European countries of Poland, Czech Republic, Slovakia, Hungary and Slovenia. Migration restrictions still apply for citizens coming from Bulgaria and Romania that joined in 2007. Those barriers will be completely removed in January 2014.

4 Migrating from Eastern Europe and Central Asia CIS to Russia

The situation is quite different in the Commonwealth of Independent States, which unites Azerbaijan, Armenia, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Uzbekistan and Ukraine. From an initial situation of visa free regiment among all countries members of the commonwealth there was a regression to an internal close border regime that then moderated in a mix system of bilateral and internal sub regional agreements. In 1992, an Agreement on visa-free entry of the CIS citizens to the territories of the member countries (the so-called Bishkek Agreement) was signed by all the CIS governments (highest point of freedom of movement in the region after the collapse of the former Soviet Union). However, in 1999 Turkmenistan and Uzbekistan, and in 2000 Russia, Kazakhstan and Azerbaijan, withdrew from the Bishkek Agreement. Russia immediately signed bilateral agreements on visa-free population movements with all the CIS members except Turkmenistan that insisted on a proper visa regime for all the post-Soviet states. In 2001, visa requirements were introduced by Russia for Georgian citizens as a result of a political tension between the two countries. In addition, an Agreement on visa-free movements was signed in November 2000 between the Eurasian Economic Community (EurAsEC) members (Belarus, Kazakhstan, Kyrgyzstan, Russia, and Tajikistan). In 2006, Uzbekistan joined the EurAsEC and correspondingly the multilateral visa-free Agreement[28]. At the moment there is not a common visa free policy for all CIS members, however as of September 2011 Russia has visa-free migration agreements with Armenia, Azerbaijan, Belarus, Moldova, Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, and Ukraine. As Russia is the main pole of attraction for migrants in the region, the focus of this paper is on Russia external migration policy and how it has changed over the past years.

Russian migration policy since the collapse of the Soviet Union has been mainly focused on the management of permanent and temporary migrant inflows[29]. Over the recent two decades, the Russian migration policy has been drifting from a relatively open immigration regulation based on a *laissez-faire* approach in the early 1990s to restrictive immigration laws in the early 2000s and to an ‘open doors’ migration policy

[28] UNDP Human Development Report, 2009.

[29] Idem.

for CIS citizens in 2007[30]. The most relevant shift in the migration policy is represented by the Federal Law "On the Legal Status of Foreign Citizens on the Territory of the Russia[31]" that was approved in 2002. The law dictates very strict conditions both for permanent and temporary workers (special clauses for ex- Soviet States were introduced in 2003). It imposes a three days registration time within each accommodation should also be found. It limits temporary stay (upon authorized registration stamp) to three months maximum and temporary residence (upon temporary residence permit) only within the administrative area where the permit is issued. Additionally the law imposes a quota on the number of permits for temporary residence that can be released and allow the employment for foreign citizens, temporary or permanently staying in Russia, only when they have a valid work permit[32].

For a country with more than 20,000 km of borders, that every year attracts thousands of migrants not surprising this system proved to be inefficient and ineffective. Paradoxically the registration procedure actually became a powerful tool against the legal immigration. Narrowing channels for legal migration provoked a growth of corruption in the immigration industry. Services issuing permits or certificates of registration unofficially emerged, cases of authorities who take bribes from migrants without valid documents became more and more common and so on (Tishkov et al. 2005).

Surveys conducted by Russian researchers in the mid-2000s proved that in the country there are close links between employment, illegality and registration. According to the surveys one migrant in two is unable to legalize his/her employment because the registration could not be obtained first. Two in three unregistered migrants are paid unofficially, while of the registered migrants, 55percent are paid officially (Tiuriukanova 2004a; Zaionchkovskaya 2007; Soboleva and Chudaeva 2007; Zotova 2006).

The discrepancy between migration flows from CIS countries to Russian growth rates and the growth rates of the remittances sent in the opposite direction also indicates that many people working in the country and sending remittances back home are not registered. Even the latest data up to Q12011 show that despite the apparent decline in migration flows from Central Asia and Eastern European countries to Russia for the past four years remittances sent from foreign migrant workers from the same countries back home continued growing (Chart 5 and 6). On average remittance sent from Russia to the Central Asia and Eastern European countries of Belarus, Moldova and Ukraine recovered from the decline due to the 2008 financial crisis and in 2010 the outflows was 44percent higher than in 2007 pre crisis levels.

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[30] Idem.

[31] No. 115-FZ of July 25, 2002.

[32] UNDP Human Development Report, 2009.

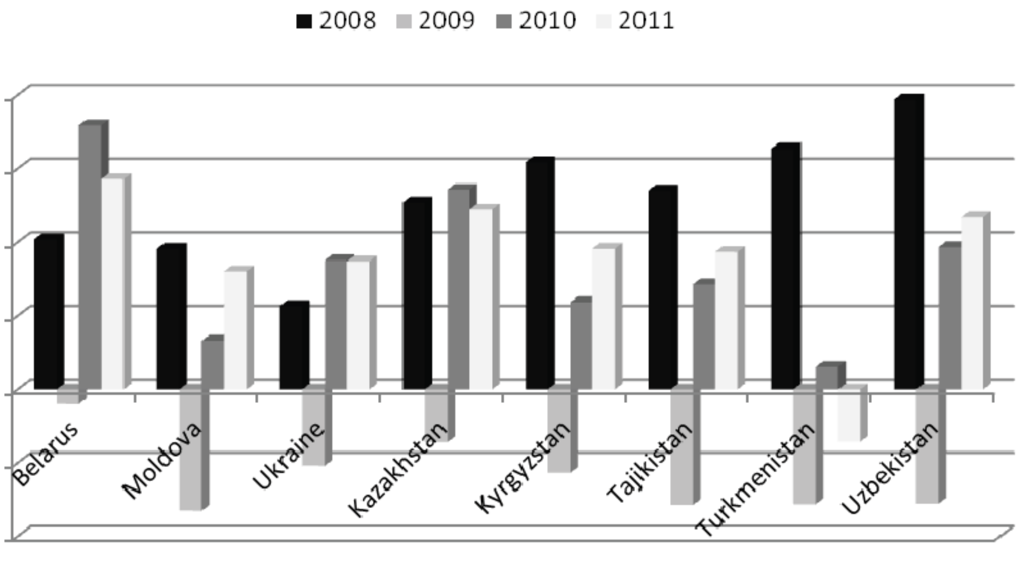

Chart 5: Remittances from Russia to CIS, growth rates (2008-2011)

Source: Russian Federation Federal State Statistic Services and Central Bank.

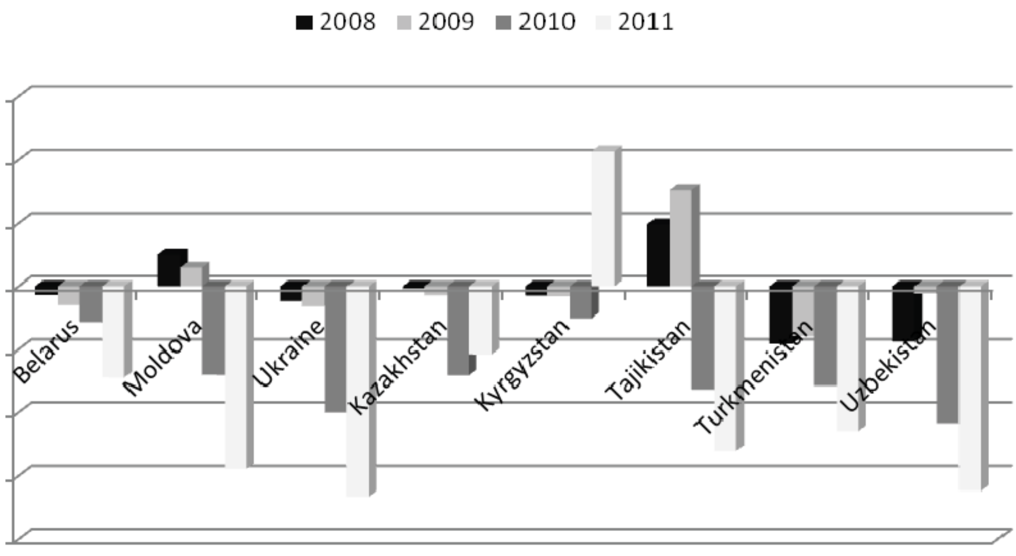

Chart 6: Migration flows from CIS to Russia, growth rates (2008-2011)

Source: Russian Federation Federal State Statistic Services and Central Bank.

5 Are restrictive migration policies effective?

The EU experience of gradually and selectively removing migration barriers' and Russia's effort to increase controls over people's mobility proves that restrictive migration policies focused on strict registration systems and quotas are not very effective in preventing immigration. So called "push" and "pull" factors determining the decision to migrate can be very strong and undermine the detrimental effect of migration restrictions.

According to the migration theory[33] migration is influenced at macro, micro and meso level by a number of factors, which are either “pulling” migrants toward a specific destination or “pushing” them to leave their country of origin. The “pull” factors are what drives migrants toward a specific countries and the main ones are the changing demographics (aging population) and the labour market needs in that specific country. The “push” factors are what encourage migrants to leave. They are population pressure, unemployment condition and crisis events (including conflicts and natural disasters) in the country of origin together with disparity in lifestyles and income between country of origin and destination. The decision to migrate is influenced most of the times by a combination of pull and push factors. Increased linkages because of globalization and access to cheap transportation have also facilitated labour mobility.

In the case of EU enlargement, migration flows trends from A8 countries and preliminary data for flows from Bulgaria and Romania suggest that labour market conditions and pressures from the country of origin “overruled” the impact of formal restrictions. In particular in the cases of Bulgaria and Romania, income disparities and population and unemployment pressures play also an important “pushing” role.

In Europe, transitional restrictions have definitely not reduced the size of the irregular migrant workforce. During the first two years since the first enlargement (2004-2006) the flow of labour from EU8 to EU15 seems to have been more demand-driven than regulated by the transitional regimes. The United Kingdom and Ireland have experienced robust economic growth and therefore attracted a significant number of migrants. The largest inflow occurred to the United Kingdom (until the end of 2006 a specially devised registered Workers Registration Scheme recorded 579,000 workers from EU8 countries). The inflow to Ireland was also quite strong: official migration figures indicate inflows of about 64,200 people between 2004 and 2006 form A8. On the contrary Sweden the country with the most liberal attitude towards migrants from A8 countries experienced a rather moderate inflow (25,000 between 2004 and 2006).

The Swedish case indicates that legal access of A8 citizens to a West European labour market does not automatically lead to considerable immigration. An empirical study based on migration flows from Central and Eastern Europe into the Nordic countries[34] (Pedersen and Pytlikova, 2008) shows that the estimated effect of the opening of Swedish labour market in 2004 on migration was almost zero. The authors suggested as a possible explanation the fact that “demand pressure in the Danish and Norwegian labour markets has been so strong that market forces have “overruled” the impact from the formal restrictions”. Denmark and Norway (not EU member) contrary to Sweden did not open their labour markets in 2004.

Other EU15 countries that had opted for transitional restrictions during the period 2004-06 have also experienced economic migration from EU8. Countries like Austria,

[33] Ernest Ravenstein introduced the concept of pull and push factors for the first time in his "Laws of Migration" (1889). After him many other migration theorists have used pull and push factors to explain migration movements.

[34] Sweden, Norway, Denmark, Finland and Island.

Germany, Italy and the Netherlands continued to issue short-term permits to A8 citizens (as this had already been the case prior to EU enlargement). In Austria the number of A8 workers – in particular from neighbouring Hungary and Slovakia – increased after 2004. In Germany the inflow from A8 – in particular from Poland – initially increased in 2004 despite an overall decline of migration flows to Germany.

Demand for labour – one of the key pull factors for migration- in those countries was stronger than migration restrictions and when could not be met by regular supply still attracted irregular workers. Economic slowdown and its effect on labour market also proved to have a stronger influence on migration flows than restrictive measures. In Germany in 2005 unfavorable labour market conditions (not restrictions) seemed to have reduced the inflow of additional labour migrants from A8. Similarly when the UK entered recession in 2009, migration flows to the country dropped significantly.

Finally, also pushing factors have a stronger effect on migration than barriers. In the same study Pedersen and Pytlikova, proved that the effect of Swedish and Finish labour markets opening towards the new EU members, Bulgaria and Romania, from the first day of the 2007 EU enlargement, was positive. Bulgaria and Romania pushing factors (including low GDP per capita, high unemployment, and population characteristics) were stronger than in the A8 countries. The results of a regression calculating the correlation between the propensity to migrate[35] to the UK and the GDP per capita in the A8 countries show that the economic prosperity in the source country has a strong influence on migration flows. Citizens of Lithuania and Latvia- the poorest of the A8 countries – showed the highest propensity to move, whereas those form the Czech Republic and Slovenia- the wealthiest A8 countries- have markedly lower rates of migration to the UK[36].

The Russia example also confirms the prevailing effect of pulling and pushing factors versus restrictions. Despite the introduction of a very strict registration system the number of migrant workers arriving to Russia in search of job continued to grow. The push factors in countries like Tajikistan and Kyrgyzstan – the poorest in the region – and the demand for cheap unskilled labour in Russia (pull) continue attract thousands of people from these countries.

Migration barriers both in the EU and in Russia ended up having the opposite effect of the one desired by the people and policy makers supporting their use. People found different ways for circumventing restrictions: for example entering the country as tourist, applying for asylum system, registering as self-employed service providers etc. Evidence shows that barriers to migration combined with the growth in demand of irregular workers in many sectors (including construction, textiles and sewing, catering, and domestic work) increased the incentives to irregular migration, employment in the informal sector or irregular employment in the formal sector.

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[35] Goldin, Cameron and Balarajan, exceptional People, Princeton Univeristy Press 2011 (Chapter 5 page 137).

[36] Goldin, Cameron and Balarajan, exceptional People, Princeton Univeristy Press 2011 (Chapter 5 page 137).

On the other side lowering migration barriers proved not only to be beneficial in terms of increasing the numbers of regular migrants, but also has not been accompanied by “migrant invasions”. Paradoxically raising restrictions enhance incentives for migrant workers to remain longer in the country and even settle. A famous case is the settlement of foreign migrants in Europe in the early 70s when the effective halt to labour migration encouraged many people to try to enter Europe through asylum systems or family reunion. After Germany closed the Gastarbeiter Programme with Turkey, for example, most of the migrants arrived in Germany through this Programme decided to remain in Germany instead of returning to Turkey and their wives and families joined them in Germany. The fear that no other migration possibilities would be available once they returned back to Turkey played a key role in convincing people to settle in Germany. Germany’s national population statistics show that in 2010 there were about 4 million people from Turkish descendent living in Germany.

6 Conclusion

The biaxial trend in migration and remittances for Eastern European and Central Asian economies showed that enhancing people’s opportunities to move within an economic union or a commonwealth union guides migration flows toward the most attractive labour markets in the region such as Russia, Germany and the UK. This can be extremely beneficial for the receiving countries as workers by filling the gaps of national labour supply can support economic growth in the countries of destination.

The migration paths in the European Union and in Russia over the past ten years show that restrictions and barriers to migration have failed in their purpose to control migration flows. Increasing migration barriers in a world where people are highly mobile does not stop migration; evidence from Russia and the EU show that trying to restrict legal migration flows had the opposite effect of enhancing illegal migration.

On the contrary, lowering barriers to migration can be extremely beneficial for both sending and receiving countries. The gains from eliminating migration barriers dwarf the gains from eliminating other types of barriers (trade and capital)[37] by a magnitude of two. Some economists[38] predict that completely opening borders would produce gains as high as US$39 trillion for the world economy in 25 years. The estimated gains from fully liberalizing international trade are about US $104 billion.

The paper’s main conclusion is that migration flows will continue no matter how restrictive the policy in place because borders are not impenetrable. Within a union the risks of restrictive migration policies seems to be more dangerous than opening the labour market to migrant workers, especially in countries where there is a strong demand for labour not fully met by national labour supply.

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[37] Clemens, 2011.

[38] Kym Anderson and Bjorn Lomborg.2008.” Free Trade, Free Labour, Free Growth”. Project Syndicate.

7 References

Babicka, K., 2011. "Cecilia Malmström: The is a Need for Legal Migration to the EU", *Migrationonline.cz,* July 2011. Available at http://www.migrationonline.cz/e-library/?x=2291323.

Black, R., Engbersen, G., Okólski, M. and Pantîru, C., 2010. *A Continent Moving West? EU Enlargement and Labour Migration from Central and Eastern Europe,* Amsterdam University Press-IMISCOE Research, Amsterdam.

Clemens, M., 2011. "Economics and Emigration: Trillion-Dollar Bills on the Sidewalk?", *Center for Global Development Working Paper 264,* August 2011. Available at http://www.cgdev.org/content/publications/detail/1425376.

Comini, D. and Faes-Cannito F., 2010. "Remittances from the EU down for the First Time in 2009, Flows to non-EU Countries More Resilient", *Statistics in Focus,* No. 40/2010. Available at http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-10-040/EN/KS-SF-10-040-EN.PDF.

Oblak-Flander, A., 2011. "Immigration to EU Member States down by 6 percent and emigration up by 13 percent in 2008", *Statistics in Focus,* No. 1/2011. Available at http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-11-001/EN/KS-SF-11-001-EN.PDF.

Goldin, I., Cameron, G. and Balarajan M., 2011. *Exceptional People: How Migration Shaped Our World and Will Define Our Future,* Princeton University Press, Princeton and Oxford.

Herm, A., 2008. "Recent Migration Trends: Citizens of Eu-27 Member States Become Ever More Mobile while EU Remains Attractive to non-EU Citizens", *Statistics in Focus,* No. 98/2008. Available at http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-08-098/EN/KS-SF-08-098-EN.PDF.

International Organization for Migration., 2010. "World Migration Report 2010. The Future of Migration: Building Capacities for Change", *International Organization for Migration,* Available at http://publications.iom.int/bookstore/free/WMR_2010_ENGLISH.pdf.

Mansoor, A. and Quillin, B., (eds.), 2007. "Migration and Remittances. Eastern Europe and the Former Soviet Union", *The World Bank*, 2007. Available at http://siteresources.worldbank.org/INTECA/Resources/257896-1167856389505/Migration_FullReport.pdf.

Marat, E., 2009. "Labour Migration in Central Asia: Implications of the Global Economic Crisis", *Central Asia-Caucasus Institute & Silk Road Study Program,* May 2009. Available at http://www.silkroadstudies.org/new/docs/silkroadpapers/0905migration.pdf.

Mensbrugghe van der, D., Roland-Holst. D., 2009. "Global Economic Prospects for Increasing Developing Country Migration into Developed Countries",*United Nations Development Programme Human Development Research Paper 2009/50,* October 2009. Available at http://hdr.undp.org/en/reports/global/hdr2009/papers/HDRP_2009_50.pdf.

Okólski, M., 2007. "Europe in Movement: Migration from/to Central and Eastern Europe", *Centre of Migration Research Working paper 22/80,* August 2007. Available at http://pdc.ceu.hu/archive/00003130/01/022_80.pdf.

OSCE Office for Democratic Institutions and Human rights, 1998. "The CIS Migration Conference: Implementation of the Program of Action of the Regional Conference to Address the Problems of Refugees, Displaced Persons, Other Forms of Involuntary Displacement and Returnees in the Countries of the Commonwealth of Independent States. The Issue of the Internal Registration (Propiska)", *Background Paper 2 for OSCE Human Dimension Meeting.* Available at http://www.osce.org/odihr/16646.

Pedersen, P. and Pytlikova, M.,2008. "EU Enlargement: Migration flows from Central and Eastern Europe into the Nordic countries - exploiting a natural experiment", *Dept. of Economics, Aarhus School of Business, Aarhus University, Prismet Working paper 8-29*. Available at http://www.hha.dk/nat/wper/08-29_marp.pdf.

Münz, R. and Tamaz, C. 2005. Labour Migrants Unbound? EU Enlargement, Transitional Measures and *Labour Market Effects.* Institute for future studies, Stockholm, Sweden.

Saari, S., 2006. "Balancing between Inclusion and Exclusion: The EU's Fight against Irregular Migration and Human Trafficking from Ukraine, Moldova and Russia", *London School of Economics-Challenge Working Paper,* January 2006. Available at http://www2.lse.ac.uk/internationalRelations/centresandunits/EFPU/EFPUchallengepapers.aspx.

Traser, J., 2008. "Who's Afraid of the EU's Latest Enlargement? Report om the Impact of Bulgaria and Romania Joining the Union on Free Movement of People", *European Citizen Action Service.* Available at http://www.ecas-citizens.eu/content/view/238/272/.

United Nations Development Programme, 2009. "Human Development Report 2009. Overcoming Barriers: Human Mobility and Development", *United Nations Development Programme,* New York.

Mobility of Top 500 Firms in the U.S., China and the Globe

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Abstract
Firm size, as an indicator of the firm's status and momentousness within the economic system, has attracted focused attention from researchers. Starting from Gibrat's seminal work, firm size distribution has been intensively studied in literature, most of which confirms the stable distribution of firm size in various scenarios including economic boom and downturn. Nevertheless, such macro-stability in firm size distribution can mask a volatile and often turbulent micro-dynamics wherein revenue and rank of a given firm fluctuate wildly while the overall distribution of all firms' sizes remains steady. In this paper, mobility, i.e. a measure of fluctuations, of top 500 companies - China 500(CH500), Fortune 500 (US500) and Fortune Global 500(FG500) - is discussed as we unveil micro-dynamics. Qualitatively, visualization of underlying fluctuations or mobility, evolving from changes in each firm within the top 500 is implemented by rank clock, revenue clock and share clock. Among three clocks, evolution of a given firm's economic strength is best illustrated by share clock. Quantitative measurements of mobility are exemplified by the number of same firms in two successive years, revenue mobility index, rank mobility index and share mobility index. A novel finding is that share mobility acts as an effective indicator for economic status: where there is a share mobility spike, there is an ailing economy. As indicated by share mobility, 2008 Financial Crisis had little impact on Chinese economy while triggering violent changes in top 500 firms in the United States and the globe.

1 Introduction

Firms or enterprises, either small businesses or giant corporations, provide various products and lucrative services to satisfy human needs, playing pivotal roles in our daily life as well as in the development of economy. For decades, scholars have paid focused attention to corporations from diverse aspects. The size of a firm is such a useful indicator of a given firm's status and momentousness within the economic system that it arouses immense enthusiasm among researchers. In addition, the non-negligible impact of firm size on other elements in business such as productivity (Dhawan, 2001), competitive advantages and export performance (Moen, 1999) further intensified such attention.

Firm size distribution has been deeply studied in literature (Gibrat, 1931; Simon, 1958; Ijiri, 1977; Axtell, 2001; Cabral, 2003; Zhang, 2009; Gallegati, 2010). The first conventional wisdom dates back to Gibrat (1931) who stated firm growth rates are independent of size as firm growth follows a random process(Law of Proportional Effect or Gibrat's Law), and that the static firm size distribution would approach log-normal under Gibrat's Law. However, later studies based on more complete data sets challenge the log-normal form as well as its explanations. Instead, they put forward another empirical regularity that firm size distribution follows a Pareto Law (or power law). Stanley et al. (1995) studied American firms and found that the log-normal distribution had too little mass in the upper tail. Simon (1958) argued that the lognormal distribution was not for the whole data, the real data actually had power law tail. Other scholars such as Axtell (2001) who studied the U.S firm size, Zhang el al. (2009) who found the distribution of top 500 Chinese firms' revenues obeyed the Zipf's law with exponent of 1 from 2002 to 2007 contended that the data followed power law as a whole. Although controversy on the shape of firm size distribution has lasted for decades without common consent, scholars agree on the opinion that the firm size distributions are statistically stable (Gallegati, 2010).

Despite such stability in the overall firm size distribution, if we check on the composition of CH500, US500, FG500, it is evident that firms comprising each list of top 500 firms shift quite dramatically from year to year. Due to the substitution of retrograded companies for new competitive ones, or annual fluctuations in firm's size and thus in its rank, turbulent fluctuations unfold when each individual company within a category is tracked. The phenomena that the size of a given firm adjusts swiftly and accordingly its rank goes up and down in a violent manner, and that different firms follow inconsistent and divergent paths of firm size growth, more often than not, relate to a highly competitive market, a vibrant economy, and thus a relatively efficient allocation of resources in the society. On the other hand, if the growth patterns of all firms are alike, the economy is otherwise regarded as stagnant and unpromising. Therefore, delving into the mobility of firm size is more than significant in gaining insights into the status of the whole economy. The fundamental aim of this paper is to demonstrate such an important indicator, i.e., mobility of firms, in both a qualitative way and a quantitative way.

In this paper, we focus on mobility of top 500 companies in the U.S., China, and the globe - China 500 (CH500), Fortune 500 (US500) and Fortune Global 500 (FG500). There are good reasons for us to believe that 500 top firms are representative of the economy where they are located. A straightforward proof is that in numerical terms, total revenue of Chinese top 500 in 2009, which is about 27.6 thousand billion RMB, accounts for 81% of China's GDP in that year; as to the U.S., the share is much lower but still constitutes about 66% of U.S.'s GDP; 39.62% of total GDP in the world come from firms listed in the Global 500. Thus, top 500 firms' substantial relative weight on the market account for their dominance over the whole economy and their economic clout. Likewise, even though the sample datasets of firms in this paper are not exhaustive, they are quite informative and intriguing because what have been left over are merely a great number of very small businesses whose economic activities are practically nil. Furthermore, all information about the top 500 companies in many countries and the globe is publicly available, more importantly, reliable.

This paper discuss on mobility in the form of firms in the above-mentioned three typical economic systems-the U.S. who is widely acknowledged super power, i.e. the largest economy so far, China, the largest developing country enjoying spectacular economic growth under the socialist market economy system, and lastly the globe who presents as a cultural, political, economic integration.

The remainder of the paper is organized as follows: in Section 2, reliable sources of datasets applied in the paper are introduced. In Section 3, underlying micro-dynamics are unveiled and visualized in three clocklike graphs. Quantification of such dynamics-mobility index-is defined and further discussed in Section 4. We conclude in Section 5.

2 Data Source

Information about Top 500 enterprises of China (CH500) from 2002 to 2010 is collected from a series of volumes of *"A Report on the Development of China's Enterprises"* issued annually by the organization named *China Enterprise Confederation* since 2002. The data also can be obtained from the website *http://www.cec-ceda.org.cn/c500*, wherein each firm's name, sales revenue (in RMB terms), rank, asset, number of employees etc. are listed in descending order of its sales revenue. Till now, 9 years of data about CH500 are available.

The Fortune 500 (US500) is an annual list compiled and published by Fortune magazine that ranks the top 500 U.S since 1955. It includes publicly and privately-held companies whose revenue is publicly available at the website *http://money.cnn.com/magazines/fortune/fortune500/*. It is noteworthy that initial edition of *Fortune 500* was restricted to companies whose revenues were derived from manufacturing, mining, or energy exploration, another list named *Fortune 50* which ranked the 50 largest commercial banks (ranked by assets), utilities (ranked by assets), life insurance companies (ranked by assets), retailers (ranked by gross revenues) and transportation companies (ranked by revenues) is a supplement to *Fortune 500*. In 1995, all the lists above consolidated to form a new version of *Fortune 500* with its current form. Thus, we collect information about US500 from 1995 to 2010 rather than from 1955 to 2010, totaling a collective dataset for 16 years.

In a similar way, the *Fortune Global 500*(FG500) is Fortune magazine's annual ranking of the world's 500 largest companies. Before 1989, it merely listed non-U.S. industrial corporations while U.S. corporations that ranked top 500 in the world were listed in *Fortune 500*. In 1990, U.S. companies were added to compile a genuine global list of top industrial corporations as ranked by sales. However, it was not until 1995 that *Fortune Global 500* had its current form listing top financial corporations and service providers as ranked by revenue. A dataset of FG500 ranging from 1996 to 2010 is obtained from the website *http://money.cnn.com/magazines/fortune/global500/*.

For each corporation in US500 and FG500, revenue by which it is ranked is measured in U.S. dollar; revenue of CH500 is measured in RMB. Noting that revenue and other statistics about the company are for the year previous to the named year when the list published, namely US500 in 2010 is a list of top 500 corporations in 2009, we adjust the date to the actual year when revenue is used to rank the firm in the following discussion for a straightforward demonstration. Since the top 500 in each group are ranked according to their revenues, we apply revenue of the firm as the only proxy for firm size in this paper.

3 The Micro-Dynamics and Clocklike Graphs

Substitution of retrograded companies for new competitive ones ("exit and entry"), or variations in surviving firms' size and rank as well as market share will lead to an updated version of top 500 firms every year. That is, if we check on the composition of CH500, US500, FG500, it is evident that firms comprising each list of top 500 firms shift quite dramatically from year to year. Narrowing the stable holistic firm size distribution down to the evolution of each individual company, turbulent fluctuations are unveiled.

Statistics indicate there are 811 companies from all around the world who have made it to FG500 from 2001 to 2009, only 325 firms from FG500 in 2001 still survive in the list in 2009, accounting for a percentage of 65.0%; in the United States, 742 firms appear in the top 500 from 2001 to 2009, while of the top 500 firms in 2001, only 331 remain in the list in 2009, accounting for a percentage of 66.2%; a total number of 1073 Chinese companies have been listed in CH500 during the same period, whereas 201 Chinese firms form CH500 in 2001 account for 40.2% of firms from CH500 in 2009. On average, it takes 11.43 years for 250 companies to appear or disappear from the top 500 in the globe, 11.83 years in the United States, and only 6.69 years in China. Therefore, components of CH500 have been experiencing more volatile changes.

According to the evidence above, macro-stability in firm size distribution over a period of time always mask a volatile and often turbulent micro-dynamics involving exit and entry of firms as well as changes in their revenues, ranks and other attributes such as market share.

One graphical presentation of such dynamics is the rank clock introduced by Michael Batty (2006), in which rank orders are plotted in polar coordinates for each corporation in temporal clockwise direction with the highest rank at the centre and the lowest on the circumference. Based on this idea, we propose two additional clocklike graphs termed revenue clock and share clock in order that those underlying mobility will be unfolded from more than one aspect.

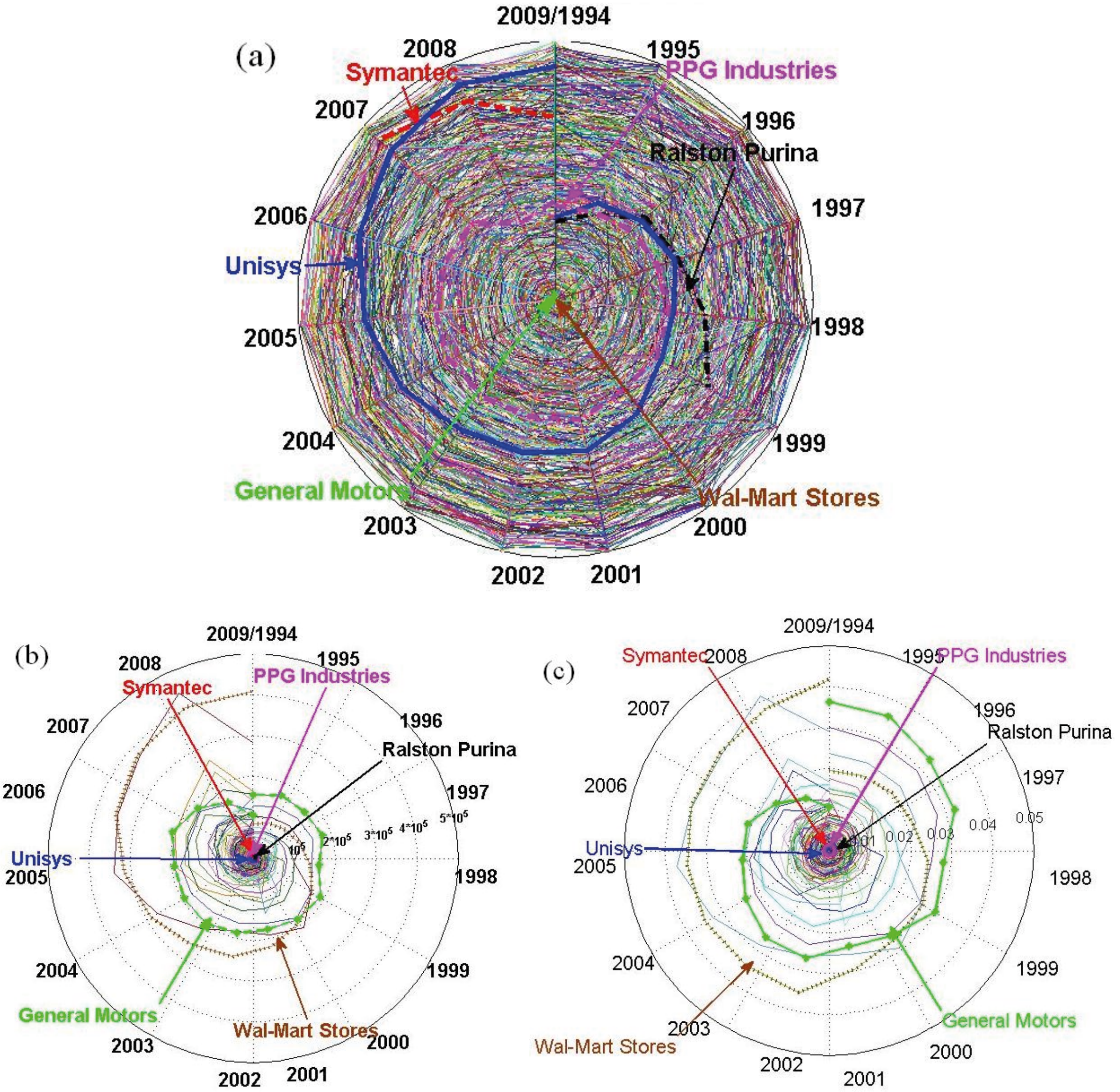

Figure 1: Clocks of US500

In the rank clock of US500, shown in Figure 1(a), the track of a firm's rank denoted by its distance from the origin in polar coordinates is displayed in a clockwise direction, and each firm is identified by an exclusive colour. Following the path, we can tell that *Wal-Mart* and *General Motors*, presenting as a small circle next to a dot, have ranked the top since 1994, that *Unisys* and *PPG Industries* slowly decline in their ranks as time passing by, that *Ralston Purina* fell out of US500 in 1999, and that new competitive corporations, such as *Symantec*, enter the list since 2007 with business innovation.

Revenue clock of US500 is displayed in Figure 1(b). Almost each curve in the plot is divergent, indicative of a boost in the revenue of each firm. It implies that economic upturn or boom is the main feature of social development despite the slight decline from 2008 to 2009. Paths of top corporations such as *Wal-Mart* are quite distinct in this revenue clock, in sharp contrast with firms who are assigned with lower ranks all the time. In 2000, revenue of *Wal-Mart* surpassed *General Motors* for the first time and then went far beyond it in the following years. Impacted by 2008 Financial Crisis, *General Motors* suffered a significant shrinkage in its revenue for the past three years. Other firms such as *Unisys* and *PPG Industries*, compared with the former, have relatively lower revenues all the time. Notably, the impact of financial crisis is revealed by revenue clock of US500, wherein revenues of all firms within the category dropped appreciably after the crisis.

The above-mentioned revenue clock explicates continuous growth of most enterprises, giant corporations in particular, who have ever been listed within the top 500, and rank clock gives us a vivid picture of the volatile changes in firm's ranks. Despite that, neither of them is convincing in showing the changes of a firm's momentousness or economic strength in the whole economy. Reasons for such a failing are twofold: on one hand, the real value of a given firm whose revenues have doubled during the last year has not necessarily increased twofold if the effects of price and other factors that would probably influence firms' absolute revenues, e.g. inflation, are taken into consideration; on the other, two firms converging towards the same rank can still have divergent growth patterns of firm sizes. In fact, a firm providing more essential products or services would accordingly play a more pivotal role in the economy. To offset this drawback of the above-mentioned two clocks, we propose another clocklike graph termed share clock. Assuming the amount of products and services provided by top 500 firms takes up a constant share of all the products and services in the economy, the market share of a given firm within the top 500, defined as the ratio of revenue to the total revenue of top 500 in a given year, is representative of its economic strength. Share clock of US500 is shown in Fig. 1(c). Over the observed period, namely from 1994 to 2009, market share of *General Motors* decline from approximately 3.5% to 1%, by contrast, *Wal-Mart* witnesses a boost in its revenue share from less than 2% to over 4%.

By applying the same descriptive techniques, rank, revenue and share mobility of CH500 and FG500 are demonstrated in Figure 2 and Figure 3 respectively.

In the case of Chinese top 500 corporations, the blue curve in Figure 2(a), Figure 2(b), and Figure 2(c) stands for *China Vanke*, the leading Chinese property developer. According to Figure 2(a), its rank has been elevated for recent years on end as the unprecedented prosperity in the market of real estate goes on. *Sinopec* who is the largest oil producer and refiner in China for many years, and who always rank first in top 500 enterprises of China witnesses a considerable boost in its revenue, as is shown by Figure 2(b). Its market share peaked in the year of 2006 (see Figure 2(c)), which is 6% of the total revenue of CH500 in that year. Slightly impacted by the 2008 financial crisis, the share of *Sinopec* decreased.

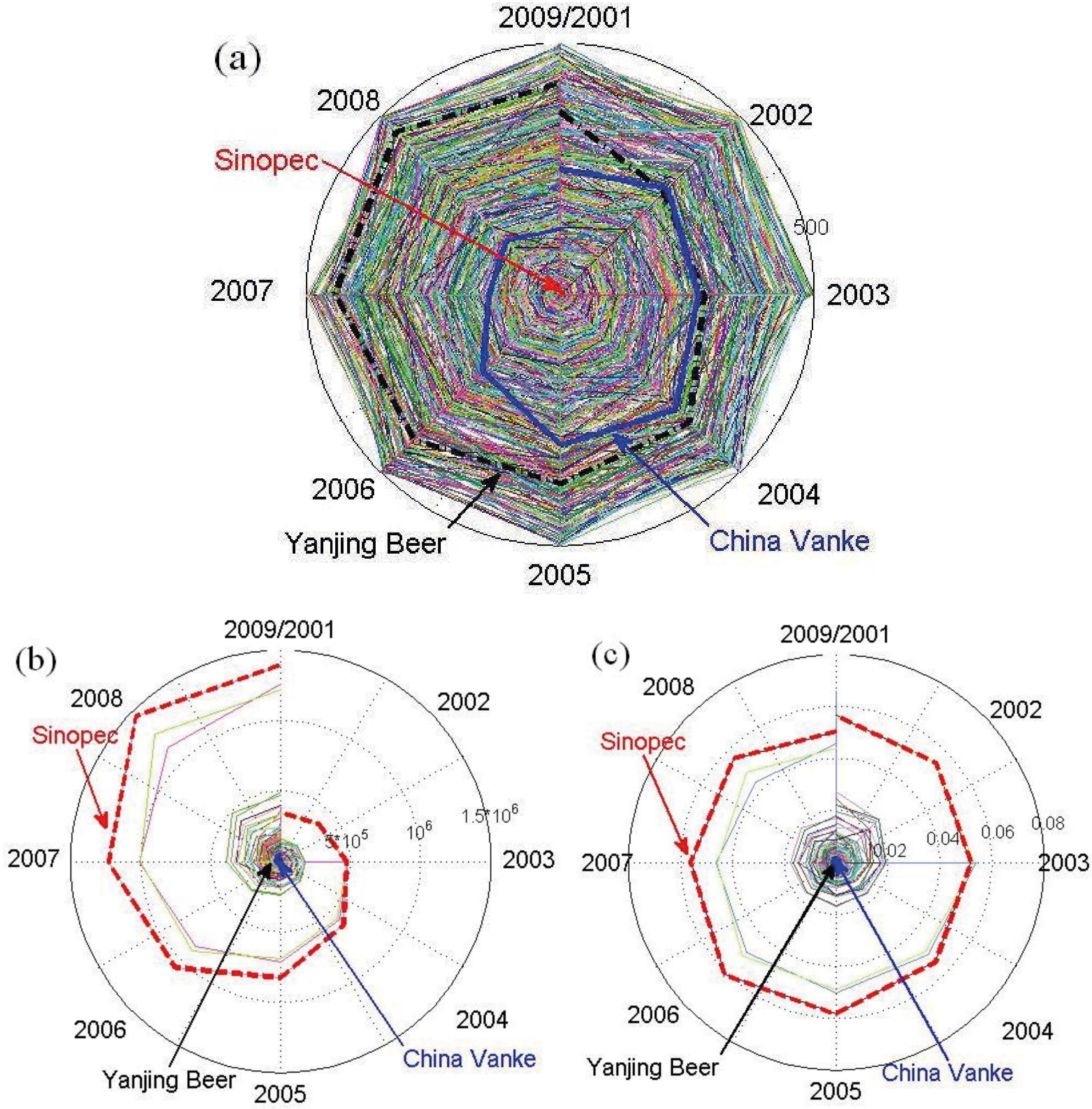

Figure 2: Clocks of CH500

According to Figure 3, the retailing industry in the world, led by several multinational conglomerates such as *Wal-Mart* and *Carrefour*, has been increasingly flourishing during the recent decades. To illustrate, revenue of *Wal-Mart* rises up all the way to the extent that its rank has been staying the top for many years. Compared with other corporations, its market share experiences a noticeable boost as well. *Toyota Motor* in the industry of automobile has also been enjoying steady increase in its revenue, however, with a stagnant and even retrograded market share in the global economy.

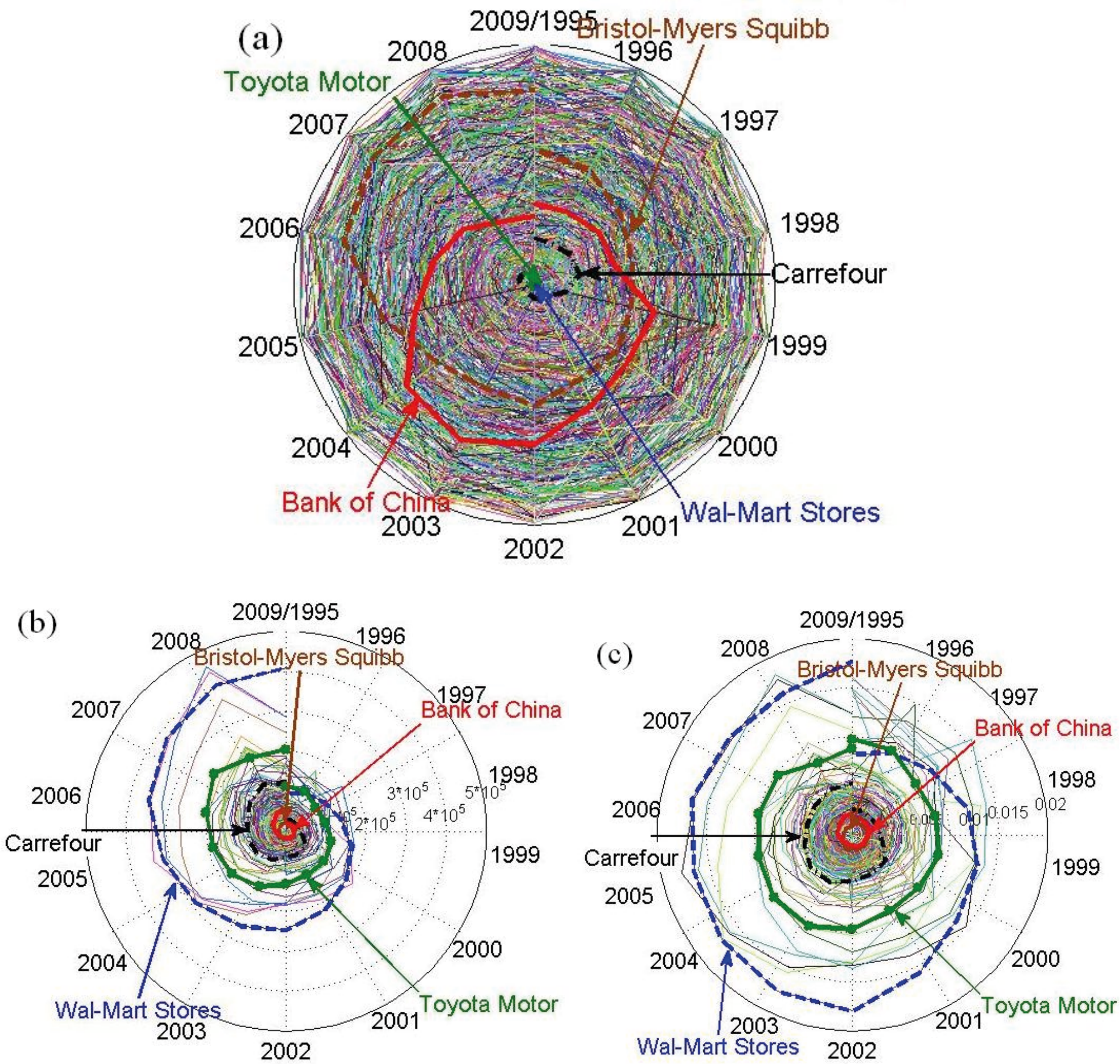

Figure 3: Clocks of FG500

In a rank clock, traces of top corporations who are always assigned with top ranks gather around the centre of the clock, while encircled by courses of many smaller companies. Information revealed by the rank clock is, though interesting, limited. Revenue clock manifest fluctuations in several top companies' revenue, however, at the cost of blurring the evolutions of smaller ones. By comparison, given a firm's absolute revenue and the total revenue of its group, a share clock effectively illustrates their relative economic clout within the category of top corporations; in the meantime, it displays the variation of its revenue to some extent.

4 Mobility Indexes

In previous section, we uncovered the underlying fluctuations within firm size distribution and visualized these micro-dynamics by graphical tools termed rank clock, revenue clock and share clock. Such techniques are effective in representing the change of one attribute of the corporation over time, but not qualified enough to give a quantitative measure of the differences within the category at different time, because in that case only comparisons within the category are possible. If mobility-a measurement of aggregate fluctuation- is computed for each category in each year, we are assured to compare the mobility of different categories at different points of time. In this section, some quantitative indexes for measure of micro dynamics are introduced by turns.

The mobility index (Fields 1996, 1999) is defined as follows

$$\bar{d}(t,t-1)=\frac{\sum_{i=1}^{N(t,t-1)} d_i(t,t-1)}{N(t,t-1)}=\frac{\sum_{i=1}^{N(t,t-1)} |x_i(t)-x_i(t-1)|}{N(t,t-1)}$$

where $x_i(t)$ is an attribute of agent i at the time t, $N(t,t-1)$ is the number of corporations who rank within the top 500 both at the time $t-1$ and t. In the discussion of mobility of top 500 enterprises, if applying the firm's revenue, rank, and its share of total revenue as the attribute $x_i(t)$ of a firm, $d_i(t,t-1)$ is termed revenue mobility, rank mobility and share mobility in the period $t-1$ to t of the *i*-th firm respectively. Revenue mobility quantifies the variation in each firm's absolute revenue. Being independent of other firms, it is an absolute index. A firm's rank and share of total revenue depends on other members in the category to which it is belong, thus both rank mobility and share mobility are relative terms.

Evolutions of revenue mobility, rank mobility and share mobility of CH500, US500 and FG500 over the observed period are displayed in Figure 4, Figure 5 and Figure 6 respectively.

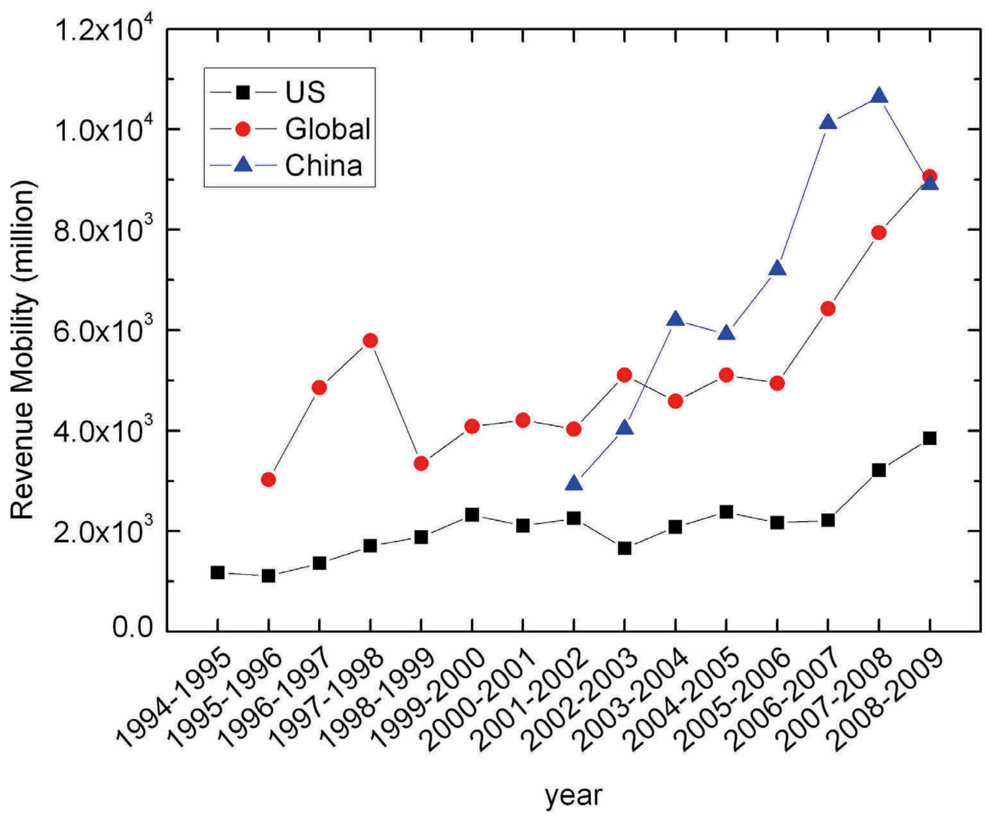

Figure 4: Revenue mobility

According to the revenue mobility plot in Figure 4, revenue mobility of each category is on the rise with divergent growth rates. Revenue mobility of US500 experiences a progressive increase, whereas that of CH500 goes up rapidly except occasional descends in 2005 and 2009. Since2006, revenue mobility in FG500 ascends more swiftly compared with previous years. Without considering direction of revenue change, the ascending trend of revenue mobility in US500 and FG500 is not altered in nearest years that it seems that these economies do not effect by 2008 Financial Crisis.

In previous discussion, revenue of US500 and FG500 is measured in the U.S. dollar while that of CH500 measured in RMB. Given historic exchange rates between RMB and the U.S. dollar, we find that revenue mobility of FG500 is higher than that of US500, and that CH500 have the least revenue mobility.

Rank mobility which quantifies the variation in a firm's rank from 1 to 500 is shown in Figure 5.

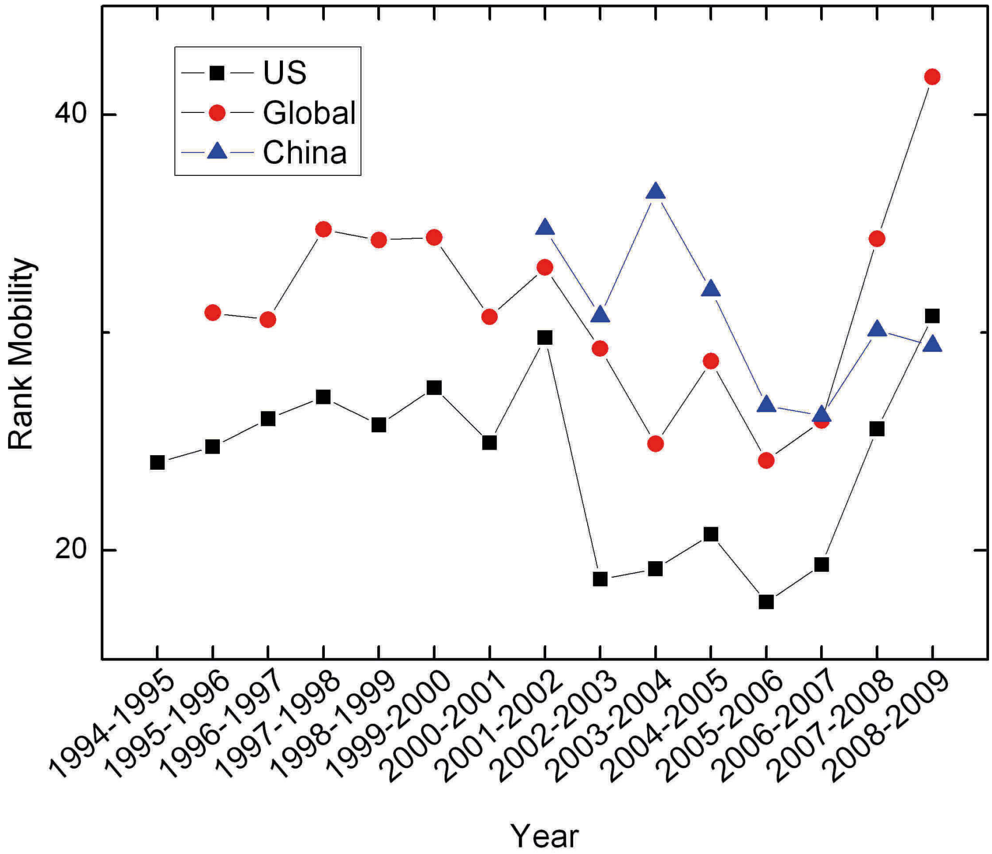

Figure 5: Rank mobility

According to Figure 5, the same company in CH500 has been experiencing a quite serious fluctuation in its rank in two successive years, which is characterized by a much higher mobility. By contrast, rank mobility of US500 and FG500 maintains at a low level, suggesting an economic climate lacking of competitions at that time. Furthermore, the impact of financial crisis on rank mobility of CH500, US500 and FG500 differs. There is not as much influence on China as on the U.S. and the globe. It is noteworthy that rank mobility of FG500 peaked during 2008 to 2009, indicative of a violent rank modification within the world top 500 enterprises as never before.

Mobility index applying the share of a firm's revenue of the total revenue in its group as the attribute of the firm is termed share mobility. Evolutions of share mobility of three categories are shown in Figure 6.

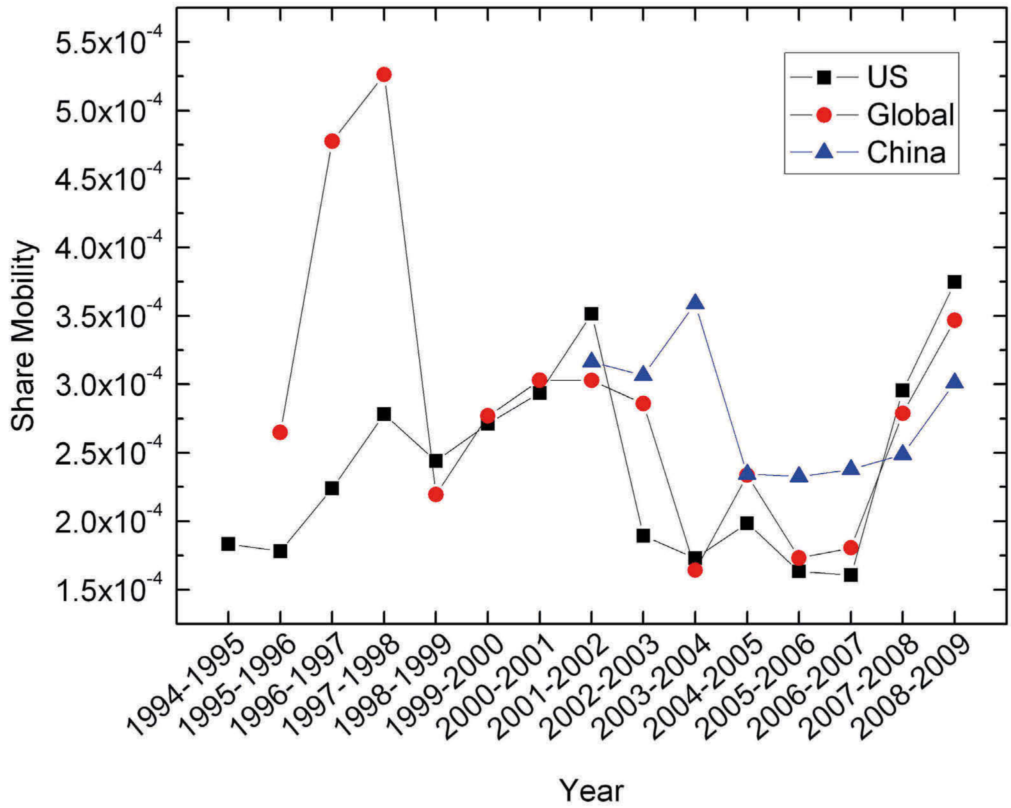

Figure 6: Share mobility

Changes in share mobility of US500 and FG500 follow a cyclical pattern. More intriguingly, the summit in a cycle corresponds with each occurrence of financial crisis.

During 1997 and 1998, share mobility of US500 and FG500 reached its pinnacle for the first time during observed period. It coincided with the 1997 Financial Crisis in Asia. At that time, share mobility of FG500 rocketed up, indicating a more severe impact of Asian Financial Crisis on the globe than on the United States. Understandably, enterprises in the United States were more immune to Financial Crisis occurring in Asia.

Share mobility reached another peak within the year of 2001 and 2002 when the Dot-com bubble in the United States burst. At that moment, it was top 500 enterprises in the United States that suffered the most severe blow. Also understandably, for U.S. corporations, adverse consequences brought about by the American Dot-com bubble overtook that brought by the Asian Financial Crisis.

More recently, share mobility of each category made another ascent in the wake of 2008 Financial Crisis. Top 500 firms in the United States suffer the most violent modifications in share mobility during this crisis, followed by top 500 in the globe and then in China.

To conclude, measured by share mobility, 1997 Financial Crisis in Asia triggered more turbulent changes in top 500 firms worldwide than 2008 Financial Crisis. However, impact of the recent 2008 Financial Crisis on the United States cannot be overtaken by the previous two crises.

5 Conclusion

The size of a firm has always aroused great attention due to its indication of the the firm's status and momentousness within the economic system. Instead of focusing on the overall firm size distribution, this paper sheds some light on the mobility, i.e., ignored fluctuations hidden behind the static distribution, of three representative categories of top 500 firms- China 500(CH500), Fortune 500 (US500) and Fortune Global 500(FG500).

Despite the prevailing feature of stability presented in previous literature in firm size distribution, firms comprising each list of top 500 firms are proven to have been shifting from year to year either due to the substitution of retrograded companies for new competitive ones, or to annual fluctuations in firm's size and thus in its rank. At a microscopic level, i.e., when tracking the evolution of only one particular company, violent fluctuations in the revenue, rank and market share of the firm unfold.

Graphically, rank clock, revenue clock and share clock are utilized to visualize these micro-dynamics evolving from changes in each firm within the top 500. On the rank clock, corporations with top ranks are located at the centre, encircled by disordered courses of a group of relatively smaller firms. Revenue clock manifests the evolutions of revenue in companies with the several largest revenues, while blurring those of smaller ones. By comparison, a share clock effectively illustrates their relative economic clout within the category of top corporations.

As a quantitative measurement, mobility index predicated on Fields (1996, 1999) is introduced and further developed into three specified indexes—revenue mobility, rank mobility and share mobility. Rank mobility and share mobility, as relative terms that are independent of unit and other members within its group, are straightforward for comparison. According to these two indexes, there exists higher mobility in top 500 firms in China than in the United States. However, 2008 Financial Crisis had little impact on Chinese economy while triggering violent changes in top 500 firms in the United States and the globe.

The most important novel finding in our research is that share mobility is a useful indicator of deteriorations in economic climate such as financial crises. Where there is a share mobility spike, there was a corresponding deterioration in the economy.

6 Acknowledgment

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7 References

Axtell, R. (2001): Zipf distribution of U.S. firm sizes, in: Science 293, page 1818–1820.

Batty, M. (2006): Rank clock, in: Nature 444(7119), page 592-596.

Cabral, L. M. B.; Mata, J. (2003): On the evolution of the firm size distribution: facts and theory, in: American Economic Review 93(4), page 1075–1090.

Dhawan, R. (2001): Firm size and productivity differential: theory and evidence from a panel of US firms, in Journal of Economic Behavior & Organization 44(3),page 269-293

Field, G. S.; Ok, E. A. (1996): The meaning and measurement of income mobility, in: Journal of Economic Theory 71(2), page 347-377.

Field, G. S.; Ok, E. A. (1999): Measuring Movement of Income, in: Economica 66(264), page 455-471.

Gallegati, M.; Palestrini, A. (2010): The complex behavior of firms' size dynamics, in: Journal of Economic Behavior & Organization 75(1), page 69-76

Gibrat, R. (1931): Les inégalités économiques; applications: aux inégalités des richesses, à la concentration des entreprises, auxpopulations des villes, aux statistiques des familles, etc., d'une loi nouvelle, la loi de l'effect proportionnel. Recueil Sirey, Paris.

Ijiri, Y.; Simon, H. A., (1977): Skew Distributions and the Sizes of Business Firms, Amsterdam.

Moen, Ø. (1999): The relationship between firm size, competitive advantages and export performance revisited, in International Small Business Journal 18(1) page 53-72

Simon, H. A.; Bonini C. P. (1958): The size distribution of business firms, in: The American Economic Review 48(4), page 607-617.

Stanley, M. H. R.; Buldyrev, S. V.; Havlin, S.; Mantegna, R. N.; Salinger, M.A.; Stanley, H.E. (1995): Zipf plots and the size distribution of firms, in Economics Letters 49(4),page 453–457

Zhang, J.H.; Chen, Q. H.; Wang,Y. G. (2009): Zipf distribution in top Chinese firms and an economic explanation, in: Physica A: Statistical Mechanics and its Applications 388(10), page 2020-2024.

Relevance of oil prices for mobility today and in the next decades

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Abstract
The paper discusses the role of crude oil prices as an important cost factor for individual and collective mobility. After a short introduction, there will be three further sections. Section 2 covers a general discussion of the relevance of oil today and also several scenarios for the future demand development will be discussed. In section 3 some oil price forecasts will be presented and compared to fundamental cost parameters. The paper ends with a conclusion section.

1 Introduction

Mobility is an important factor in a globalized world. This paper focuses on the cost aspects of an increasing need for mobility, here translated into transport costs.

Even if the recent discussion on is dominated by alternative technologies and fuels (E-cars, CNG, biofuels, fuel cells, hydrogen etc.), most of the worldwide energy needs in the transport sector is still covered by oil products such as Diesel, gasoline or fuel oil. As these product prices are fully correlated with the crude oil price, fluctuations on the world oil market are fully passed on to the transport sector.

This paper first (section 2) discusses the current role of oil in covering the world demand and the transport sector. Also some future scenarios are discussed with special emphasis on the future energy demand and the supply mix in the transport sector. Afterwards some oil price forecasts will be discussed. This will be supplemented by a fundamental view on the physical and commercial availability of oil resources (section 3). Conclusions will be drawn in section 4.

2 Oil demand today and in future

2.1 World primary energy consumption

Oil is nowadays still the most important primary energy source worldwide (see left side of Figure 1). Even a drop in demand after the oil crises in the 1970s/early 1980s and an increase of other conventional fuels (especially coal and gas) in the last decades haven't challenged the role of oil as the leading energy. And it is also worth to mention that the latest world financial crisis starting in 2008 hasn't eroded the growth of energy demand (which of course accounts for all energy sources and not only for oil).

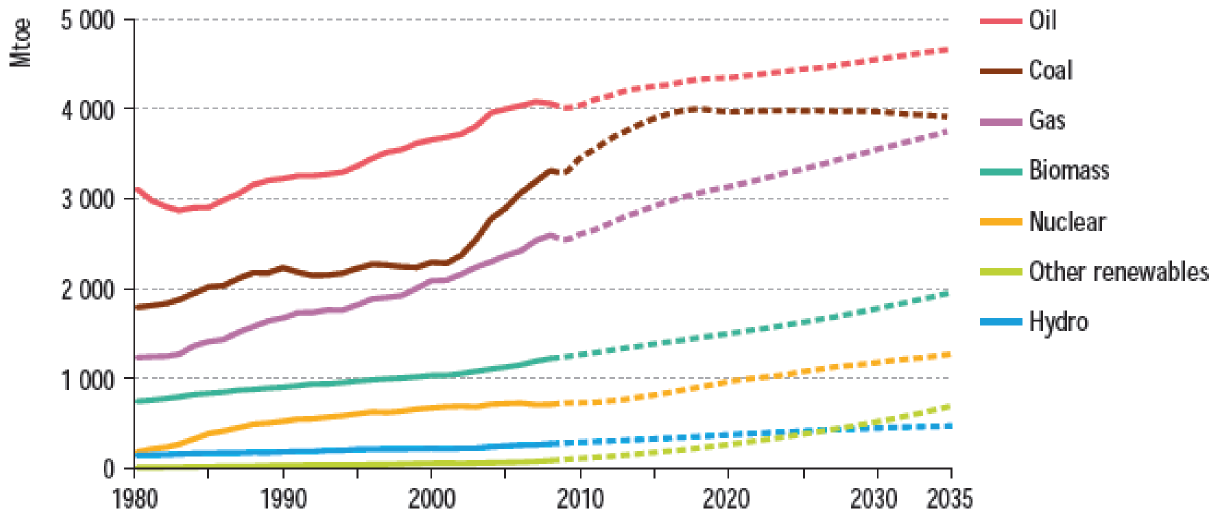

Figure 1: World primary energy demand in the past and in IEA's New Policy Scenario[1]

[1] See IEA, 2010a, page 84.

On the right hand side of the figure above, a future view of the energy demand for the next 25 years is indicated. The forecast presented is the "New Policy Scenario" published by the International Energy Agency (IEA) of the OECD. It represents a moderate set of assumptions, considering measures to reduce energy demand and CO2-emissions – but on an economic reasonable basis. Other scenarios published in the latest issue of the "World Energy Outlook" are defined as more extreme variations of the future development: a "Current policy scenario", which assumes no further enhancement of environment and climate policy and the so called "450 scenario", which includes massive measures to reduce CO2 emissions. The first one sees an even stronger increase of world energy needs, the latter end up with a demand in 2035 which is slightly lower than today. But however, oil will be the most important energy source in all scenarios.[2]

Of course, other forecasts exist - and other assumptions usually produce other results. But the most comparable studies, meaning such covering the whole world and all sectors and which are based on (at least some kind of) economic modeling, tend to support the general conclusion that oil will keep its position at least until 2030.[3]

Some more regional focused studies (as well as those only focused on one sector, e.g. electricity generation) could tend to see higher shares of renewables or other sources or even replacement of oil by alternative sources. But once again, usually the role of oil as the world's leading primary energy source is not challenged within the next 20 or more years.[4]

2.2 Energy demand in the transport sector

Since the oil crises in the 1970s/1980s the position of oil has been challenged in several sectors. Especially in the electricity sector, oil products are more or less fully displaced in most countries. In other sectors, oil loses massive market shares to competing fuels - but is not (yet) displaced. This is e.g. the case in the space heating sector in the majority of industrialized countries, where gas or district heating overtaking oil-fired heating. In contrast to these applications, only very small limited achievements have been made in the transport sector. As been shown in Figure 2, oil products (Diesel, gasoline, jet fuel and heavy fuel oil) still cover the vast majority of energy needs.

Forecasts focusing on the transport sector provide very wide ranges of the future share of oil products. In principle, two key parameters influence the result: the total demand and the share of alternative energy sources in the supply mix. As with the primary energy forecasts discussed above, results for smaller geographic regions or countries could show a more or less full displacement of oil, but in worldwide dimensions this is realistically not possible. Figure 2 summaries the results of several scenarios from the IEA.

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2 See IEA, 2010a, page 80.

3 E.g. see EIA, 2011, ExxonMobil, 2010, or Shell, 2008.

4 Examples for country or regional specific analysis are EU (2010) and EWI et al. (2010).

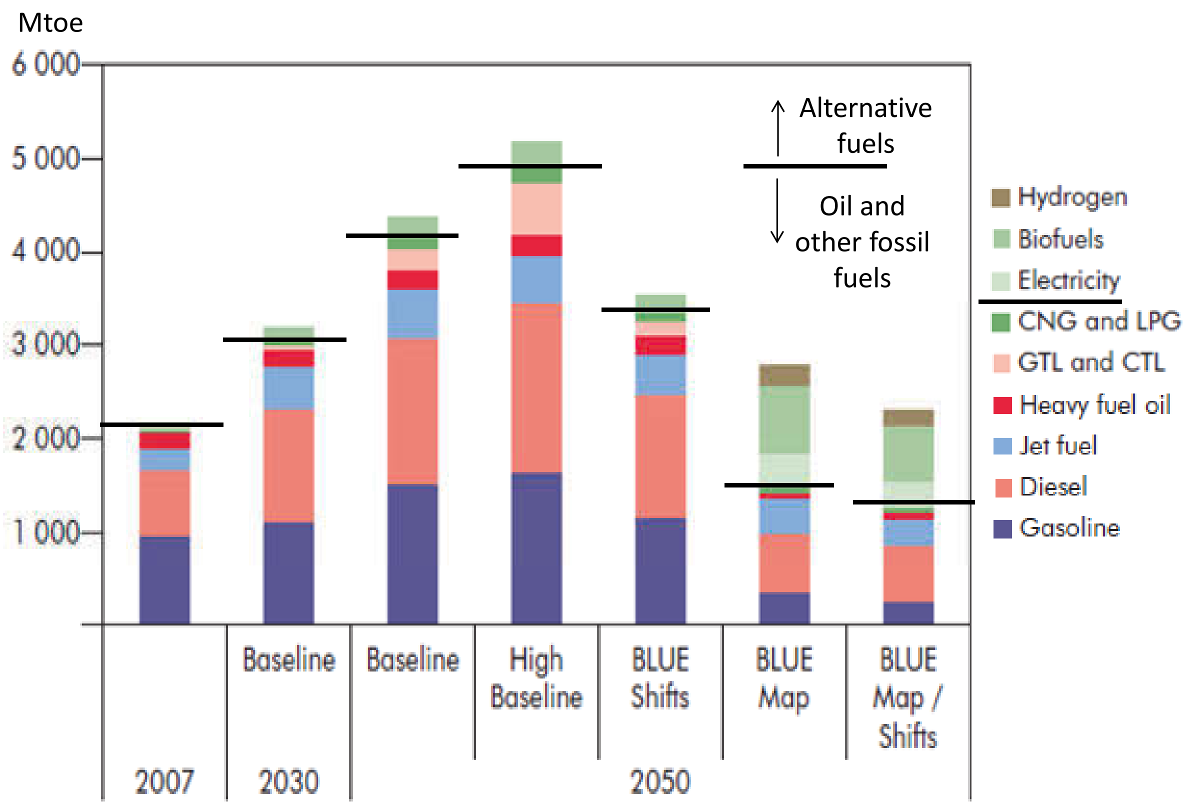

Figure 2: Evolution of fuel demand in the transport sector in various scenarios[5]

The “Baseline” scenarios see only a gradual replacement of oil which, in combination with a strong increase in total demand, leads to significant higher oil consumption than today. The “Blue” scenarios are more optimistic about the potential of new energy sources (especially electricity and biofuels) – but none of them forecasts a full replacement of oil products, even in 2050. In contrast, in all scenarios oil products stays the most important fuel type. Depending on the specific scenario assumptions, the combined share of Diesel and other oil products is forecasted to be between around 50% and nearly 95%.

2.3 Impact of oil prices

As shown in section 2.2, oil will remain the most important source to cover energy needs in the transport sector. When discussing the development of the future costs of mobility, it is obvious that the oil price will be the key element. A very important fact to consider is that the oil price is not only relevant for the share of oil products - which is already very high in all scenarios. Also other fuel types a directly or indirectly influenced by the world oil market.

Given the recent price developments this is not an unproblematic circumstance. As shown in the figure below, a dramatic price increase has taken place between the very

[5] See IEA, 2010b, page 265.

low price level after the Asian financial crises in 1997 and just before the emerging of the latest world economic crisis which starts in 2008. This increase by a factor of approx. 10 is very notable, but not the first time in history of oil prices such a price boost has happened. A comparable situation has taken place in the early 1970s, when crude oil prices exploded from less than 2 USD/bbl to 12 USD/bbl in context of the so called first oil crises. Even if the absolute level of the prices (not only in nominal but also in real terms) is quite low, the impact on the economy has been more dramatic the last price increase. This is driven by the fact that in the early 1970s the share of oil on the primary energy supply was significantly higher than today. Since then, several measures, especially in the OECD countries, have been implemented to reduce dependency from oil. Of course, as discussed in the section above, the transport sector was more or less exempted from this demand trend.

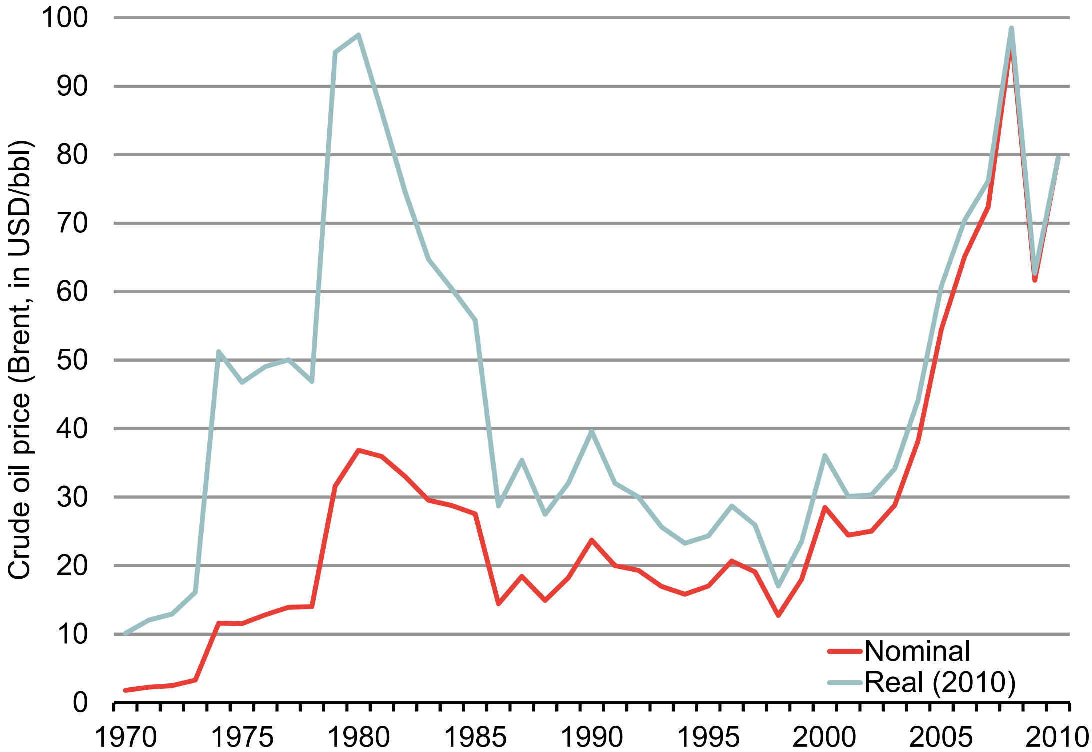

Figure 3: Historic price development of crude oil[6]

As discussed in section 2.2, oil products will also satisfy the majority of energy needs in the transport sector. The presented scenarios provide a wide range of possible shares from approx. 50 to nearly 100% of the demand. Of course, other scenarios from other institutions would produce an even wider range. However, the direct share of oil products is not the only relevant figure that gives an indication over future impact of oil prices on the mobility costs. Also other fuels rely on the oil price and by this consumers of these fuels also suffer from increases of this price (and of course, in turn would benefit from price declines). The economic relationships could be summarized as followed:

6 Data source: BP, 2011.

- Oil products: all products are fully correlated with crude oil (depending on the product, the correlation coefficient is between 0.96 and 0.99). Diesel, gasoline and gasoil have prices above the crude price (plus refinery margin and product specific factors), fuel oil is traded below the crude oil price (as it is a residual product with unfavorable environmental characteristics and has only limited applications). Also LPG (Liquefied Petroleum Gas) is an oil product and fully correlated with crude oil.[7]
- Natural gas: usually gas prices are highly correlated with oil prices. In most countries this is driven by price formulas with oil indexation in long-term import and domestic supply contracts. This is the case for most countries worldwide (e.g. Asia, Eastern Europe, and Latin America). Also in Western Europe, the majority of gas is still prices under the regime of oil-indexation, even if in recent years progress has been made in establishing gas markets where supply and demand situation of gas is the driver and not the price of another energy source (oil in that case). Nevertheless, with the exemption of the UK, oil indexation is still a key parameter for gas prices, especially in medium and longer terms. But also in the UK and the US (the country with the by far most developed gas market) the supply and demand driven gas prices show a high correlation to oil prices. In their case it is not forced by formulas but by downstream competition between oil and gas as well as a lot of similarities and common factors on the upstream side (e.g. same producers, fields producing both gas and oil).[8] This applies also for GTL (Gas-to-Liquids), which is the production of synthetic Diesel with gas as input parameter.
- CTL (Coal-to-Liquids): Synthetic fuel produced by converting coal is (and most likely will always be) a rather exotic product. However, even if it will gain significant market shares from oil products, the dependency on oil prices will not fully be cut. Long-term price analysis show that also coal prices react on oil price movement, although to a much lower extent as for gas.[9]
- Electricity: In modern electricity markets the price is formed by the competition of different generation technologies. As renewables are usually outside this market process and supported by subsidies conventional power plants define the electricity price for the majority of hours in a year. As lignite and nuclear power have very low variable costs, gas and hard coal are the most important price drivers for electricity (modified by CO2 prices). As discussed before, both energy sources are correlated with the oil price. By this, also the electricity price is in the long-run influenced by the oil prices. But given the indirect impact chain the relation is less close as for gas or coal. Also short-term prices could vary significantly.[10]
- Alternative fuels: Biofuels are to be expected to become an important energy source in the future. In principle, no direct relations between biofuels (e.g. by us-

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7 See Frontier Economics/EWI, 2010, p.174.

8 Energy Charter Secretariat, 2007, chapter 4, provides an elaborate overview over pricing mechanisms for natural gas.

9 See IEA 2010a, p.73.

10 The economic fundamentals of modern electricity markets are described in Kreuzberg, M., 2001.

ing biomass such as sugar or rapeseed) is economically inherent. However, the country specific regulations and technical implementation often not allow the establishing of a fully independent pricing system. This could be the case if biofuels are used as an addition in oil products (e.g. E10 in Germany). But also for the case that in future a separate market for biofuels (i.e. a mass market and not a niche) one could expect that retailers and traders also keep an eye on the main competitor oil. By this economic substitution competition the oil price is always of importance for alternative products, but to a lower extent as for gas. This argument also accounts for hydrogen technologies.[11]

Summarizing these economic relationships between the various substitutes it is obvious, that the oil price will keep its important role in the transport sector. This could be either on a direct (by using oil products) or on an indirect way (by using substitutes which are price correlated or at least face competition to oil). Of course, higher portions of non-oil fuels limit somehow lower the impact but could not eliminate this completely.

3 Oil price forecasts

As oil prices will keep its impact on transport costs on direct or indirect channels it is important to have an - as far as possible – clear view on the future developments. International institutions as the IEA, EIA or EU regular publish price forecast which are based on models (or are used as a model input). Usually several scenarios are defined (e.g. the above introduced scenarios by the IEA) covering several possible variations of input parameters (e.g. GDP, population growth, reserve situation).[12]

Figure 4 illustrates a range of price forecasts as derived from recent IEA, EIA and EU scenarios. It is somehow amazing, how wide the range of these forecasts is. In 2030 the difference between the lowest and the highest price path is more than 230 USD/bbl, which is around double as high as the price level today (around 115 USD/bbl as of September 2011).

The forecasts from the institutions are not the only available views on the future development. There are numerous publications by bank analysts, academics, lobby associations, energy companies and self-proclaimed "experts", to name only a few. Their views are not shown in the graph, as

- usually the validity duration of these forecasts is very low (especially banks and "experts" tend to overstress recent developments and not focus too much on fundamentals and long-term trend),
- their assumptions and methodology is often unclear, and
- the price forecasts are often formulated somehow vague (like "I could imagine the oil price will be more than 200 USD/bbl in the future" without going too much into details like real or nominal prices, which oil quality, which year and so on).

[11] See Bukold, S., 2009, for an overview over biofuels and other alternative fuels.
[12] See Energy Charter Secretariat, 2007, for oil market fundamentals.

But also if only focus on transparent and reliable forecasts as shown in the figure the spread is much too wide for inspiring confidence. And it doesn't really provide a helpful guidance for policy makers or investors.

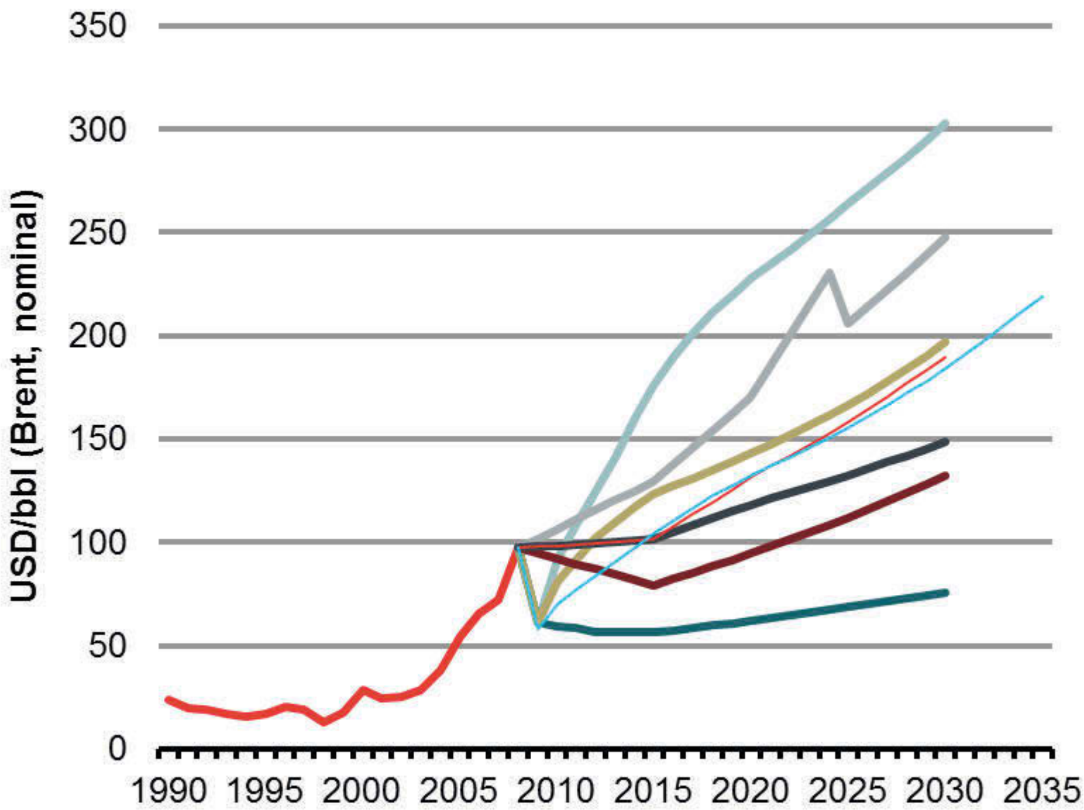

Figure 4: Historic price development of crude oil (red) and selected forecasts[13]

Most high price oil forecasts are driven by the assumption that the world is facing a physical scarcity of oil. In such cases often a mismatch of short-term production capacity and actual demand is mixed with long-term resource availability. By comparing reserves and resources of oil with assumed future demand, it becomes obvious that no physical shortage will occur in the long-run. Figure 5 illustrates this by using the above introduced New Policy Scenario as an example for future demand development. The red bar summarizes the cumulated demand between 2010 and 2035. By comparing this with the total volume produced in the past (the yellow bar) one could see that in the next 25 years mankind will consume more than 50% of the oil used since the start of commercial oil business around 150 years ago. Nevertheless, when focusing on the remaining resources instead, the ratios change. In theory, the demand in the next decades could be completely sources by low-cost oil sources (labeled "MENA" = oil from Middle East and North Africa and "Other conventional") – as it has been the case in the 1980s and 1990s.

13 Based on IEA, 2010a, EIA, 2011, and EU, 2010.

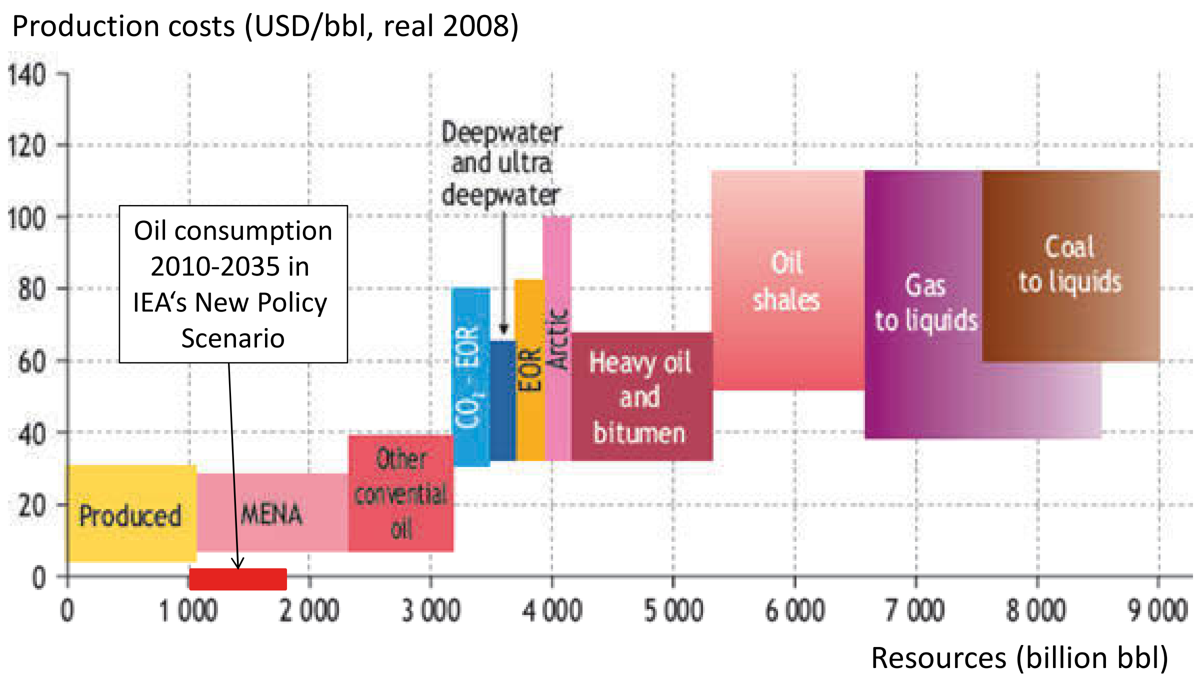

Figure 5: Estimation of world oil reserves and resources[14]

Unfortunately (from consumer's perspective) technical, economic, environmental and political constraints exist which prevents a production that strictly follows the cost structure. Instead of first produce from the low-cost sources until they are depleted and then switch to the next fields in the cost curve, sources from various cost categories are needed to cover actual demand. So are at present beside the traditional sources (MENA and conventional) also deepwater, heavy oil, bitumen, EOR (Enhanced Oil Recovery measures) and oil shales needed to meet the demand.

When considering the economic rule that the last needed or marginal supplier defines the market price then one could conclude that, even if in all cost category only the low-cost sources will be produced first (at least in the first years), the future oil price is unlikely drop below 50 USD/bbl again. One could consider this as a long-term lower price bound. In short-term (e.g. in times of a world economic crisis) the price could fall below, but this should not last very long.

As the oil market is by far not a perfect competitive market, this lower price bound will not be reached or undercut very often. In contrast, given the market structure and other specific characteristics of the world oil market, a premium on the marginal supply cost will be the rule. How much this premium will be is of course difficult to predict and subject to various parameters. However, given the fundamental settings, an oil price of 200 USD/bbl (or more) as predicted in some scenarios and by some "experts" is rather unlikely in longer-terms (but possible in very short-time frames, e.g. after some supply shocks).

[14] See IEA, 2008, p. 218.

4 Conclusions

Oil is today the world's leading energy source and will keep this position most likely be in the next few decades the. When looking at the transport sector, oil is with around 95% the dominant fuel type. Even if also in this sector technological changes and fuel substitution will take place, like in the heating sector or electricity generation, the role of oil as the most important fuel will remain unchanged. This is also the case if optimistic scenarios come true, where oil's share on energy needs from the transport sector will drop to around 50%. But also in such an environment, oil's importance will higher than the market share, which is nevertheless still high enough to remain the leading fuel for transport. This could be explained by the role of the oil price as the energy "leading currency", meaning that the oil price directly or indirectly defines or at least influences the price of the competing fuels. As oil price forecasts are more art than science, a high uncertainty over the future oil price and by this also over the future costs of mobility exist. But fundamental parameter indicates that the price will never drop back to the low level which could be observed during the 1980s and 1990s. Given this, the key for lower costs for mobility is not a simple shift form one fuel to another. Significant efforts are needed to reduce the total demand. And presumably even moderate efficiency gains in conventional motor technologies and an efficient utilisation of existing infrastructure is a more adequate tool to keep mobility costs controllable than introduce a completely new technology and infrastructure (such as hydrogen) before it is really necessary. And given the resource situation this will not happen in the next decades.

5 References

BP (2011): Statistical Review of World Energy, London.

Bukold, Steffen (2009): Öl im 21. Jahrhundert – Band II, München.

Energy Charter Secretariat (2007): Putting a Price on Energy, Brussels.

EIA (2011): International Energy Outlook, Washington DC.

EU (2010): EU Energy Trends, Luxembourg.

EWI/GWS/Prognos (2010): Energieszenarien für ein Energiekonzept der Bundesregierung, Basel/Köln/Osnabrück.

ExxonMobil (2010): The Outlook for Energy – A View to 2030, Irving.

Frontier Economics/EWI (2010): Energiekosten in Deutschland – Entwicklung, Ursachen und internationaler Vergleich, Cologne.

IEA (2010a): World Energy Outlook 2010, Paris.

IEA (2010b): Energy Technologies Perspectives, Paris.

IEA (2008): World Energy Outlook 2008, Paris.

Kreuzberg, Martin (2001): Spot prices of Electricity in Germany and other European Countries, Cologne.

Shell (2008): Energy Scenarios to 2050, The Hague.

Revenues from National Resource Taxation – both a blessing and a curse

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Abstract
There are 31 oil producing countries in the world where fiscal oil revenues account more than 25 percent of total fiscal revenue.However, revenues from national resource taxation are not always a blessing. This paper therefore explains the Dutch disease and describes National resource funds, instruments to reduce the negative economic effects of the Dutch disease.

1 Introduction

Like all commodities, the prices of natural resources are prone to huge fluctuations as can be seen in the development of oil prices from 1960 until 2009

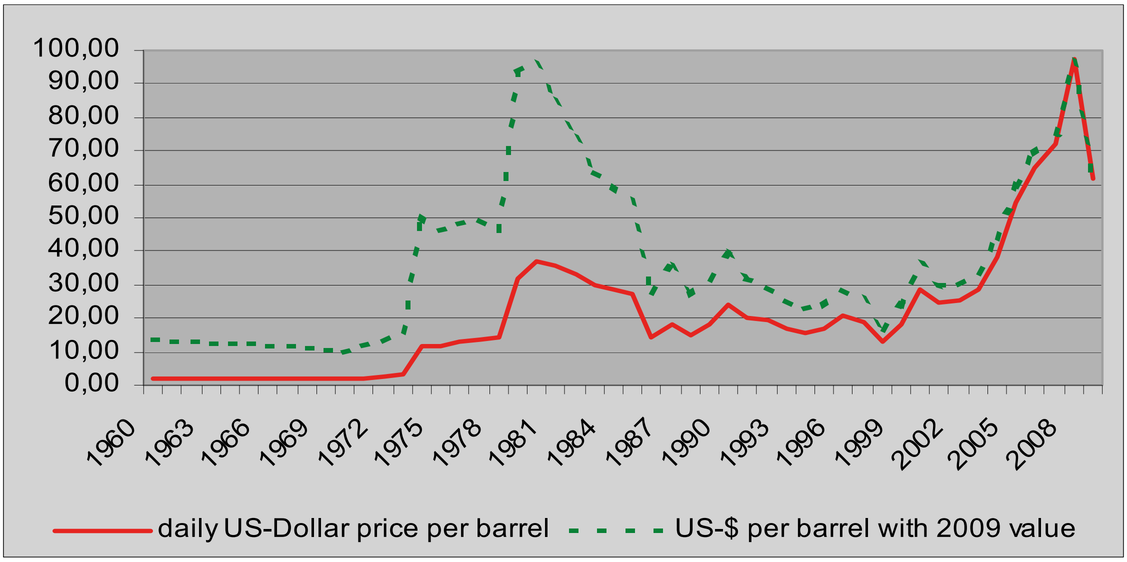

Figure 1: Development of oil prices in US dollars per barrel from 1960 until 2009
Source: own illustration

Revenues from natural resource taxation are quite important in some counties because there are 31 oil and gas producing countries in the world where fiscal oil revenues account more than 25 percent of total fiscal revenue. These 31 countries are listed in the table below according to the indicator per capita GNI in US dollars during the period 2005-2008

Low income ($995 or less)	Lower-middle-income economies ($996 to $3,945)	Upper-middle-income economies ($3,946 to $12,195)	High-income economies ($12,196 or more)
Chad	Algeria	Gabon	Bahrain
Nigeria	Angola	Kazakhstan	Brunei
Vietnam	Azerbaijan	Libya	Equatorial Guinea
Yemen	Bolivia	Mexico	Kuwait
	Cameroon	Russia	Norway
	Congo	Venezuela	Oman
	Ecuador		Qatar
	Indonesia		Saudi Arabia
	Iran		Trinidad
	Sudan		United Arab Emirates
	Timor-Leste		

Table 1: Counties with huge oil revenues sorted by GNI income
Source: Villafuerte and Lopez Murphy, 2010

2 The Dutch disease

On the one hand, a country benefits from the exploration of natural resources because it receives money from foreign countries. On the other hand, this extra money will cause an increase in the exchange rate and destabilise the non oil producing industries. The term "The Dutch disease" was coined to describe the decline of the manufacturing sector in the Netherlands after the discovery of a large natural gas field in the North Sea in 1959.

The concept of the Dutch disease explains the connection between the increase in exploitation of natural resources and a decline in the manufacturing sector resulting from the fact that the increase in revenues from natural resources strengthens the nation's currency compared to that of other nations so that the nation's other exports become more expensive for other countries to buy and the manufacturing sector is consequently less competitive.[1] Apart from this reference to revenues from natural resources, some economists also use the idea of the Dutch disease to explain the effect when foreign aid flows into a small developing country or when the currency appreciates as a result of foreign direct investments.[2]

Furthermore, revenues from natural resources can lead to excessive borrowing and tax exporting, because a country with huge revenues from natural resources receives easy credit from financial markets. Politicians can also use the extra money from resource taxation to subsidise domestic cuts in personal income tax or corporate income tax. For this reason, a huge oil price fluctuation has a huge impact around the world.

Moreover, the revenues from natural resources can generate more corruption and disregard of education. With the extra money from abroad there is no incentive to „invest" in the educational level of the population. Finally, natural resources can even provoke armed conflicts as was the case with diamonds in Sierra Leone and Angola or oil in South Sudan (Christian versus Moslem entities).

The so-called national resource funds which have been set up in various different forms and which were described in the following subchapter present one solution for preventing the negative impacts of the Dutch disease.

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[1] The "classic paper" of the Dutch disease was written by Max Corden and Peter Neary in 1982. They show that when a country catches the Dutch disease, the traditional export sector gets crowded out. See Corden / Neary, 1982.

[2] However, some economists have even observed a positive effect for natural resources. For example, Graham Davids has analysed 43 mineral oil-producing developing countries for the period from 1970 until 1991 and has concluded that the effects of the exploitation of natural resources for the long-term development of resource-based developing countries are not widespread; see Davids, 1995. Alan Gelb (1988) and Richard Auty (1990), on the other hand, documented many of the development problems of natural resource dependent economies and the cross-country data of Xavier Sala-i-Martin (1997) as well as Gernot Doppelhofer et al. (2000) show that natural resources are among the most robust variables negatively affecting countries economic growth.

3 National resource funds

One way of preventing the Dutch disease are so-called national resource funds which have been set up in various different forms. These national resource funds include, for example, the Alaska Permanent Fund (APF), Government Pension Fund Global in Norway and the Stabilization Fund of the Russian Federation.

The Alaska Permanent Fund (APF) was established in 1976 after a referendum. Based on the result of this referendum, at least 25 percent of all mineral lease rentals, royalties, royalty sales proceeds, federal mineral revenue-sharing payments and bonuses received by the state have to be placed in a permanent fund, the principal of which may only be used for income-producing investments. Half of the annual net profits are distributed via a dividend directly to the people of Alaska. Each resident receives the same amount although citizens with a criminal record are excluded from the dividend. The following figure highlights the people's dividend in US dollars from the APF from 1980 until 2009:

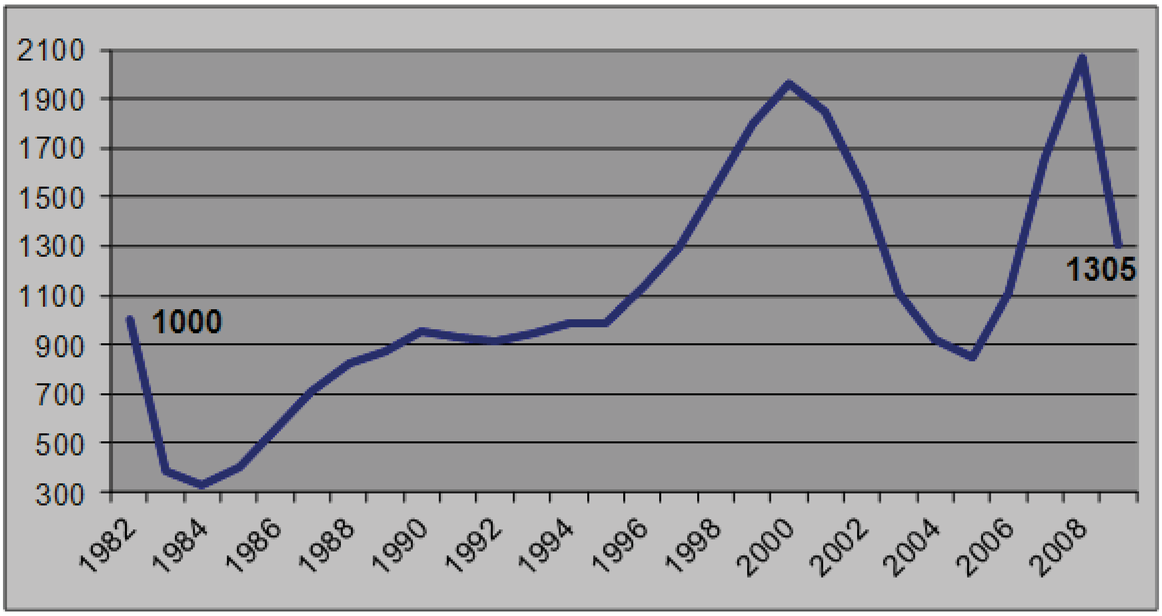

Figure 2: People's dividend from the APF from 1980 until 2009
Source: own illustration

A further national resource fund is the Government Pension Fund Global in Norway, formerly the Government Petroleum Fund. In 1990 the Norwegian Parliament passed a law to create the fund and in 1996 the Norwegian Ministry of Finance transferred the first amount of money. The Fund's inflow consists of all state petroleum revenues, net financial transactions related to petroleum activities, as well as the return on the Fund's investments. The Norwegian Ministry of Finance sets guidelines, including benchmark and risk limits, while the operational management is carried out by the Central Bank. The fund only invests abroad based on ethical guidelines (e.g. no investments in companies that produce tobacco or sell weapons) and does not hold more than 3 % stock share from one company. The fund had a volume of € 352 billion at the end of June 2010.

The Stabilization fund of the Russian Federation was established in 2004 in order to balance the federal budget when the oil price falls below a cut-off price, currently set at $27 per barrel. The Fund accumulates revenues from the export duty for oil and the tax on the oil mining operations when the oil price exceeds the set cut-off price. The capital of the Fund may be used to cover the federal budget deficit and for other purposes, if its balance exceeds 500 billion rubles (€ 12 billion). Since 2005, the surplus of the fund has been used for early foreign debt repayments as well as to cover the Russian Pension Fund's deficit. The investment structure is 45 % US dollars, 45 % € and 10 % British pounds, mainly in debt securities of countries in the Euro zone as well as the United States of America.

In January 2008 the volume of the fund was around US $ 150 billion. It was then closed and in February 2008 two new funds were set up, the Reserve Fund (RF) and the National Wealth Fund (NWF). The objective of the RF is to ensure that the federal budget expenses are financed and the federal budget balance is maintained if oil and gas revenues decline. The RF can also be used for early state foreign debt repayment. Its level is limited to 10 percent of GDP. The objectives of the NWF are to co-finance voluntary pension savings of the Russian citizens and to maintain the budget balance of the Pension Fund of the Russian Federation. The NWF assets may not be used for any other purposes. As of December 1, 2011, the RF and NWF totaled US$ 25.60 billion and US$ 88.26 billion, respectively.

There are over 40 public-owned funds in the world, for example the State Oil Fund of Azerbaijan, the Future Generations Fund of the State in Kuwait, the Abu Dhabi Investment Authority (ADIA) or the Alberta Heritage Fund (AHF).

4 Conclusion

National resource funds are one solution for preventing the negative impacts of the so-called Dutch disease are. However, without a transparent "business policy" a national resource fund is a danger for the democracy. The appearance of oil revenues in a region which already wishes to separate from a country simply adds fuel to the fire. Institutional arrangements can reduce fiscal conflicts, e.g. through an intergovernmental forum. However, if the political stakeholders do not possess a common interest such as the continuance of a country and would prefer to see the secession of a region, even a well designed equalisation system would not able to prevent such a situation.[3]

[3] The case of Bosnia and Herzegovina is quite unique (see Werner, Guihery and Djukic, 2006), because on the one hand the respective ethnic groups in this country use the distribution of tax revenues to heat up national tension, and on the other hand the international community is working to avert a separation through external political pressure as well as an internal control institution named OHR. In some countries like Spain, fiscal conflicts are the result of an unfulfilled wish for independence by the regions and if one erroneous trend in the intergovernmental system is rectified, the political leaders of the Autonomous Communities bring up another painful subject, instead of considering their huge autonomy and the successful development of Spanish democracy over the last decades. See Werner 2009 and Werner 2008.

Paul Bernd Spahn's suggestion that "such conflicts are best avoided a priori through clear tax and revenue assignments rules" (see Spahn, 2007, page 51) is more than reasonable in order to reduce fiscal conflicts, especially in the area of natural resources.

5 References

Auty, R. (1990): Sowing the Oil in Eight Developing Countries, Oxford University Press, New York.

Corden, M. ; Neary, P. (1982): Booming Sector and De-industrialization in a Small Open Economy, in Economic Journal, Volume 92, Issue 368, page 825-848.

Davis, G. (1995): Learning to Love the Dutch Disease: Evidence from the Mineral Economies in World Development**,** Volume 23, Issue 10, page 1765-1779.

Doppelhofer, G., R. Miller and X. Sala-i-Martin (2000), 'Determinants of Long-Term Growth: a Bayesian Averaging of Classical Estimates (BACE) Approach, OECD Economics Department Working Papers Number 266

Sala-i-Martin, X. (1997): I Just Run Two Million Regressions in American Economic Review, Volume 87, Issue 2, page 178-183.

Gelb, A. (1988): Oil Windfalls, Blessing or Curse, Oxford University Press, Oxford

Spahn, B. (2007): Resolving Fiscal Conflicts in Ron Watts and Rupak Chattopadhyay (eds.) Unity in Diversity: Learning From Each Other: Fiscal Federalism - Volume 2, New Delhi / India, Viva Books, page 51-76.

Villafuerte, M.; Lopez-Murphy, P.(2010): Fiscal Policy in Oil Producing Countries During the Recent Oil Price Cycle, in IMF Working Paper, WP /10/28.

Werner, J. / Guihéry, L. and Djukic, O. (2006): Fiscal Federalism in Bosnia and Herzegovina: Ten Years after the Dayton Treatment and Still not in a Steady Condition in Journal of Economic Asymmetries, Volume 3, Issue 2, page 125-148.

Werner, J. (2008): Fiscal Equalisation and Fiscal Conflicts are Like the Chicken or Egg Question – Which Came First? in Ron Watts and Rupak Chattopadhyay (eds.) Unity in Diversity: Learning From Each Other: Fiscal Federalism - Volume 2, New Delhi / India, Viva Books, page 114-127

Werner, J. (2009): Fiscal Solidarity: Key Benefits and Pitfalls for Spain to Lower their Fiscal Conflicts in Journal of Public Administration and Policy Research, Volume 1, Issue 2, page 19-34.

Mobility in Marketing and Engineering Research

Mobility in a Globalised World

Economics
Engineering
Informatics
Logistics
Urban Planning

Mobility in Marketing and Engineering Research

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The development of modern information and communication technologies is changing the way of global transaction within countries and across borders. New technologies have a significant impact on mobility in different industries and on different levels. For example intelligent technology-mediated services enable a global mobility for service providers without physical travelling. But these changes of marketing transactions pose technical, social, and organizational challenges for companies and their customers. In the following chapter the impact of *mobility in a globalized world* is analyzed and challenges are discussed for the automotive, logistics and the healthcare industry.

This variety of mobility aspects in the field of marketing and engineering research is reflected in the contributions selected for this thematic section. The first contribution titled *"Development of Customer Satisfaction Studies to Improve Expert Tests"* by Jan Hendrik Schreier, Reinhard Kolke and Niels Biethahn focuses on the development of a model to verify the validity of expert tests on their ability to predict customer satisfaction in the automobile industry. The research is based on empirical data provided by the automobile club ADAC and will therefore offer valuable insights about future mobility topics from the customer's perspective.

The second contribution by Matthias Hohmann, Alexander Kempny, Laura Mervelskemper and Thomas Meuser titled *"Night Star Express: With Sustainable Solutions into the Future – the Calculation of Carbon Dioxide Emissions"* takes a more practical approach towards mobility. The paper deals with the calculation and representation of carbon dioxide emissions of the nighttime transport services provider Night Star Express with regard to greener future mobility.

The third contribution by Stefanie Paluch titled *"Internationalization of Remote Service Technologies – A three Country Study on Perception, Adaptation and Relationship Marketing"* is concerned with an innovative service technology that allows a global service provision without personal interaction of service customer and provider. These remote services are provided via IT-infrastructure to worldwide connected service objects. The service technology allows a global reach and at the same time a decrease in labour- and travelling costs.

These three contributions discuss important and very different aspects of mobility in diverse industries and clearly demonstrate that mobility will be an emerging and sustainable topic in marketing and engineering research.

Development of Customer Satisfaction Studies to Improve Expert Tests – Demonstration of a Pilot Study for Child Restraint Seats in Northern and Southern Europe

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The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the view of the ADAC.

Abstract

The following paper introduces a model both to verify the validity of expert tests on their ability to predict customer satisfaction and to identify different expectations in Northern and Southern European countries by using customer satisfaction surveys. At this moment, the model is limited onto child restraint seats. Existing methods for customer requirement engineering and test validation are reviewed before the model and its components are introduced. The model is validated with the help of its practical application on the German market and by reviewing the European expert tests conducted by the ADAC.

1 Introduction

In Europe child restraint seats (CRS) are tested centrally and in cooperation by over 20 automobile clubs and consumer protection organizations in the European Test Consortium for Child Restraint Systems. For all CRS the same test and almost the same evaluation schema is used[1]. The test has two main parts "safety" and "handling & comfort" which are basis for the overall rating of a CRS[2]. The safety part is evaluated on basis of objective measures for each seat in form of well defined crash tests. The area of handling & comfort depends on subjective factors such as body dimensions or skill of the person fitting the seat into the car. For this handling part, experts of the organizations that run the tests develop evaluation criteria based on experiences from every day use[3].

Due to country specific preferences and because of varying market presence of CRS manufacturers not all seats are offered in all countries. Also there are deviations in preferences for certain CRS types: Scandinavians prefer rearward facing seats for children up to the age of 4 years[4], while southern European countries show a preference for booster seats[5].

These different preferences for CRS in different countries lead to the assumption that the satisfaction with different seats is also evaluated differently depending on the country. A seat that received a top rating in the expert test could create deviating customer satisfaction values in various countries. In an extreme case a top rated seat could fail to create customer satisfaction in one or more countries.

To date an empiric validation – especially to validate CRS expert tests - has taken place only in form of unsystematic practical tests conducted by ADAC and the Austrian equivalent ÖAMTC. Given the fact that there are several seats per category that achieve high scores in the safety area, the decision of buying a certain CRS depends strongly on usability and cost aspects.

2 Problem Statement

A good test score is a strong requirement for the market success of every CRS. Thus it can be assumed that CRS manufacturers take into account the test criteria of the above described test during the development phase already[6]. Incorrect test criteria or wrong weights of test aspects would hit consumers twofold: First by making wrong sugges-

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[1] See Ratzek, 2008, slide 2.

[2] "Hazardous substances" and "cleaning & workmanship" are also reported but are only part of the final rating in case of extremely poor results. See ADAC, 2011a.

[3] See Ratzek, 2008, page 3.

[4] See Vroman, 2008.

[5] See Fiorentino, 2010, slide 16. The CASPER project (http://www.casper-project.eu) is currently running a survey in European countries to gather more information on different cultural requirements.

[6] This assumption is also made by Johannsen / Müller / Schindler, 2008, page 5.

tions and second by leading CRS manufacturers to create products that do not meet consumer requirements.

To verify that test criteria and ratings meet day to day requirements of various countries, satisfaction levels with CRS should be measured in each country where the study results are published.

Aim of this research is the development and prototypic implementation of a model that can be used to validate current expert tests for CRS in relation to their ability to predict customer satisfaction. In case of a failed validation the model should also be capable of providing insights how expert tests weighting or test procedures should be changed in order to predict customer satisfaction better. The to-be-developed model should include all aspects necessary to reach the intended aims of the model's application.

Beside this main goal for the model, a second goal is that – by applying it in different countries – the model should highlight country specific consumer requirements.

3 Current State of Research

3.1 Child Restraint Seat Research

Scientific research and corresponding publications for CRS in cars put their focus on increasing safety. This includes improving crash tests[7] and corresponding simulation models[8]. Other main areas of research are misuse[9] and how this can be reduced by teaching sales personnel and parents[10].

Insights gained in this research lead to improved expert tests and also into the EU standards. Comfort, handling, and manuals were subject of few research activities or were only a side aspect in other research[11]. The current EU standard defines that "Devices of the 'quick adjuster' type shall be easy to reach when the child restraint is correctly installed and the child or manikin is in position" [12], besides this requirement and requirements towards the manual there are no additional requirements concerning comfort and usability.

According to our knowledge until now, an evaluation if expert tests are a good indicator for high customer satisfaction in regard to handling and comfort has not taken place for child restraint seats.

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[7] See for example Johannsen / Huijskens / Schnottale / Schindler, 2005.

[8] See for example Schoeneich, 2005.

[9] See for example Langwieder / Stadler / Hummel / Fastenmeier / Finkbeiner, 1997, page 156 and also Doyle / Levitt, 2011.

[10] Ibid., page 159.

[11] Langwieder et. al., 2007, page 159. See also Johannsen, 2007, page 5 or the qualitative study from Glaser, 2006. RoSPA, 2001, made a comprehensive study for manual quality in UK.

[12] European Union, 2007, number 7.2.2.3.

3.2 Customer Satisfaction

Customer satisfaction is commonly defined by the confirmation / disconfirmation paradigm (CDP)[13]. CDP defines satisfaction (or dissatisfaction) with a product (or service) as result of a process of comparing ones subjective expectations with the perceived quality of the product. If expectations exceed the perceived performance the result will be dissatisfaction, if expectations are met by the perceived performance the result will be satisfaction or even high satisfaction. This is shown in the following figure:

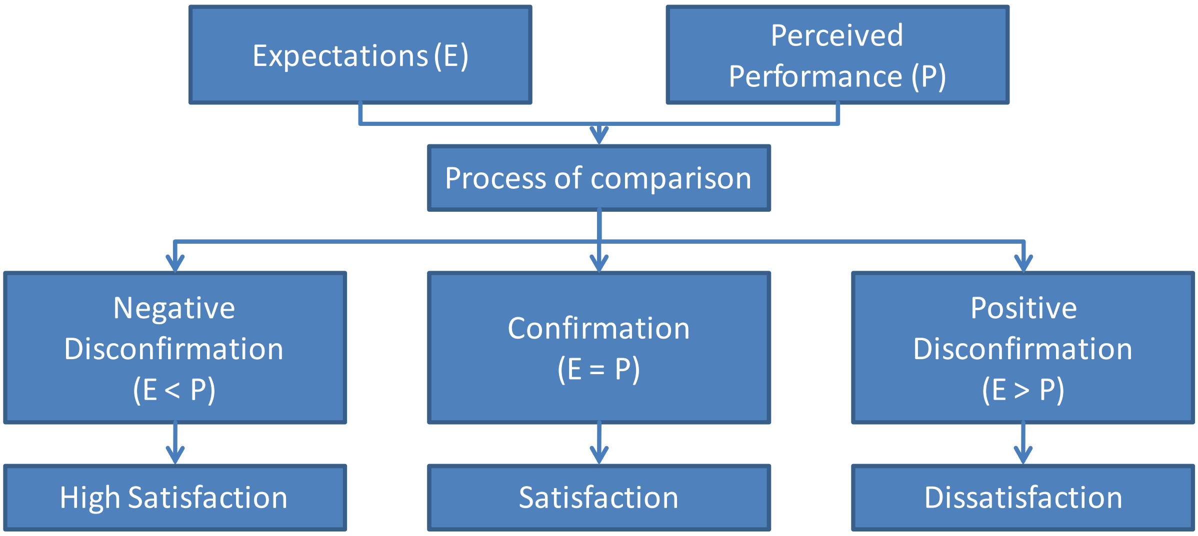

Figure 1: Confirmation / Disconfirmation Paradigm[14]

There are several methods how customer satisfaction can be measured. Giesa classifies methods according to the following to figure:

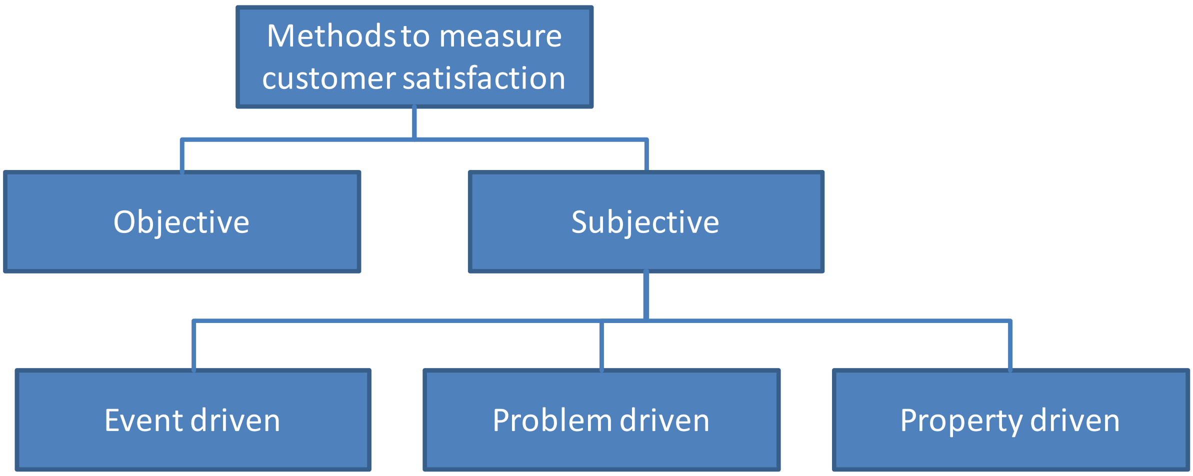

Figure 2: Methods to measure customer satisfaction[15]

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[13] Diez, 2006, pages 63-65.

[14] Based on Homburg / Krohmer, 2003, page 103.

[15] Based on Giesa, 2007, page 18.

Objective methods to measure customer satisfaction do not take into account customers but try to derive customer satisfaction for example from market shares. Subjective methods put customers directly into the focus. Event driven methods assume that customer satisfaction is result of certain key events of usage, while problem oriented methods focus on analyzing customer feedback for example by reviewing complaints databases. Property driven methods assume that customer satisfaction is a product of many properties of the used product.[16] A survey asking the customer about specific properties of a product would fall into the last category.

According to Giesa overall satisfaction is always a result of satisfaction with performance parameters (for example “usability”, “quality of used material”) which in turn can each be broken down to performance criteria (e. g. “quality of used material” could be broken down to “optical appearance”, “surface feel”, and “durability”).[17] An example of such a structure for CRS is shown in the following figure:

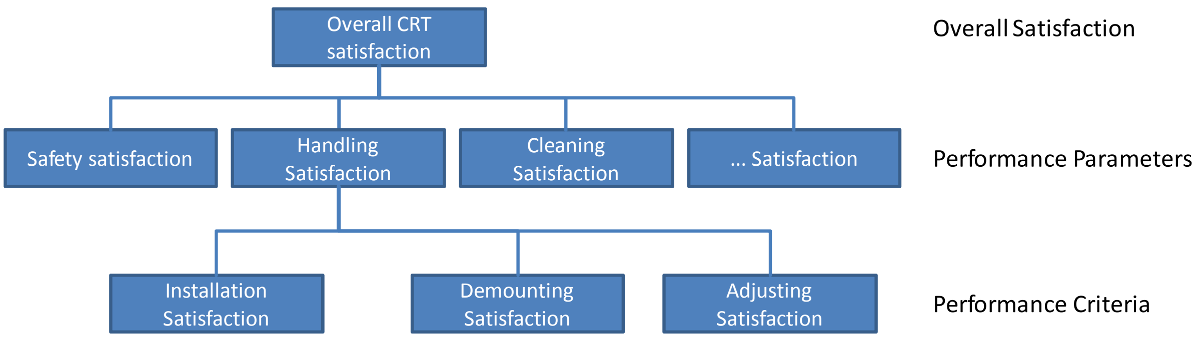

Figure 3: Example of hypothetical hierarchy for overall satisfaction, performance parameters, and performance criteria with CRS[18]

As can be seen in the above figure, satisfaction could be queried in form of the overall satisfaction or on one of the lower levels. Asking only for the top level is considered insufficient for most purposes. In order to generate action plans, one usually needs performance criteria.[19] This leads to the question of measuring the relative importance of the different performance parameters, respectively performance criteria.

Methods to measure importance can be clustered into direct and indirect methods. Direct methods ask customers explicitly for relative importance of performance parameters / criteria in various ways. Indirect methods ask only for the overall satisfaction and derive importance values for performance parameters / criteria commonly by regression analyses[20]. A good overview on this subject is provided by Giesa who states that

[16] See Elfroth / Neckermann / Zupancic, 2006, pages 51-52.

[17] See Giesa, 2007, pages 21-22.

[18] Example based on currently used testing scheme, see ADAC, 2011b. The hierarchy is hypothetical in that it cannot be said with certainty that these are the factors that drive satisfaction. The figure is based on Giesa, 2007, page 23.

[19] See Giesa, 2007, page 19.

[20] Ibid, pages 24-25 and pages 30-31.

"it is a good choice to capture importance of performance parameters / criteria directly and indirectly at the same time"[21].

For the verification of an expert test similar requirements exist that are also relevant for the product development. E. g. the knowledge about relative importance of different requirements helps building a good product as well as creating a good expert test that aims at being a good help for consumers. In this sense Quality Function Deployment or related methods could be applied.[22] A main shortfall for QFD is that it requires knowledge about customer requirements and their relative importance, thus it is not considered for CRS is this information is not available[23].

3.3 Child Seat Expert Tests in Europe

The single most important CRS test in Europe is conducted twice a year by the European Test Consortium for Child Restraint Systems (ETC). This consortium exists since 2003 and consists of more than 20 automobile clubs from Europe and consumer protection organizations from the entire world. More than 250 crash tests and over 500 handling tests are conducted every year. The results are published by each member of the ETC on the same date but in a form that depends on each member organizations own guidelines.[24]

The ETC test is broken down into four categories safety, handling & comfort, workmanship & cleaning, and hazardous substances[25]. Each of these categories consists of several sub criteria that are rated with grades from 0.6 (very good) to 5.5 (poor). The composite of these values is aggregated to one overall grade. The overall grade is calculated by weighing the categories safety and handling & comfort with each 50 %. Additionally the overall grade calculation has some side conditions. E. g. an overall grade from 0.6 to 1.5 can only be achieved if the values both for safety and handling & comfort themselves are in this range and the grade for hazardous substances is not worse than 3.5. If these side conditions are not met, the overall grade is downgraded until all side conditions are met. Finally the test results are published in a form that each seat belongs to one of the five categories from "very good" to "poor" – the exact figures are not published[26].

The categories safety and hazardous substances are evaluated on basis of objective methods with a priori defined grades for certain measure results. The other two categories are based on expert ratings. While there is a procedure of how the experts rate a seat, to some extent handling test is still a subjective review by one or more experts.

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[21] Ibid, page 205, (translated by the author).

[22] See Wildemann, 2008.

[23] See Heiss, 2007, page 9.

[24] See Ratzek, 2008, slide 2.

[25] The rating procedure was updated in spring 2011, the here described procedure considered hazardous substances for the first time. Apart from that the procedure is fairly equal but a comparison of old and new ratings is not entirely possible.

[26] See ADAC, 2011b.

4 Model Introduction

4.1 Model overview

In order to validate that current expert tests predict consumer satisfaction correctly in each country and in order to identify varying requirements towards CRS, the current level of satisfaction has to be measured in each country and compared to the expert tests' results.

This requires an almost identical project in each country to collect and evaluated the required data. The creation of a standard model that includes all essential activities and their order is a logical consequence[27]. This way it can be ensured that project contents are as equal as possible but at the same time country and organization specific requirements can be taken into account during the implementation.

The developed model consists of 6 phases which can be followed in sequential order. Phase 6 is special in that it is not a typical phase but a self reference to the model: Once the model has been followed the control of success can be reached by checking if adapted test procedures or changed weights for creation of ratings lead to expert test results that show an increased ability to predict customer satisfaction levels. If this is not the case, phases 5 and 6 would have to be repeated again. Graphically the model can be represented as shown in Figure 4.

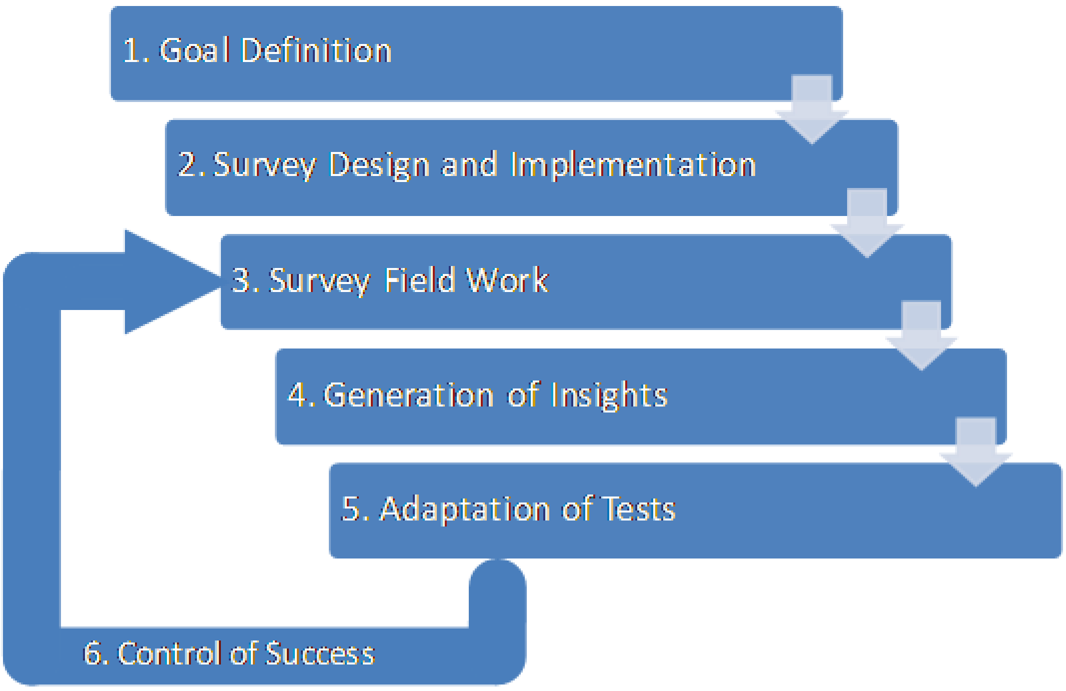

Figure 4: Sequence Model for CRS Expert Test Improvement

Within this paper, the emphasis is put on phases 1, 2, and 4 as this is the core of our current research. Phases 3, 5, and 6 are descried briefly to ensure completeness of the model.

[27] Schneider / Daun / Behrens / Wagner, 2006, page 116.

4.2 Model description

4.2.1 Goal Definition Phase

For the current model the goal is to validate expert tests' ability to predict high customer satisfaction, especially in day to day use as this aspect can only be tested to a limited extend in expert tests. In case of the CRS expert tests aspects that can be reviewed are the overall satisfaction and the satisfaction for the performance parameters handling & comfort and cleaning & workmanship. The hypothesis that has to be validated is thus: "If CRS model A has received a better grade for ease of use & ergonomics and cleaning & workmanship than a CRS model B of the same ECE group, the satisfaction in these areas should be higher for model A over model B, also the size of the gap between grades should be reflected in the size of the gap of satisfaction levels". ECE groups define the weight/age a certain CRS model is suitable for. Groups are 0, 0+, I, II, and III. Group 0 is defined as suitable for babies up to 10 kg.

The validation of this hypothesis for all reviewed CRS can be done with an analysis of variance (ANOVA) test[28]. This test checks if there is a significant difference in the mean of two (or more) samples. To identify which CRS have different mean satisfaction levels for example the Bonferroni method can be applied[29]. Running all results from the survey through this test will identify those CRS that do not meet the above hypothesis. To adjust test procedures more insights are needed – this will be discussed in the next chapter.

A question that has to be answered during this phase is the basic population for the expert tests which would then also be the basic population for the survey. In this model it is most likely every time all adults that use CRS or have used CRS in the past 3 months to transport children.

4.2.2 Survey Design and Implementation

The first step in survey design is the generation of questions of interest. Valuable sources for this are the expert test procedures, the knowledge of test experts, and parents experience with CRS. From these discussions a first satisfaction model can be derived that defines how performance parameters influence overall satisfaction and each other.

The arrows show the direction of influence. E. g. a good manual can directly contribute to overall satisfaction but also can increase handling satisfaction. In this model price is marked as it is not directly part of the survey but it can be expected that the price of a CRS also influences the expected quality, thus the satisfaction. Safety here does not refer to crash scenarios but to issues like loose seat belts or children's ability to unfasten their seatbelt accidently.

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[28] See Moore / McCabe, 2003, pages 746-756.

[29] Ibid, pages 773-775.

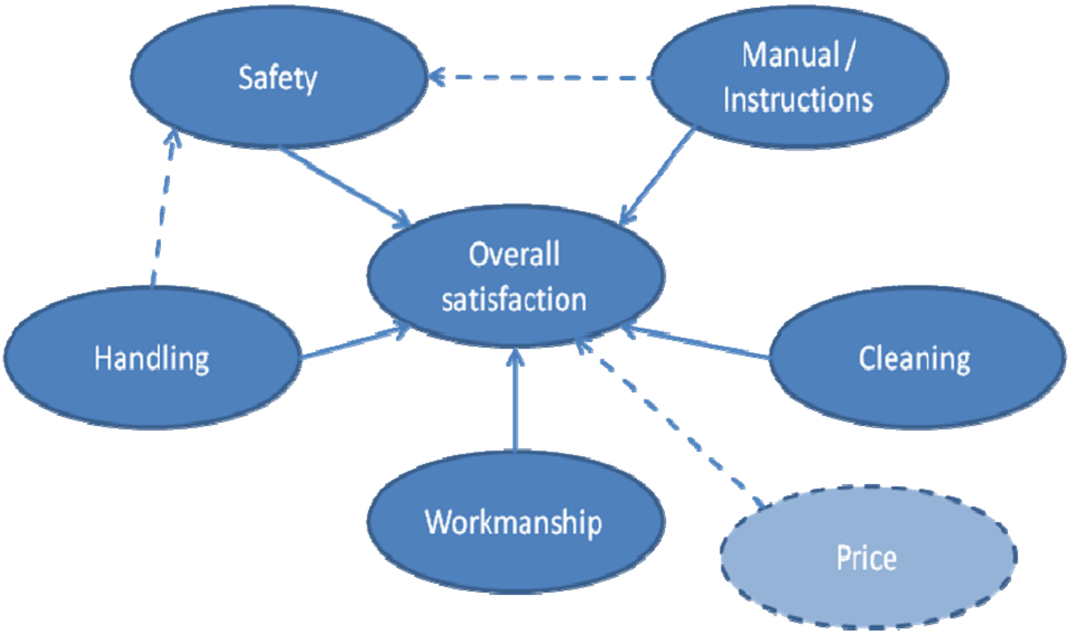

Figure 5: Sample CRS Satisfaction model with six performance parameters[30]

Each performance parameter has to be broken down to a number of specific aspects that can be surveyed. At this step a preliminary questionnaire must be created which has to be discussed with test experts for fine tuning of questions and potential answers. In this questionnaire it is important to allow for sufficient opportunities for open text questions to allow interviewees describe situations that were unforeseen by test experts. By this combination of open and closed questions it can be ensured that all interviewees have enough room to explain their ratings. This is necessary to ensure that enough information can be generated so that one can update expert tests by insights generated from the questionnaire.

Once the questions are defined, the number of to be reviewed CRS model-years has to be defined. As there is an interest in long term usability the included models should range from the newest CRS to models several years old. To keep the number of required returned surveys at reasonable level, the maximum age should be five years. While there are properly older seats in use, there are doubts that these seats can still be identified correctly in all cases. With around 30 models per year the number of filled out surveys will become very large.

For the intended ANOVA test a power calculation has to be conducted[31]. Various sample calculations have shown that a minimum of 30 completed surveys per CRS model is sufficient to identify differences of 0.3 points between average satisfaction levels with a 95 % level of confidence with an assumed standard deviation of 0.3 points. With these assumptions the number of surveys that would be needed is at least 4,500 (=30 models per year * 5 years * 30 surveys per model). While the standard deviation

[30] Based on Giesa, 2007, page 147.

[31] See Moore / McCabe, 2003, pages 778-779.

for now is not validated, 0.3 as difference is sufficiently small as minimum gap as the final results from the expert tests are published in clusters with size 1.0.

It can be assumed safely that not all CRS models are sold in equally high numbers, thus for some CRS models, getting a sufficient high number of answers would be very costly. As alternative the target number of interviews can be defined and the review of test criteria be applied only to those CRS models that are above the threshold of 30 interviews.

The survey type has to be defined in this phase. Costs, the ability to use multimedia elements and filter questions makes online surveys a suitable method for this survey[32]. With more than 95 % of Germans from 20 to 39 years age being online, 86 % from 40 to 49 and above 57 % for the age groups from 50 to 69 years age in 2011[33], the majority of CRS users can be reached. While the older age groups are still underrepresented, this group has the highest growths in going online. For CRS the prime audience is parents so this issue is acceptable.

The research aims at making conclusions for the above defined basic population. An accepted limitation is asking “onliners” only. To ensure the study results can be mapped to the basic population, the interviewees should resemble the basic population as good as possible[34]. Besides opposing views[35], making use of an online panel is seen as best method to ensure representativeness for reasonable costs. When selecting a panel the methods used to ensure representativeness of that panel have to be carefully reviewed.[36] To get indications or identify issues overlooked during expert tests non-representative surveys can be conducted. In this case the insights cannot be generalized for the basic population[37].

This phase ends with a pre-test of the questionnaire to verify that all questions are understood by all persons from the defined basic population.

4.2.3 Survey Field Work

Even the best testing cannot ensure an error-free questionnaire; results from the field work should be monitored constantly to reduce the risk of identifying errors only after the field work is completed. This phase ends with filtering out low quality interviews and the generation of a method report which describes the field work phase, includes the net- and gross number of interviews, where and how the interviews were conducted, and also includes a version of the used questionnaire.[38]

[32] See Jacob / Heinz / Décieux / Eirmbter, 2011, Pages 116-117.

[33] See Initiative D21, 2011, page 21.

[34] See Jacob / Heinz / Décieux / Eirmbter, 2011, pages 72-76.

[35] Ibid, pages 92-94.

[36] Ibid, page 94.

[37] Günther / Vossebein / Wildner, 2006, pages 19-20

[38] See Jacob / Heinz / Décieux / Eirmbter, 2011, pages 190-214.

4.2.4 Generation of Insights

A first analysis is an ANOVA test to check if the mean satisfaction with different CRS models differs significantly. If this would not be the case the questions to further analyze are: “Why do top rated CRS fail to create higher satisfaction?” and “Why do low rated CRS manage to create high satisfaction?” The investigation should start with best and worst rated CRS as the deviation for those seats is the most extreme.

If the ANOVA test shows different satisfaction levels, the hypothesis from the goal definition phase has to be checked for all CRS combinations of the same ECE group. For those combinations confirming the hypothesis it has to be checked if reasons that drive up/down satisfaction are in line with the expert ratings. For those combinations that disconfirm the hypothesis a detailed analyses of the survey results has to be conducted to identify reasons that lead to these deviating results. The proceeding for analyzes is summarized in the following figure.

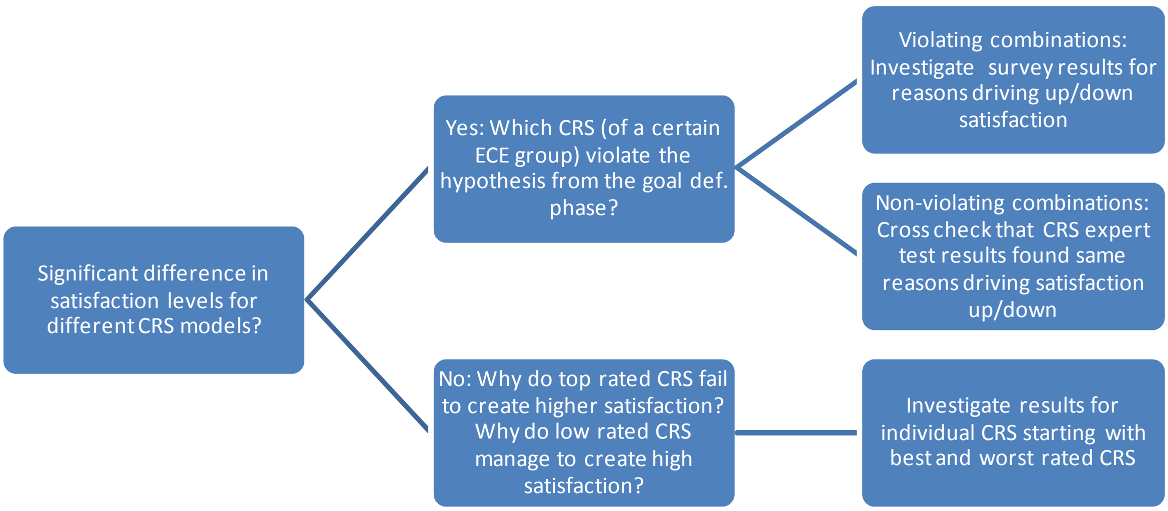

Figure 6: Analysis proceeding for survey data

The review of the used weights in the aggregation to an overall grade for each CRS is done by regression analysis for all survey data. In a second step the regression has to be repeated on ECE group level. This gives insights that could be directly applied to the expert test rating aggregation schema, if deviating importance on ECE group level is detected. For the current testing schema a comparison on model level could give an indication for different requirements by different user groups – for this initial model, this third step is thus optional.

Finally, the results from this phase have to be summed up and prepared as statements. Those results have to be discussed with CRS test experts to validate the practical understandability of the identified issues. To support this process CRS should be available physically. Answers from the free text fields from the questionnaire can give hints why expert ratings deviate from customer satisfaction levels, too. The outcome of this process is a list of issues that are both statistically significant and accepted by the test experts.

4.2.5 Adaptation of Expert Tests

Depending on the results of the previous phase, it may be required to either adjust test procedures or to adapt weights in the aggregation of test grades. As written above the expert tests are conducted in cooperation by more than 20 institutes. Thus findings of this study and derived recommendations for changes have to be presented to the ETC before test procedures will be updated. Additional research in different countries may be necessary to verify findings from one country.

4.2.6 Control of Success

It has to be verified if the adapted test procedures and weights of different test parts lead to an increased ability of the expert test grades to predict satisfaction correctly. While this can be done partly by re-grading old seats, this somewhat artificial situation may lead to biased results. The preferred method to verify this is to conduct the same questionnaire again and check if CRS from the updated expert test are able to better predict satisfaction than the old expert tests.

To do this the described model should be executed a second time concentrating on phases 3 and 4. Since the questionnaire is already developed and tested, one can start with conducting a second survey after new (and adapted) expert test results are published.

To ensure comparability of both surveys' results, the second survey has to be conducted with the same parameters (duration, questionnaire, method of surveying, etc.) like the first[39]. Since all CRS that are tested in the latest expert test are new on the market, the result of the prediction should be compared with those CRS that were new on the market in the previous test only. E. g. if the surveys are conducted six months after the publication of test results only survey data from CRS that were six to twelve months old should be compared.

5 Model Validation

5.1 Need for a Pilot Study

Validation of this model can be done by showing its practical applicability. As described in the previous chapters, there are still open questions to be answered before a full validation of the model can take place. Answering the following question will help improving the model and allow justifying costs associated with a full model application:

- What is the likeliness that expert tests and consumer satisfaction for CRS differ significantly?

[39] See Jacob / Heinz / Décieux / Eirmbter, 2011, pages 43-44.

- What are the market shares of different CRS models?
- What is the expected standard deviation for consumer ratings of CRS?
- Do problem areas exist that were unforeseen yet?

These questions are worked on in a pilot study in which volunteers are invited to answer the questionnaire that was developed during the model application. Although the generated data does not meet the quality requirements of being representative for the defined basic population[40], the pilot study can be used to validate the general proceeding of the model.

The results of the pilot study will enable improved estimations and also allow a first validation of the shown CRS satisfaction model. In the next step there will be sufficient information to decide if a full scale adoption of the model can be justified from a cost perspective.

5.2 Status of the Pilot Study

As there is a lack of knowledge on the distribution on CRS market shares in Germany[41] no explicit goals have been defined which CRS models' expert test ratings should be compared to their customer satisfaction levels. Instead it has been defined that all models where 30 or more answers are received are going to be reviewed. The topics that should be evaluated cover all parameters shown in Figure 5.

The comparison of satisfaction values with expert test ratings will take place as described above: A seat with a better grade in the expert test should create higher satisfaction values. Form the expert test the composite grade for handling & comfort is compared. This grade also includes performance parameters that are part of the Safety and Manual categories in the CRS satisfaction model.

From the survey the overall satisfaction value will be compared. This value is calculated as composite from the items "I would buy this CRS again" and "I would recommend this CRS to others" which have to be graded on a scale from 1 (excellent) to 6 (poor).

The survey has been developed according to the above described procedure. For each performance criterion a question was added to the questionnaire. Several versions of the questionnaire were discussed until a final version was accepted and implemented as online survey. The pretest took place with colleagues from ADAC who had not taken part in the development process to ensure all questions are understandable for non-experts.

The survey has been implemented using the free survey solution from "ofB – online-Fragebogen"[42] and the project is in the Survey Field Work phase. The survey is advertised on adac.de on the page where the CRS expert tests are presented. The study is

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[40] It can be assumed that the persons taking part in the survey show high interest in the topic of child safety.

[41] See Biedefeld, 2010.

[42] See https://www.soscisurvey.de

branded as scientific study and does not offer any incentives. To increase the number of participants it will be advertised in the next ADAC email newsletter. Experience by ADAC shows that this generates a sufficiently high number of interviewees.

6 Conclusion & Outlook

The presented conceptual model describes how customer satisfaction surveys can be implemented and used to review CRS expert tests in their ability to predict customer satisfaction and to identify consumer requirements. After its initial validation the model can be applied in several countries to identify local differences in consumer requirements. The conjoint analysis of data from several countries will enable the identification of differing requirements.

The proposed model can be enhanced by including international aspects such as ensuring equality of surveys in different languages or the above described conjoint data analysis.

Another option is to adopt this model for other expert tests – for example satisfaction with cars. The application of artificial intelligence for pattern detection, in conjunction with technical data, seems to be a promising field of research and is the intended goal of a planned dissertation project. Last but not least the question if gained information can be used to foster product improvement directly should be researched.

7 References

ADAC (2011a): Kindersitze im ADAC-Test. Retrieved August 23, 2011, from http://www.adac.de/infotestrat/tests/kindersicherung/kindersitz-test/default.aspx?ComponentId=29903&SourcePageId=31900

ADAC (2011b): Kimdersitze im ADAC-Test. So testen wir Kindersitze. Retrieved September 8, 2011, from http://www.adac.de/infotestrat/tests/kindersicherung/kindersitz-test/default.aspx?tabid=tab4

Biedefeld (2010): Sicherheit der Kinder im Fokus. Retrieved August 8, 2011, from http://www.frankenpost.de/lokal/kulmbach/kl/art3969,1242247

Diez, W. (2006): Automobil-Marketing. Navigationssystem für neue Absatzstrategien, 5th Ed., Landsberg am Lech.

Doyle, J. J. Jr.; Levitt, S. D. (2010): Evaluating the Effectiveness of Child Safety Seats and Seat Belts in Protecting Children from Injury, in Economic Inquiry, Vol. 48, No. 3, July 2010, page 521-536.

Elfroth, A.; Neckermann, S.; Zupancic, D. (2006): Kundenzufriedenheit – Ein Konzept zur Messung und Verbesserung im Business-to-Business-Geschäft, Düsseldorf.

European Union (2007): Regulation No 44 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of restraining devices for child occupants of power driven vehicles (‘child restraint systems’. Revision 1, in Official Journal of the European Union.

Fiorentino, A. (2010): Use and misuse, sociological approach of child safety. Cultural Comparison: France, Spain, Italy, in: CASPER / EPOCh Mid-term Workshop, Munich, 30th November 2010.

Giesa, T. (2007): Bestimmung relativer Wichtigkeiten in der Kundenzufriedenheitsmessung. Köln.

Glaser, C. (2006): Die Nutzersicht bei der Gestaltung von Sicherheitssystemen am Beispiel des Kindersitzes im Pkw. Retrieved from http://lexikon.kfz.tu-berlin.de/apsn/index.php?id=815&L=1

Günther, M.; Vossebein, U.; Wildner, R. (2006): Marktforschung mit Panels. Arten – Erhebung – Analyse – Anwendung (2nd Edition), Wiesbaden.

Heiss, S. F. (2007): Kundenwissen für Forschung und Entwicklung in der Automobilindustrie: Fallstudie und Modellentwicklung zum Wissen von und über Kunden, Augsburg.

Homburg, C.; Krohmer, H. (2003). Marketingmanagement. Studienausgabe. Strategie - Instrumente - Umsetzung – Unternehmensführung, Wiesbaden.

Initiative D21 (2011): (N)onliner Atlas 2011. Eine Topographie des digitalen Grabens durch Deutschland.

Jacob, R.; Heinz, A.; Décieux, J. P.; Eirmbter, W. H. (2011): Umfrage. Einführung in die Methoden der Umfrageforschung (2nd Edition), Munich.

Johannsen, H. (2007): Concepts towards Reduced Misuse Rates, in: 5th International Conference “Protection of Children in Cars”, Munich, 7th and 8th December 2007.

Johannsen, H.; Huijskens, C.; Schnottale, B.; Schindler, V. (2005): Site Impact Test Procedure for Child Restraint Systems. Review of Existing Methods and Proposals for Continuation, in: Proceedings of 2005 International IRCOBI Conference On Biomechanics of Impact, page 431-434.

Johannsen, H.; Müller, G.; Schindler, V. (2008): How did Child Safety Develop During the Last Ten Years, in: 6th International Conference “Protection of Children in Cars”, Munich, 4th and 5th December 2008.

Langwieder, K.; Stadler, P.; Hummel, T.; Fastenmeier, W.; Finkbeiner, F. (1997): Verbesserung des Schutzes von Kindern in Pkw, in: Mensch und Sicherheit, Heft M. 73, page 153-171.

Moore, D. S.; McCabe, G. P (2003). Introduction to the Practice of Statistics (4th Edition), New York.

Ratzek, A. (2008): Practical experience and consumer recommendations for an improved regulation, in: 6th International Conference “Protection of Children in Cars”, Munich, 4th and 5th December 2008.

RoSPA – The Royal Society for the Prevention of Accidents (2001): A Review of Child Restraint Instructions. Reveived August 15, 2011, from http://www.childcarseats.org.uk/pdfs/child_restraints.pdf

Schneider, K.; Daun, C.; Behrens, H.; Wagner, D. (2006): Vorgehensmodelle und Standards zur systematischen Entwicklung von Dienstleistungen, in: Service Engineering: Entwicklung und Gestaltung innovativer Dienstleistungen, Heidelberg.

Schoeneich, O. (2005): Virtuelle Testmethoden zur Unterstützung der Entwicklung von Kinderrückhaltesystemen, Berlin.

Vroman, R. (2008): A Fatal Contradiction, in: 6th International Conference “Protection of Children in Cars”, Munich, 4th and 5th December 2008.

Wildemann, H. (2008): Quality Function Deployment. Die Stimme des Kunden in Entwicklung, Produktion und Zulieferung - QFD-Schulungsunterlage. Munich.

Night Star Express: With Sustainable Solutions into the Future – the Calculation of Carbon Dioxide Emissions

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Abstract

The following paper deals with the calculation and representation of carbon dioxide emissions of the nighttime transport services provider Night Star Express. As "green" logistics are gaining importance within the current movement towards a more sustainable economy, more and more logistic companies are providing a carbon dioxide balance sheet to their stakeholders. This paper describes the approach and procedures used during the project. In addition, both Night Star Express and the Institute for Environmental Management Gaia e. V. explain their motivation to determine the amount of carbon dioxide emissions. Finally, the paper presents the results and analyses their meanings for the nighttime transport services provider.

1 The Project

Night Star Express is a leading provider of overnight transportation solutions within Germany and throughout Europe. Goods can be picked up by late afternoon and—even in the absence of a physical customer recipient—be delivered nationwide that night or in the following early morning hours throughout Germany and to some neighboring European countries. The service enables customers to forego extensive inventory. Moreover, those customers who need their goods supplied before the start of the business day can have them provided quickly with this "overnight express" service every night. More than 4 million items have been shipped annually through the company's network of 20 branches, 600 employees and 650 vehicles.

For the logistics company, the concept of "first-class overnight express" means a consistent focus on customers' needs. This demonstrates, among other things, a vibrant quality management system and Night Star Express's capability to deliver the highest quality standards.

A company's success depends greatly on increasingly dynamic operating markets. This also means taking the needs of the corporate environment into consideration. And so, the political environment, as well as the economic, social and technological, must also be considered. In the context of strategic planning, the so-called "PEST analysis"[1] provides an increasingly important, yet often neglected, aspect of the business environment: the ecological[2]. Given that this aspect is core to its corporate mission, Night Star Express GmbH Logistik contracted GAIA e. V. – Institut für Umweltmanagement, a private environmental management institute of the Business and Information Technology School (BITS) gGmbH, to measure and assess Night Star's CO_2 emissions.

This study served several objectives, primarily to find out:

- What is the logistics service provider's amount of annual CO_2 emissions?
- Where are the company's main sources of CO_2 emissions (and thus identify opportunities to reduce them)?
- How much CO_2 emissions can be allocated to a shipment or to 1 kg of shipped goods?

Based on this evaluation, concrete ideas to reduce or compensate for emissions can be checked for their practical relevance. It also raises the possibility of future comparison with other logistics services, as long as relevant data can be captured. Finally, as a leader in the field, Night Star Express has the opportunity to show this information to an increasingly environmentally-conscious customer base.

With this study, Night Star Express has established itself as a company which doesn't just react passively to the environmental challenges of our time. Instead, the issue has

[1] See Macharzina / Wolf, 2010, page 301.

[2] See Deltl, 2004, page 76.

been actively integrated into its corporate policies – an excellent example of the new Environmental Management 2.0[3].

This project began in fall 2010. Just six months later, the results were presented at the Munich "Transport Logistics" Trade Fair, and subsequently awarded the 2011 Science Prize. In the following, we explain the essential approach and present the conclusions of this project.

2 The Approach

The task was to calculate the company's carbon dioxide emissions and to create an initial balance. Nearly all business fields are seeing an increased focus on sustainability, and so many companies have started to publicly report a balance of their carbon dioxide emissions. This is not only important for the company itself but also to fulfill stakeholders' demands. More and more customers consider a company's environmental impacts when choosing their service provider. Other companies consider the carbon dioxide emissions of their business partners as it may consequently impact their own balance as part of emissions in their value chain.

The project has been split up in different segments: preparation and introduction, research and data collection, calculation and reflection.

The first phase began with a visit to the main trade and trans-shipment center in Hünfeld to find out about the nighttime service provider's processes and operation methods. Subsequently, we collected all the available data needed to calculate the carbon dioxide emissions. Night Star's franchise network provided a large volume of complex data from twenty different sources, thus revealing the first challenges for the project.

3 The Calculation

After having collected and edited all necessary data, we could start with the main part of this project – the calculation. The calculation of carbon dioxide emissions included emissions generated by vehicles, offices and storage buildings. As some of the buildings are only partially used by Night Star Express, the amount of energy and electricity consumption had to be divided proportionally to the area exclusively occupied by Night Star Express.

The same calculation challenge occurred because some vehicles also take routes for other companies. Therefore, the exact amount of fuel spent by Night Star Express was not always ascertainable. The only information available was the exact number of kilometers driven by each vehicle per day. Nevertheless, by listing every single transport device, showing the car type, the engine, the fuel type, as well as brake horsepower and the European emission standard, we were able to get an overall image of the Night Star fleet.

[3] See Meuser, 2010, page 297.

But before being able to use these data to calculate the fleet emission, we needed some statistical data. To ensure reliability, we decided to use “EcoBusiness”, an online software from the Swiss company “EcoSpeed”, as our calculation tool. This software specializes in determining greenhouse gas balancing for enterprises. Based on the software “EcoRegion”, which has been approved and recommended by the European Commission to be used to balance greenhouse gases for towns and cities, “EcoBusiness” has excellent references in carbon dioxide reporting.

Differentiated on the information collected before, the software offered us information on how many miles to the gallon different vehicles would need. With the fuel consumption and annual mileage of each vehicle, the total annual fuel consumption can be predicted. The amount of CO_2 emissions can be estimated by using some statistical information. For example, the majority of the Night Star Fleet uses diesel as fuel, and the combustion of diesel releases 2.620g of CO_2 per liter[4]. But in order to determine Night Star Group's overall climate impact, other greenhouse gases aside from CO_2 must also be included in the calculation. Fuel combustion also includes the release of methane (CH_4) and nitrous oxide (N_2O).

At this point, it is necessary to consider the different effects of the three greenhouse gases. These are expressed by their Global Warming Potential (GWP). The GWP of methane is about 25 times higher and the GWP of nitrous oxide is 298 times higher, over a period of 100 years[5]. Therefore, the calculated amount of methane and nitrous oxide afterwards can be converted into carbon dioxide equivalents[6] according to the GWP. In order to calculate methane (CH_4) and nitrous oxide (N_2O) emissions, “EcoSpeed” provides statistical values per kilometer, which are graded according to vehicle weight, European emission standard and year. Thus, the calculation of vehicle emissions already considers most of Night Star Express’s emissions. Similar calculations were subsequently carried out for office and warehouse consumption, so that an overall carbon footprint could be drawn.

4 Results and Reflection

After having finished the calculation, we could present our results: The total emissions of Night Star Express amount to 18,621 tons of greenhouse gases. Because figures were important for Night Star Express in order to present well in competition, mere calculation of the annual total output was not meaningful enough. Relative to the 73,995,556 tons total of all transported goods, it is a strikingly small amount. In 2010, each kilogram of transported goods is assigned a CO_2 value of 0.25 kg.

During the project, and especially after having elaborated the amount of carbon dioxide emissions, we were looking for comparable data in this sector which became yet another challenge. As there are no accounting standards, particularly in the logistics

4 See Innenministerium Baden-Württemberg, 2008, page 20.

5 See IPCC 2007, page 212.

6 The amount of CO_2 that would have the same global warming potential.

industry, one finds very different approaches. In the majority of cases, the biggest difference is the extent of covered areas flowing into the calculation. Depending on which areas are to be covered, one can choose between a balancing according to Scope 1, 2 or 3. According to the Greenhouse Gas (GHG) Protocol, Scope 1 contains all direct greenhouse gas emissions. Scope 2 includes indirect emissions from the consumption of purchased electricity, heat or steam as well. Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities (e.g. T&D losses) not covered in Scope 2, outsourced activities, waste disposal, etc. are included in Scope 3[7].

Our calculation is based on Scope 1 and 2 according to the GHG Protocol. This means that all direct emissions as well as the emissions from consumption of purchased energy and electricity are included – however all other indirect emissions have been disregarded.

The carbon dioxide emissions represent by far the highest part of the entire emissions. The other emissions (methane and nitrous oxide) only account for less than 5%. However, in order to have an appropriate comparison, it is necessary to convert the values according to their GWP as previously described. Expressed as carbon dioxide equivalents, the amount of methane would be 25 times higher and the amount of nitrous 298 times greater.

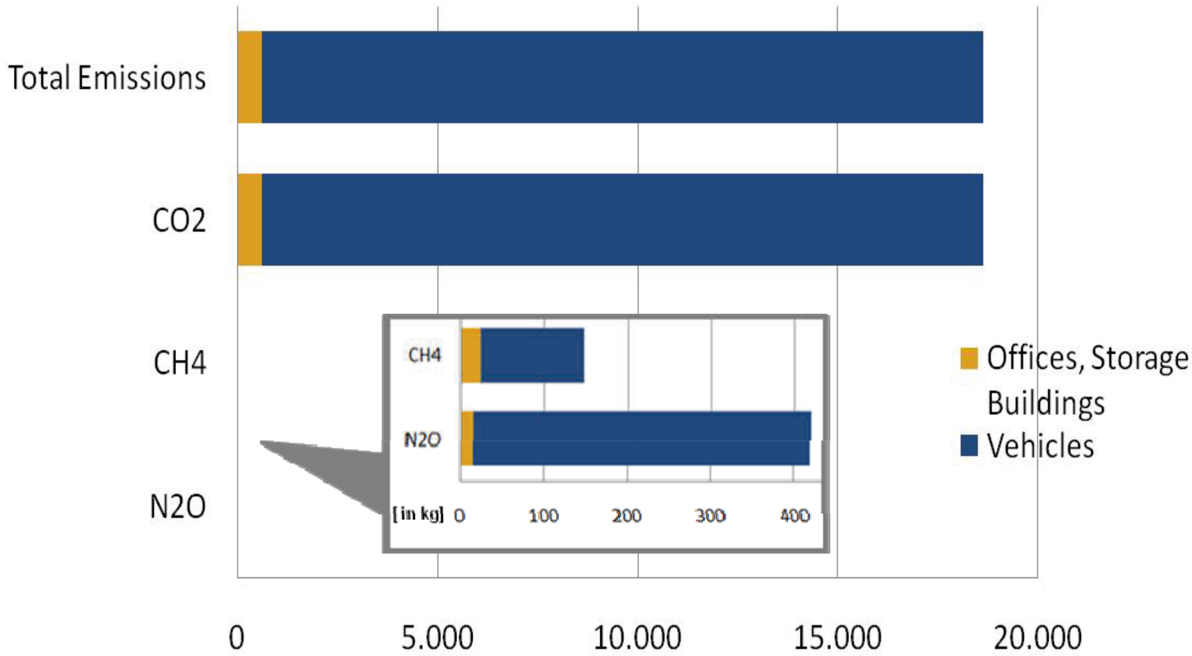

Figure 1: Amount, type and origin of emissions 2010

A second conclusion provided by the results is the huge contribution by the vehicle fleet to total emissions. The vehicles are clearly responsible for the major part of emissions which confirms the notion that switching to a green electricity provider, for in-

[7] See WBCSD, 2004, page 25.

stance, or replacing all light bulbs with energy-saving bulbs would be nice to have, but it would never lead to the desired effect of a noticeable reduction of carbon dioxide emissions. This goal can only be reached by measures which explicitly address vehicular emissions. That said, these measures also represent the most expensive ones. Therefore, a balance between ecologically desirable and economically feasible measures has to be found – and that is the art of sustainability!

5 References

Deltl, J. (2004): Strategische Wettbewerbsbeobachtung, Wiesbaden.

Innenministerium Baden-Württemberg (2008): Energiesparend Fahren; 7th Ed., page 20.

IPCC (2007): Fourth Assessment Report: Climate Change 2007, Chapter 2: Changes in Atmospheric Constituents and in Radiative Forcing, Cambridge, United Kingdom and New York, USA, page 212; Table 2.14

Macharzina, K.; Wolf, J. (2010): Unternehmensführung. Das internationale Managementwissen. Konzepte – Methoden – Praxis, 7th Ed., Wiesbaden.

Meuser, T. (2010): Anforderungen an ein Green Business Management & Controlling, in: Reichmann, T. (Ed.), 25. Deutscher Controlling Congress: Neue Anforderungen an das Management & Controlling, Dortmund, page 293-330.

World Bank (2010): World Development Report 2010: Development and Climate Change, page 81.

World Business Council for Sustainable Development (2004): The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard

Internationalisation of Remote Service technologies – A three Country Study on Perception, Adaptation and Relationship Marketing

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Abstract
Modern information technologies alter not only the nature of services and their delivery process but also the interaction at the interface between service providers and customers. The transformation from close personal contact to technology-mediated interaction is challenging both sides. Against this background, this research focuses on the exploration of remote services in a B2B-context. This study aims at (1) exploring how customers perceive and evaluate remote services; (2) identifying their expectations; (3) revealing how technology-mediated interaction affects the relationship. Results of this study generate managerial implications for remote service providers that help to enhance acceptance and strengthen customer relations.

1 Introduction and Research Question

During the last decade, services industries were subject to considerable changes with regard to the way services are provided and delivered[1]. Modern information technologies alter not only the nature of services and their delivery process[2] but also the interaction at the interface between service providers and customers[3]. (Self)-service technologies in B2C-settings have received considerable research interest over the last years[4]. By contrast, little empirical research has been done to examine more complex and technology demanding remote services that are used and delivered in B2B-settings[5]. Motivated by this existing gap our research focuses on the exploration of remote service adoption in B2B-settings.

In contrast to B2C self-service technologies that "are technological interfaces that enable the customer to produce a service independent of direct service employee involvement"[6], B2B remote services are provided in an interactive technology-mediated production process, exclusively allowing the service providers to access and modify the service object over long distances[7]. Particularly in high technology industries such as IT, medical healthcare equipment and mechanical engineering, remote services are established instruments and are often used for remote repair and remote diagnosis and maintenance[8].

Investigating remote services adoption in a research context that is characterized by established B2B service relationships is important for a number of reasons. First, the provision of services from a distance complicates customers' perception of the actual rendered services and the subsequent judgment of quality[9]. The customer will not necessarily be informed and notice when, how often and which services are provided. Hence, for providers it is important to make the "evidence of service"[10] realizable and traceable[11]. These facts make it evident to explore the actual perception and evaluation of remote services from a customer´s perspective and to unfold possible factors that determine the successful service perception and implementation. Second, remote services replace the face-to-face exchange and communication between the service organizations and their customers. This new form of technology-mediated interaction

[1] See Meuter et. al 2000; Meuter et al. 2005; Zeithaml and Bitner 2003; Dabholkar 1994

[2] See Bitner, Brown and Meuter, 2000

[3] See Colby and Parasuraman, 2003; Bhappu and Schultze, 2006

[4] See e.g. Dabholkar, 1996; Dabholkar and Bagozzi, 2002; Baholkar et al., 2003; Weijters et al., 2007; Shamdasani et al., 2008

[5] See Wünderlich and v. Wangenheim, 2007

[6] See Meuter et al, 2000, p.50

[7] See Schumann et al. 2007

[8] See Biehl et. al 2004

[9] See Zeithaml et al. 2006

[10] See Bitner 1993

[11] See Zeithaml et al. 2006

generates unexpected challenges both for the service providers and the customers [12] and change the relationship performance especially in a B2B-setting[13]. Exactly these interpersonal exchanges are important factors determining services success and give an impression about service quality[14]. Interpersonal exchanges furthermore lead customers to develop strong personal relationships with an organization[15] and bind customers[16]. For the above reasons it is necessary to analyze how the transformation from close personal contact to technology-mediated interaction will affect the relationship.

2 Literature Review

Remote Services allegorize a particular form of previously researched technology mediated services and are therefore defined as a unique service type[17]. According to Wünderlich and v. Wangenheim (2007) remote services are "provided in a technology mediated production process independent of the physical separation of customer and provider. Hereby, the service object is remotely modified via control and feedback devices." There are three important characteristics that differentiate them from self-service technologies. First, remote services are complex and technology demanding compared to simple self service technologies (e.g. ATMs). Second, the service object is actively accessed by the service providers during the production and delivery process. And third the service customers are integrated in the production process and have to co-produce the services via technology-mediated interaction[18]. From a service provider's perspective remote services offer increased flexibility concerning the reaction time on service failure, diagnosis and repair[19]. Furthermore the service employees can work for several customers at the same time without physically being present. This saves time and labour cost. Noticeable benefits for the customer are increased uptime for the systems, stability and consequently higher productivity[20]. Additionally, service providers can offer 'customized solutions' in form of remote services to commit their customers to the organization[21] and to differentiate themselves from competitors. On the contrary remote services challenge providers and customers in certain areas. Especially data security is a great concern because providers often have full access to confidential data[22]. Moreover the interaction is relocated on a technology mediated level meaning that human to human interaction does not exist. Personal exchange and face

[12] See Zeithaml 2002

[13] See Bhappu and Schultze 2006; Gremler and Gwinner 2000; Selnes and Hansen 2001

[14] See Bitner et al. 1990; Bettencout and Gwinner, 1997; Gremler and Gwinner, 2000

[15] See Grönroos 1990; Parsuraman, Zeithaml and Berry 1985

[16] See Bateson and Hoffman 1999

[17] See Schumann et al. 2007

[18] See Wünderlich 2007

[19] See Biehl et al. 2004

[20] See Wünderlich and v. Wangenheim 2007

[21] See Tuli et al. 2007

[22] e.g., digital patient´s records

to face discussion are no longer an integrated part of the customer-provider relationship.

In the last years, service technology received attention from researchers in both disciplines management and marketing. Especially self-service technologies in the B2C setting gain sustainable research interest[23]. Literature on self-service technologies (SST) generally examines factors that determine acceptance[24]. These studies are based on technology acceptance research for example the technology acceptance model (TAM)[25]. The TAM is based on the theory of reasoned action (TRA) meaning that an attitude toward a specific behavior has an impact on behavioral intentions[26]. Applied to TAM this means that the degree of technology acceptance is reflected in the strength of attitude or intention toward using the technology[27]. In their study Davis, Bagozzi and Warshaw (1989) identified the constructs ease of use and perceived usefulness influencing the attitude to use technology at work. Curran and Meuter (2005) emphasize the importance of variables like perceived risk and need for interaction that are missing in the TAM. Drivers of usage and satisfaction[28] are examined and predictors of self service adoption like technology-readiness[29] and technology anxiety[30] are identified. Research from B2C-settings proves that from a consumer´s perspective the technology-mediated service encounter can be both beneficial and challenging[31]. Customers are used to close personal contact in the service encounter and oftentimes prefer personal exchange and interaction[32].

Interactive services research has identified the service provider representative's behavior as an important component in service perception[33]. Customer´s general evaluation of the service experience depends on employee´s characteristics (e.g. friendliness, responsiveness and enthusiasm)[34]. Further important outcomes being affected by the employees are the customer's perception of service recovery[35], satisfaction[36] evaluation of

[23] See e.g. Dabholkar, 1996; Dabholkar and Bagozzi 2002; Baholkar et al. 2003; Meuter et al. 2005; Weijters et al. 2007; Shamdasani et al. 2008

[24] See Curran Meuter and Suprenant 200; Dabholkar 1994; 1996; Dabholkar and Bagozzi 2002)

[25] See Davis 1989

[26] See Ajzen and Fishbein 1980; Fishbein and Ajzen 1975

[27] See Davis, Bagozzi and Warshaw, 1989

[28] See Parasuraman, Zeithaml and Malhotra 2005

[29] See Parasumraman 2000

[30] See Meuter et al. 2003

[31] See Curran and Meuter 2005

[32] See Zeithaml and Gilly 1987; Dabholkar 1992; Dabholkar and Bagozzi 2002

[33] See Bettencourt and Gwinner 1996; Bitner, Booms and Tetreault 1990; Gremler and Gwinner 2000; Solomon et al. 1985; Zeithaml, Berry and Parasuraman 1988

[34] See Sundaram and Webster 2000

[35] See Liao 2007

[36] See Solomon et al. 1985; de Ruyter and Wetzels 2000

the service organizations[37], employees support the integration of the customer in the service production process[38].

All studies and approaches apply to B2C-settings. Due to this fact it is essential to investigate remote services in B2B-settings in order to examine to what extend these approaches can be transferred to organizational contexts. In addition, by identifying factors and aspects that cannot be explained with the existing concepts our research will contribute by extending these concepts and theories. With regard to the research questions and the overall aims of this study, a qualitative research design seems appropriate for this study.

3 Qualitative research design

Remote services represent a relatively new field of services research therefore literature and concepts on remote services are limited. Moreover the key research questions of this research have not been investigated before and seem to be important in the context of B2B remote services usage and implementation from a theoretical and practical perspective. An exploratory research design that emphasizes discovery over confirmation is thus appropriate for this study. We utilize in-depth interviews as a method to capture the underlying dimensions[39] of how customers perceive the remote service technology, to explore basic perceptions and evaluations of remote service encounters and to identify the impact of the remote service technology on the quality of customer relations. In-depth interviews were selected as they are a "useful method for exploring new and under-researched topics" and enable researchers to gather "rich and meaningful data"[40].

We have chosen the healthcare industry as unit of analysis since in the medical- and healthcare sector remote services are established to a certain extent and interview partners can refer to their experience, incidents and know-how collected over the time. Interview partners were selected according to a criterion sampling method meaning that selected interview partners must meet some predetermined criterions that method is important concerning the quality assurance of the data[41]. In accordance with our research aims we selected medical engineers and technicians being directly affected by remote service technologies. This study comprises a total of 25 extensive qualitative interviews with remote service customers and 10 interviews with remote service representatives across 10 different hospitals in the USA, Germany and Sweden. Data material is analyzed with the help of a computer-aided software tool called Gabek®/WinRelan. The convincing strengths of Gabek are the strict rule-based coding

[37] See Bitner, Booms and Tetreault 1990

[38] See Bettencourt et al. 2002; Lovelock and Wirtz 2004; Lovelock and Young 1979; Vargo and Lusch 2004

[39] See Miles and Hubermann 1994, Carson et al. 2001

[40] See Carson et al. 2001

[41] See Patton 2004

process, the closeness to the original data and respondent's language and transparency during the complete analysis process[42].

4 Results

Remote services represent a relatively new field of services research therefore literature and concepts on remote services are limited. Moreover the key research questions of this research have not been investigated before and seem to be important in the context of B2B remote services usage and implementation from a theoretical and practical perspective. An exploratory research design that emphasizes discovery over confirmation is thus appropriate for this study. We utilize in-depth interviews as a method to capture the underlying dimensions[43] of how customers perceive the remote service technology, to explore basic perceptions and evaluations of remote service encounters and to identify the impact of the remote service technology on the quality of customer relations. In-depth interviews were selected as they are a "useful method for exploring new and under-researched topics" and enable researchers to gather "rich and meaningful data"[44].

The major themes and topics that emerged from the interviews with remote service customers are discussed in the next paragraph, supported by exemplary quotes. Some of these results correspondent to previous studies about technology mediated services in a B2C-context but for example the responsibility toward a third-party is unique in B2B-context.

Remote service perception. The perception of the service technology is depending on the individual experience of the respondents. In theory they all know the benefits and how this technology should work. "*Well, I mean, in theory there is this concept that somebody can get in to our system and look out what is wrong, remote. And remote doesn't work between you and me. There is nothing like having a person here"*[45]. But in reality customers express predominantly their concerns "*I think remote services are pretty useful, but when I wanted to start the remote service procedure I had problems with the technology and it was very difficult for me to handle this. I did not know what to do"*[46].

Perceived Risk. Customers have a higher risk perception especially when the service technology is new, complex and highly intangible[47]. Concerning remote services the risk perception is even stronger because the provider can log on the customers' system at any time and has full access to sensitive data for example patient´s records. This is why trust plays a crucial role in the remote service delivery. "*Usually, I really want to*

[42] See Buber and Kraler 2000; Zelger and Oberprantacher 2002

[43] See Miles and Hubermann 1994, Carson et al. 2001

[44] See Carson et al. 2001

[45] [customer, USA, A 19]

[46] [customer, USA, Q 36]

[47] See Bettmann 1973; Dowling 1986

know, who is on my system and what kind of changes he made. Not letting people know [that they are on my system] is horrible. I have to trust them without knowing what's going on."[48].

Perceived Integration. The benefits of remote services are limited by the willingness and competence of the customer[49]. Remote services are complex services and require a lot of special know-how and training of the customer "*I need technical help from the provider, the system is too complex for me, I am not able to handle this.*"[50]; "*Sometimes I wish, when I call in with a problem, the remote service would be trying to explain to me how to do something. So sometimes I wish they had the ability to solve the problem.*"[51]. Because of the complexity providers often solve a problem without involving customers in the process. This separation is a very serious problem for the customers. They have the feeling that providers do not value the counterpart's competence. "*So, if remote service could diagnose the problem and allow me to physically fix it, then it would be helpful.*"[52]. "*I would like to be involved. I think there is a benefit to, again, I would think that belongs to the relationship, I mean, why not allow me to be part of that process? Why does it have to be separated?*"[53].

Negative Benefit Perception. The new technology can malfunction and frustrate customers[54], although it is it supposed to be extraordinary beneficial. Particularly the intangible and non-observable nature of remote services make it difficult to show the 'evidence of service'[55] and the benefit, although a clean functional system can be the result of several remote service operations but that is hard to notice. "*In the past I don't think it was thought to bring value to the end user, to us.*"[56].

Perceived Service Quality. Customers do not only receive benefits from the product itself; they also receive benefits from interaction with service employees[57]. The human interaction is an important element in how customers define service quality[58]. "*And I want to see prove an evidence of that. I want to see okay, you had this error and we fixed it remotely by doing this and correcting this problem in the system.*" [59]

Personalization. When it comes to personalization, customer of remote services criticize the impersonality of this kind of services and they describe remote services as "*less friendly, [it should be] a little bit more sensitive, a little bit, you know, when you*

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[48] [customer, Sweden, L 22]

[49] See Walker and Craig Lees 2000; Walker and Johnson 2006

[50] [customer, Germany, M 13]

[51] [customer, USA, C 17]

[52] [customer, USA, D31]

[53] [customer, USA, A16]

[54] See Prendergast and Marr 1994

[55] See Bitner 1993

[56] [customer, USA, E42]

[57] See Hennig-Thurau 2004; Zeithaml and Bitner 2003; Parasuraman, Zeithaml and Berry 1985)

[58] (Walker and Craig Lees 2000; Walker and Johnson 2006

[59] [customer, USA, A48]

are just typing you send something out, there is not personality in it. I'm not saying that's good or bad, it just is. When you're dealing with a body not somebody you act a different way"[60]. "*You might be willing to give the somebody you talked with the last three years an extra day to fix the problem when you may not give a remote person any time.*"[61]. With remote services "*everybody gets into the same category; there is no differentiation and priority.*"[62].

Social Bonds. Without personal contact it is almost impossible to build up personal relationships between customers and service providers[63], since service employees convey the provider's identity and personality[64]. "*I want remote services but I insisted on having somebody onsite*"[65]; "*When you have a person onsite they can build on a relationship with him and of course the provider*"[66]. Furthermore it became clear that a discussion in privacy between the customer and the service employee can help to solve problems and together they are able to develop more efficient solution for the future. "*When I have a problem and I talk with Frank, he knows me and my system. We always find a way together even after work"*[67].

Responsibility of third-party. One concern that is mentioned throughout the interviews is the responsibility towards a third party. In the medical contexts the hospitals are responsible for their patients and they want to ensure that the equipment is functional so they on the other hand can offer medical service "*This hospital is unique, people come here for only one thing and that's cancer. They want to know if they're going to live or die. It's personal. I don't want to hear that my CT scanner wasn't available when I got to CT"*[68].

Metaphors. As results the analysis identified the above mentioned topics but all through the interviews it was surprisingly that respondents use continuously strong metaphors to describe their attitudes and perceptions. Altogether 42 metaphors are mentioned and can be divided into two categories. Things of the everyday life like car, refrigerator and puzzle are often used for demonstrating the problem solving process and to explain their needs. *"Remote service to me is always looking at, let's do it this way: if I am sitting in my automobile I have a speedometer, I can see the oil pressure. You can look at those same things sitting in Germany if I had the ability to send those electronically to your screen. So, you could look and you could say, hey, you know what; he needs a new battery"*[69]. The second category implies technology in extreme

[60] [customer, USA, B35]

[61] [customer, B 50]

[62] [customer, USA, H28]

[63] See Liljander and Stratvik 1995

[64] See Berry 1981; Lovelook et al. 1998; Berry and Parasuraman 1991

[65] [customer, USA, Q30]

[66] [customer, Germany, O45]

[67] [customer, USA, P34]

[68] [customer, USA, M23]

[69] [customer, USA, M4]

situations[70]. One the one hand the expressions highlight the respect towards the technology and the importance of reliability on remote services. The submarine as an example shows the high pressure on reliability and trustworthiness "*basically if you're on a submarine and you're under water for six months that is a long time, you know, if that pump is available from 7 in the morning to midnight, then I don't want to hear it's not available from 7 a.m. to midnight.*"[71].

5 Discussion and Limitations

This research implies that since remote services are provided with no direct face-to face contact between the service providers and the customers, a sole focus on technology performance is not enough to increase the customer's perception of remote services and respective acceptance. The integration of customers in the production process in order to increase and demonstrate the service quality is essential. Service customers can integrate their specific knowledge and gain a certain degree of control about the processes. For this reason service providers should support their customers by providing clear instructions, good training and additional guidance to optimize the co-production. Customer integration is also important for reducing uncertainty about customers' perception of their own competence and ability to perform the co-production activities in a technology-mediated service provision. This study reveals that customers perceive remote services as risky due to the non-observable nature of the delivery. Therefore it is necessary to continuously exchange information to strengthen and assure a trustful relationship. It is further necessary to provide transparency of the process by providing protocols and reports about remote service operations. Additionally pictures and CVs of service employees should be displayed to provide a personal component to the transaction and facilitate the relation between service providers and their customers.

As with all empirical studies, our study suffers from limitations: In summary, this research examines 30 customers and employees from one industry only. Therefore, further research should extend to different industries and settings. In addition only one type of product/service constellation was investigated. Different effects may exist with regard to services of less critical nature than in the medical equipment industry. Therefore, we recommend research designs comparing different types of remote services. Our results will be used to develop a conceptual model and test it empirically using a larger number of remote service-customers.

6 References

Ajzen, I. and M. Fishbein (1980), "Understanding Attitudes and Predicting Social Behavior, Englewood Cliffs, NJ: Prentice Hall.

Bateson, J.E.H. (1985), "Self-Service Consumer. An Exploratory Study," Journal of Retailing, 61 (3), 49-76.

[70] (submarine, Apollo 13, George Orwell 1984)

[71] [customer, USA, M23]

Berry, L.L. (1981), "The Employee as Customer," in: Journal of Retail Banking, 3 (1), 33-40.

Berry, L.L. and A. Parasuraman (1991), Marketing Services, New York: Free Press.

Berry, L.L.; K. Seiders; D. Grewal (2002), „Understanding Service Convenience“, Journal of Marketing, 66 (3), 1-17.

Bettencourt, L.A., Amy L.O., Stephen W.B. and R.I. Roundtree (2002), "Client Co-Production in Knowledge-Intensive Business Services," in: California Management Review, 44 (4), 100-28.

Bettencourt, L.A. and K. Gwinner (1996), "Customization of the Service Experience: The Role of the Frontline Employee," in: International Journal of Service Industry Management, 7 (2), 3-20.

Bettmann, J.R. (1973), "Perceived Risk and Its Components: A Model and Empirical Test," in: Journal of Marketing Research, 10 (5), 184-90.

Bhappu, A. and Schultze A. (2006), "The Role of Relational and Operational Performance in Business-to Business Customers' Adoption of Self-Service Technology", Journal of Service Research, 8 (4), 372-385.

Biehl, M., Prater, E. and J.R. McIntyre (2004), "Remote Repair, Diagnostics and Maintenance: An Overview and Comparison of the U.S., Japanese and German Machine Tool Industry," in: Communications of the ACM, 47 (11), 101-6.

Bitner, M.J. (1990), "Evaluating Service Encounters: The Effect of Physical Surroundings and employee responses", Journal of Marketing, 54, 69-82.

Bitner, M.J.; B. Booms and M. S. Tetreault (1990), "The Service Encounter: Diagnosing Favorable and Unfavorable Incidents," in: Journal of Marketing, 54 (1), 71-84.

Bitner, M.J. (1992), "Servicescapes: The Impact of Physical Surroundings on Customers and Employees," in: Journal of Marketing, 56 (2), 57-71.

Bitner, M.J. (1993), "Managing the Evidence of Service," in: Scheuing, E.E. and W.F. Christopher, The Service Quality Handbook, NY: American Marketing Association, 358-70.

Bitner, M.J.; B. Brooms; L.A. Mohr (1994), Critical Service Encounters: The Employee's Viewpoint. Journal of Marketing, 58, 95-106.

Bitner, M.J., Stephen W. Brown and Matthew L. Meuter (2000), "Technology Infusion in Service Encounters," in: Journal of the Academy of Marketing Science, 28 (1), 138-149.

Bitner, M.J. (2001), "Service and Technology: Opportunities and Paradoxes", Managing Service Quality, 11 (6), 375-379.

Brown, S.W. & Swartz, T.A. (1989), "A gap analysis of professional service quality", Journal of Marketing, 53, 92-98.

Buber, R.; C. Kraler (2000), "How Gabek and WinRelan Support Qualitative Research. In Buber, R; Zelger, J. (Hrsg.) Gabek II – On Qualitative Research: Studien Verlag, Innsbruck, Wien.

Carson, D., Gilmore, A., Perry, C., and K. Gronhaug (2001), Qualitative Marketing Research, Thousand Oaks: Sage Publications.

Colby, C.L. and Parasuraman, A. (2003), "Technology Still Matters Never Mind the Doomsayers. E-Services are Alive, Well, and Positioned for Growth," Marketing Management, 12 (4), 28-33.

Cortsen, H. (2001), Dienstleistunsgmanagement, 4th edition, München, Oldenburg Verlag.

Curran, J.M.; M.L. Meuter; C.F. Suprenant (2003), "Intentions to Use Self-Service Technologies: A Confluence of Multiple Attitudes," Journal of Service Research, 5, 209-224.

Curran, J.M.; M.L. Meuter (2005), "Self-Service Technology Adoption: Comparing three Technologies", Journal of Services Marketing, 19 (2), 103-113.

Dabholkar, P.A. (1994), "Technology-Based Service Delivery: A Classification Scheme for developing Marketing Strategies," Advances in Services Marketing and Management, 30 (3), 241-271.

Dabholkar, P.A. and R.P. Bagozzi (2002), "An Attitudinal Model of Technology-Based Self-Service: Moderating Effects of Consumer Traits and Situational Factors," in: Journal of the Academy of Marketing Science, 30 (3), 184-201.

Dabholkar, P.A.; Bobbitt, L.M.; Lee, E.J. (2003), Understanding Consumer Motivation and Behavior Related to Self-Scanning in Retailing, “International Journal of Service Industry Management, 14 (1), 59-95.

Davis, F.D. (1989), “Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology,” MIS Quaterly, 13, (3), 319-340.

Davis, F.D.; R.P. Bagozzi; P.R. Warshaw (1989), “User Acceptance of Computer Technology: A Comparison of Two Theoretical Models,” Management Science, 25 (8), 982-1003.

Dowling, G.R. (1986), “Perceived Risk: The Concepts and Its Measurement,” in: Psychology and Marketing, 3 (3), 193-210.

Fishbein, M. I. Ajzen (1975), “Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research,” Reading: Addison-Wesley.

Froehle, C.M and A.V. Roth (2004), “New Measurement scales for evaluating perceptions of the technology-mediated customer service experience,” in: Journal of Operations Management, 22 (1), 1-21.

Gremler, D.D. and K.P. Gwinner (2000), “Customer-Employee Rapport in Service Relationships,” in: Journal of Service Research, 3 (1), 82-104.

Grönroos, Ch. (1190), “Relationship Approach to Marketing in Service Contexts: The Marketing and Organizational Behavior Interface,” Journal of Business Research, 20 (1), 3-11.

Hennig-Thurau, T. (2004), “Customer Orientation of Service Employees. Its Impact on Customer Satisfaction, Commitment, and Retention,” in: International Journal of Service Industry Management, 15 (5), 460-78.

Liao, H. (2007), “Do It Right This Time: The Role of Employee Service Recovery Performance in Customer-Perceived Justice and Customer Loyalty After Service Failures,” in: Journal of Applied Psychology, 92 (2), 475-89.

Liljander, V. and T. Stratvik (1995), “The Nature of Customer Relationships in Services,” in: Swartz, T.A., Bowen, D.E. and S.W. Brown, eds., Advances in Services Marketing and Management, 4th ed., Greenwich, JAI Press, 141-67.

Lovelock, C.H., Patterson, P.G. and R.H. Walker (1998), Services Marketing: Australia and New Zealand, Sydney: Prentice-Hall.

Lovelock, C.H. and J. Wirtz (2004), Services Marketing, 5th ed., Upper Saddle River: Prentice-Hall.

Lovelock, C.H. and R.F. Young (1979), “Look to Consumers to Increase Productivity,” in: Harvard Business Review, 57 (3), 168-78.

Meuter, M.L., Ostrom, A.L., Roundtree, R.I. and M.J. Bitner (2000), “Self-Service Technologies: Understanding Customer Satisfaction with Technology-Based Service Encounters,” in: Journal of Marketing, 64 (3), 50-64.

Meuter, M.L., Ostrom, A.L., Bitner, M.J., and R.I. Roundtree (2003), “The Influence of Technology Anxiety on Consumer Use and Experiences with Self-Service Technologies,” in: Journal of Business Research, 56 (1), 899-906.

Meuter, M.L., Bitner, M.J., Ostrom, A.L. and S.W. Brown (2005), “Choosing among Alternative Service Delivery Modes: An Investigation of Customer Trial of Self-Service Technologies,” in: Journal of Marketing, 69 (2), 61-83.

Miles, M.B. and A.M. Huberman (1994), Qualitative Data Analysis: An Expanded Sourcebook, Thousand Oaks: London.

Parasuraman, A., Zeithaml V.A. and Berry, L.L. (1985): “A Conceptual Model of Service Quality and its Implications for Future Research,” in: Journal of Marketing, 49 (1), 41-50.

Parasuraman, A. (2000), “Technology readiness index (TRI): a multiple item scale to measure readiness to embrace new Technologies”, Journal of Service Research, 2, 301-320.

Parasuraman, A., V.A. Zeithaml, and A. Malhotra (2005),” E-S-QUAL a multiple-item scale for assessing electronic service quality,” Journal of Service Research 7, 213–233.

Patton, M.Q. (2004), Qualitative Research and Evaluation Methods, Thousand Oaks: Sage Publications.

Prendergast, G.P. and N.E. Marr (1994), "Disenchantment Discontinuance in the Diffusion of Self Service Technology in the Service Industry: A Case Study in Retail Banking," in: Journal of International Consumer Marketing, 7 (2), 25-40.

de Ruyter, K. and M.G.M. Wetzels (2000), "The Impact of Perceived Listening Behavior in Voice-to-Voice Service Encounters," in: Journal of Service Research, 2 (3), 276-84.

Schumann, J. H., N. V. Keller, F. v. Wangenheim ; H. H. Holzmüller (2007), "Technology Mediation in Service Delivery: A new Typology and an Agenda for Managers and Academics", AMA Winter Educator's Conference Proceedings, 44-45.

Selnes, F. and H. Hansen (2001), "The Potential Hazard of Self-Service in Developing Customer Loyalty," Journal of Service Research, 4, 79-90.

Shamdasani, P; A. Mukherjee; N. Maholtra (2008), „Antecedents and Consequences of Service Quality in Consumer Evaluation of Self-Service Internet Technologies," The Service Industries Journal, 28 (1), 117-138.

Solomon, M.R., Surprenant, C., Czepiel, J.A. and E.G. Gutman (1985), "A Role Theory Perspective on Dyadic Interactions: The Service Encounter," in: Journal of Marketing, 49 (1), 99-111.

Sundaram, D.S. and C. Webster (2000), "The role of nonverbal communication in service encounters," in: Journal of Services Marketing, 14 (5), 378-91.

Tuli, K.R.; A.K. Kohli; S.G. Bharadwaj (2007), "Rethinking Customer Solutions: From Product Bundles to Relational Processes," Journal of Marketing, 71 (3), 1-17.

Vargo, S.L. and R.F. Lusch (2004), "Evolving to a New Dominant Logic for Marketing," in: Journal of Marketing, 68 (1), 1-17.

Vickery, S.K.; C. Droge; T.P. Stank; T.J. Goldsby; R.E. Markland (2004), "The Performance Implications of Media Rcihness in a Business-to-Business Service Environment: Direct versus Indirect Effects", Management Science, 50, 1106-1119-

Walker, R.H. and L.W. Johnson (2006), "Why consumers use and do not use technology-enabled-services", in: Journal of Services Marketing, 20 (2), 125-35.

Walker, R.H. and M. Craig-Lees (2000), "Technology-enabled service delivery: at risk of compromising the customer-service provider connection?" in: Cavusgil, S.T. and R.B. Mc Naughton, eds., Advances in International Marketing, Greenwich: JAI Press, 305-22.

Weijters; B.; Rangarajan, D.; Falk, T.; Schillewaert, N. (2007), Determinants and Outcomes of Customer's Use of Self-Service Technology in a Retail Setting," Journal of Service Research, 10 (1), 3-21.

Wünderlich, N.V.; F.v. Wangenheim (2007), „Die zukünftige Entwicklung von Remote Services in Deutschland – Ergebnisse einer Delphi Studie, in: D. Holtbrügge, H.H. Holzmüller, F. v. Wangenheim (Hrsg.): Remote Services – Neue Formen der Internationalisierung von Dienstleistungen, Wiesbaden.

Zeithaml, V.A. and M.C. Gilly (1985), "Characteristics affecting the Acceptance of Retailing Technologies: A Comparison of elderly and nonelderly Consumers," Journal of Retailing, Vol. 63, Spring, 49-68.

Zeithaml, V.A., Bitner, M.J. and D.D. Gremler (2006), Services Marketing Integrating Customer Focus Across the Firm, 4, Singapur: Mcgraw-Hill.

Zeithaml, V.A., Berry, L.L. and A. Parasuraman (1988), "Communication and Control Processes in the Delivery of Service Quality," in: Journal of Marketing, 52 (2), 35-48.

Zeithaml, V.A.; Parasuraman, A., and A. Malhotra (2002), "Service quality delivery through web sites: a critical review of extant knowledge," in: Journal of Academy of Marketing Science, 30 (4), 362-75.

Zelger, J. and A. Oberprantacher (2002), "Processing of Verbal Data and Knowledge Representation by GABEK®-WinRelan®", in: Qualitative Social Research Forum, www.qualitative-research.net.

Mobility in Computer Science and Information Systems

Mobility in a Globalised World

Economics
Engineering
Informatics
Logistics
Urban Planning

Mobility in Computer Science and Information Systems

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It is quite natural that a term like mobility has different meanings across various scientific disciplines like economics, information systems and computer science, logistics, urban planning and engineering. But even within a certain discipline such as computer science the term can be interpreted in several different ways. The classic interpretation of mobility in computer science is to associate the term with mobile computing, which is often defined as the use of a portable computer capable of wireless networking[1]. Mobile computing enables users to access information anytime from anywhere and the necessary infrastructures such as GSM are available all over the world. Nowadays there is an app for almost everything and the app-stores have become the predominant model for distributing software online.

However, with the increasing importance and the pervasive use of information and communication technology (ICT) in everyday life, it also has started to play an important role in other areas associated with mobility such as the automotive industry, public transportation or air transportation. In the automotive industry, ICT is used to collect and process information about the car and its environment, to operate complex control systems and to enable car-to-car-communication. Aviation in its current form and complexity would not be possible without modern information and communication technology. In public transportation, modern ICT systems are used for daily operational business needs ranging from security monitoring to automatic train control systems.

This diversity of mobility aspects in the field of information systems and computer science is reflected in the contributions selected for this thematic section. The first contribution titled *"A Survey of Interoperability Concepts for Security Systems in Public Transport"* by Sebastian Kurowski, Jan Zibuschka, Heiko Roßnagel and Wolf Engelbach focuses on security in public transportation. In this context the term mobility refers to the mobility of the passengers while the ICT systems mostly remain at fixed locations. Furthermore, as the authors emphasize interoperability across different or-

[1] See Forman and Zahorjan, 1994

ganizations as a key component to provide security in public transport, the mobility of data and information also plays a significant role.

The second contribution by Vivian Prinz, Johann Schlichter, Benno Schweiger and David Taniar titled *“The Vehicular Information Space Framework – A Comparative Study”* takes a more pervasive approach towards mobility. The authors use mobile communication technology to enable communication between driving cars. They are able to form highly mobile ad-hoc networks to distribute relevant information about existing hazards, parking spaces or traffic densities in a location aware and fully distributed manner.

The third contribution by Uwe Laufs, Jan Zibuschka, Patrick Schneider titled *“Decision Support for Energy Efficient Production in SME”* uses mobility in the classic sense of mobile communications. They describe an IT-System that is realized utilizing affordable mobile devices to support energy-efficiency in production for small and medium enterprises increasing their competitiveness by reducing energy costs.

These three contributions discuss important and very different aspects of mobility and clearly demonstrate that mobility will be a very interesting and diverse topic in information systems and computer science for years to come.

References

Forman, G. H., and Zahorjan, J. 1994. The Challenges of Mobile Computing, IEEEComputer, vol. 27, no. 4, pp. 38-47

A Survey of Interoperability Concepts for Security Systems in Public Transport

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Abstract

In large urban hubs such as metro or train stations, transportation operators and first responders collaborate in the prevention of and reaction to security issues. In order to optimise their specific daily operational business needs, heterogeneous information and communication systems are used. In case of an incident, however, it is crucial that the various involved parties exchange relevant information to get a shared understanding and act in a coordinated way in critical situations. Yet, heterogeneous communication and information system infrastructures often disrupt this crucial flow of information.

This contribution provides a survey of current research with regard to system-of-systems for information systems in the domain of security in public urban transportation. It was developed in the EU-funded security project SECUR-ED, and may support the involved stakeholders in dealing with a diversity of security challenges, technologies and organisational procedures. We integrate the results of earlier projects and synthesize them on a homogenous level of abstraction. This results in first insights regarding modelling and design requirements of an interoperable system-of-systems for this application domain.

1 Introduction

In public transport and especially large urban hubs, many transport operators and first responders collaborate in the prevention of and reaction to security issues. They use heterogeneous information and communication systems, optimized for their specific daily operational business needs; security matters are only one aspect of these broader requirements. This also implies that it is sometimes very difficult to differentiate security-relevant information from the huge body of information available. At the same time, recent events have demonstrated that public transport can be subject to various security incidents, and outcomes may be quite severe due to the volume of passengers[1]. In case of such incidents, it is crucial that the various involved parties exchange relevant information to get a shared view and understanding of the situation and act in a coordinated way in critical situations[2]. However, heterogeneous communication and information system infrastructures often hinder this crucial flow of information[3].

This paper gives an overview of different approaches to interoperability of information systems within a given city, by providing assets distilled from related research projects in the domain of security and public transport and by categorizing them along different levels of interoperability.

We first present a conceptual model of interoperability as basis for our analysis in section 2. In section 3, the dimensions used for this research are explained. Section 4 provides an overview of the surveyed research projects and the interoperability assets that have been identified are presented in section 5. A mapping of these assets according to the conceptual interoperability model is provided in section 6, before we summarize our findings.

2 Conceptual Interoperability Levels

According to ISO/IEC-2382-1 interoperability is the “the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units” [4]. Hence, interoperability reflects the capabilities of systems to interact with other systems and form a larger functional unit. However such interaction can pose a complex task for the systems and the engineers to achieve, including a wide range of problem sets of different origins and for different goals.

The conceptual interoperability model by Turnitsa[5] offers a classification of different interoperability capabilities. Figure 1 shows the 7 different levels of interoperability defined there. Level 1 describes the technical interoperability. On this level two sys-

1 See Roßnagel and Junker, 2010

2 See Dantas and Seville

3 See Engelbach, Roßnagel, and Frings, 2010

4 See ISO, 2010

5 See Turnitsa, 2005

tems are able to connect. They may share the same protocol and are able to communicate. However, simply having a connection does not yet ensure that two software applications are able to interpret the data shared. This is achieved by sharing the same format or being able to understand each others data format, hence exchanging information. If this state is reached the level of syntactic interoperability is fulfilled. Semantic Interoperability extends this requirement, by adding the interpretation of data, ensuring that the applications share knowledge instead of information. On this level applications are e.g. able to localize the information exchanged, allowing communication even with different glossaries or languages.

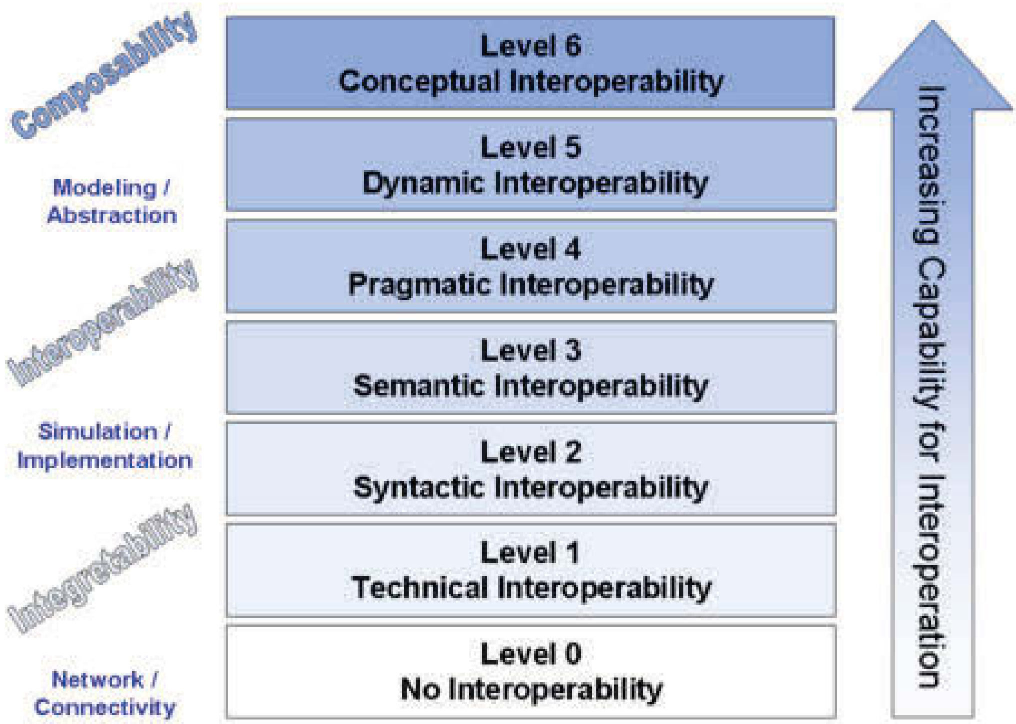

Figure 1: The levels of conceptual interoperability model[5]

Pragmatic interoperability enables the participating systems to be aware of each others procedures and routines. Systems realizing dynamic interoperability even consider other systems assumptions and constraints, enabling them to be aware of state changes which may occur during or as a result of the communication. Finally, level 6 describes the interoperability of systems' concepts, requiring all systems to be fully specified and independent from their respective implementations. This requires full documentation of conceptual models, enabling interpretation by other engineers.

This model defines a wide range of potentially achievable goals for interoperability of systems, ranging from simple connection of systems, over context aware collaborating systems to collaboration of engineers. In the following we will describe a survey on research projects in the domain of public transport security, while referring to the goals described by the different levels.

3 Dimensions of Interoperability in Public Transport Security

The conceptual interoperability model presented in the previous section requires several dimensions of documentation, covering communication (e.g. syntax, semantics), processes, constraints, capabilities to structures and concepts. Since research projects in public transport security did not yet investigate interoperability directly, identifying assets using the dimensions of communication, processes, constraints and capabilities might not result in a comprehensive view of information assets describing a system-of-systems for interoperability in public transport on a coherent level of abstraction. However, simply listing functional units from all those projects would create indigestible information. Therefore, we organized functional units into a hierarchical model, primarily separating between actors and communication systems/sensors. The research focussed on identifying assets inside the research projects which contain information on or were identified as (1) actors, (2) communication systems, (3) sensor systems or (4) structure.

4 Surveyed Research Projects

In the domain of public transport security, a lot of research has been done on how to support and coordinate emergency responders and other stakeholders during operations, as well as on modularization and technical equipment. None of the earlier work aimed at creating an interoperating system, or providing interoperability capabilities. However, the body of work on security in public transport is a great source for surveying entities representing one of the dimensions mentioned in section 3. We now present an overview of the research projects we considered.

4.1 DEMASST

The “Demonstration project for MASS Transportation security” focused on security in public mass transport, while emphasizing terrorist attacks. The research done on current technologies created a viable source for further research on especially the dimension of Sensor Systems. Regarding the domain of interoperability, DEMASST provides a system-of-systems map for mass transportation security[6]. Although this map describes an approach on interoperability in mass transport security, it focuses on topics rather than actors or information units, leaving out both the ISO[7] definition of interoperability and Turnitsa’s widely accepted[8] levels of conceptual interoperability[9].

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6 See Eriksson, 2009

7 See ISO, 2010

8 See W. G. Wang, Tolk, and Wang, 2009

9 See Turnitsa, 2005

4.2 COUNTERACT

The project "Cluster Of User Networks in Transport and Energy Relating to Anti-terrorist aCTivities" also focuses on public mass transport systems but considers security on a more general level. Although it is exclusively concerned with terrorism, a broader approach also considering other types of hazards was used in the development of awareness campaigns, guidelines for conducting risk assessment in public transport networks[10], and collaboration tools supporting operations during incidents and catastrophic events[11]. It gives a definition of the general security management framework and details on sensor systems, field security plans, concepts of operations and security procedures. Additionally, general interfaces for communicating in a public mass transport environment are described[11], including involvement of infrastructure managers in the incident response and preparedness routines. This investigation results in a more holistic view on the data involved. The interfaces introduced[11] and the developed security management systems[10] facilitate geographical information and inter-organisational collaboration between different public mass transport providers. This more holistic view on the shared data can provide a key for creating the syntactic and semantic interoperability.

4.3 COPE

The project for "Common Operational Picture Exploitation" dealt with the collaboration and support of the involved parties at ground-site[12]. Although it did not emphasize public transport, the research conducted on incident ground teams and their collaboration with other stakeholders such as energy suppliers created a good view on general incident response. COPE used methods for analysing cognition and decision making in teams[13], such as Joint Cognitive Systems[14] which are a mean to describe the unit of technological and human actors for further analysis. Using this, several use cases were created which describe the collaboration of the stakeholders at ground site during emergencies[15]. The use cases provide a general understanding of collaboration and roles involved in case of an incident and are therefore a major contributor in the dimension of actors and structures.

4.4 Modurban

Without a particular focus on security but on public transport systems, Modurban investigated on Modular Urban Guided Rail Systems. The communication between de-

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10 See COUNTERACT, 2009a

11 See COUNTERACT, 2009b

12 See COPE, 2009a

13 See COPE, 2008

14 See Hollnagel, 2002

15 See COPE, 2009a

vices in and among train systems was emphasized[16]. By doing so, approaches were developed for creating autonomous train systems and passenger information systems[17]. Although the communication of devices implies interoperability capabilities, the approach taken emphasizes modularization as a design paradigm, rather than interoperability of existing systems. The research project was therefore not further included in the research.

4.5 VeRSiert

VeRSiert is focused on security at large public events. During the project information management solutions for all participating actors during an event were developed. Additionally, mobile solutions were provided for mitigation in the post incident phase, offering visitors faster evacuation and information capabilities[18]. The assets created for the development of these services provide an overview on the integration of semantic web technologies and social media[19], while taking into account the different roles correlated with all phases of an event, including public security organisations and first responders[20]. Regarding inter-organisational cooperation, the VeRSiert project developed a web portal that supports the planning of public events and provides communication facilities for inter-organisational information exchange[21].

4.6 Integrail

The project for INTElligent integration of RAILway systems (Integrail) aimed at enabling "sharing of information to increase efficiency and quality and support the business objectives of the Railway Undertaking and Infrastructure Manager".[22]. The contributors avoid replacing existing systems, but try to using them to create a system-of-systems architecture. The project does not involve any urban transport systems, yet the goals do slightly comply with the ISO definition of interoperability[23] and due to the projects' focus on using information on different levels (management, maintenance, operative) the results may even comply with the "levels of conceptual interoperability model"[24]. Unfortunately no deliverable was available at the time of the research.

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16 See MODURBAN, 2009

17 See MODURBAN, 2008

18 See Roßnagel, Zibuschka, and Junker, 2010

19 See Roßnagel and Zibuschka, 2011

20 See Roßnagel, Zibuschka, and Junker, 2011

21 See Engelbach et al., 2010; and Engelbach, Roßnagel, and Frings, 2010

22 See InteGRail, 2010

23 See ISO, 2010

24 See Turnitsa, 2005

4.7 Protectrail

The Railway-Industry Partnership for Integrated Security & Rail Transport named Protectrail focuses on providing “a viable integrated set of security solutions” with the focus on rail transport systems[25]. This offers potential for deriving interoperability building blocks or solutions for interoperability in public transport. However, the project has just started recently and no deliverables were available at the time of the research.

4.8 Modsafe

The MODular urban transport SAFEty and security analysis (Modsafe) approaches interoperability from a different perspective of creating an environment with interchange ability capabilities, hence standardizing the domain of urban transportation to a degree where system can not only interact with each other but be replaced as well. This includes “safety requirements, safety models, responsibilities, roles, safety approvals, acceptance, and certification schemes”[26]. Like Modurban, the approach taken on interoperability focuses more on the design methodology of the systems itself, rather than the design of a system-of-systems architecture of heterogeneous systems. Therefore important issues such as semantics of communication are not yet addressed. However the project is still in progress.

4.9 SECUREMETRO

The small to medium scaled research project SECUREMETRO aims at “Increased safety, security and resilience of metro vehicles from terrorist attack by explosives and firebombs through material choices and design, thereby increasing resilience and reducing the impact of attack on passengers, staff, infrastructure and property.”[27]. It aims at developing “validated materials selection and design strategies for building metro vehicles with intrinsic security features.”[27]. Since no deliverables were accessible, the project was not included during further research.

Not all of these research projects were included in the identification of interoperability elements, due to the reasons mentioned above. However, outcome could be obtained especially from the research projects COPE, DEMASST and COUNTERACT, which offer the most information for the investigated dimensions of sensors, communication systems, actors and structures. Figure 2 draws a clear picture of those three projects undermining most of the investigated dimensions. Especially in the fields of communication systems and sensors, those reference projects offered the opportunity for further aggregation of different sensor systems.

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[25] See PROTECTRAIL, 2011

[26] See MODSafe, 2011

[27] See NewRail, 2011

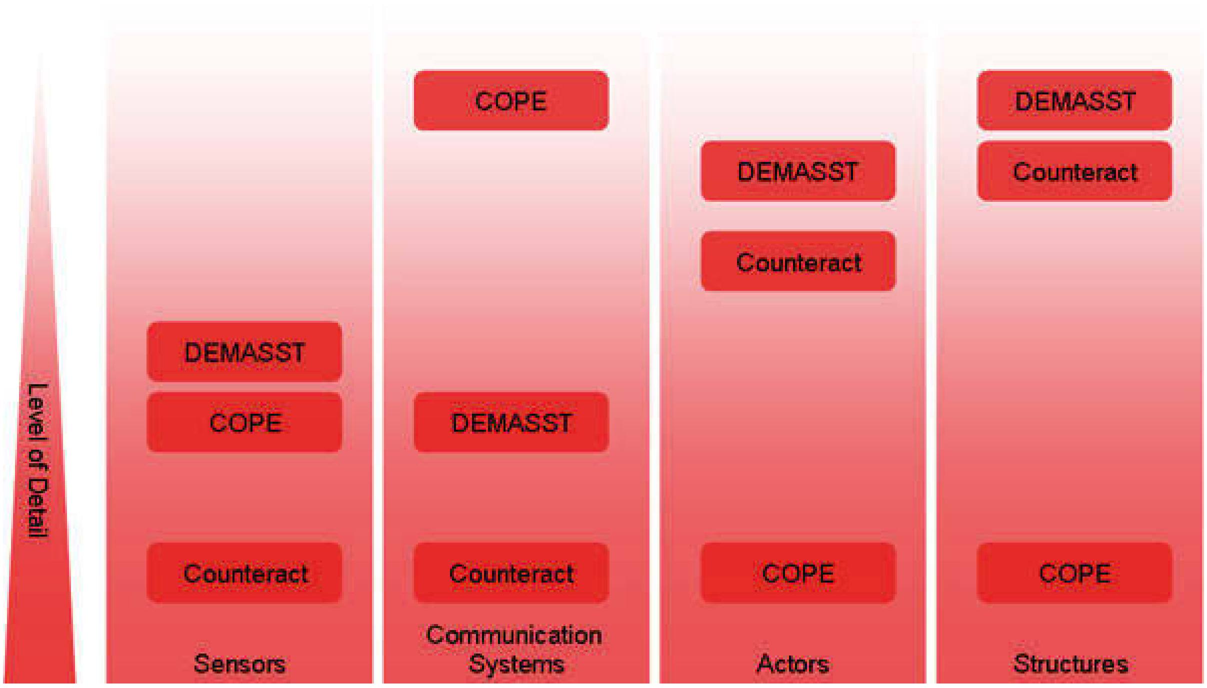

Figure 2: Level of Detail of Functional Components in Surveyed Projects

5 Interoperability Elements

Looking at Figure 2, it becomes visible that all three projects provide valuable input for the investigated dimensions of Sensors, Communication Systems, Actors and Structures. The most important contributions hereby came from analysis of the projects COPE and COUNTERACT. Especially in the field of sensor and communication systems, combining the output of COUNTERACT[28] and DEMASST[29] creates a broad view on available systems and their relationships. COPE, as a project regarding ground site incident management in the post incident phase of the incident life cycle, focuses more on actors[30] and structures[31] involved in the collaboration during the incident. In the following we will provide an overview on the potentially useful assets identified in these reference projects. Hereby each asset is presented along with its providing project. The following list of assets is not ordered as the overview given in Figure 2 but by their corresponding project. It covers the aspects of Incident Ground Collaboration, Sensor Systems, Concept of Operation, Field Level Security Plans, Interfaces with other Organisations and Current Situation in Mass Transport Security.

[28] See COUNTERACT, 2009b

[29] See DEMASST, 2009

[30] See COPE, 2008

[31] See COPE, 2009a

5.1 Incident Ground Collaboration

By analysing incident ground processes, COPE provides several use cases including collaboration in the post incident phase[32]. Like the overall project, these use cases emphasize the roles directly involved in resolving the incident or the catastrophic event. The use cases described include: incident ground organisation, tactical mode & risk assessment, management of human resources, resource management (non-human), command & control devolution, coordination with other agencies, first responder & emergency services collaboration, first responder & police collaboration, fire attack, water management, search & rescue, and command hand over.

These use cases give an overview on the persons communicating and collaborating, hence showing potential for further requirements of interoperability on the operational incident ground level during the response to the incident. Therefore, they can serve as an asset for further design and implementation of an overall system-of-systems architecture. The roles participating in the use cases are:

- Hazardous material / chemical material responsible
- Control centre
- Incident commander
- Incident command board
- Sector commander
- Operations commander
- Command support officer
- Senior police officer
- Command support radio operator
- Command support runner
- Operations command radio operator
- Operations command runner
- Fire-fighter
- Senior medical officer
- Regional emergency centre
- Other emergency agencies
- Company key holder
- Caller
- Electric
- Water
- Gas
- Environmental protection agency
- Nominal roll board
- Visitor roll board
- MediaSensor Systems

Sensor systems become important when the retrieval of information from the systems' environment is required in order to react or support decisions. Sensing systems can

[32] See COPE, 2009a

provide data on general or explicit objects, such as general chemical agents or an improvised explosive device. This makes a more general view on sensor systems necessary. Therefore, when referring to sensor systems in this document, the unit of a sensor and its interpreting appliance is meant. By doing so, a view on sensor systems as information providing assets can be obtained, rather than dealing with raw data.

All of the projects define a various amount of sensor systems, whereby each project, depending on their scope, focuses on different levels of detail. COPE, for example, uses sensor systems as part of a decision support system at ground site[33]. Although very specific sensors are being used, they are not further described. However different sensor systems are mentioned, also including non-technical systems. In COUNTERACT a detailed view on sensor systems is provided[34]. Since the main focus of this project is on terrorism, the systems focus more on behaviour and detection of hazardous or explosive material. DEMASST[35] includes this also in its deliverables, although the level of detail provided by this project is larger. Here we find various sensor systems along with their technological readiness level. All sensor systems found in the reference projects were generalized to their functions of either monitoring a certain area/status or detecting anomalies regarding objects and persons. The monitoring section must be understood as a supportive data supplier, for example a Closed Circuit Television (CCTV) camera monitoring a hallway without any further interpretation. Detection enhances the monitoring by interpretation and acting on the basis of the sensor data supply. Therefore, the ontology distinguishes between systems that provide data (Monitoring) and systems that deliver information on which basis an action can be performed (Detection). Such systems can include technical solutions, such as behaviour detectors along with CCTV; while the CCTV alone would be a monitoring sensor system (see Figure 3).

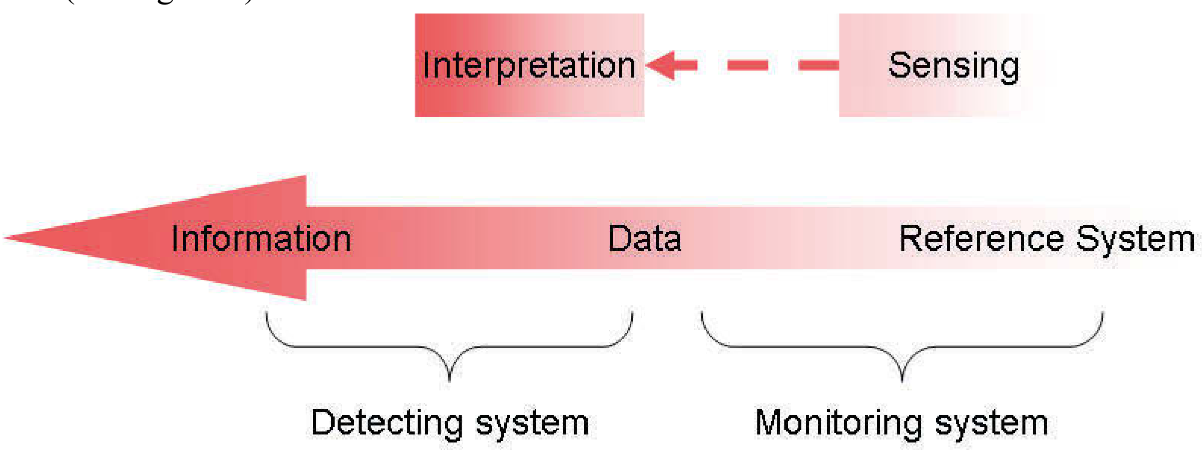

Figure 3: Definition of sensor systems

Based on this interpretation, a further classification is possible. The “Detection” part can be split into the detection of objects (chemical, radioactive, biological or metal

33 See COPE, 2009b

34 See COUNTERACT, 2009a

35 See DEMASST, 2009 and DEMASST, 2010

detection) and the detection of behaviour. Behaviour can include the detection of intrusion in certain areas as well as detecting suspicious behaviour of monitored people. This ontology provides a benefit regarding the identification of suitable sensor systems, while taking into account their adaptability and ease of integration into an overall interoperable system.

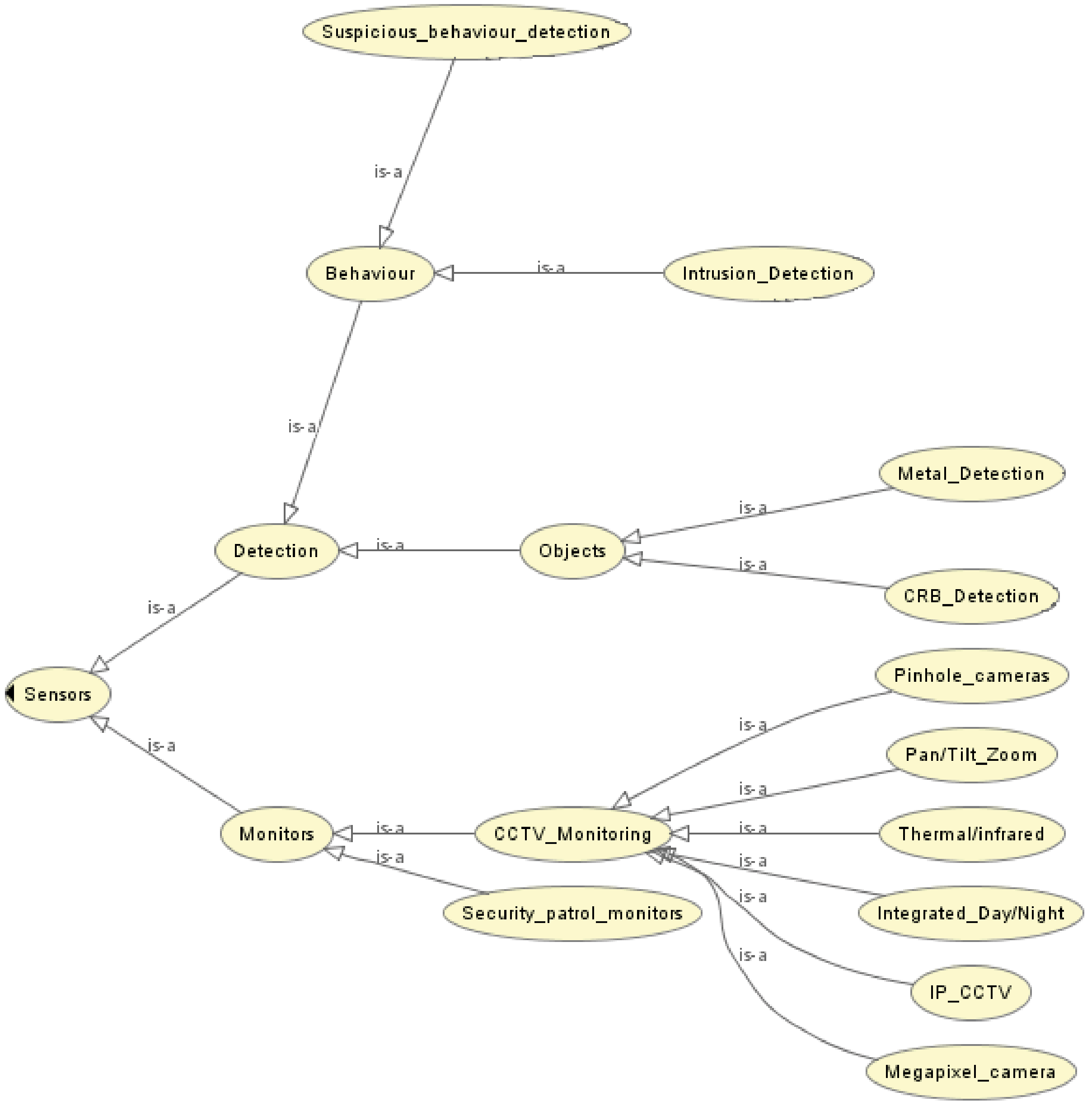

Figure 4: Overview on top level categories and attributes

Figure 4 provides an overview on this ontology. Here the distinction between detecting and monitoring systems, regarding their ability to either deliver data or information becomes visible. While the detection Section provides specific use cases that are aimed towards the detection of behaviour (suspicious behaviour or intrusion) and objects, the monitoring Section does not contain any further use cases. In the latter, we find Closed Circuit Television (CCTV) Monitoring as an asset, which contains multiple attributes. These attributes show the different variations of CCTV Monitoring, which are applicable for various use cases (i.e. thermal / infrared cameras can be used to monitor areas during night operations).

The systems researched in the area of detection focus mainly on the detection of behaviour and objects. The detection of behaviour can be further be partitioned into intrusion detection and detection of suspicious behaviour. COUNTERACT[36] provides an overview of various sensors for intrusion detection, such as photo electric beams or radar sensors. The third use case in the detection Section is the detection of objects including the detection of metal and the detection of chemical, radioactive and biological agents. These ontologies can be used to derive further typologies for evaluation or classification of systems. This contributes to both semantics in inter-system communication and collaboration through awareness of the other system. An example for a derived typology is displayed in Figure 5.

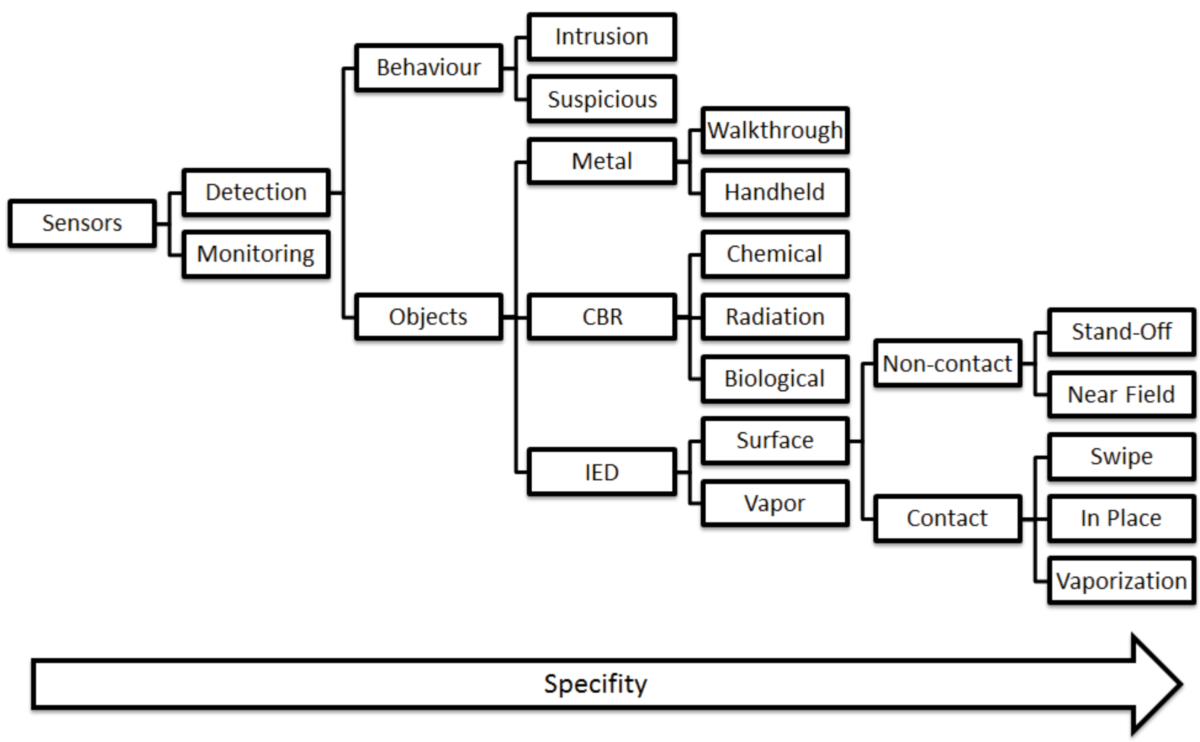

Figure 5: Typology derived from Sensor ontology

5.2 *Concepts of Operations*

According to COPE[37], maintaining common ground during operation and planning phases along the emergency lifecycle is a core process when responding on ground level. Therefore, the concept of operation (CONOP) describes basic information re-

36 See COUNTERACT, 2009a

37 See COPE, 2008

quired for collaboration[38]. Such concepts offer the opportunity to derive metadata for the required interfaces of the system. The concepts are described on an operational and high level, offering metadata for both ground-site communication and inter-organisational communication.

When regarding more generic information in emergency response and security organisations, the high level concept still offers capabilities for implying and therefore accessing the information with more detail, while not over-defining the information container itself. This makes the concept on this level very interesting for later interface implementations and design. The high level concepts include the following assets:

Organisational structure: Description of the organisations' structure for which this concept was defined. This may include the organisations hierarchy, its processes, its communication structure, and its institutions. For example information could be gathered on whether this organisation provides a quality management system or whether the persons communicating with this organisation can communicate with each other.

Legal basis: The organisations' rights and laws applying to the organisation and the situation. For example an emergency service has extra rights in public traffic during emergency response operations. This information container would contain which rights apply to this organisation, on which basis it can operate and what it cannot do.

Security operating methods: Security operations in general, security operations under elevated threat conditions, available safeguards and equipment. The security operations include used interfaces, a description of the management, the means and the methods involved. The security operations under elevated threat conditions include ad-hoc safeguards, the standard level of security, rules of engagement and the threat levels defined.

Auditing: Describes who is responsible for reviewing and assessing this concept, as well as the processes involved in auditing.

Professional terms: Include the definition of terms regarding the security systems, security procedures, position holders, past assessments and risk management results, security means and field level security plans. Therefore this asset includes the definition of all assets somehow correlated with the security organisation.

Risk reduction measures: Actions taken as response to risk assessment results.

Interfaces: Existing interfaces in this organisation.

Security procedures: Description of existing security procedures.

Field level security plans: Description of existing field level security plans.

Security typology: Assessment of the organisation as a system, including the level of security and the organisation type regarded as being an open system or controlled system.

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[38] See COUNTERACT, 2009b

Maintenance of CONOP: Describes which persons are responsible for updating the concept of operation.

Systems, assets & components: Description of systems, assets & components existing and available in the organisation.

Risk management policies: Restrictions and rules from risk assessment.

Communication strategy: Strategy for communicating with the public.

Threat definitions: Basic definition of threat levels.

Security training and exercises: Definition of training procedures and cycles.

Regarding the ground level, the operational concepts of operations define basic routines and actions taken at the incident ground. They aim more at the collaboration of teams and personnel at ground site rather than collaboration between different organisations. These operational concepts include:

Activity objectives: A general definition of objectives, which have to be elaborated. They include objectives on deterrence, detection, incident response and prevention.

Tasks under routine conditions: Includes routine operations, list of security procedures, a communication diagram, a list of security exercises, immediate actions taken during emergencies, a list of security monitoring appliances and the security training implementations. The tasks also include the logistical support of incident ground teams. Routine operations refer to the security handling of people, preventive measures, supervision and control, information security, security observations, security searches, communication & reporting and deterrence and security deception.

Rules of engagement: The rules of engagement describe what incident ground teams should aim at, what is allowed and what should be avoided during incident resolving.

Organisational structure: This is the structure of the organisation to which this concept applies. In this case, the structure would probably describe a certain operating unit at ground level, its internal hierarchy and its internal communication means. For example, how a fire-fighter communicates with his commander.

Legal basis: The legal basis for operations performed. What can this particular unit do at ground site? Are there any extra rights? What mustn't this unit do?

Professional terms: Same as in the high level concept, but describing the understanding of terms for the specific unit.

This concept played an important role in defining metadata for the interfaces and / or mediators in the interoperability concept.

5.3 Field Level Security Plans

Apart from the more general concepts of operations, field level security plans, as described in COUNTERACT[39] focus more on objected assets, such as passenger stations, depots or operations control centres rather than the executing organisation. Therefore the focus is more on the objected assets and their role during incident response, prevention and deterrence. Consequently, a field level security plan, as presented in COUNTERACT, includes:

Description of the facility and its surroundings: A geographical and semantic description of the facility itself and the facility's environment. Includes which systems are found in and around the facility.

Operational and commercial functions: The role of this facility. For example an emergency in a relay station will have a larger impact on the connected households than a burning house.

The facility's level of security: Are there any special security plans already existing? How is the threat level for this particular facility?

Analysis of the critical infrastructure in the facility: Is there any critical infrastructure existing in the facility? For example a gas pipe inside a burning house can lead to extensive damage during the emergency. Units must be aware of risks correlated with this infrastructure.

Threats and tactics analysis: Which threat levels apply? Which particular threats are correlated with this facility? How can first response units respond to these threats?

Routine security plans: Which operations apply to daily work? One example is monitoring of the facilities' environment.

Immediate actions in emergencies: Which operations are taken when an emergency occurs?

The field level security plans can be categorized in being specific or generic. The generic field level security plans include types of facilities but no specific facilities. For example, a generic field level security plan would refer to the actions taken in case of an (unknown) emergency at a power plant, but not in case of a specific emergency at a specific power plant. The routine security plans describe operations carried out under routine conditions. This includes activities regarding deterrence, access control, security searches & patrols, security handling of persons, baggage and vehicles, actions to increase public awareness and information security. Immediate actions in emergencies refer to actions such as crowd management, immediate response, self defence and the cooperation with first responders. Along with the concepts of operations, the field level security plans can be combined to metadata, since both define information needed for preparedness and response to emergencies and incidents.

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39 See COUNTERACT, 2009b

5.4 Interfaces with other Organisations

COUNTERACT defines interfaces by requirements. All communication with external organisations is first generalized to include assets like general and case specific policies, high level decisions, secure access and basic documentation. Documentation hereby refers to the documentation of interfaces, supporting processes, arrangements, organisational power, individual power, roles, responsibilities and management of interfaces. This generalization is further used for specializing interface requirements of other organisations. In case of security agencies, which include ministries, national security agencies and intelligence agencies, the requirements refer additionally to the office / facility section level, whether an individual or a whole office or facility communicates by using this interface, if a continuous contact is required and which level of security clearance needs to be considered. The information security becomes very important in this case, therefore additional meta-information describing information needed, the timescale in which the information is needed and the communication equipment is included. However, the emergency services focus of the requirements is put more on the communication and interoperability. Therefore, the compatibility of technical equipment and the security incident response arrangements play an important role. Additionally, coordination responsibilities, relationships between the organisations and the support of specialist security responders must be considered.

6 Integrated Interoperability Model

In the following we will show, how the elements describe in the previous section comply with the levels of the conceptual interoperability model presented in section 2, mapping those elements to the particular levels and providing an overview on how these assets fulfil the special requirements of each level.

This model provides different requirements for different levels of interoperability, offering the possibility to classify the system. However, once passing the first level of simple connection of two systems, the assets required become a matter of documentation, enabling the engineer to create interoperating systems. Figure 6 provides a mapping of the assets identified to the levels of the model. We can see that none of the assets (symbolized by the blue ellipses) can be mapped to one single level. Further, the assets identified offer capabilities for reaching interoperability levels above the syntactic interoperability. This is due to the organizational nature of the identified assets, which focus more on common understanding, intra- and inter-team communication, rather than inter-system communication. However, the levels lower than the semantic interoperability must be ensured as well, since inter-system communication including state awareness and semantic translation, requires awareness of syntactic problems. Yet these assets contribute in creating interoperating systems while taking the special requirements of the public transport domain into account due to their origin of research projects in the domain of security in public transport.

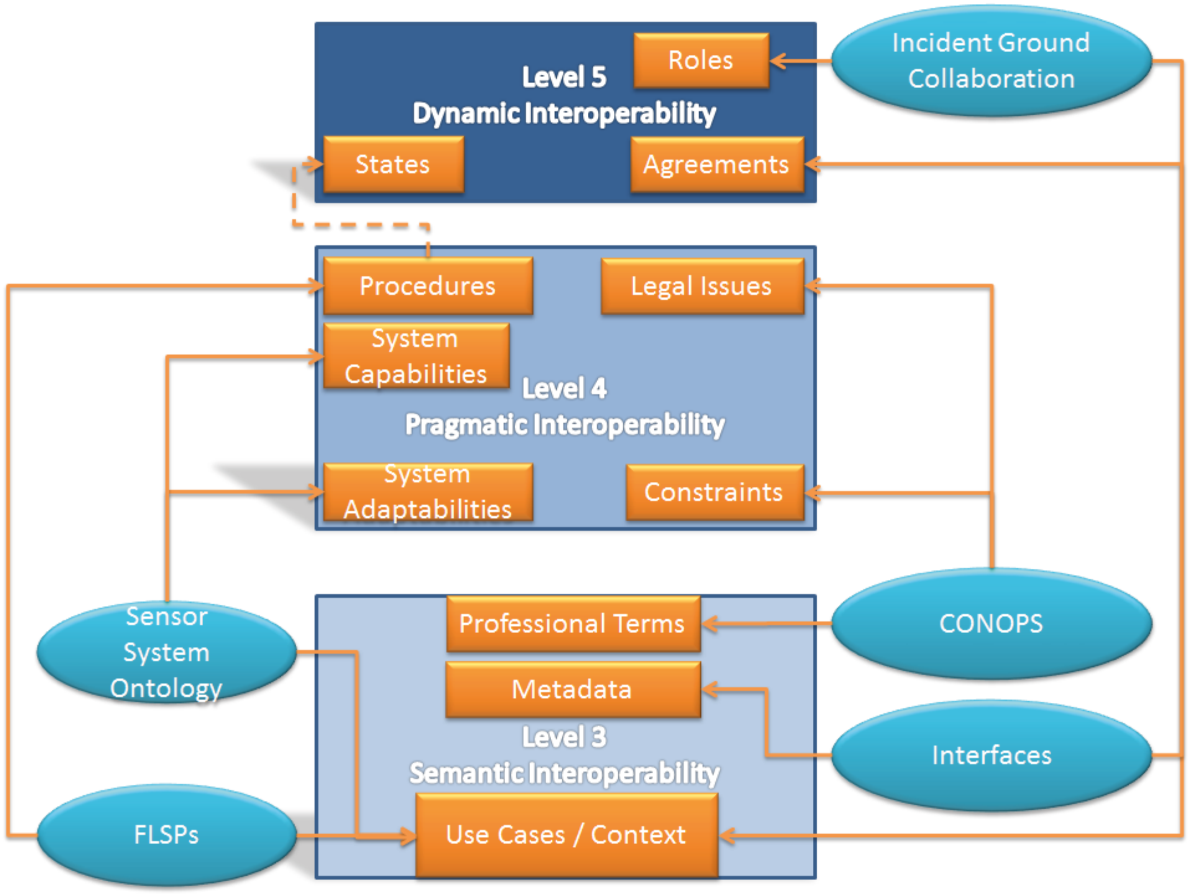

Figure 6: Mapping of Elements to the Levels of the Conceptual Interoperability Model

The orange arrows, originating the identified assets point to the included parts and their categorisation inside the levels of the conceptual interoperability model. Hereby, dashed arrows point at derivable elements, which includes elements which are not contained at first hand inside the identified assets, but which can be derived. The mapping shows that the identified use cases and roles of the incident ground collaboration research can contribute by categorizing participating systems into roles, yet offering the possibility for further state awareness modelling depending on the role and by creating a context of the actions taken, depending on the use cases. Such contexts are important for further communication, since meanings can change depending on the situation, hence enabling semantic awareness between the systems.

The concepts of operations (CONOPs) offer a description of basic situation dependant actions and plans, as well as, legal requirements and rights for the units or organizations at incident ground site. Since such CONOPs therefore offer a good description of the participants during an incident, they can be used as potential metadata, hence offering description of the systems involved. Furthermore, the professional terms inside the concepts of operations enable a mapping of the meaning of the terms to the terms itself, enabling further engineering for semantic interoperability between the systems. The systems' description including the systems' constraints and its legal issues, offer capabilities of pragmatic interoperability enabling other systems to which border this particular system can operate and what it cannot do.

The interfaces provided, describe basic requirements to the information needed. These requirements can be used to describe the information shared through this interface, thus describing the interface itself, creating context for the information shared. Further these descriptions include agreements of both exchanging parties, creating an overview on the states of both parties during exchange and the constraints. Therefore, this particular asset was mapped to the fifth level of the levels of conceptual interoperability model.

Field Level Security Plans (FLSP) include the description of situations this particular plan is made for. These descriptions can again be used to create context between the stakeholders described in the plan. Since such plans include basic descriptions of actions of the stakeholders during incidents, they basically describe collaboration and give insights in interoperability of units and potential interoperability of the systems included. Therefore, this description of scenarios creates a context of collaboration and its included communication aiding in creating semantic interoperability. Further the procedures included give an insight on what capabilities each stakeholder is able to contribute during collaboration, hence offering the description of the system-of-system actors' capabilities and procedures. Further such procedures imply states of the actors during collaboration, allowing establishment of dynamic interoperability by deriving these states.

Finally the sensor system ontology contributes in establishing both pragmatic and semantic interoperability. The ontology regards both isolated use cases for using these systems, their capabilities due to the distinction between information and data delivering systems and their adaptability effort, since specialization is implied by the included is-a relation between the systems. The use cases, such as in the FLSPs, create a context of usage, illustrating the context of communication and creating semantics in communication. Information on adaptability and capability of the sensor systems, contribute to pragmatic interoperability, describing the systems capabilities and the possibilities of its usage.

7 Conclusion & Outlook

We identified multiple assets able to describe systems and their interoperation in the domain of security in public transport by analysis of related research work. We were able to show the specific details of the contribution by mapping these assets to the levels of the conceptual interoperability model. Since none of the research projects coped with interoperability itself these assets must be seen as building blocks for interoperability, offering capabilities to create context between systems and between the engineers. Therefore, these assets fully comply with the aspects of the presented levels by offering knowledge and information preservation and exchange capabilities. However, security in public transport is a domain with many facets, including endless possibilities of scenarios and usable systems. Concluding we can notice that these elements offer capabilities for information and knowledge preservation on the involved systems while establishing semantics between the systems. Therefore, tools can be derived for enabling collaboration of systems and of engineers during creation of a system-of-systems architecture. The elements do not restrict the systems' capabilities, but allow engineering of extended collaboration up to the systems' awareness of other systems' states. These assets will be further combined and derived, building the basis for an interoperability notation language in future research.

References

COPE. 2008. Use Case Descriptions and a Human Factors Engineering Framework. Deliverable. COPE. December.

———. 2009a. Comprehensive Model of First Responder Operations & Concept of Operations. Deliverable. COPE. May.

———. 2009b. HF-based Design Inputs to COPE Technology - Conceptual and Empirical Considerations of Common Operational Picture. Deliverable. COPE. November.

COUNTERACT. 2009a. Public Transport Security Planning - Organisation, Countermeasures & Operation Guidance - Part C: Systems and Equipment - Design Strategies and Considerations. Final Report. Counteract. March.

———. 2009b. Public Transport Security Planning - Organisation, Countermeasures & Operation Guidance - Part B: Security Operations Planning - Development of Operational Concept, Field Level Security Plans, Procedures and Training. Final Report. Counteract. March.

Dantas, A., and E. Seville. "Organisational Issues in Implementing an Information Sharing Framework: Lessons from the Matata Flooding Events in New Zealand."

DEMASST. 2009. Current technological solutions and relevant research. Deliverable. DEMASST. September.

———. 2010. Report on Potential Integrated Solutions. Deliverable. DEMASST. February.

Engelbach, W., S. Frings, H. Roßnagel, and J. Zibuschka. 2010. Peer-to-peer Integration of Security-oriented IT -Systems in Public Urban Transport. In Proceedings of the 5th Security Research Conference, 2010. Berlin, September.

Engelbach, W., H. Roßnagel, and S. Frings. 2010. Ein Konzept zur organisationsübergreifenden Integration von IT-Systemen für die zivile Sicherheit. In Software Engineering 2010 - Workshopband, 379-386. Bonn: Köllen Druck + Verlag GmbH, February.

Eriksson, W. 2009. System-of-Systems Demonstration & Experimentation for Mass Transport Security presented at the Workshop to discuss the scope of Call for Demonstration Project Security of Mass Transportation (Phase 2), March, Berlin. http://www.bmbf.de/pubRD/WS_MT_Eriksson.pdf.

Hollnagel, E. 2002. "Cognition as control: A pragmatic approach to the modelling of joint cognitive systems." IEEE Transactions on Systems, Man and Cybernetics (November).

InteGRail. 2010. InteGRail - Intelligent Integration of Railway Systems. Final Report. InteGRail. April.

ISO. 2010. ISO/IEC 2382-1:1993 Information technology - Vocabulary - Part 1: Fundamental terms. June. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=7229.

MODSafe. 2011. Description of the project. MODSafe. July. http://www.modsafe.eu/programm.html.

MODURBAN. 2008. Functional Interfaces specification for Passenger Information System. Deliverable. MODURBAN. May.

———. 2009. MODURBAN Architecture, Description of alternatives, for publication. Summary. MODURBAN. May.

NewRail. 2011. SECUREMETRO - Inherently secure blast resistant and fire safe metro vehicles. July. http://securemetro.inrets.fr/.

PROTECTRAIL. 2011. PROTECTRAIL - The Railway-Industry Partnership for Integrated Security of Rail Transport. (...). July. http://protectrail.eu/.

Roßnagel, H., and O. Junker. 2010. Evaluation of a Mobile Emergency Management System: A Simulation Approach. In Proceedings of the 7th International Conference on Information Systems for Crisis Response and Management (ISCRAM 2010). May.

Roßnagel, H., and J. Zibuschka. 2011. Using mobile social media for emergency management: a design science approach. In Proceedings of the 8th International ISCRAM Conference. Lisbon, Portugal.

Roßnagel, H., J. Zibuschka, and O. Junker. 2010. "Agent-Based Simulation for Evaluation of a Mobile Emergency Management System." Sustainable e-Business Management: 100–114.

———. 2011. On the effectiveness of mobile service notifications for passenger egress during large public events. In Proceedings of the 8th International ISCRAM Conference. Lisbon, Portugal.

Turnitsa, C.D. 2005. Extending the Levels of Conceptual Interoperability Model. In Proceedings IEEE Summer Computer Simulation Conference. CS Press.

Wang, W.G., A. Tolk, and W.P. Wang. 2009. The Levels of Conceptual Interoperability Model: Applying systems Engineering Principles to M&S. In SpringSim'09 Proceedings. San Diego, CA, USA: SCS.

The Vehicular Information Space Framework – A Comparative Study

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Abstract
Vehicular networks are distributed, self-organizing, and highly mobile ad hoc networks. They allow for providing drivers with up-to-the-minute information about their environment. Therefore, they may become a decisive future enabler for enhancing driving comfort and safety. Vehicles running the Vehicular Information Space framework (VIS) form a kind of distributed database. It enables them to provide information like existing hazards, parking spaces or traffic densities in a location aware and fully distributed manner. Moreover, arbitrary vehicles can retrieve, modify, delete, and subscribe to these information items. The underlying algorithm is based on features derived from existing structured Peer-to-Peer algorithms and extended to suit the specific characteristics of highly mobile ad hoc networks. This article details a comparative VIS study. Repeated broadcasting is a common way to realize distributed information provisioning. Therefore, we simulate and evaluate the VIS as well as repeated broadcasting-based information provisioning using a motorway and an urban traffic environment. Amongst others, comparative studies show that the VIS performs equally or even better than common distributed information provisioning. Also, overall VIS message traffic is independent from the number of managed information items. These are additional benefits besides the further distributed database and publish/subscribe functionalities of the VIS.

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1 Introduction

Vehicular networks are distributed, self-organizing and highly *Mobile Ad Hoc Networks* (*MANET*s). *Vehicular Communication Systems (VCSs) enable* vehicles to warn each other about existing hazards, for example. In this context, *Vehicle-to-Vehicle (V2V)* communication offers important possibilities to reduce the number of accidents particularly through the fast propagation of locally relevant warnings. In addition, VCSs allow for the provision of convenient add-on applications. For instance, drivers can be supplied with up-to-the-minute traffic information or check for nearby parking spaces currently available. Furthermore, traffic jams lead to annual economic costs of 17.4 billion Euros in Germany alone.[1] By improving roadway system utilization, VCSs bear the possibility to reduce economic costs as well as fuel consumption and CO_2 emissions. These are additional potentials besides enhancing road safety and driving comfort.

Accordingly, the research field has gained much interest from both academia and industry. Many aspects of *Vehicular Ad Hoc Networks* (*VANET*s) have been investigated profoundly. Yet, in the field of distributed information management, VCS solutions can be further improved. This includes functionalities such as the efficient distributed provision of information items like existing hazards, parking spaces or traffic densities. Also, subsequent data handling of already distributed information is of concern. In addition, the *Publish/Subscribe (Pub/Sub)* communication paradigm allows for information filtering and tracking of changes in the information environment. Thus, vehicles could monitor traffic changes, for example.

The *Vehicular Information Space* framework *(VIS)* provides the named functionalities by establishing a fully distributed vehicular database. The VIS core algorithm is based on features derived from existing structured *Peer-to-Peer (P2P)* algorithms and extended to suit the specific characteristics of VANETs. This article provides a comparative study of the VIS. For this evaluation, we simulate and evaluate the VIS as well as common repeated broadcasting-based distributed information provisioning on the basis of different traffic environments.

The remainder of the paper is structured as follows: Section 2 discusses requirements for VCSs and related work. Section 3 introduces the VIS approach and its implementation. In section 4, we present the comparative VIS study. Finally, we give a summary and an outlook on future work in section 5.

2 Requirements and Related Work

This section derives demands on a VCS with regard to different VCS applications. Afterwards, it gives a survey of work related to these functionalities.

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[1] See Lange, 2009

2.1 VCS Applications and Accompanied Requirements

The most important application area of vehicular communication is *active safety*. For example, vehicles can inform each other about preceding accidents or black ice. Also, vehicles are able to relay video information. This can be of considerable benefit in an urban emergency, as it allows emergency vehicles approaching the scene to better understand the nature of the emergency.[2] Another example is the improvement of roadway system utilization, e. g., through cooperative traffic jam detection performed by multiple vehicles. This raises the possibility to warn vehicles about sudden traffic jams or even to avoid them by propagating appropriate speed limitations.

In addition, *deployment applications* aim at offering drivers supplemental benefits. For instance, car parks are able to provide information about their capacities and costs using wireless communication endpoints. Vehicles leaving a public parking space can announce this as well. By aggregating this information, VCS applications are able to recommend appropriate nearby parking spaces. In the process, they may account for given costs or the intended route, for example. For route identification or *Points Of Interest (POI)* visualization, VCS applications may use in-car navigation systems, for instance. For more information on situation-aware in-car recommender systems, see[3]. Further information on the problem of identifying dedicated POIs in mobile navigation can be found in[4].

To support the multitude of possible applications in the named fields, a VCS has to be provided arbitrary applications can be built on. We focus on decentralized VCSs relying on present communication enabled vehicles only. Centralized systems either base on a network of dedicated roadside stations or they use existing cellular networks. Amongst others, decentralization avoids dependencies on roadside stations or cellular internet access. Compared to information exchange via a server, vehicles are also able to propagate information items, which might be safety critical, very fast when exchanging them directly. Consequently, decentralization is regarded as an additional VCS mode that will be very interesting in certain regions or for certain applications. In particular, we focus on the following requirements on decentralized VCSs:

Resource Efficiency: Vehicles communicate over the air interface. Hence, many messages lead to higher collision probabilities and longer access times. Both consequences should be avoided particularly with respect to safety applications.

Persistent Availability: It is not sufficient to send a black ice warning to all successive vehicles once. Vehicles reaching a hazard zone later have to be warned as well. Hence, information should be available over variable periods of time.

Retrievability: Data like parking space information is interesting for only a few vehicles and rather seldom. Due to given resource constraints, a VCS should not provide information items like this by retransmitting them all the time. Instead, it would be ad-

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[2] See Qadri, Altaf, Fleury, Ghanbari, 2010
[3] See Bader, Neufeld, Woerndl, Prinz 2011
[4] See Xuan, Zhao, Taniar, Srinivasan, 2008; Yang, Liu, Vaidya, Zhao, 2004; Zhao, Xuan, Rahayu, Taniar, Safar, Gavrilova, Srinivasan, 2010

vantageous to store information in a distributed manner and to allow arbitrary vehicles to retrieve this information. In the following, we will refer to this kind of distributed storage as *publishing.*

Modifiability: Information like the capacity of a car park changes frequently. Thus, it should be possible to modify published information.

Deletion/Expiration: Drivers must not be warned about black ice after road conditions have normalized again.

Location Awareness: A warning about bad road conditions is irrelevant in far-off regions. Thus, it should not be managed there for efficiency reasons and for fast propagation.

Reliability: As we presume no centralized infrastructure, cars manage information themselves. Thereby, information must not get lost if a vehicle passes a tunnel or is being parked, for example.

Pub/Sub: The Pub/Sub asynchronous messaging paradigm allows for loosely coupled, asynchronous communication covering information filtering and the tracking of changes. In short, a Pub/Sub-system manages information items and declarations of interest on certain information items (*subscriptions).* Subscribers can give particulars about themselves or the intended message contents. This enables the Pub/Sub-system to relay newly published information items to matching subscribers only. Likewise, it can notify subscribers about the modification or deletion of an item. Finally, it is able to inform new subscribers about existing items. For instance, Pub/Sub allows for passing published parking space information only if there are searching vehicles. This includes present vehicles and cars arriving / subscribing at a later point in time. Also, cars can be informed if certain published information –car park capacities or traffic conditions in an area – change.

To summarize, a VCS should allow for publishing information with respect to certain geographical regions or specified validity periods. Furthermore, it should be possible to modify, delete and to retrieve this information. In the following, we will refer to these mechanisms as *distributed information management*. Additionally, providing asynchronous messaging over Pub/Sub would be of advantage. From the application point of view, it implies the provision of publish, delete, search, modify and subscribe primitives besides send and receive.

2.2 Related Work

A lot of profound work in VANET research is on media access, multi-hop routing, multicast and geocast. In addition, The *IEEE 1609 Family of Standards for Wireless Access in Vehicular Environments (WAVE)* focuses secure V2V and *Vehicle-to-Infrastructure (V2I)* wireless communications. They rely on the *IEEE 802.11p Standard*. In our context, it is particularly interesting that this standard envisions direct communication within a distance of up to one kilometer.

The named technologies provide the basis for distributed information management. Regarding the latter, many approaches deploy intelligent retransmissions of broadcast messages to realize persistent availability of information.[5] That is, vehicles within an area retransmit information items according to dedicated rules. This way, vehicles reaching the area later receive the messages as well. A common alternative are *Stored Geocast*-like approaches.[6] A Geocast message is sent to one node being a fixed infrastructure point or elected out of present mobile nodes. Afterwards, that node delivers the message within the desired region using continuous retransmissions. Alternatively, every vehicle can broadcast its location or the like periodically. This way, Geocast servers can deliver Geocast messages on demand as they notice a vehicle entering their area of interest. However, the named approaches utilize continuous rebroadcasts resulting in redundant messaging. Moreover, on-demand modifiability, deletion and retrievability are additional matters.

Among other things, *structured P2P algorithms* address reliable, distributed information management. Also, the *Distributed Hash Table (DHT)* of a structured P2P network can be used to efficiently realize distributed Pub/Sub (e.g.[7]). Structured P2P networks utilize DHTs as carriers: Information items have unique keys. These keys are hashed onto identifiers, likewise peer addresses. Information is then stored and to be searched on the peer whose identifier is most similar to the information's identifier. Expiration is realized by passing a validity period when publishing. The peer storing the information deletes it as soon as the validity expires. Structured P2P algorithms basically differ in their data object schemata, their address spaces, their routing strategies and their replication strategies to achieve fault tolerance. If a peer fails, neighboring peers in the address space usually take over its identifier interval and corresponding information. A popular example is the structured P2P algorithm Chord[8] and its ring topology. Chord virtually places peers onto a ring ordered by ascending identifiers. Hence, the aforementioned similarity of peer and information identifiers equates to unidirectional proximity on a ring as far as the Chord algorithm is concerned. Likewise, the named neighborship relation refers to peers next to each other on the virtual ring.

Several protocols utilize synergies between P2P networks and MANETs to optimize MANET routing protocols. Regarding application layer structured P2P information management, different existing approaches deal with mobile devices and structured P2P overlays. However, these approaches do not regard VANETs. Thus, they do not have to consider properties like high velocities, the size of vehicular networks or references to and impacts of the street topology. In VANET research, Lochert et al. [9] compare the central server approach and the possibility to maintain one big structured P2P overlay on top of the vehicular network. For the latter, application specific informa-

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[5] See Caliskan, Graupner, Mauve, 2006; Wischoff, Ebner, Rohling, Lott, Halfmann, 2003
[6] Maihöfer, Franz, Eberhardt, 2008
[7] Gupta, Sahin, Agrawal, Abbadi, 2004
[8] Stoica, Morris, Karger, Kaashoek, Balakrishnan, 2001
[9] Lochert, Rybicki, Scheuermann, Mauve, 2008

tion, requests and topological information have to be exchanged over vehicular multi-hop connections. These connections may exceed many kilometers. Thereby, information exchange has to take place in a fast and reliable way, which poses a problem in VANETs (see Section 3.1). In addition, they point out the huge network load. All named information would have to be routed frequently and most often over long distances. Thus, Lochert et al. conclude that, despite the substantial benefits of P2P, infrastructure-based solutions will be the ones preferred in the near future. In [10] they suggest a solution for an infrastructure-based P2P network. The network is made up of vehicles each of which maintains an internet connection to be able to access fixed network infrastructure. This way, they take advantage of P2P functionalities while avoiding the stated problems. However, as motivated in section 2, we are focusing on infrastructure-independent solutions. For a more detailed discussion of work related to the VIS see, for example.[11]

3 The Vehicular Information Space Framework

First, this section gives an overview on the VIS. Afterwards; it describes the integrated structured P2P algorithm.

3.1 Framework Overview

To give an overview, we introduce the motivation behind the VIS as well as key challenges that influenced it. Subsequently, we depict the framework's basic concept and its implementation.

3.1.1 Motivation and Challenges

VANETs and P2P networks bear strong resemblances. For example, both are distributed, self-organizing networks suffering from frequent topology changes. Therefore, P2P algorithms account for properties prevailing in VANETs as well. Also, they address reliable, distributed information management and their DHTs can be used to efficiently realize distributed Pub/Sub. However, P2P algorithms were designed for the internet. In VANETs, communication over multiple vehicles is not as fast and reliable. On the one hand, reliability is restricted because obstacles like trees may jam wireless connections. On the other hand, communication is slower because flooding-based vehicular communication causes redundant messaging. Also multi-hop routing protocols for vehicular networks require a lot of message exchanges. This is due to the high vehicle speeds necessitating many routing table updates. In both cases, multiple messages result in higher collision probabilities and longer access times at the air interface. Alternatively, connections are established on demand, which results in delays. Finally, established connections over multiple vehicles are not very stable again because of the high vehicular velocities.

The problem is that P2P algorithms require fast and reliable exchange of topology in-

[10] Rybicki, Scheuermann, Kiess, Lochert, Fallahi, Mauve, 2007
[11] Prinz, Brocco, Woerndl, 2009

formation and application data independent from the peers' physical distance. First, inconsistencies in the P2P network may occur if topology data is not exchanged adequately. Second, rapid (re-)allocation of application data during regular publish, join, and leave procedures or in case of failure recovery becomes a problem. Apart from that, information like a black ice warning should not be managed in far-off areas for efficiency reasons and for fast retrievability. Existing P2P algorithms are not concerned with information management referring to certain regions of the road network.

3.1.2 The Basic VIS Concept

A way to cope with these different conditions is not to regard the vehicular network as one big structured P2P network. Instead, the VIS divides it into segments each forming a structured P2P network. The segment sizes are chosen according to the available communication range. For example, in urban areas street sections of half a kilometer are chosen when assuming an average IEEE 802.11p communication range. The address space of a VIS P2P network is limited to these segments whereas adjacent segments overlap logically at their borders (see Fig. 1).

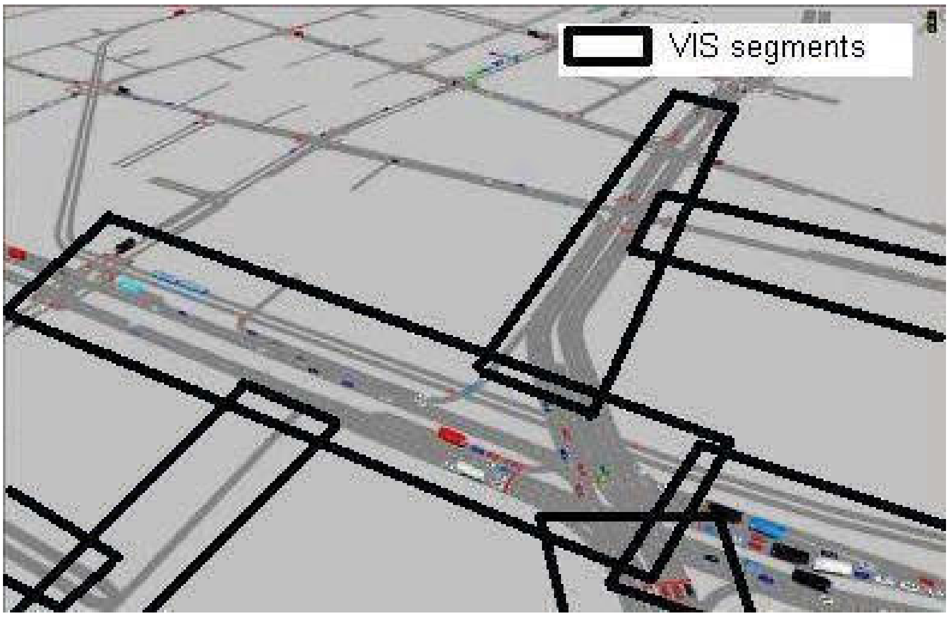

Fig. 1: VIS road network segmentation

Within a VIS segment, vehicles are able to communicate directly. Thus, they can exchange topology and application data in an adequate manner. The VIS uses a vehicle's position to determine whether a vehicle crosses segment borders. As soon as a VIS vehicle approaches a new segment, it contacts the first vehicle of the corresponding VIS P2P network using beacon messages. This way, it is able to obtain all information required to join the new topology. Furthermore, it announces its departure from the old VIS network to avoid overhead from failure recovery.

By default, information is published, and then managed, in one segment. Yet, a piece of information might be of relevance beyond the borders of that segment as well. This *segment-overlapping* information has to be forwarded between neighboring VIS segments. In order to facilitate this, a VIS vehicle crossing segment borders first searches segment-overlapping information in its old segment. Then, it publishes found items in the new segment. Finally, it marks these items as being forwarded by modifying them. Thus, there is no redundant forwarding. To be able to specify segment-overlapping information, a corresponding information type is defined. Hence, segment-overlapping information becomes searchable and markable for all vehicles. If segment-overlapping information is modified or deleted, the forwarded mark is reset again and, in case, set deleted. This way, the information item is passed to adjacent segments again. There, the responsible VIS vehicle has to overwrite or to delete the existing information. Exceptions are segment-overlapping warnings. If they are of relevance in adjacent segments as well, they are flooded. It is not possible to wait until the next vehicle leaves the segment. However, as this corresponds to wide ranging warnings only, it can be assumed that the scenario is going to emerge rather seldom.

Pub/Sub is built on top of each segment's DHT. However, application level subscriptions need to be valid not only in one segment. Therefore, a vehicle's subscriptions are published in its new segment on crossing segment borders. Furthermore, they are deleted in the old segment. As information items are forwarded between segments according to their relevance range, it is sufficient to manage subscriptions in the originators current segment. They will be checked against all relevant information items.

3.1.3 Framework Implementation and Architecture

We implemented the VIS as a framework using the programming language Python. The network segmentation and all further mechanisms are realized at the VIS framework layer. Currently, the network segmentation needs to be configured and was manually determined for each deployed traffic environment (see Section 4). Future work is to enhance this by implementing existing algorithms for object-aware geographical segmentation.

VCS applications access the VIS functionalities using publish, search, modify, delete and subscribe primitives provided by its interface. We refer to VIS information items as *resources*. These objects typify any kind of application data to be managed by the VIS. When a resource is published, its default scope can be modified. This scope is an attribute of a resource specified in meters. As part of a resource, it is passed to the VIS when calling the publish method. The VIS then selects relevant segments and publishes the resource accordingly. Likewise, resources obtain a validity attribute whose default value can be modified. A VIS vehicle storing a resource deletes it as soon as the validity expires. To determine if a vehicle crosses segment borders, the framework requests a vehicle's position periodically. Also, the VIS needs to be provided with send and receive primitives for information exchange. To achieve loose coupling, an application has to pass a callback specifying what to do in case a request returns a result. A search request's result is an array of found resources, for example. The VIS calls this callback on receiving the respective result.

Consequently, VCS application developers do not need to know about the vehicular network segmentation. They use the VIS as if working on a local database. Likewise, the VIS does not need to know about existing applications. The design aims at maximizing loose coupling while offering ease of application development.

3.2 The VIS P2P Algorithm

The VIS implements the chord address space. In addition, it adapts existing join, leave and maintenance procedures independent from Chord. Finally, it integrates extensions handling the increased message loss rate of VANETs.

3.2.1 Address Space: Chord Ring

Structured P2P algorithms use their DHTs to determine on which peer to store an information item. Likewise, they know which peer to contact in order to retrieve, modify or delete it. Overlay routing is applied to route a request to the corresponding peer. Thereby, more complex address spaces usually offer better overlay routing performance. On a peer failure, they can provide alternative overlay routes not crossing that peer, for instance. In exchange, they require more messages to keep up their topology. Usually, overlay routes are decoupled from underlay routes – One-hop overlay routes may result in long-distance multi-hop underlay routes. Overlay routing is necessary because structured P2P algorithms potentially need to scale for millions of peers on the internet. It is not possible to maintain consistent overlay address tables if each table comprises all peers participating in the network whereas, network-wide, each table has to be updated on each single topology change.

Regarding the VIS, it is possible to utilize the limited number of nodes participating in the overlay simultaneously. The node number is bounded because of the limited segment size. This again implies that overlay address tables remain relatively small even if they comprise all segment participants. In addition, updates of overlay address tables can be carried out comparatively fast as each VIS vehicle is in physical one-hop distance. Therefore, each VIS vehicle maintains the overlay identifier and the corresponding network address of every other VIS overlay member. As a consequence, each overlay member is able to address every other overlay member. Thus, there is no need for a complex address space. Therefore, the VIS is based on the rather simple Chord ring structure (see Section 2.2 and Fig. 2a). Following Chord, the VIS calculates identifiers by hashing a vehicles address and a resource's key. In accordance to Chord, VIS vehicles manage resources, whose identifiers lie in the interval bounded by the vehicle's identifier and its predecessor's identifier. In the example illustrated in Fig. 2a, vehicle 170xxx hosts the resource with identifier 124xxx, for instance.

VIS application developers may specify resource keywords the framework uses for identifier generation. For example, a resource might hold the keyword "parking space" in case it describes the location (and other attributes) of a certain parking space. This way, other instances of the same distributed VCS application are able to search, modify or to delete corresponding resources. By naming the keyword, they enable the VIS to calculate the respective identifier needed to identify the successive vehicle on the Chord ring (*successor)* to contact (see Fig. 2b, lines 4 - 9). If no keyword is specified, the VIS publishes resources using a unique key being a standard attribute of every resource (see Fig. 2b, lines 11 - 15). In that case, only the publishing vehicle is able to access the resource as no other vehicle knows its key.

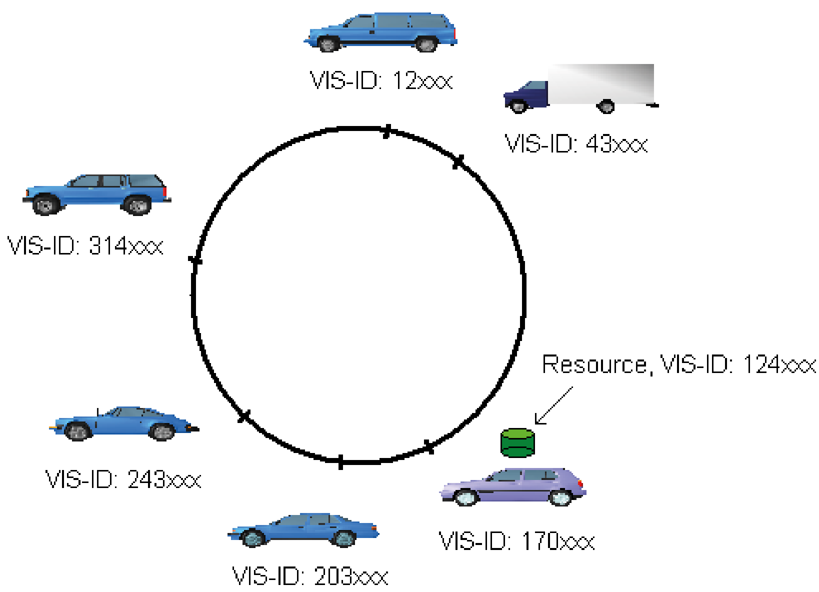

Fig. 2a): The VIS address space

```
PUBLISH(info : Resource)
topics[] = info.getTopics()
if topics ≠ NIL
   then ▷ Publish resource using its topics by default
        for j ← 0 to length[topics] − 1
            VISId = HASHLIB.MD5(topics[i])
            VISSuccessor = FINDSUCCESSOR(VISId)
            PR = PublishRequest(VISSuccessor, info)
            send(PR)
            PENDINGREQUESTS.add(PR)
   else ▷ Use resource's UUID
        VISId = HASHLIB.MD5(info.getUUID())
        VISSuccessor = FINDSUCCESSOR(VISId)
        PR = PublishRequest(VISSuccessor, info)
        send(PR)
        PENDINGREQUESTS.add(PR)
```

Fig. 2b) Pseudocode VIS publish

3.2.2 Adaptations of Existing Join, Leave and Maintenance Procedures

Generally, maintenance mechanisms are concerned with irregular peer failures. In addition, they may imply handling leave events in case only join is performed proactively. In contrast to Chord, VIS joins and leave procedures are purely proactive: As soon as a VIS vehicle approaches a new segment, it broadcasts a join request. Thereupon, the VIS vehicle's successor sends a reply message including the segment's address table. In addition, the message comprises resources that are no longer under the responsibility of the successor but have to be managed by the joining VIS vehicle. Apart from that, every VIS vehicle adds the joining vehicle to its address table on receiving the join request. As the whole ring is common knowledge, every VIS vehicle is aware if it is the new VIS vehicle's successor. In case a VIS vehicle leaves a segment or a driver performs a usual shut down (parking), the VIS vehicle broadcasts a leave request. In answer to receiving that leave request, all VIS vehicles delete the leaving vehicle from their address tables. Moreover, the leaving vehicle attaches resources its successor has to resume.

As leave procedures are purely proactive, VIS maintenance is concerned with irregular failures only. For example, VIS vehicles may fail on entering a basement garage or if a vehicle's engine is stalled. Failure recovery utilizes the fact that published resources can be replicated on a VIS vehicle's successor easily. A VIS vehicle publishing a resource is aware of the entire ring. Hence, it knows the responsible VIS vehicle to contact for publishing as well as the responsible VIS vehicle's successor. It is able to publish the resource on the latter for replicated storage as well. Likewise, a VIS vehicle contacting a failed VIS vehicle for any kind of request is able to inform the failed VIS vehicle's successor immediately. If so, the whole overlay can be stabilized by a single following leave message representative for the failed VIS vehicle sent by its successor.

3.2.3 Increased Message Loss Probability

The VIS has to cope with high message loss probabilities due to wireless vehicular communications. To give an example, the reply to a join request issued by *VIS vehicle A* might get lost. Vehicle A does not get the information necessary to join the VIS segment's topology. This might recur after vehicle A repeated the request. Meanwhile, all other vehicular peers added vehicle A to their routing tables as they received its request. Therefore, *VIS vehicle B* might send a leave request where all VIS vehicles assume vehicle A in the role of the successor. Only vehicle A is not able to know as it has not yet established its ring structure. Hence, all resources vehicle A would have to take over get lost. There might occur losses of join, leave, publish, search, modify or delete requests and losses of corresponding responses. Thus, diversified scenarios exist where single message losses or combinations of these losses lead to serious faults in the overlay. The VIS applies the following mechanisms to avoid these faults:

Every VIS vehicle memorizes requests it did not receive a reply to. Thereby, a VIS vehicle's successor answers to a join or a leave request. Publish, search, modify and delete requests are answered by the VIS vehicle responsible for the corresponding resource. Requests have unique identifiers and version numbers. In case there is no reply to a request, a VIS vehicle repeats the request using a higher version number. VIS vehicles check whether they recognize a request using this identifier. If so, they do not repeat the respective operation. Yet, they repeat a reply in case it is their task.

A VIS vehicle in *state joining* memorizes incoming requests corresponding to its new segment. It performs them as soon as the join procedure is complete. A VIS vehicle in *state leaving* does not process requests corresponding to its old segment and does not answer to them. The requesting VIS vehicle has to repeat the request after updating its address table.

Leave requests are processed by every segment member to delete the leaving VIS vehicle. Thereby, they comprise the sending VIS vehicle's address table and its version.

All VIS vehicles perform the same operations on their address tables. Their versions have to be equal. If not, a join or a leave request was lost whereas the VIS vehicle not receiving the message was not in the role of the successor – the request was not repeated. Therefore, VIS vehicles whose version number is lower than a received one replace their address table and its version number.

The VIS also deals with reliability beyond segment borders. We do not detail corresponding mechanisms here as they are not relevant for the presented study and the overall understanding of the VIS approach. More details on the topic can be found in[12].

3.2.4 Discussion of an Alternative Solution

In case a VCS application publishes a resource, each segment member physically receives the publish request since we are in a wireless environment. An intuitive suggestion is to simply let each vehicle store the resource and avoid the costs for VIS overlay messaging. On second thought, this is no satisfying alternative:

If each VIS vehicle would store every published resource, all VIS vehicles would have to process every publish request. In case there's an explicit receiver address, other VIS vehicles drop a request at an early stage. Also, every VIS vehicle newly arriving would need to request existing resources to know about them and to keep them alive. Thereby, every arriving VIS vehicle would have to broadcast the resources-request since it does not know a responsible receiver VIS vehicle. Again, every VIS vehicle would have to process this request. Also, every VIS vehicle would need to reply and pass all existing resources since there's no responsible vehicle commonly known.

If a VCS application publishes, modifies or deletes a resource, the VIS vehicle would have to broadcast the request to force every VIS vehicle to perform the operation. Besides redundant processing, this bears consistency problems. In the common case of message loss, single vehicles would not know about a resource. Hence, every VIS vehicle would need to send a publish reply to acknowledge a resources receipt, not only the responsible VIS vehicle. And, even in the latter case, the publishing VIS vehicle would still not be able to detect a VIS vehicle not receiving the resource as it does not know present VIS vehicles. If a VCS application modifies a resource, there will soon be different versions due to losses of modify requests. With deletion, it is not known if information – an available parking space – should still be existent.

4 Comparative Study of the VIS

It is necessary to realistically simulate factors like car movements and wireless vehicular communications as they strongly influence evaluation results. Thus, this section first describes our simulation environment. Then, we present evaluation results on occurring VIS message traffic. Thereafter, we implement and evaluate information provisioning based on repeated broadcasting. Finally, we compare our findings to draw conclusions about VIS message overhead.

[12] See Prinz, Brocco, Woerndl, 2009

4.1 Simulation Environment

For our simulation studies, we utilize the commercial traffic and V2V communication simulation environment VISSIM/Vcom and different simulation settings.

4.1.1 VISSIM/VCom

VISSIM by PTV Vision is a time step oriented and behavior-based simulator for urban and highway traffic simulation including pedestrians, cyclists and motorized vehicles. A simulation's result is a two- or three-dimensional traffic flow animation. VISSIM visualizes the animation using a graphical user interface (see Section 4.2). Furthermore, different traffic characteristics can be logged and analyzed offline. Traffic-dependent control logic is modeled using external modules for traffic signaling and control. Concerning the traffic flow model, *driver-vehicle* entities move through the transport network autonomously. Each driver and his behavioral patterns are associated with a dedicated car. This way, driving behavior and a vehicle's technical possibilities correlate. A driver-vehicle entity is characterized by different attributes. Besides the vehicle's technical specification, they span individual human behavior patterns. Examples are psychophysical perception barriers like estimation abilities or the readiness to assume risk. Moreover, dependencies between different driver-vehicle entities influence a vehicle's behavior. To simulate V2V communication, we are working with the VISSIM module *Vcom.* The module is based on statistics of the network simulator *ns-2* to simulate V2V communication[13].

4.1.2 Simulation Settings

We deployed the VIS and repeated broadcasting using two different VISSIM traffic environments. For both environments, we manually determined segment boarders of three segments on the basis of the VISSIM coordinates. In accordance to VCom and the average IEEE 802.11p communication range, a segment's maximum diameter is 500m. The first traffic environment is an urban environment (see Fig. 3a). Passenger cars as well as trucks are assigned desired speeds of 50 km/h. We modeled a traffic load of 250 vehicles per lane per hour. There are two lanes of traffic, each running opposite directions. Consequently, there is a traffic load of 500 vehicles per hour. It is thought that medium to long-term adoption will result in around 25% of WLAN-enabled cars.[14] Therefore, we defined an average rate of 25% of V2V unit equipped vehicles resulting in 62,5 vehicles able to communicate per hour and direction.

In the depicted traffic environment, vehicles are comparatively slow and traffic density is rather sparse. Thus, there is relatively little VIS join and leave traffic (*churn*). Hence, there are not as many VIS leave requests utilized for distributed address table adjustments (see Section 3.2.3). But then, there's fewer stress concerning wireless data load and resulting message loss. Also, the number of distributed VIS address table updates is low. To be able to evaluate the VIS and repeated broadcasting under high churn and for high node numbers, we deployed a 4-lane motorway traffic network as

[13] See Killat, Schmidt-Eisenlohr, Hartenstein, Rössel, Vortisch, Assenmacher, Busch, 2007
[14] Matheus, Morich, Lübke, 2004

well (see Fig. 3b). There are four lanes of traffic, two each running opposite directions. A passenger car's desired speed is 140 km/h. Trucks have desired speeds of 80 km/h. Furthermore, we modeled a traffic load of 2000 vehicles per hour for each driving direction. Like in the urban scenario, there is an average rate of 25 percent V2V unit equipped vehicles. Consequently, there are about 500 vehicles able to communicate wirelessly per hour and direction equating to 1000 vehicles distributed over the given 4 lanes.

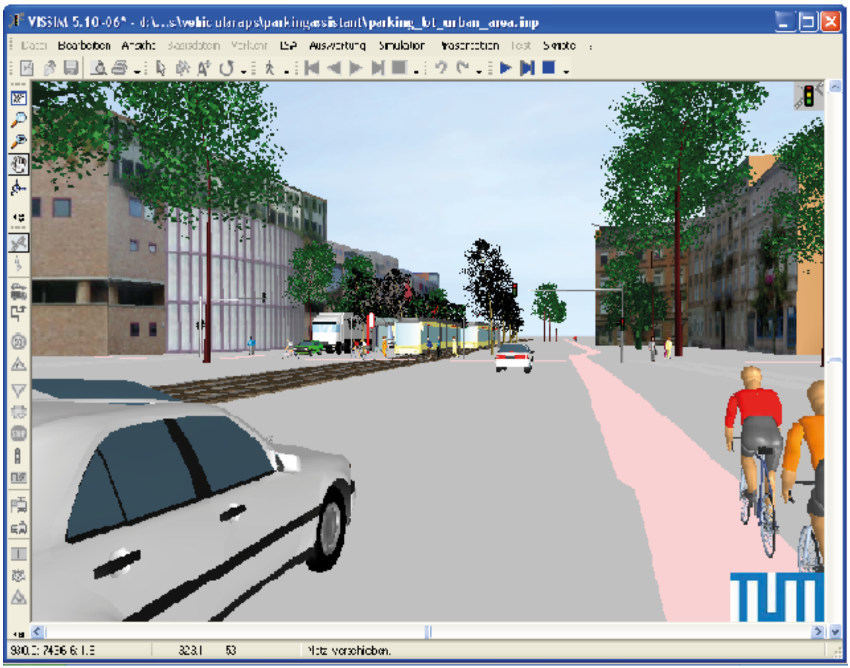

Figure 3a) Motorway traffic environment

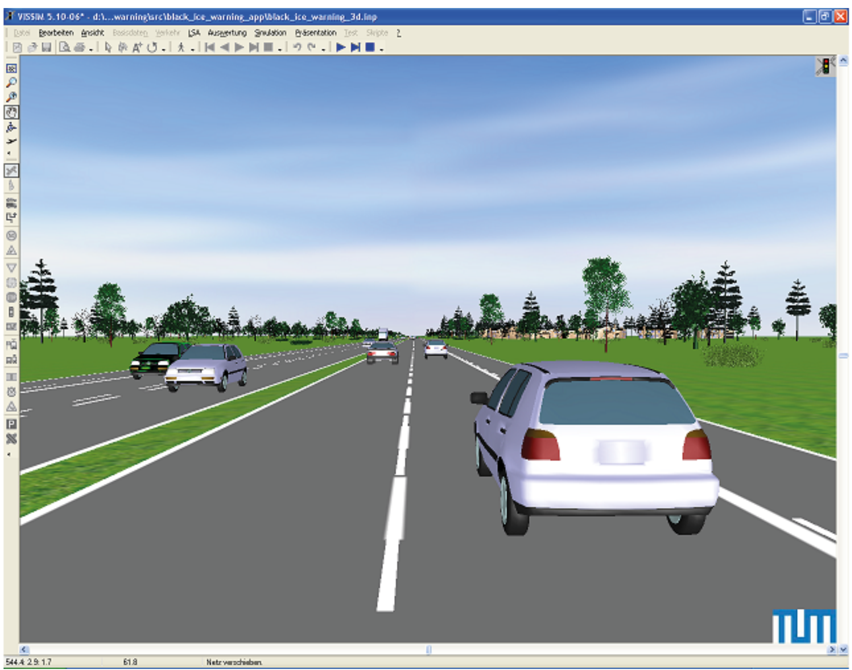

Figure 3b) Urban traffic environment

4.2 VIS Information Provisioning

To evaluate the VIS, each V2V enabled vehicle of the depicted traffic environments runs the framework. As described, it joins a VIS overlay on entering a segment and leaves it when crossing its borders again. On starting a simulation run, the first VIS-SIM vehicle entering a VIS segment does not get a response to its join request. After repeating the request to exclude the possibility of message loss, it builds up a new information space. The behavior is identical in case a segment failed. The new information space is then joined by subsequent vehicles. Thereby, we wait until vehicles dispersed throughout the road network. Afterwards, arbitrary vehicles publish dummy resources to determine the number of VIS messages needed for their provisioning.

Figure 4a visualizes the number of VIS messages transmitted per time in case vehicles provide one resource. It depicts the measurements starting short before publishing the resource in the motorway traffic environment. Noticeable is the sharp message increase after simulation second number 200. Reviewing the logfiles showed that there are two leave requests simultaneous at simulation second 199,9. Only one of the two is answered. Starting from simulation second 199,9, there is one leave request continuously repeated until simulation second 212,6. Meanwhile, there are 4 join and 4 further leave requests issued by other vehicular peers. These requests influence the overlay in a way that there is always one peer waiting for a leave reply resulting in the visible huge stabilization traffic.

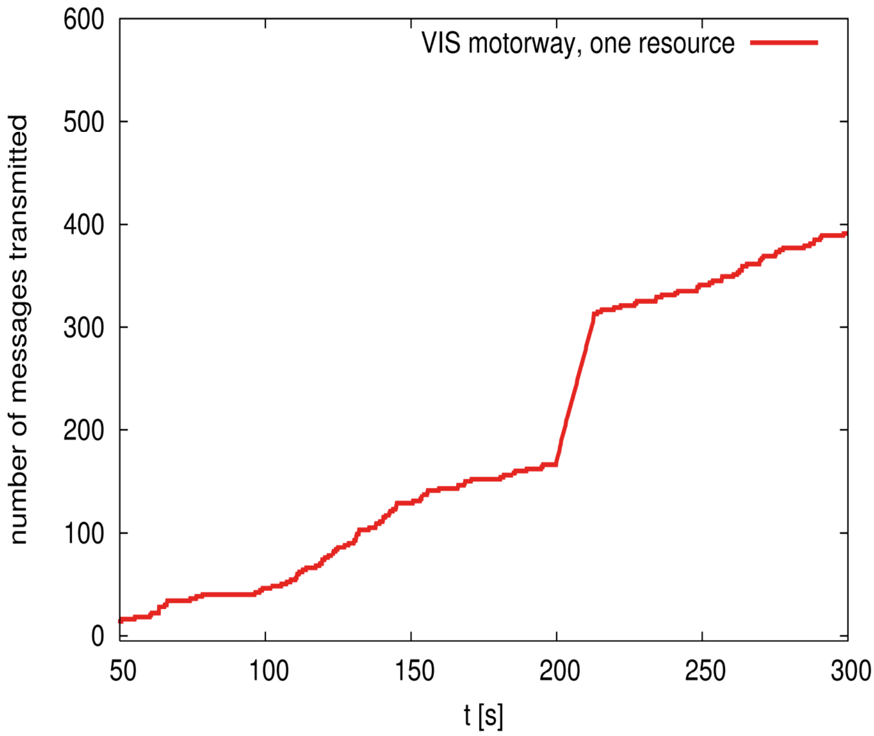

Figure 4a) VIS message traffic, motorway

Figure 4b shows the number of VIS messages transmitted for one provided resource in the urban traffic environment. Message traffic is much lower than on the motorway. This is because there are fewer overlay members due to the lower traffic density. Also, message occurrence is less constant. This is because there are fewer vehicles traversing a VIS segment slower. Therefore, regular join and leave traffic occurs more frequent on the motorway. In comparison, it appears in irregular steps in the urban traffic environment, which is emphasized by the higher y-axis resolution.

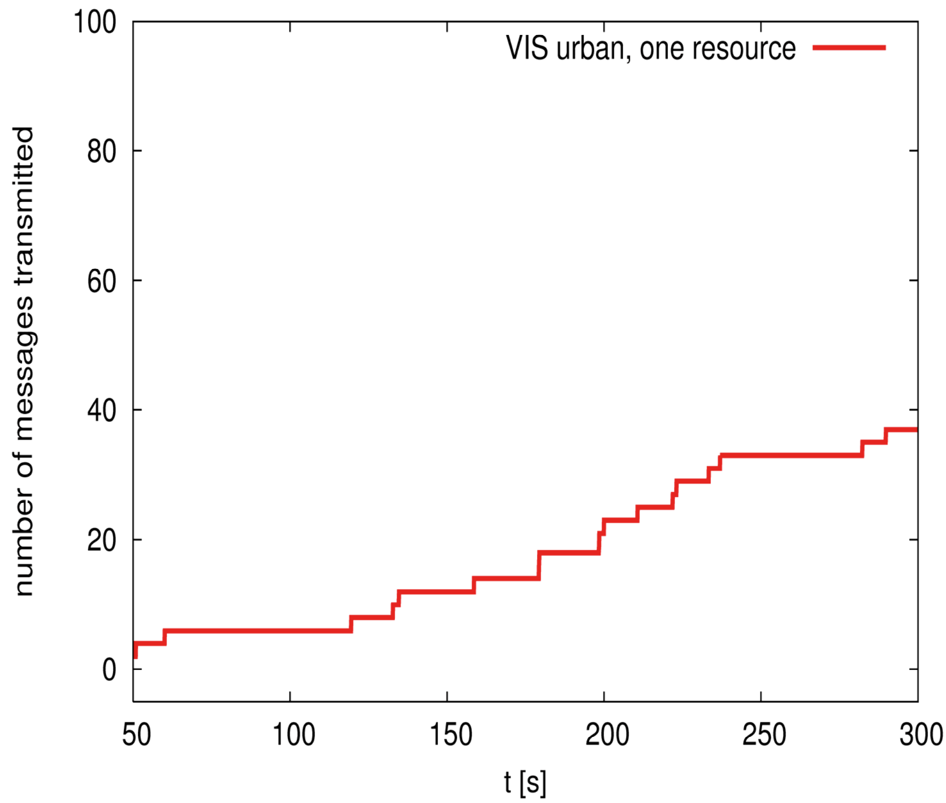

Figure 4b) VIS message traffic, urban

As stated in previous sections, we aim at providing different resources necessary for diversified applications (traffic densities, multiple available parking lots, gas stations and their prices, restaurants nearby et cetera). Therefore, we also measured the number of VIS messages transmitted in case multiple resources are published. At first thought, additional published resources should have no impact on the VIS message load as long as they do not imply multiple data packages due to their sizes: Resources are handed over during regular join and leave procedures. Join and leave messaging is required no matter if there are resources to pass or not. Yet, Figure 5a displays that there is a difference in the number of transmitted VIS messages for a varying number of resources on the motorway. This is because a single additional publish request influences the message loss probability of subsequent messages. In detail, message loads equal for one and four present resources (compare Fig. 4 and Fig. 5a). Moreover, Figure 5a shows there are even less transmitted messages when four resources are published instead of three. With two resources, there is no need for high VIS stabilization traffic. In case three resources are present, visible stabilization overhead occurs starting from simulation seconds number 200 and number 260. In contrast, measurements in the urban traffic environment show equal overall behavior given two, three and four resources (see Fig. 5b). The only difference is that message counts differ in the number of transmissions needed for each additional publish request and the corresponding reply. This is because there is relatively little churn due to sparse traffic density and lower velocities. This implies less stress concerning wireless data load and resulting message loss. Therefore, the probability of overlay stabilization necessity is lower. During the depicted runs, there's no stabilization traffic at all.

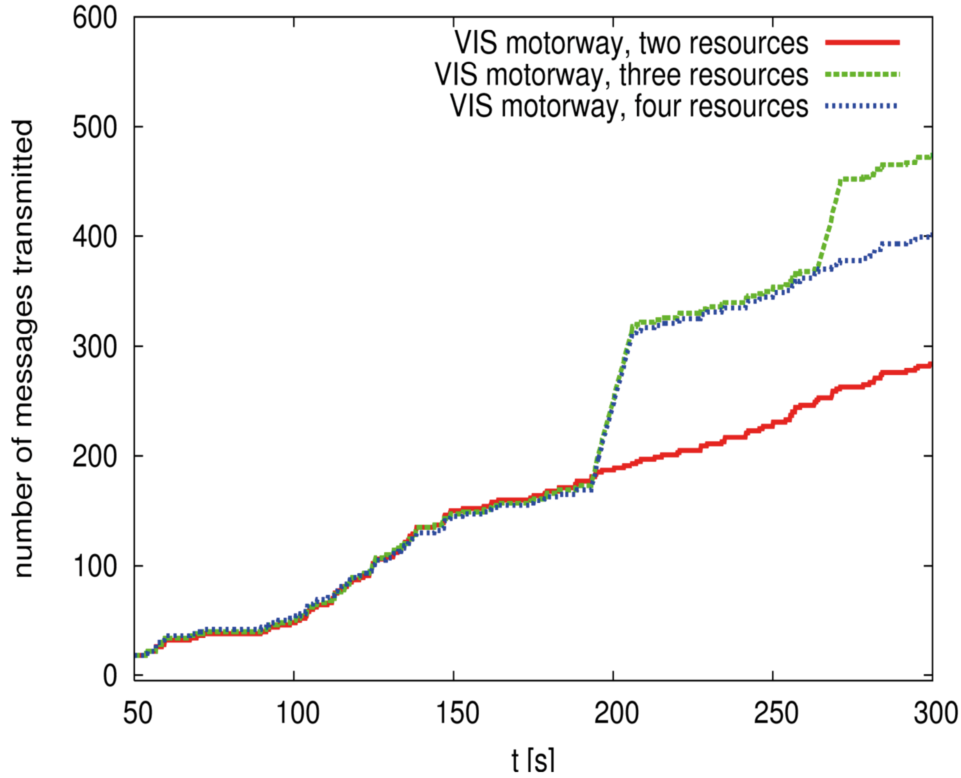

Fig. 5a) VIS messages, up to 4 resources, motorway

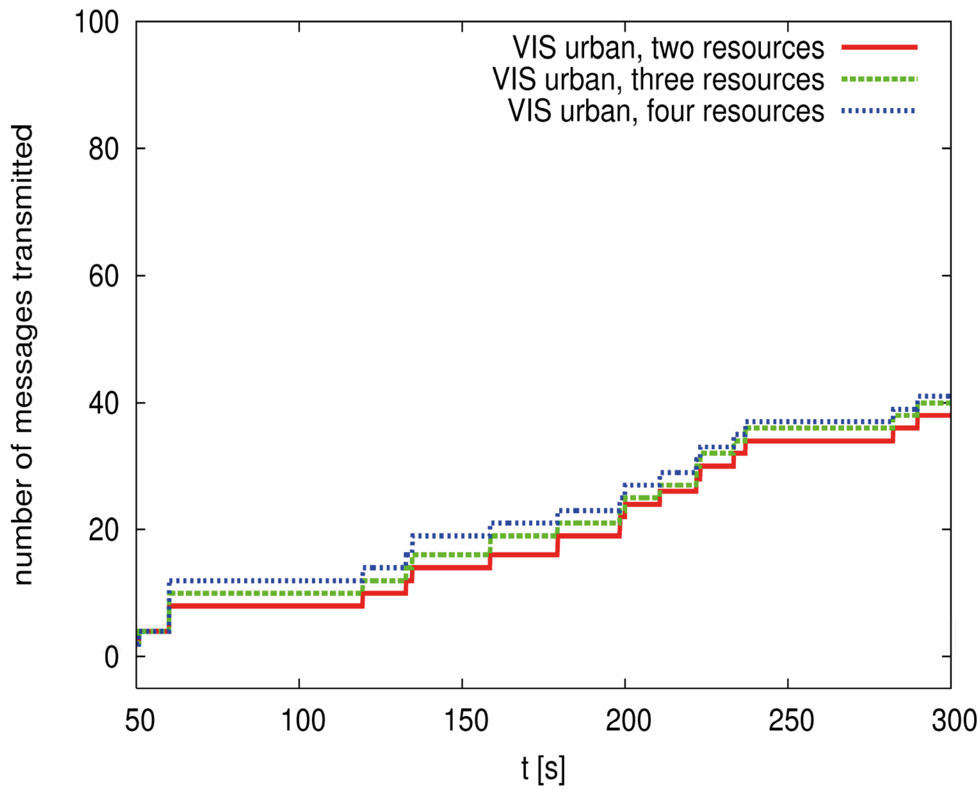

Fig. 5b) VIS messages, up to 4 resources, urban

4.3 Distributed Information Provisioning based on Repeated Broadcasting

We aim at comparing VIS message overhead to that of well-known distributed information provisioning. Repeated broadcasting is a common way to realize distributed information provisioning (see Section 2.2). Thus, we implemented repeated broadcasting and ran it using the depicted VIS simulation settings. This enabled us to evaluate repeated broadcasting-based information provisioning in a comparable manner.

Regarding our repeated broadcasting implementation, every vehicle within relevance range of an information item becomes a repeater. In this context, also vehicles driving on the opposite lane of the publishing vehicle or veering away from it are concerned as they help to carry the information and to keep it alive. Each repeater retransmits a received information item according to a variable repetition frequency starting from the information's reception time. Thereby, a repeater calculates his current distance to the information's source location each time. This way, it is able to stop broadcasting after leaving the information's relevance range. When running the implementation, we use the two introduced traffic environments and a relevance range of half a kilometer. Again, we initiate information provisioning after vehicles distributed throughout the road networks. First, it is of relevance to determine the retransmission interval needed to guarantee an acceptable rate of informed vehicles within relevance range. Therefore, we ran the simulation using varying retransmission intervals.

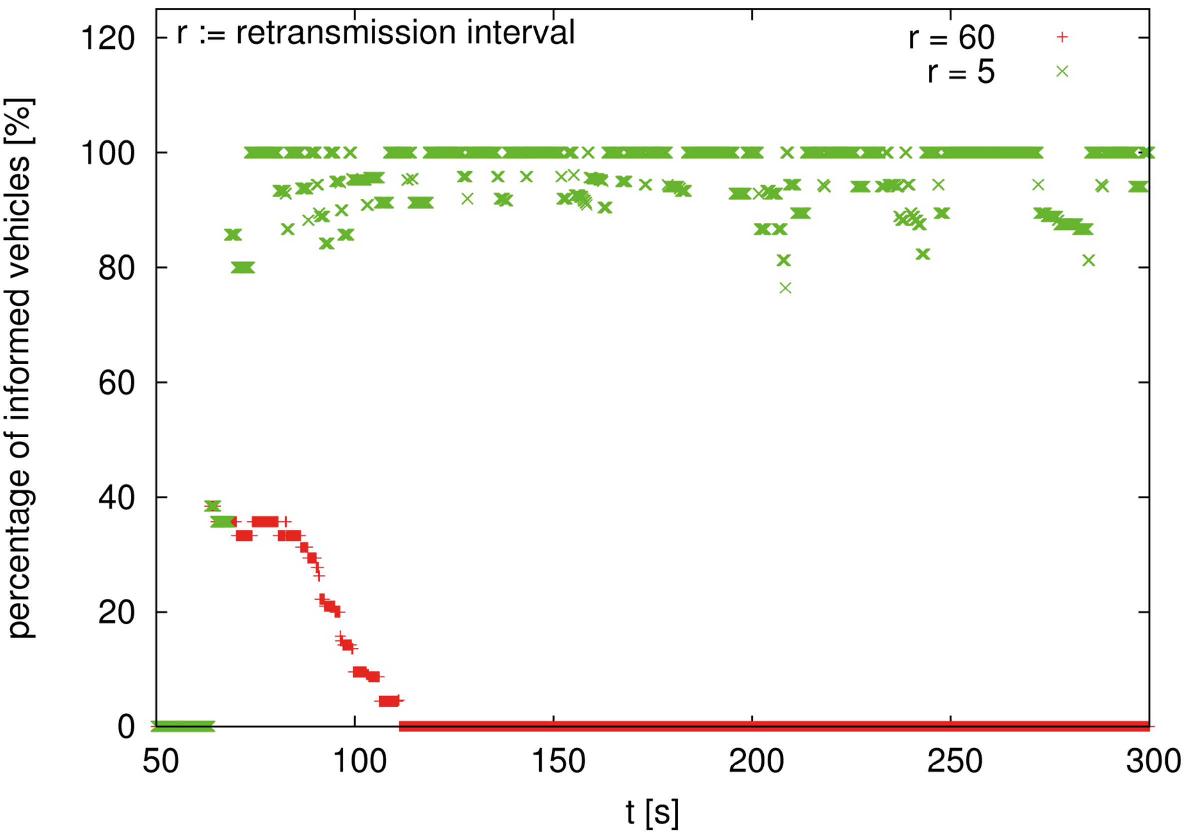

Fig. 6a) Percentage of informed vehicles, motorway

Figure 6a and b chart the percentage of vehicles informed about one information item for each traffic environment. Obviously, it is not possible to keep an information item alive when repeating vehicles retransmit it every 60 seconds. Present repeaters leave the relevance range before informing other vehicles. When applying a retransmission interval of 5 seconds, we are able to maintain an information transfer rate of 80-100 percent on the motorway (see Fig. 6a).

Figure 6b shows there are fewer but stronger variations when repeating an item every 5 seconds in the urban traffic environment. In this context, one has to bear in mind that a single uninformed vehicle influences the percentage of informed vehicles much more because of the lower number of vehicles. Also, variations occur less frequently given fewer vehicles and lower speeds. Due to the depicted rates of informed vehicles, we consider a repetition interval of 5 seconds as sufficient. This is in accordance to related publications (e.g.[15]). Yet, it becomes obvious that the frequency should be higher if, e.g., safety critical information is concerned.

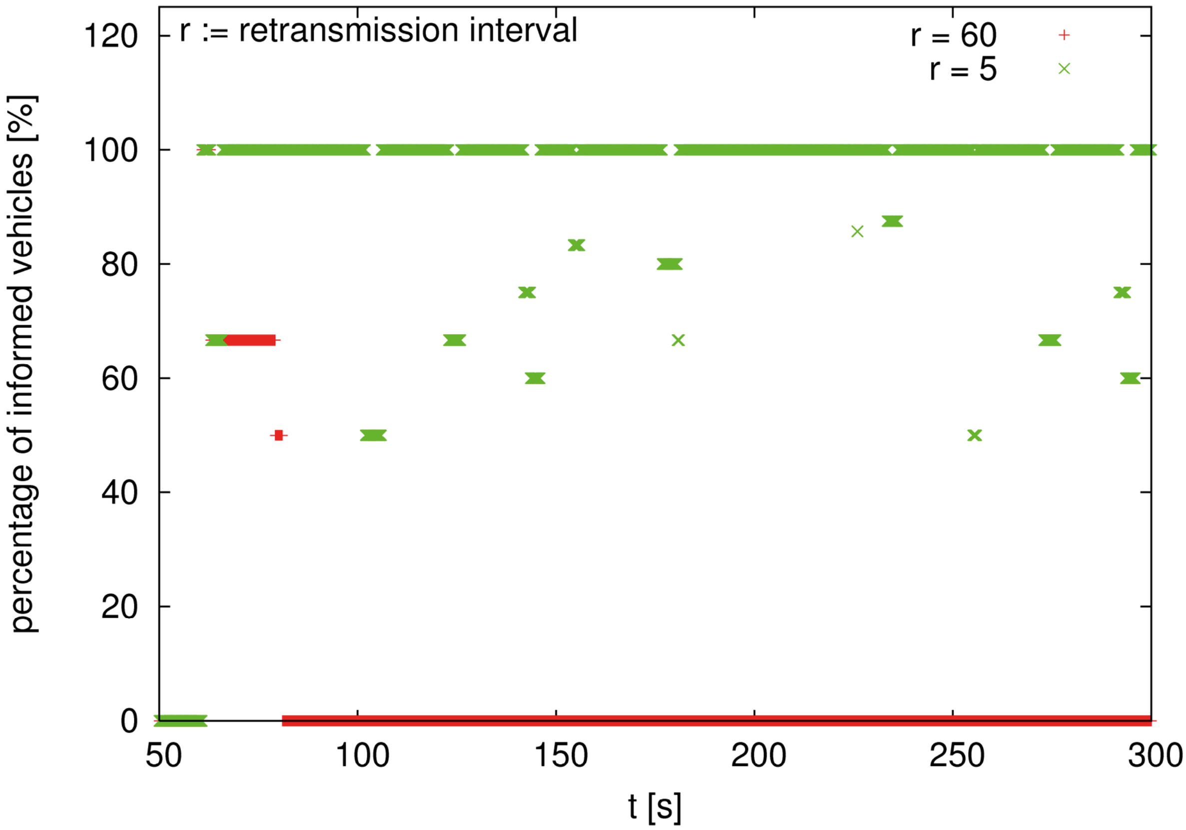

Fig. 6b) Percentage of informed vehicles, urban

[15] Wischoff, Ebner, Rohling, 2003

Figure 7 visualizes occurring message traffic when applying the repetition interval of 5 seconds. The visible steps result from the fact that different vehicles receive a broadcasted information item only fractions of milliseconds delayed. Thus, the repeating vehicles' iteration schedules reappear quasi-simultaneous for the given time axis resolution. The wavelike graph behaviour is due to the varying number of vehicles within relevance range. In the urban traffic environment, the overall message occurrence is lower than on the motorway. This is again due to the lower traffic density causing a decreased number of repeaters.

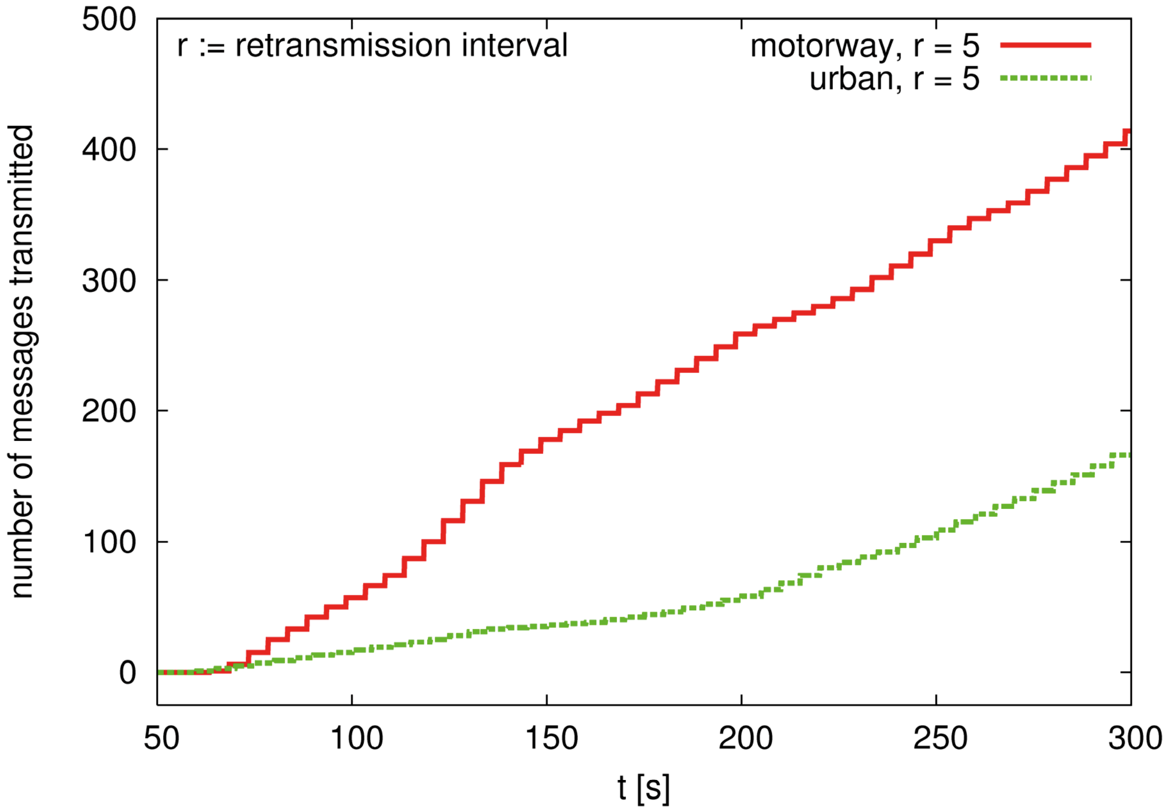

Fig. 7 Message traffic urban and motorway

4.4 Comparison of the Introduced Findings

In the following, we compare both presented evaluations to draw conclusions about VIS message overhead. Figure 8a visualizes the number of messages transmitted for each approach providing one item on the motorway. Comparing the required messages over time, VIS stabilization routines compensate the stronger growth of repeated broadcasting traffic. Therefore, overall message occurrence seems to settle down at a similar level. Regarding the urban traffic environment, the VIS proves to be more efficient in case one item is provided (see Fig. 8b).

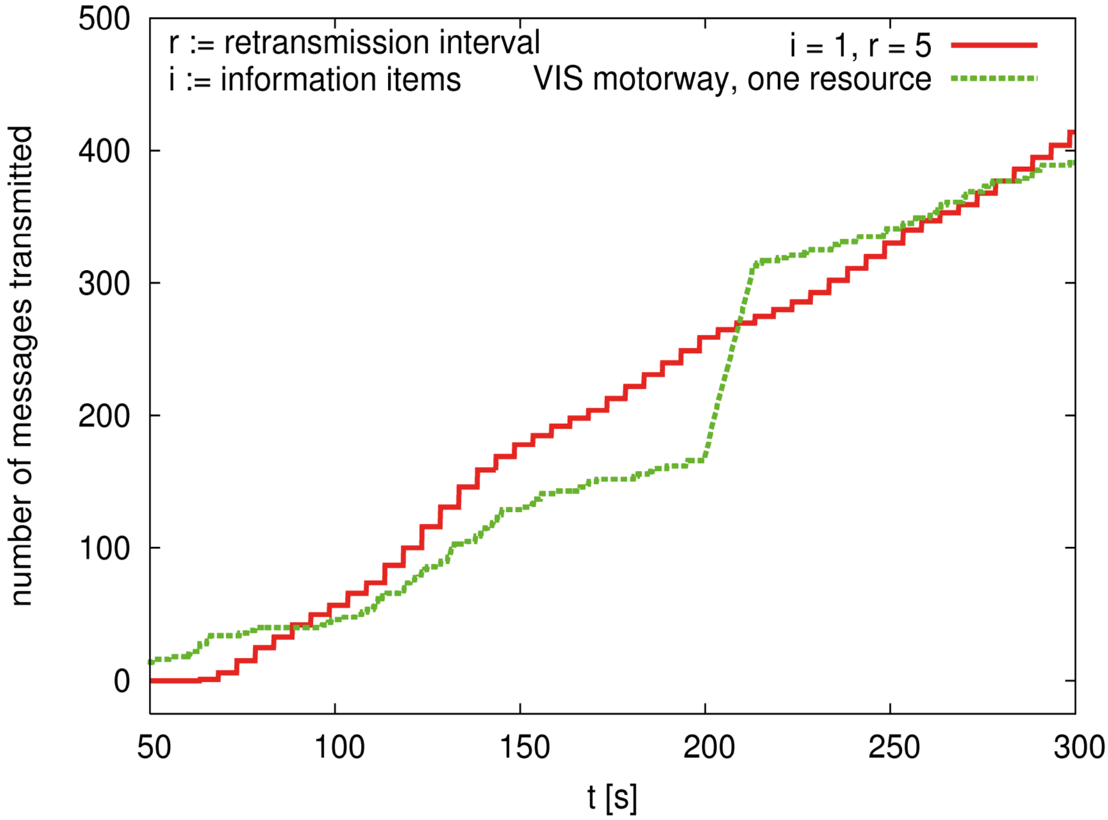

Fig. 8a) Comparison, motorway

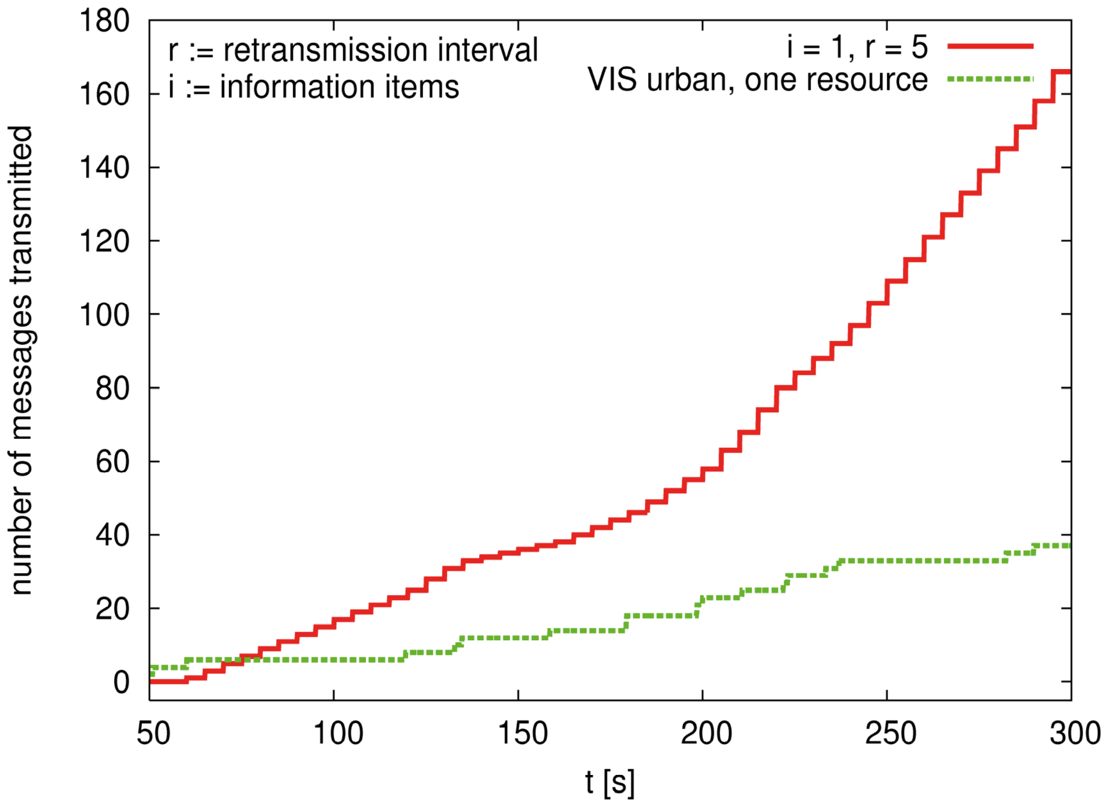

Fig. 8b) Comparison, urban

Figure 9a illustrates that both approaches behave comparably, in case there are multiple VIS resources but only one broadcasted item on the motorway. Just like VIS join and leave messages, this single broadcasted item could incorporate multiple information items in an optimized implementation. In the urban traffic environment, the VIS shows better performance than repeated broadcasting. Again, this is observable in case there are multiple VIS resources provided but only one information item repeated (see Fig. 9b).

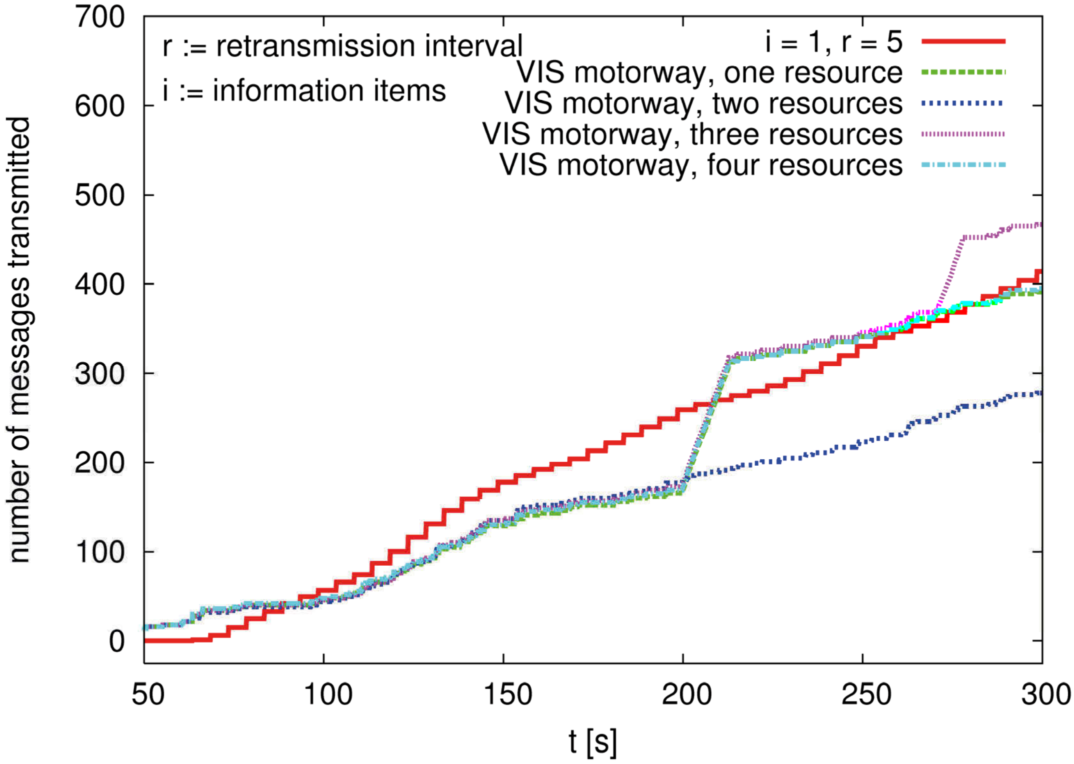

Fig. 9 a) Comparison, up to 4 resources: motorway

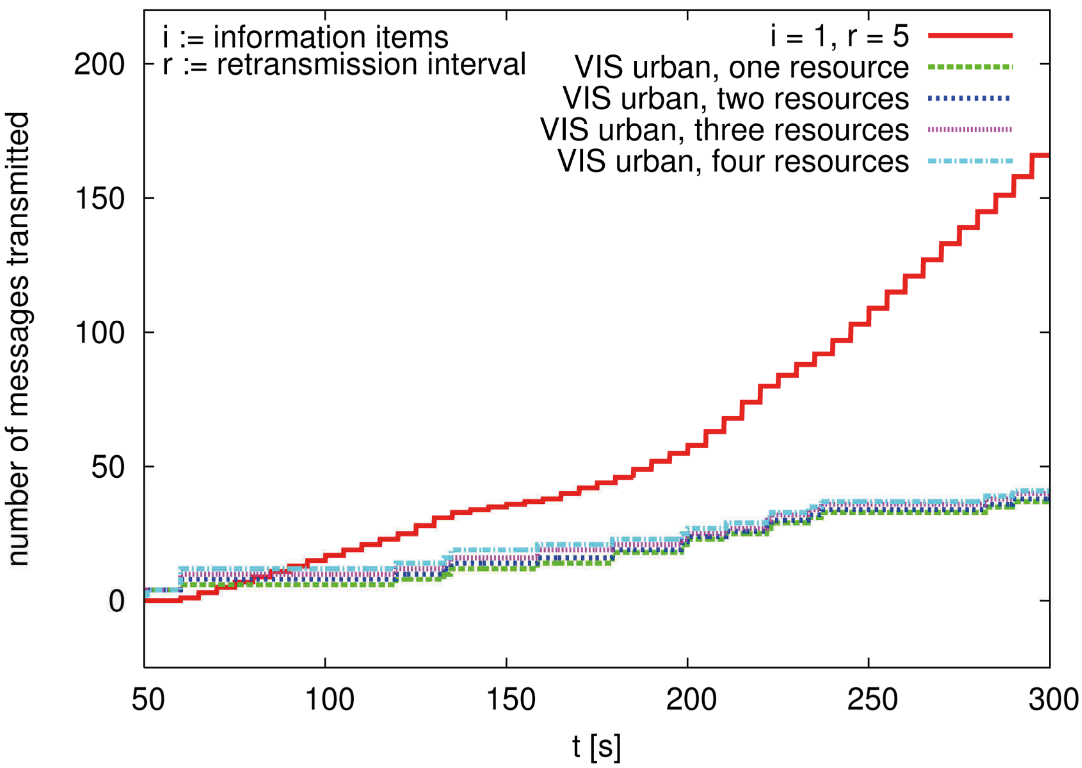

Fig. 9 b) Comparison, up to 4 resources: urban

To conclude, the VIS proves to imply equal or even better performance than repeated broadcasting depending on occurring overlay stabilization load. Moreover, overall VIS message traffic stays the same when providing additional resources. These are additional benefits besides the further distributed information handling and Pub/Sub functionalities of the VIS.

5 Conclusions and Future Work

Future VCS applications like up-to-the-minute hazard notification, parking assistance or traffic jam detection may considerably contribute to driving comfort and traffic safety. To this end, vehicles should provide information about existing hazards, parking spaces or traffic jams in a distributed manner within the concerned region. In addition, VCS applications should be able to modify published information about car park capacities or delete an eliminated hazard. Finally, Pub/Sub allows for passing car park capacity changes or a published parking space only if there are searching vehicles. This includes present vehicles and cars arriving at a later point in time.

The article first described the VIS concept and its implementation. Vehicles running the VIS form a kind of distributed database. It enables them to publish arbitrary information items with respect to certain areas or validity durations. In addition, they can handle published items and subscribe to information items. The underlying algorithm is based on features derived from the structured P2P algorithm Chord and adapted to suit the specific characteristics of VANETs. Subsequently, the article presented a comparative study. To compare VIS message overhead to that of common distributed information provisioning, we simulated and evaluated the VIS. Likewise, we implemented, simulated, and evaluated repeated broadcasting as it is a common way to realize distributed information provisioning. Amongst others, we showed that overall VIS message traffic is independent from the number of managed resources. In addition, the VIS performs equally or even better than repeated broadcasting-based information provisioning depending on occurring overlay stabilization load. These are additional benefits besides further VIS distributed information handling and Pub/Sub.

Our next step is to implement a VIS based example VCS application for traffic jam avoidance. Thereby, we aim at utilizing characteristics of the VIS: Vehicles falling below their desired speed to a dedicated extend publish a slowdown warning naming their current velocity. They modify this information in case their speed changes and delete it when exceeding the velocity threshold again. By setting the term "slowdown warning" as keyword, it is hashed and all triggered slowdown warnings are placed on the same vehicular peer. Thus, the peer is able to recognize an unusual amount of slow cars. In case, it triggers a slowdown prompt. On receiving that prompt, vehicles decrease their speed to avoid the "accordion effect" causing traffic jams. By issuing a subscription on these prompts naming a vehicle's direction, cars entering the area later are informed as well. Additionally, the prompt is only sent to vehicles heading for the affected direction.

6 References

R. Bader, E. Neufeld, W. Woerndl, V. Prinz, Context-aware POI recommendations in an automotive scenario using multi-criteria decision making methods, Workshop on context-aware retrieval and recommendation, 2011.

M. Caliskan, D. Graupner and M. Mauve: Decentralized discovery of free parking places, Proceedings of the 3rd international workshop on vehicular ad hoc networks, 2006, pp. 30-39.

A. Gupta, O.D. Sahin, D. Agrawal, and A. Abbadi, Meghdoot: content-based publish/subscribe over p2p networks. 5th international conference on Middleware, 2004, pp. 254–273.

M. Killat, F. Schmidt-Eisenlohr, H. Hartenstein, C. Rössel P. Vortisch, S. Assenmacher, and F. Busch, Efficient and accurate largescale simulations of vanets for vehicular traffic management, 4th international workshop on vehicular ad hoc networks, 2007, pp. 29–38.

B. Lange, 2009. Enhancing line-of-sight. iX magazine on professional information technology 11/2009, Heise Verlag publishing house, 113-115.

C. Lochert, J. Rybicki, B. Scheuermann and M. Mauve, Scalable data dissemination for inter-vehicle-communication: aggregation versus peer-to-peer. it - Information Technology, 2008, vol. 50, no. 4. Oldenbourgh, pp. 237-242.

C. Maihöfer, W. Franz, and R. Eberhardt, Stored Geocast. Kommunikation in Verteilten Systemen (KiVS) 2008, pp. 257-268.

K. Matheus, R. Morich and A. Lübke, Economic background of car-to-car communication, in: Informationssysteme für mobile Anwendungen, 2004.

V. Prinz, M. Brocco, W. Woerndl, Distributed Information Management and Publish/Subscribe in VANETs: Requirements, State of the Art and a Novel P2P-based Approach. Journal of Mobile Multimedia, 2009, vol. 5 no. 2, pp.158–180.

N.N. Qadri, M. Altaf, M. Fleury, M. Ghanbari, Robust video communication over an urban VANET, Mobile Information Systems, 2010 vol. 6 no. 3, pp 259-280.

J. Rybicki, B. Scheuermann, W. Kiess, C. Lochert, P. Fallahi, and M. Mauve, Challenge: peers on wheels - a road to new traffic information systems, 13th international Conference on Mobile Computing and Networking, 2007, pp. 215-221.

I. Stoica, R. Morris, D. Karger, M. F. Kaashoek, and H. Balakrishnan, Chord: A scalable peer-to-peer lookup service for internet applications, Conference on Applications, Technologies, Architectures, and Protocols for Computer Communications, 2001, pp. 149-160.

L. Wischoff, A. Ebner, H. Rohling, M. Lott and R. Halfmann, Sotis - a self-organizing traffic information system. 57th IEEE Vehicular Technology Conference, 2003, pp. 2442 – 2446

K. Xuan, G. Zhao, D. Taniar, M. Safar and B. Srinivasan, Voronoi-based multi-level range search in mobile navigation, Multimedia Tools and Applications, 2010.

K. Xuan, G. Zhao, D. Taniar and B. Srinivasan, Continuous range search query processing in mobile navigation, 14th international conference on parallel and distributed systems, 2008 pp. 361-368.

X. Yang, L. Liu, N.H. Vaidya, and F. Zhao, A vehicle-to-vehicle communication protocol for cooperative collision warning, First annual international conference on mobile and ubiquitous Systems: Networking and services, 2004, pp. 114-123.

G. Zhao, K. Xuan, W. Rahayu, D. Taniar, M. Safar, M. Gavrilova and B. Srinivasan, Voronoi-Based Continuous k nearest neighbor search in mobile navigation, IEEE Transactions on Industrial Electronics, 2010.

Decision Support for Energy Efficient Production in SME

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Abstract

Energy-efficient production has become more and more important over the last few years due to increasing scarcity of resources and increasing energy costs. While large companies already focus on energy-efficiency in production, small and medium enterprises (SME) still lack suitable support in realizing better energy-efficiency. This paper describes an IT System that aims to support SME in order to realize energy savings in production and to thereby help to increase SME competitiveness by reducing energy costs. The system is designed to support both the planning and execution phases of production and is realized utilizing affordable mobile devices. This allows for usage of the system at the shop floor.

1 Introduction

Sustainable production and energy-efficient production are generally seen as the central new paradigms[1] for production research in the coming years. More specifically, energy-efficiency has become a more and more important aspect of sustainability, which was originally coined to describe systems allowing for an agile response to competitive challenges[2].

There are several ongoing regional[3], national[4] and international[5] initiatives promoting energy-efficient production systems[6]. Those initiatives are seen to be highly relevant from an economic standpoint, for example a study performed by Roland Berger predicts that the market for systems supporting resource efficiency will likely triple by 2020[7], emphasizing both its strategic and immediate economic relevance. The EU road mapping project IMS2020 provides similar forecasts[8].

IT Systems can contribute to realizing energy savings in several ways: they are both needed to analyze energy inputs, which can hardly be performed manually in today's complex manufacturing processes, and to control the production machines on a fine-granular level to realize energy savings based on the analysis of the inputs[9].

While this capability to analyze and optimize energy inputs into the production process may well be central to the success of enterprises in a market that is characterized by high competitiveness[10] and high energy prices[11], the business intelligence systems necessary for such approaches will probably not be present in small and medium enterprises (SME), at least not for all sensors and in SME from sectors where energy costs are not perceived as strategic[12].

We present a system design that provides support for energy-efficient production in SME during both the planning and execution/deployment stages.

The system fuses data from sensors reading e.g. energy meters, using metadata and formalized heuristics as well as planning information provided e.g. by an ERP system. From this data the system infers possible actions to reduce energy consumption and is able to notify the stakeholders during production runs via mobile devices. In addition,

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[1] See Jovane, Koren and Boër, 2003.

[2] See Jovane, Koren and Boër, 2003.

[3] See ISH 2011.

[4] See BMWi 2011.

[5] See Kommission der Europäischen Gemeinschaften, 2006.

[6] See Bleischwitz, 2009.

[7] See Bleischwitz, 2009.

[8] See Andrews et al., 2005.

[9] See Bunse / Vodicka, 2010.

[10] See Vijayaraghavan / Dornfeld, 2010.

[11] See Johnston / Wright, 2004.

[12] See Grimes / Kentor, 2003.

integrated underlying sensor information is visualized as a strategic decision support tool.

The system is designed specifically towards the needs of SME, e.g. it can be temporarily deployed and the optimization of energy efficiency be offered as a service.

At the current state of implementation, the design of the system is completed and parts of the system backend are already implemented. The front-end is currently under implementation, as part of the preparation of a pilot study.

2 Related Work

There have been several initiatives aiming at making energy efficient equipment more attractive for purchasers, including labels that serve as performance indicators for energy efficiency. The ENERGY STAR[13], for example, is well known to consumers.

There has also been quite some research in strategic, large-scale models, analysing energy in- and outputs of whole value chains, and used in strategic planning of future development scenarios[14] for assessing the sustainability of complex, large enterprises or entire industry sectors. The EU road mapping project IMS2020 provides a roadmap for future production research, identifying sustainable and energy-efficient production as key areas. Bunse and Vodicka[15] offer a review of tools and performance criteria for Energy efficient production based on the project's results.

Information systems for supporting energy efficiency within enterprises have also been investigated. Roos and Hearn[16] present a decision support system integrating enterprise planning systems with control systems and sensors to enable control of energy inputs in the ferroalloy industry. As they note themselves, such an integrated decision support system would need a high level of commitment from management, which is unlikely in most other industry sectors due to the less relevant role of energy costs[17] (Requirements I & II).

Similarly, Guo and Zhang[18] propose an agent-based system for "intelligent manufacturing". This system would require a coordinated effort between the manufacturers, all its suppliers, and all suppliers of manufacturing equipment used. Therefore, it also does not meet our requirements. It is also notable in how it goes beyond energy efficiency, and aims at controlling entire value chains fully automatic. It seems unlikely such a system would be very attractive for the SME targeted by our approach.

Vijayaraghavan and Dornfeld[19] present an approach for energy monitoring of machines in production, which supports and integrates analysis on various levels, from value

[13] See Boyd et al., 2008.

[14] See Schleich, 2009; Hu / Bidanda, 2007.

[15] See Bunse / Vodicka, 2010.

[16] See Roos / Hearn, 2004.

[17] See Grimes / Kentor, 2003.

[18] See Guo / Zhang, 2009.

[19] See Bunse / Vodicka, 2010.

chains to machine sub-components. Our approach is quite similar, but instead of presenting on the details of the energy monitoring model, we focus on the overall information system used to apply the model,

Bengtsson et al.[20] propose a system based on a broad life cycle model of energy and material consumption as well as waste outputs, which are fed into a simulation component for forecasting of future e. The system presented is applied to assess environmental impacts over the whole product life cycle, using Excel macros evaluated by domain experts. Our system is conceptually similar, but we present an integrated information system aimed at SME, which is less suitable for overall analysis, but offers an integrated user experience, requires less expertise, and focuses on realizing immediate benefits for SME.

3 Requirements

There are a number of barriers to the adoption of energy-efficiency projects. The barriers are quite heterogeneous, and vary from sector to sector[21]. However, it is possible to generalize that in the commercial and services sectors, energy costs are usually below 3% of overall costs, and thus projects aiming at increasing energy efficiency within such organisations are often rejected simply because they are not seen as “strategic”[22]. We address this problem by designing a system that enables outsourcing of large parts of the energy optimization process, reducing both the initial investment necessary to establish the process, and the necessary strategic commitment. Offering intermediation through vertical service providers is a well-known strategy for supporting SME[23].

Requirement I: The system should allow for the outsourcing of the metering and analysis processes to a specialized service provider.

As a corollary, it could improve the willingness of enterprises to adopt energy efficiency projects if the system was able to not only supply them with strategic information they can use when e.g. planning future purchases of manufacturing equipment, but also offers a way to identify immediate benefits[24] that could be reaped by e.g. rescheduling tasks.

Requirement II: The system should allow for operational short-term analyses to enable immediate benefits for enterprises.

Alcántara et al.[25] identify promising horizontal technologies for improving energy efficiency. The proposed technologies of metering energy and steam, and controlling these inputs, specifically by eliminating peak hours, seem promising approaches for IT assistance.

[20] See Bengtsson et al., 2010.

[21] See Grimes / Kentor, 2003; Schleich, 2009

[22] See Grimes / Kentor, 2003

[23] See Albino / Kühtz, 2004.

[24] See Lockett / Brown, 2005.

[25] See Alcántara et al., 2010.

Requirement III: The system should integrate inputs from (e.g.) energy meters, and enable the machine operator to perform a fine-granular analysis of the current energy inputs and develop plans for improving energy efficiency, e.g. by eliminating peak hours. Additionally, also planning information e.g. coming from an ERP system is required, which means that the system has to provide a generic input interface.

Based on those requirements, we derived the architecture presented in the next section.

4 System Design and Architecture

A powerful approach that fulfills the requirements mentioned above is the paradigm of service-oriented architectures (SOA)[26]. Based upon open common internet standards, services are implementation-neutrally described via the Web Service Description Language (WSDL)[27]. Almost any proprietary application can easily be fitted with a web service interface and embedded into a business process using the Business Process Execution Language for Web Services (BPEL4WS, short BPEL)[28]. A business process described through BPEL can itself be presented as a web service and embedded further into a new process. These facts make SOA the first choice in this project.

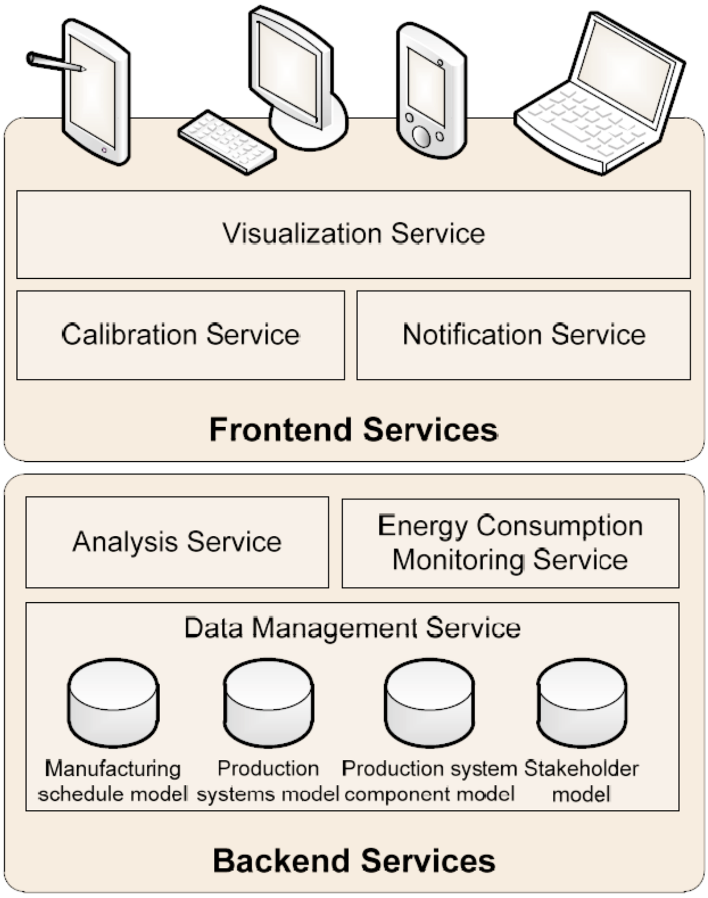

Figure 1: System architecture overview

[26] See Weerawarana et al., 2010.

[27] See Christensen et al., 2001.

[28] See Andrews et al., 2005.

The system design is based on layers, separating frontend and backend services, enabling flexible adaptation of the SOA composition to the requirements of specific SME use cases, e.g. integration of specific enterprise protocols in the backend. The backend services, which are from a technical point of view the more complex part of the system, have already been implemented and tested on a wide range of test data, demonstrating the basic feasibility of our system design. The frontend services are still under design, as those require inputs from the actual people going to use them to reach their full potential. The preparation of pilot studies is ongoing.

4.1 Back End

Relying on a service-oriented architecture, several key backend services are required on the server side. The system design includes the following backend services:

4.1.1 Energy Consumption Monitoring and Analysis Service

In order to be aware of the real energy consumption of a production system, the system provides an interface that can be connected to energy meters and provides backend storage functionality for such data. Existing meters range from inexpensive systems (suitable for long term measurements in SME) to expensive multi-channel meters (suitable for external service providers but too expensive for SME).

To keep the system flexible, we use an interface abstraction for input sources. This allows connecting all kinds of meters as input sources by implementing the appropriate connectors.

Before energy consumption data can actually be analyzed, the data has to be prepared first. This e.g. includes data smoothing. Also, some parts of the data need to be aggregated, e.g. combined information for the energy consumption of production system component sets.

The service also provides a job scheduler which can be configured to fetch energy consumption data from given data sources. The time intervals in which data is fetched can be modified during the configuration.

For some of the notification functionality, forecast of future energy consumption is needed to provide a base on which decisions, like component replacement, can take place. Therefore, the service provides forecasting functionality. To realize this, a SARIMA model[29] is provided. It allows forecast of future energy consumption as well as other relevant data such as energy prices.

4.1.2 Data Management Service

Within the system, different kinds of information have to be collected and managed. Therefore, a data management service is introduced. The service if responsible for providing read/write access to the data and meta-data of the system. Against the background of proprietary implementations and heterogeneous data structures as well as

[29] See Olsson / Soder, 2008.

semantic differences in the data provided by energy meters and ERP systems, there is a need for an integrative way to represent this data. We use ontologies to describe the information from various platform-internal and external sources. This approach has already proven to be purposeful, especially in heterogeneous environments[30]. For the realization of the backend models, we decided to use the web ontology language (OWL)[31]. OWL is a XML-based ontology description language which is built upon the less expressive W3C standards RDF[32] and RDFS[33]. OWL itself offers three variants that contain different subsets of the OWL syntax. While OWL lite is focussed on simple classifications and restrictions OWL DL and OWL full offer much more expressiveness but also increase the complexity. We decided to use OWL DL because OWL lite is not expressive enough and OWL full does allow complex definitions on which no formal decision making is possible.

Data and meta-data are structured by the following OWL models:

Production systems model: To describe a production system as a whole, a meta-model is provided. It holds a classification of the component types contained in a production system. In addition to types (e.g. motors or lasers), additional properties related to the whole component class (e.g. typical energy consumption ranges, existing component states like on, off, stand-by and valid transitions between states) or relations to other component classes (e.g. interchangeable parts) are included in the model. Based on this information, we are able to infer components of a specific production system that deviate from the typical state in their class.

Production system component model: Furthermore, information about the configuration of the real production system has to be managed. One part of this information is provided by external systems like energy meters or external planning systems. Another part has to be provided during the configuration of the system. The production system component model relies on the high level model described above, which means that a comparison between components that are included in a specific production system and alternative components can be realized.

Manufacturing schedule model: In order to perform scheduling optimizations, we introduce a unified internal scheduling model. The model provides a generic model that contains the relevant scheduling information for the analysis service. In general, any scheduling data that contains the required data (e.g. coming from an ERP system) can be transformed to the internal representation by implementing a translating connector based on a generic interface provided with the platform.

Stakeholder model: Based on the stakeholders of the system, we use a role model which describes which information and which notifications are relevant for which users.

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[30] See Bullinger, 2006; Bügel / Laufs, 2009.

[31] See McGuinness / van Harmelen, 2011.

[32] See Ankolekar et al., 2008.

[33] See Celino et al., 2009.

4.1.3 Data analysis Service

Based on the data stored and provided by the data management service, the Data analysis service realizes the optimization functionality required to reduce the overall energy consumption of a production system. It provides a set of algorithms and also contains heuristics, which are based on best practices. Based on the potential optimizations which the service has identified, notification events are created and presented to the users in the front end.

4.2 Front End

When providing system functionality aimed at increasing efficiency to the stakeholders involved in the production process, an adequate user interface is required. For a seamless integration into given processes, a mobile solution is desirable because it also allows to use the system directly in the production environment. Mobile systems also typically have less power consumption than stationary PCs. In order to provide an affordable solution that can amortize in SME, it is necessary to rely on products from the mass market in a low price range.

While smaller mobile devices like smart phones offer better mobility, the small dimension of the screen of course is an issue regarding the visualization of vast amounts of data e.g. for visualizations of the production system's configuration.

In order to provide a mobile solution that can fulfill the requirements regarding the user interface but is also mobile, we decided to use tablet PCs for the implementation of the front end. Affordable tablets are available on platforms like Android and Windows. Also, versions that have been designed for use in harsh industrial manufacturing environments are available if required.

5 Conclusion

We described the design of an IT System that aims to support SME in order to realize energy savings in production and to thereby increase SME competitiveness by reducing energy costs. The system is designed to provide decision support both in the planning and execution phases of production. This functionality relies on the combination of data provided by sensors, production orders and additional metadata describing the properties of the production systems. In addition, it is designed to be deployable temporarily, as a service, addressing SME which avoid energy efficiency projects due to he associated up-front costs and strategic commitment.

A service-oriented architecture is used to allow portability of the system across different manufacturing environments. On the server side, a bundle of key services provides generic functionality like data management, sensor data fusion and state data analysis. In the system's frontend, stakeholder interaction such as notification and system calibration is realized using a front-end library that can support several platforms, many of which are especially energy-efficient.

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7 References

Jovane F., Koren Y., and Boër C. R., 2003, "Present and Future of Flexible Automation: Towards New Paradigms," CIRP Annals – Manufacturing Technology, 52(2), pp. 543-560.

ISH 2011, Investitionsbank Schleswig-Holstein, "Energieeffizienz-Initiative Schleswig-Holstein."

BMWi 2011, "BMWi - Exportinitiative Energieeffizienz."

Kommission der Europäischen Gemeinschaften, 2006, "Aktionsplan für

Energieeffizienz: Das Potenzial ausschöpfen - KOM(2006)545."

Bleischwitz R., 2009, Eco-innovation - putting the EU on the path to a resource and energy efficient economy, University Library of Munich, Germany.

Bunse K., and Vodicka M., 2010, "Managing Energy Efficiency in Manufacturing Processes–Implementing Energy Performance in Production Information Technology Systems," What Kind of Information Society? Governance, Virtuality, Surveillance, Sustainability, Resilience, p. 260–268.

Vijayaraghavan A., and Dornfeld D., 2010, "Automated energy monitoring of machine tools,"

CIRP Annals - Manufacturing Technology, 59(1), pp. 21-24.

Johnston D. A., and Wright L., 2004, "The e-business capability of small and medium sized firms in international supply chains," Information Systems and E-Business Management, 2(2), pp. 223-240.

Grimes P., and Kentor J., 2003, "Exporting the Greenhouse: Foreign Capital Penetration and CO2

Emissions 1980–1996," journal of world-systems research, 9(2), p. 261–275.

Schleich J., 2009, "Barriers to energy efficiency: A comparison across the German commercial and services sector," Ecological Economics, 68(7), pp. 2150-2159.

Albino V., and Kühtz S., 2004, "Enterprise inputoutput model for local sustainable development—the case of a tiles manufacturer in Italy," Resources, Conservation and Recycling, 41(3), pp. 165-176.

Lockett N. J., and Brown D. H., 2005, "An SME Perspective of Vertical Application Service Providers," International Journal of Enterprise Information Systems, 1(2), p. 37–55.

Robert J., Buhman C., Garcia S., and Allinder D., 2003, "Bringing COTS Information Technology into Small Manufacturing Enterprises," Proceedings of the Second International Conference on COTS-Based Software Systems, p. 187–195.

Alcántara V., del Río P., and Hernández F., 2010, "Structural analysis of electricity consumption by productive sectors. The Spanish case," Energy, 35(5), pp. 2088-2098.

Weerawarana S., Curbera F., Leymann F., Storey T., and Ferguson D. F., 2005, Web Services Platform Architecture: SOAP, WSDL, WS-Policy, WSAddressing, WS-BPEL, WS-Reliable Messaging and More, Prentice Hall PTR, Upper Saddle River, NJ, USA.

Christensen E., Curbera F., Meredith G., and Weerawarana S., 2001, "Web services description

language (WSDL) 1.1."

Andrews T., Curbera F., Dholakia H., Goland Y., Klein J., Leymann F., Liu K., Roller D., Smith D., and Thatte S., 2005, "Business process execution language for web services version 1.1 (BPEL4WS)."

Olsson M., and Soder L., 2008, "Modeling Real-Time Balancing Power Market Prices Using Combined SARIMA and Markov Processes," Power Systems, IEEE Transactions on, 23(2), pp. 443-450.

Bullinger H.-J., 2006, Fokus Innovation, Carl Hanser Verlag, München.

Bügel U., and Laufs U., 2009, “Einsatz innovativer Informations- und Kommunikationstechnologien,” Fokus Technologie. Chancen erkennen, Leistungen entwickeln, Hanser, München.

McGuinness D., and van Harmelen F., “OWL Web Ontology Language Overview.”

Ankolekar A., Krötzsch M., Tran T., and Vrandecic D., 2008, “The two cultures: Mashing up Web 2.0 and the Semantic Web,” Web Semantics: Science, Services and Agents on the World Wide Web, 6(1), pp. 70-75.

Celino I., Valle E., and Cerizza D., 2009, “From Research to Business: The Web of Linked Data,” Business Information Systems Workshops, pp. 141-152.

Boyd G., Dutrow E., and Tunnessen W., 2008, “The evolution of the ENERGY STAR® energy

performance indicator for benchmarking industrial plant manufacturing energy use,” Journal of Cleaner Production, 16(6), pp. 709-715.

Hu G., and Bidanda B., 2007, “Modeling Sustainable Product Lifecycle Decision Support Systems,” 19th INTERNATIONAL CONFERENCE ON PRODUCTION RESEARCH.

Roos J. G., and Hearn A. M., 2004, “Optimising the effective use of energy in the ferroalloy industry through innovative technology,” Proceedings, Tenth International Ferro Alloys Congress, Cape Town, p. 712–725.

Guo Q., and Zhang M., 2009, “A novel approach for multi-agent-based Intelligent Manufacturing System,” Information Sciences, 179(18), pp. 3079-3090.

Bengtsson N., Michaloski J., Proctor F., and Shao G., 2010, “TOWARDS DATA–DRIVEN SUSTAINABLE MACHINING–COMBINING MTCONNECT PRODUCTION DATA AND DISCRETE EVENT SIMULATION,” Proceedings of ASME 2010, p. 6

Mobility in Logistics

Mobility in a
Globalised World

Economics
Engineering
Informatics
Logistics
Urban Planning

Mobility in Logistics

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Mobility has long become one of the “bare necessities” of mankind. Not only do we want to be able to get almost anywhere anytime. Today we are required to be mobile throughout every segment of our society, for instance for getting to work. And often we take the virtually unbounded accessibility and short-term availability of almost any type of product anywhere on earth for granted. It is in the nature of things that this behaviour shall impact the environment on an ever increasing scale – unless we do something about it.

Therefore the Logistics section will discuss the opportunities presented by logistics networks in linking people and goods, as well as best practice examples from a car manufacturer view for individual mobility and logistics.

In addition to globalisation, there are other mega-trends that will have an impact on logistics and its development. It is the key aspects ranging from growing energy resource scarcity, increasing cost of transportation, growing urbanisation and their impact on political decision-taking that will affect the future development of logistics.

In the first paper, *The concept of an energy self-sufficient port as a contribution to green and robust supply chains*, Björn Asdecker, Christian Schad, Clemens Wieban and Immanuel Zitzmann develop a concept for turning ports into “green” logistics hubs. The authors establish solutions that show ways to deal with our dependence on today’s energy sources and the increasing cost of energy. A concrete example shows that the concept of the energy self-sufficient port is viable. In addition to decreasing the dependence on supply shortages and rising energy prices, it will help the businesses located at the port to reduce their carbon footprint.

The paper by Andreas Deutsch and Eric Sucky is entitled *Potential Shifting Effects on Maritime Container Markets – Current Developments and Requirements on Market Players and Policy: The Case of Continental Europe*. The studies and suggested solutions confirm that the significance of container traffic is likely to rise tremendously in the next decades. This will require making container traffic a crucial part of inbound logistics and intensifying pertinent research.

In the final paper, *Mobility in a globalised world – BMW,* Andreas Form and Thomas Elsweier present the point of view of the global automotive manufacturer whose products do not only depend on efficient supply chains. The BMW paper describes the trends in the environment, economy, urban development, culture, politics and customer relationships, suggesting appropriate solutions. In this context the BMW Group addresses all three dimensions of sustainability: environmental, economic and social. For BMW i, sustainability is of fundamental importance throughout the entire value chain. From the earliest strategic and planning stages, therefore, clearly defined sustainability targets were set for the BMW i vehicles. BMW i is setting new standards of sustainability across the entire value chain, as some solutions were developed by suppliers as well.

Konzept eines energieautarken Hafens als Beitrag zu grünen und robusten Lieferketten

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Abstract

In Germany, the recently decided withdrawal from the nuclear energy program leads to two supply chain risk categories that have received little attention so far: blackouts in the short run and increasing energy costs in the long run. Taking these risks requires innovative concepts. This article focuses on ports and aims at developing a procedure to assess the feasibility of energy self-sufficiency.

From a methodological perspective this paper is mainly conceptual. The general idea of an energy self-sufficient port employs the theory of prosuming as its theoretical foundation. We further validated the applicability of the approach in a case study.

1 Einleitung, Motivation und Zielsetzung

Seit der Verabschiedung des Dreizehnten Gesetzes zur Änderung des Atomgesetzes am 30. Juni 2011 durch den Deutschen Bundestag steht fest, dass die letzten deutschen Atomkraftwerke (AKW) im Jahr 2022 vom Netz gehen und nicht mehr für die Energieversorgung zur Verfügung stehen.[1] Vor dem Hintergrund, dass die AKW-Betreiber die überdurchschnittlichen Renditen aufgrund der ungeklärten Endlagerfrage und des unversicherbaren Restrisikos hauptsächlich auf Kosten zukünftiger Generationen erwirtschaften, ist diese Entscheidung aus der Perspektive einer nachhaltigen Entwicklung generell zu begrüßen. Allerdings gehen damit gleichzeitig große Herausforderungen einher. Die Bundesnetzagentur warnt bereits eindringlich vor Versorgungsengpässen, die es unter der Berücksichtigung bestehender Nachhaltigkeitsprogramme zu schließen gilt. Im aktuellen integrierten Energie- und Klimaprogramm setzt sich die Bundesregierung das konkrete Ziel, die CO_2-Emissionen bis zum Jahr 2020 um 40% gegenüber dem Referenzwert von 1990 zu senken.[2] Aus diesem Grund muss der Anteil an regenerativen Energiequellen in der Stromproduktion signifikant zunehmen, was weitere Veränderungen nach sich zieht. Wurde der Strom bisher hauptsächlich an einigen wenigen zentralen Standorten erzeugt, erfordern regenerative Energiequellen dezentrale Strukturen. Es ist davon auszugehen, dass die Versorgungsunternehmen die notwendigen Investitionen in Milliardenhöhe langfristig auf den Strompreis umlegen.[3]

Demnach ergeben sich für Unternehmen aus dem Atomausstieg zwei bisher wenig beachtete Risikokategorien: kurzfristig unvorhergesehene Stromausfälle und langfristig steigende Energieversorgungskosten. Um den beschriebenen Unsicherheiten entgegen zu treten, sind neuartige Standortkonzepte notwendig. Dieser Beitrag fokussiert dabei auf Häfen, die als Vermieter und Verpächter von Hafenflächen[4] ein großes Interesse an der dauerhaften Wettbewerbsfähigkeit der dort ansässigen Unternehmen haben. Eine Möglichkeit den Risiken vorzugreifen, besteht darin, sich von der externen Energieversorgung zu lösen und selbst als Produzent aufzutreten. Aufbauend auf dem theoretischen Bezugsrahmen des „Prosumings“ verfolgt der vorliegende Essay das Ziel, eine Entscheidungsunterstützungsmethodik zu entwickeln, die die Realisierbarkeit eines energieautarken Hafens systematisch überprüft. Die Anwendbarkeit des Konzepts wird abschließend im Rahmen einer Fallstudie veranschaulicht.

Der weitere Aufbau des vorliegenden Artikels gliedert sich in vier Abschnitte. Nach der Erörterung der theoretischen Grundlagen im zweiten Passus, erläutert das dritte

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1 Vgl. BMU (2011a).

2 Vgl. BMU (2007), S. 1.

3 Die Kosten für den Netzausbau lassen sich derzeit noch nicht genau abschätzen. Aktuelle Untersuchungen weisen eine enorme Bandbreite auf. Eine Studie des Bundesverbands der Energie- und Wasserwirtschaft (BDEW) veranschlagt den Ausbaubedarf auf 195.000 Kilometer, wohingegen eine Analyse des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit (BMU) von 380.000 Kilometern ausgeht. Daraus ergibt sich ein Investitionsbedarf von 13 bzw. 27 Mrd. €. Vgl. BDEW (2011), S. 3.

4 Vgl. Fischer/Foißner (2002), S. 157; Clasmeier (2009), S. 99.

Kapitel das Konzept des energieautarken Hafens. Den dabei vorgestellten Prozess zur Abschätzung der Realisierbarkeit validiert die im vierten Gliederungspunkt beschriebene Fallstudie. Den Abschluss bildet ein zusammenfassendes Resümee, welches den Beitrag des vorgestellten Konzepts zu grünen und robusten Lieferketten herausstellt.

2 Theoretische Grundlagen

Ursprünglich als Ankerplatz für Schiffe konzipiert, haben sich Binnenhäfen mittlerweile zu zentralen multimodalen Umschlagspunkten in Supply Chains gewandelt. Neben dieser Entwicklung erschließen sich Häfen bzw. ihre Betreibergesellschaften durch die Vermietung und Verpachtung von Flächen sowie dem Angebot von Logistikdienstleistungen neue Erlöspotenziale.[5]

In einem Hafen kommen entsprechend des angebotenen Leistungsspektrums verschiedene Transportträger zum Einsatz. Außer den obligatorischen Schiffen hat sich zur Sicherstellung des Hinterlandverkehrs unter dem Stichwort der Trimodalität eine zusätzliche Kombination mit Eisenbahn und Lastkraftwagen (LKW) als zuverlässig erwiesen. Den weitaus größten Anteil am kombinierten Verkehr nehmen dabei aktuell und auch zukünftig LKW-Transporte ein.[6] Ein Grund hierfür ist, dass die Zieldestinationen in vielen Fällen über keine direkte Bahnanbindung verfügen und die Alternative des Schienenverkehrs gegenüber dem direkten LKW-Transport aufgrund des unvermeidbaren Umschlagvorgangs für die „letzte Meile“ als unrentabel erscheint.

Zwar basiert der LKW-Antrieb derzeit überwiegend auf Dieselmotoren, die durch die Kraftstoffverbrennung Energie erzeugen. Jedoch sollen diese mittel- bis langfristig aufgrund der besseren CO_2-Bilanz und der geringeren Abhängigkeit vom knappen Rohstoff Öl durch Elektromotoren ersetzt werden.[7] Beispiele für den zunehmenden Durchdringungsgrad der Elektromobilität finden sich bei führenden Logistikdienstleistern. So setzt z.B. die Firma United Parcel Service (UPS) bereits heute 1.600 rein elektrisch betriebene Kleinlaster ein.[8] Sicherlich wirken aktuell noch die beschränkte Leistungsfähigkeit und Haltbarkeit der Akkumulatoren als limitierende Faktoren für einen flächendeckenden Einsatz im Schwerlastverkehr[9], allerdings gibt die zügig voranschreitende Forschung in Verbindung mit dem derzeitig vorhandenen politischen Willen[10] Anlass zur begründeten Hypothese, dass der Durchdringungsgrad der Elektromobilität zeitnah zunimmt.

5 Vgl. Fischer/Foißner (2002), S. 157; Mester (2005), S. 45-50; Clasmeier (2009), S. 99.

6 Vgl. Forschungs-Informations-System (2011).

7 Vgl. Kortlüke/Pieprzyk (2010), S. 33-34.

8 Vgl. Grünig (2011), S. 51.

9 Die aktuell im Einsatz befindlichen Akkumulatoren weisen eine Reichweite zwischen 70 und 130 Kilometern auf. Vgl. Grünig (2011), S. 50-52.

10 Vgl. Bundesregierung (2009), S. 2.

Zusammenfassend lässt sich festhalten, dass sich der Hauptenergiebedarf eines Hafens zukünftig auf drei Komponenten verteilt:

1. den Hafenanlagen zur Durchführung der logistischen Dienstleistungen,
2. den Wertschöpfungsprozessen, der im Hafen ansässigen Unternehmen, sowie
3. den auf Elektromobilität basierenden Transporten im Hinterlandverkehr.

3 Das Konzept eines energieautarken Hafens

Um den Risiken kurzfristig unvorhergesehener Stromausfälle und langfristig steigender Energieversorgungskosten proaktiv vorzugreifen und die Robustheit der Supply Chain zu erhöhen, ergibt sich die Notwendigkeit, den im voranstehenden Abschnitt formulierten Energiebedarf unabhängig von externen Einflüssen und Effekten sicherzustellen. Diese Vision wird im Folgenden als „Konzept eines energieautarken Hafens“ bezeichnet. Der grundlegende Gedanke des Zukunftsszenarios besteht darin, den Energiebedarf durch eigene Quellen zu decken. Da der Hafen demnach einerseits als produzierende, andererseits als verbrauchende Institution auftritt, eignet sich das Konstrukt des „Prosumers“ bzw. des „Prosumings“ als übergeordneter theoretischer Bezugsrahmen.

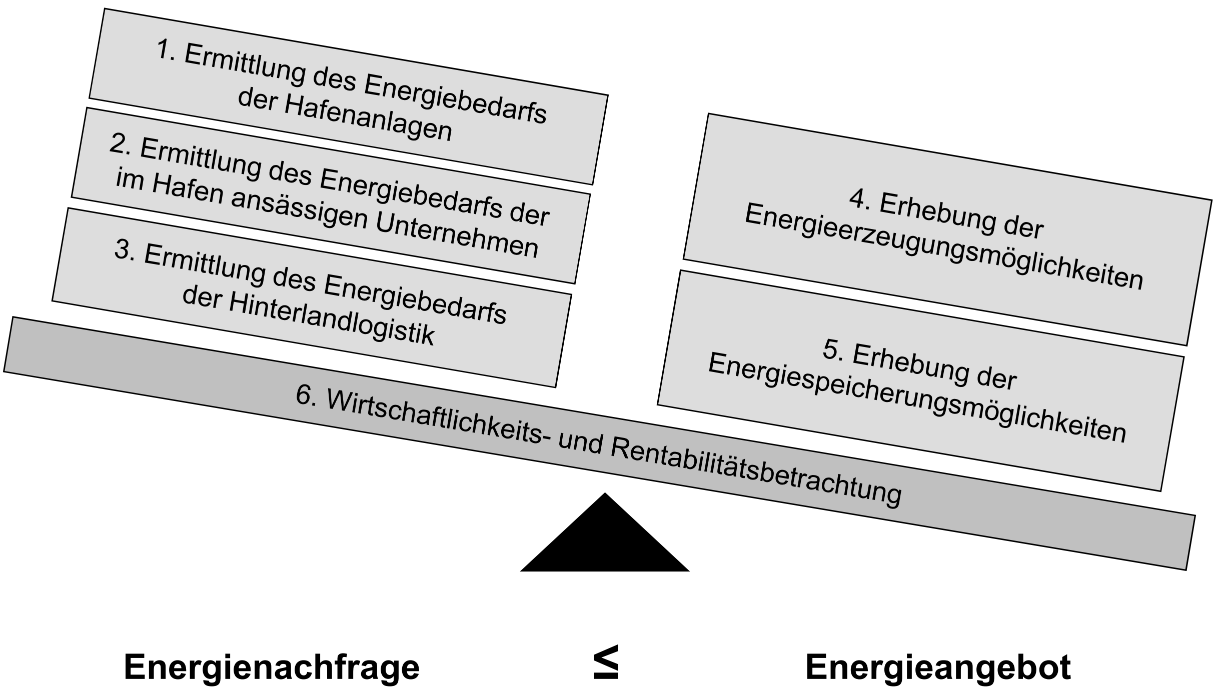

Abb. 1: Prozess zur Überprüfung der Realisierbarkeit eines energieautarken Hafens

Laut Toffler (1980) konsumiert ein „Prosumer“ die von ihm selbst hergestellten Güter, was eine Abgrenzung von Produzent und Konsument verhindert.[11] Vielmehr verschmelzen die Rollen beider Marktakteure.[12] Normann (1984) entwickelt diesen Ge-

[11] Vgl. Toffler (1980), S. 273.

[12] Vgl. Bandulet/Morasch (2005), S. 251.

danken weiter, indem er Prosuming mit jeglicher Form der Kundenpartizipation gleichsetzt.[13] Der Gedanke des Prosumings findet in der Energiewirtschaft breite Anwendung, wenn Verbraucher bspw. einen Teil ihres Energiebedarfs mithilfe von Solaranlagen selbst produzieren und die verbleibende Menge gegen eine Vergütung in das allgemeine Energienetz einspeisen. Folgerichtig muss zur autarken Energieversorgung eines Hafens sowohl die Konsumenten- bzw. Nachfrage- als auch die Produzenten- bzw. Angebotsseite detailliert betrachtet werden, um die geforderte Versorgungssicherheit gewährleisten zu können. Zur Überprüfung, ob das Konzept im Einzelfall anwendbar ist, dient der in Abbildung 1 vorgestellte sechsstufige Prozess. Darin zielen die ersten fünf Schritte auf die technische Machbarkeit, die abschließende Wirtschaftlichkeits- und Rentabilitätsbetrachtung auf die betriebswirtschaftliche Sinnhaftigkeit ab.

Die Rolle des übergeordneten Entscheidungskriteriums nimmt das zentrale Charakteristikum eines energieautarken Hafens ein, welches darin besteht, dass das Energieangebot die -nachfrage zu jedem Zeitpunkt übersteigt. Bei der Anwendung sind innerhalb der einzelnen Prozessphasen folgende Rahmenbedingungen zu beachten:

1. *Ermittlung des Energiebedarfs der Hafenanlagen:*
   Ausgangspunkt des Prozesses ist die Energiebedarfsermittlung der Hafenanlagen, das heißt deren Strom- und Wärmeverbrauch. Da die Hafengesellschaft meist als Projektkoordinator fungiert, sind diese Daten verhältnismäßig einfach durch eine Fortschreibung der Verbrauchswerte vergangener Planungsperioden zu erheben.
2. *Ermittlung des Energiebedarfs der im Hafen ansässigen Unternehmen:*
   Der zweite Schritt fokussiert auf die hafenansässigen Unternehmen. Deren Energiebedarf lässt sich entweder direkt abfragen oder über den Strom- und Wärmeverbrauch pro Mitarbeiter überschlagen. Eine Abschätzung empfiehlt sich insbesondere während der internen Grobplanungsphase.
3. *Ermittlung des Energiebedarfs der Hinterlandlogistik:*
   Eine Herausforderung stellt die Energiebedarfsermittlung des Hinterlandverkehrs dar. Um die politisch angestrebte Elektrifizierung der Hinterlandlogistik schon bei der Konzeptentwicklung adäquat zu berücksichtigen, wird angenommen, dass bereits zum aktuellen Zeitpunkt alle Hinterlandtransporte durch Elektro-LKW erfolgen. Für die Berechnung des Energiebedarfs bilden die umgeschlagenen Gütermengen die Analysegrundlage.
4. *Erhebung der Energieerzeugungsmöglichkeiten:*
   Als regenerative Energiequellen eignen sich in einem Hafen Photovoltaik (PV)-Anlagen, die die elektromagnetische Strahlungsenergie der Sonne in elektrische Energie (Elektrizität) umwandeln.[14] PV-Anlagen verfügen in Nord- und Mitteleuropa aufgrund der mangelnden Strahlungsintensität maximal über einen Wir-

[13] Vgl. Normann (1984), S. 51.

[14] Für eine vertiefende Darstellung vgl. Pelte (2010), S. 161-163.

kungsgrad von 15%.[15] Biomasse stellt ebenfalls eine adäquate Energiequelle dar. In Biomassekraftwerken werden feste Energieträger in vollautomatischen Anlagen verfeuert oder die Wärme der organischen Vergärung genutzt.[16] Bei optimaler Auslastung lassen sich Wirkungsgrade von über 90% erzielen. Ein thermodynamischer Kreislauf ermöglicht ferner die Umwandlung der gewonnenen Wärmeenergie zu elektrischem Strom.[17] Der Wirkungsgrad des Gesamtsystems liegt dann bei circa 85%. Einen weiteren Ansatz zur regenerativen Energieerzeugung bildet die sogenannte Geothermie. Hierbei wird durch Bohrungen oder Kollektoren die thermische Energie des Erdinneren genutzt, um einerseits mit Fernwärmesystemen den Bedarf an Heizungs- oder Prozesswärme zu decken und andererseits Elektrizität zu erzeugen. Während für die Heizungs- und Prozesswärmenutzung schon Temperaturen ab 50°C ausreichen, erfordert die Stromerzeugung Temperaturen von mehr als 100°C.[18] Ein großer Vorteil der Biomasse und Geothermie gegenüber PV-Installationen besteht in der Zuverlässigkeit der Energiequellen, die sich als grundlastfähig erweisen.

5. *Erhebung der Energiespeicherungsmöglichkeiten:*
   Da die Energieproduktion aus regenerativen Quellen Schwankungen unterworfen ist, gilt es, diese durch die Energiespeicherung auszugleichen. Neben der Stabilisierung des Stromnetzes haben Energiespeicher die Aufgabe, einen Erzeugungsausgleich zu schaffen, Netzengpässe zu überwinden und Spitzenlasten abzufangen. Die Energiespeicher lassen sich in thermische (z.B. Wärmespeicher), mechanische (z.B. Pump- und Druckluftspeicher), elektrische (z.B. Kondensatoren) sowie chemische Formen (z.B. Batterien/Akkumulatoren und Methanspeicher) unterteilen.[19]
6. *Wirtschaftlichkeits- und Rentabilitätsbetrachtung:*
   Kann der in den ersten drei Prozesselementen bestimmte Energiebedarf durch das im vierten sowie fünften Schritt ermittelte Energieangebot gedeckt werden, ist aus betriebswirtschaftlicher Sicht abschließend eine Wirtschaftlichkeits- und Rentabilitätsrechnung durchzuführen.

Die Anwendbarkeit des beschriebenen Prozesses zeigt die im nachstehenden Abschnitt beschriebene Fallstudie.

4 Validierung im Rahmen einer Fallstudie

Die folgenden Analyseschritte basieren auf den realen Daten eines europäischen Binnenhafens. Alle genannten Werte beziehen sich, falls nicht anders angegeben, auf das Geschäftsjahr 2010. Da der Studienpartner den Wunsch der Anonymität hegt, wird

[15] Vgl. Pelte (2010), S. 164.

[16] Vgl. Quaschning (2009), S. 339-341.

[17] Für eine vertiefende Darstellung vgl. Quaschning (2009), S. 144-146.

[18] Vgl. Wesselak/Schabbach (2009), S. 256.

[19] Vgl. Radgen (2007), S. 7; Völler (2010), S. 8.

dieser im Folgenden fiktiv als Greenport bezeichnet. Um einen Rückschluss von den Daten auf den Hafenbetreiber zu verhindern, wurden ferner sämtliche firmenbezogenen Parameterwerte mit einem konstanten Faktor multipliziert. Dadurch bleibt die Aussagekraft der durchgeführten Berechnungen erhalten. Das weitere Vorgehen orientiert sich an dem im dritten Kapitel vorgestellten Rahmenprozess.

4.1 Ermittlung des Energiebedarfs der Hafenanlagen

Auf Anfrage übermittelte die Greenport-Controllingabteilung einen jährlichen Strombedarf in Höhe von 331.800 Kilowattstunden (kWh) für die im Hafen in Eigenverantwortung betriebenen Anlagen und Gebäude. Zusätzlich beläuft sich der Bedarf an Wärmeenergie auf 854.200 kWh im Jahr.

4.2 Ermittlung des Energiebedarfs der im Hafen ansässigen Unternehmen

Die Abschätzung des Strom- und Wärmebedarfs der hafenansässigen Unternehmen stützt sich auf Daten der vom Bundesministerium für Wirtschaft und Arbeit in Auftrag gegebenen Studie zum Thema Energieverbrauch der privaten Haushalte und des Sektors Gewerbe, Handel, Dienstleistungen (GHD).[20] In dieser sind die spezifischen branchenabhängigen Energieverbräuche pro Beschäftigtem angegeben. Für die hafenansässigen Betriebe mit insgesamt von 13.000 Mitarbeitern ergibt sich für den Stromverbrauch das in Tab. 1 beschriebene Bild.

Branche	**Anzahl Beschäftigte**	**Stromverbrauch / Beschäftigte (in kWh)**	**Stromverbrauch (in kWh)**
Sonstige betriebliche Dienstleistungen	5.280	1.671	8.822.880
Herstellungsbetriebe	1.056	4.687	4.949.472
Handel	1.716	5.139	8.818.524
Spedition, Lagerei, Verkehrsvermittlung	4.948	1.659	8.208.732
Gesamt			30.799.608

Tab. 1: Jährlicher Stromverbrauch innerhalb des Greenports

Die Berechnung des Wärmeverbrauchs vollzieht sich analog zur Kalkulation des Strombedarfs. Die entsprechenden Ergebnisse führt Tab. 2 auf.

Branche	**Anzahl Beschäftigte**	**Wärmeverbrauch / Beschäftigte (in kWh)**	**Wärmeverbrauch (in kWh)**
Sonstige betriebliche Dienstleistungen	5.280	6.238	32.936.640
Herstellungsbetriebe	1.056	10.819	11.424.864
Handel	1.716	9.083	15.586.428
Spedition, Lagerei, Verkehrsvermittlung	4.948	4.271	21.132.908
Gesamt			81.080.840

Tab. 2: Jährlicher Wärmeverbrauch innerhalb des Greenports

[20] Vgl. Schlomann et al. (2004), S. 108, 114.

4.3 Ermittlung des Energiebedarfs der Hinterlandlogistik

Im nächsten Schritt erfolgt die Energiebedarfs-Berechnung der Hinterlandlogistik, die bereits zum jetzigen Zeitpunkt die von der politischen Agenda angestrebte Elektrifizierung präventiv berücksichtigt. Hierfür wird der prognostizierte Greenport-Güterumschlag mit dem durchschnittlichen Energieverbrauch pro umgeschlagener Tonne (DEVUT) multipliziert. Der DEVUT berechnet sich wie folgt[21]:

$$DEVUT = \frac{Primärenergieverbrauch}{Ladungsaufkommen} = \frac{711.300\ Mio.\ MJ}{3.062,1\ Mio.\ t} = 232,29\frac{MJ}{t} \tag{1}$$

Im zugrunde gelegten Geschäftsjahr 2010 betrug der Güterumschlag 23.928 t, was zu einem Energiebedarf in Höhe von 1,55 GWh führt[22]:

$$\begin{aligned} Energiebedarf &= DEVUT \cdot LKW\ Güterumschlag = 232,29\frac{MJ}{t} \cdot 23.928\ t \\ &= 5.558.235,12\ MJ = 1.545.189,36\ kWh \approx 1,55\ GWh \end{aligned} \tag{2}$$

Insgesamt ergibt sich demnach ein Strombedarf in Höhe von 32,68 GWh und ein Wärmebedarf in Höhe von 81,93 GWh, die es durch regenerative Energiequellen zu decken gilt.

$$Gesamtstrombedarf = 0,33\ GWh + 30,80\ GWh + 1,55\ GWh = 32,68\ GWh \tag{3}$$

$$Gesamtwärmebedarf = 0,85\ GWh + 81,08\ GWh = 81,93\ GWh \tag{4}$$

4.4 Erhebung der Energieerzeugungsmöglichkeiten

Aus den vorgestellten Energieerzeugungsarten eignen sich für diesen Binnenhafen insbesondere PV-Anlagen sowie Biomasseheizkraftwerke (BHKW). Zunächst ist eine Ermittlung der Fläche erforderlich, welche für den Einsatz von PV-Anlagen zur Verfügung steht. Aufgrund von Oberlichtern, Schattenwurf sowie statischen Gesichtspunkten ist ein Abschlag von 60% zu beachten. Die effektive Nutzfläche berechnet sich daher folgendermaßen.

$$Nutzfläche = Gesamtfläche \cdot Nutzungsfaktor = 484.973,59\ m^2 \cdot 0,4 = 193.989,44\ m^2 \tag{5}$$

Bei der Energiegewinnung durch PV-Installationen gilt grundsätzlich, dass 8 m^2 PV-Zellen durchschnittlich 1 Kilowatt Peak (kW_P) Leistung erzielen[23], was die nachstehende Spitzenleistung (SpL) zur Folge hat.

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[21] Vgl. Kolodziej (2009), S. 10-12.

[22] Der Umrechnungsfaktor beträgt 0,278 kWh/MJ.

[23] Vgl. Adam (2003), S. 474.

$$SpL = \frac{Nutzbare\ Fläche}{\varnothing\ Flächenleistung} = \frac{193.989,44\ m^2}{8\frac{m^2}{kW_P}} = 24.248,68\ kW_P \tag{6}$$

Zur Bestimmung der erzielbaren Leistung ist es notwendig, die kW_P in kWh umzurechnen. In den mittel- bis nordeuropäischen Breitengraden des Hafenstandorts schwanken die dafür verwendbaren Werte zwischen circa 700 kWh/kW_P und 1100 kWh/kW_P [24], sodass für die vorliegende Berechnung der Mittelwert von 900 kWh/kW_P herangezogen wird:

$$\begin{aligned} Erzielbare\ Leistung &= SpL \cdot Umrechnungsfaktor = 24.248,68\ kW_P \cdot 900\frac{kWh}{kW_P} \\ &= 21.823.812\ kWh \approx 21,82\ GWh \end{aligned} \tag{7}$$

Damit decken die PV-Anlagen 66,77% des Stromverbrauchs ab.

$$Stromabdeckung = \frac{Gesamtleistung}{Stromverbrauch} = \frac{21,82\ GWh}{32,68\ GWh} = 0,6677 = 66,77\ \% \tag{8}$$

Bezeichnung	**Energiemengen**
Gesamte erzeugte Strommenge	$21,82\ GWh + 15,00\ GWh = 36,82\ GWh$
Über-/Unterdeckung des Strombedarfs	$36,82\ GWh - 32,68\ GWh = +4,14\ GWh$
Gesamte erzeugte Wärmemenge	$96,00\ GWh$
Über-/Unterdeckung des Wärmebedarfs	$96,00\ GWh - 81,93\ GWh = +14,07\ GWh$

Tab. 3: Gesamtmengen an erzeugter und benötigter Energie

Der Einsatz eines BHKW dient der Versorgung der verbleibenden Stromnachfrage sowie der Deckung des Wärmebedarfs. Die Berechnungen für das Verhältnis zwischen Strom- und Wärmegewinnung orientieren sich an den Erfahrungswerten vergleichbarer Anlagen in anderen Häfen. Bei einer wärmegeführten Ausrichtung der Anlage beträgt das Verhältnis 1 zu 6,4. Eine Auslegung der Jahreswärmeleistung auf 96 GWh ermöglicht es, auch vorübergehende Schwankungen in der Nachfrage auszugleichen. Demzufolge ergibt sich eine Jahresstromleistung von 15 GWh. Die gesamten Energiemengen fasst Tab. 3 zusammen.

4.5 Erhebung der Energiespeicherungsmöglichkeiten

Zum Ausgleich temporärer Schwankungen bei der Energieerzeugung, bedarf es ferner der Schaffung von Speicherungsmöglichkeiten. Als realistische Handlungsalternative schätzen die Greenport-Entscheidungsträger die Methangasspeicherung ein. Der Wirkungsgrad der Methangasspeicherung von Strom aus erneuerbaren Energien liegt bei

[24] Vgl. bspw. Deutscher Wetterdienst (2010).

rund 60%.[25] Die Umwandlung der Stromüberproduktion führt zu folgendem Energiewert an synthetischem Erdgas, welches im Erdgasnetz gespeichert oder bei Nichtbedarf gegebenenfalls verkauft werden könnte.

$$\begin{aligned} \text{Energiewert synthetisches Erdgas} &= \text{Stromüberproduktion} \cdot \text{Wirkungsgrad} \\ &= 4{,}14\ GWh \cdot 0{,}6 = 2{,}48\ GWh \end{aligned} \tag{9}$$

Zusätzlich ist die Überproduktion an Wärmeenergie in Höhe von 14,07 GWh in einem Erdbeckenspeicher vorzuhalten. Derartige Speicher nutzen die thermische Aufnahmefähigkeit von Wasser und sind deshalb für einen Einsatz in einem Hafen prädestiniert.[26] Nach den Aussagen eines Experten für Speichertechnologien ist für die genannte Energiemenge eine Größe von 768 m^3 ausreichend.

Bezeichnung	**Berechnung**	**Wert**
Investitionssumme Wärmeversorgung	$\frac{\text{Wärmeleistung (in kWh)}}{\text{Jahreslaufzeit (in h)}} \cdot \text{Kostensatz} \left(\text{in } \frac{€}{kW}\right)$ [27]	8,64 Mio. €
Investitionssumme Stromversorgung	$\frac{\text{Stromleistung (in kWh)}}{\text{Jahreslaufzeit (in h)}} \cdot \text{Kostensatz} \left(\text{in } \frac{€}{kW}\right)$ [28]	11,55 Mio. €
Gesamtinvestitionen BHKW	*Investitionssumme Wärmeversorgung + Investitionssumme Stromversorgung*	20,19 Mio. €
Fixe Betriebskosten Wärmeversorgung	*Fixkostensatz der Investitionssumme + Personalbedarf* [29]	0,83 Mio. €
Fixe Betriebskosten Stromversorgung	*Fixkostensatz der Investitionssumme + Personalbedarf* [30]	1,35 Mio. €
Jährliche fixe Betriebskosten BHKW	*Fixe Betriebskosten Wärmeversorgung + Fixe Betriebskosten Stromversorgung*	2,18 Mio. €

Tab. 4: Investitionsvolumen und jährliche fixe Betriebskosten des BHKW

4.6 Wirtschaftlichkeits- und Rentabilitätsbetrachtung

Abschließend erfolgt eine Wirtschaftlichkeits- und Rentabilitätsbetrachtung, da Projektrealisierung stets an betriebswirtschaftliche Sachzwänge geknüpft ist. Die in Tab. 4 dargestellte Kostenkalkulation des BHKW bezieht sich auf eine Studie des BMU, welche bereits Abschreibungen und Zinskosten berücksichtigt.[31] Eine weitere Annahme

25 Vgl. Sterner et al. (2010), S. 55.

26 Vgl. Reuss (2003), S. 40f.

27 Für eine mit Hackschnitzel betriebene Anlage mit einer thermischen Leistung von 5.000 kW betragen die Investitionskosten 450 €/kW.

28 Die Investitionskosten betragen bei gleichbleibenden Annahmen 3850 €/kW.

29 2,7% der Investitionssumme und geschätzter Personalbedarf von 12 Mitarbeitern à 50.000 €/Jahr.

30 3,5% der Investitionssumme und geschätzter Personalbedarf von 19 Mitarbeitern à 50.000 €/Jahr.

31 Vgl. Nitsch et al. (2004), S. 39f.

stellt eine Auslastung von jährlich 5.000 Volllaststunden dar.[32] Die berechneten Investitions- und Kostensummen lassen sich durch den Vergleich mit bestehenden Anlagen verifizieren.[33]

Aufgrund des Marktwachstums für PV-Anlagen und der realisierten Größendegressionseffekte sind die Erzeugungskosten zuletzt stark gesunken. Für 1 kW_p kann aktuell mit Gesamtkosten von 4.000 € inklusive Montage gerechnet werden.[34] Auf diesen Kostenwerten gründen die in Tab. 5 zusammengefassten Investitionen und Betriebskosten.

Bezeichnung	**Berechnung**	**Wert**
Gesamtinvestitionen PV	$Spitzenleistung\ der\ PV\ \left(in\ kW_P\right) \cdot Kostensatz \left(in\ \frac{€}{kW_P}\right)$	96,99 Mio. €
Jährliche fixe Betriebskosten PV	$Investitionssumme\ PV\ \left(in\ €\right) \cdot Kostenanteil$ [35]	0,97 Mio. €

Tab. 5: Investitionsvolumen und jährliche fixe Betriebskosten der PV-Anlagen

Die Marktreife der angestrebten Methangasspeicherung wird für das Jahr 2014 erwartet.[36] Zur Durchführung einer Wirtschaftlichkeitsrechnung dienen vergleichbare Werte eines Druckluftspeicherkraftwerks (vgl. Tab. 6).

Bezeichnung	**Berechnung**	**Wert**
Gesamtinvestitionen Methangasspeicher	$\frac{Strom\ddot{u}berschuss\ \left(in\ kWh\right)}{Umrechnungsfaktor \left(in\ \frac{kWh}{kW}\right)} \cdot Kostensatz \left(in\ \frac{€}{kW}\right)$ [37]	3,45 Mio. €
Jährliche fixe Betriebskosten Methangasspeicher	$Investitionssumme\ Methangasspeicher\ \left(in\ €\right) \cdot Kostenanteil$ [38]	0,17 Mio. €

Tab. 6: Investitionsvolumen und jährliche fixe Betriebskosten der Methangasspeicherung

Wie in Kapitel 4.5 beschrieben, wird zur Wärmespeicherung ein Erdbeckenspeicher mit einem Volumen von 768 m^3 installiert. Dafür fallen einmalige Investitionen in Höhe von 480.000 € sowie jährliche fixe Betriebskosten in Höhe von 4.800 € an.

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32 Vgl. Erdmann/Dittmar (2010), S. 21.

33 Die notwendigen Investitionen für die Berliner Heizkraftwerke „Köpenicker Straße“ bzw. „Wendenschloßstraße“ betrugen, umgerechnet auf eine Jahresleistung von 40 GWh, 3,58 Mio. € bzw. 3,72 Mio. €. Vgl. z.B. Berlin.de (2011). Diese Beträge liegen in der gleichen Größenordnung wie die ermittelten Investitionen für das BHKW im Greenport.

34 Vgl. Hufnagel (2010), S. 26-27.

35 Die fixen Betriebs- und Wartungskosten einer PV-Anlage betragen 1% der Investitionssumme.

36 Vgl. juwi Holding AG (2011).

37 Die erforderlichen Investitionen belaufen sich auf 750 €/kW. Vgl. Höpfner/Pehnt (2009), S. 8.

38 Bei den veranschlagten Betriebskosten in Höhe von 5% der Investitionssumme handelt es sich im Vergleich zu den Betriebskosten des BHKW um eine hohe Schätzung. Dies spiegelt die zurückhaltende Haltung der Autoren gegenüber der neuartigen Technologie wider und schließt eventuell auftretende Mehrkosten bereits mit ein.

Somit ergibt sich für die Umsetzung der autarken Energieversorgung ein Investitionsvolumen in Höhe von 121,11 Mio. €:

$$\begin{gathered}Gesamtinvestitionen(BHKW, PV, Speicheranlagen) \\ = 20{,}19\ Mio.\ € + 96{,}99\ Mio.\ € + 3{,}45\ Mio.\ € + 0{,}48\ Mio.\ € = 121{,}11\ Mio.\ €\end{gathered} \tag{10}$$

Die Berechnung der jährlichen fixen Gesamtbetriebskosten führt zu folgendem Ergebnis:

$$\begin{gathered}Fixe\ Gesamtbetriebskosten(BHKW, PV, Speicheranlagen) \\ = 2{,}18\ Mio.\ € + 0{,}97\ Mio.\ € + 0{,}17\ Mio.\ € + 0{,}0048\ Mio.\ € = 3{,}32\ Mio.\ €\end{gathered} \tag{11}$$

Nachfolgend werden nun die zu erwartenden Einnahmen aus der Einspeisung überschüssiger Energiemengen sowie die Kosteneinsparungen durch den Verzicht auf den Fremdbezug betrachtet. Stromeinspeisungen aus PV-Installationen (30,17 Cent/kWh) weisen im Vergleich zu denen des BHKW (18,34 Cent/kWh) einen wesentlich höheren Vergütungssatz auf.[39] Bei einer Überdeckung des Strombedarfs erfolgt deshalb zunächst eine Einspeisung von PV-Strom. Der Greenport erzielt dadurch nachstehende Einnahmen:

$$\begin{gathered}Einspeisungserlöse\ Strom = Stromüberschuss \cdot Stromvergütungssatz \\ = 4.140.000\ kWh \cdot 0{,}3017 \frac{€}{kWh} = 1.249.038\ € \approx 1{,}25\ Mio.\ €\end{gathered} \tag{12}$$

Die Einkünfte aus der Einspeisung des Wärmeüberschusses (14,07 GWh) berechnen sich analog, wobei der marktübliche Kostensatz von 5,00 Cent/kWh[40] als Vergütungssatz fungiert.

$$\begin{gathered}Einspeisungserlöse\ Wärme = Wärmeüberschuss \cdot Wärmevergütungssatz \\ = 14.070.000\ kWh \cdot 0{,}05 \frac{€}{kWh} = 703.500\ € \approx 0{,}70\ Mio.\ €\end{gathered} \tag{13}$$

Daneben stellen Kosteneinsparungen durch den Verzicht auf den Fremdbezug einen weiteren positiven ökonomischen Beitrag dar. Hierfür dient ein Vergleich zwischen externen Bezugs- und internen Produktionskosten. Es werden die Ersparnisse im Bereich der Eigennutzung des erzeugten Stroms, der Wärmeenergie sowie der Kraftstoffersparnis für die Hinterlandlogistik, die im Rechenszenario elektrisch betrieben wird, analysiert (vgl. Tab. 7).

Die Berücksichtigung der Fixkosten führt zu einer jährlichen Kostenersparnis in Höhe von 4,78 Mio. €. Demnach beträgt die jährliche Summe aus Einspeisungserlösen und Kostenersparnis 6,73 Mio. €:

[39] Vgl. BMU (2011b), S. 70, 122.

[40] Die Kostensätze für eine kWh Fernwärme sind sehr unterschiedlich und schwanken von 5 bis 10 Cent/kWh. Für die vorliegende Fallstudie wird ein Kostensatz am unteren Ende von 5 Cent/kWh Wärmeenergie verwendet.

$$\begin{aligned} Ersparnis\ Eigenproduktion &= \sum Verbrauchsersparnis - \sum Fixe\ Gesamtbetriebskosten \\ &= 8.102.882\ € - 3.320.000\ € = 4.782.882\ € \approx 4,78\ Mio.\ € \end{aligned} \tag{14}$$

$$\begin{aligned} &Einspeisungserlöse\ Strom + Einspeisungserlöse\ Wärme + Ersparnis\ Eigenproduktion \\ &= 1,25\ Mio.\ € + 0,70\ Mio.\ € + 4,78\ Mio.\ € = 6,73\ Mio.\ € \end{aligned} \tag{15}$$

Die getätigten Investitionen amortisieren sich innerhalb von 18 Jahren, wobei das Gesamtprojekt eine Rentabilität von 5,6% aufweist.

$$\frac{Gesamtinvestitionen}{Erlöse + Kostenersparnis} = \frac{121{,}11\ Mio.\ €}{6,73\ Mio.\ €} = 18,00\ Jahre \tag{16}$$

$$\frac{Erlöse + Kostenersparnis}{Gesamtinvestitionen} \cdot 100\% = \frac{6,73\ Mio.\ €}{121{,}11\ Mio.\ €} \cdot 100\% = 5,6\% \tag{17}$$

	Strom (BHKW)	**Strom (PV)**	**Wärme (BHKW)**	**Kraftstoff (PV)**
Übliche Bezugskosten	12,7 Cent/kWh	12,7 Cent/kWh	5,00 Cent/kWh	13,4 Cent/kWh
Erzeugungskosten	0,38 Cent/kWh	0 Cent/kWh	0,12 Cent/kWh	0 Cent/kWh
Ersparnis pro kWh	12,32 Cent/kWh	12,7 Cent/kWh	4,88 Cent/kWh	13,4 Cent/kWh
Verbrauchte kWh	15.000.000 kWh	16.130.000 kWh	81.940.000 kWh	1.550.000 kWh
Verbrauchsersparnis	1.848.000 €	2.048.510 €	3.998.672 €	207.700 €
∑ Verbrauchsersparnis	8.102.882 €			

Tab. 7: Berechnung der jährlichen Verbrauchsersparnis[41]

5 Schlussbetrachtung und Ausblick

Wie die Ergebnisse der Fallstudie zeigen, ist das Konzept des energieautarken Hafens grundsätzlich als realisierbar einzustufen. Neben dem Beitrag zum Risikomanagement durch die verringerte Anfälligkeit gegenüber Versorgungsengpässen und steigenden Energiepreisen verbessert der vorgestellte Ansatz aufgrund der eingesetzten regenerativen Erzeugungsquellen auch die Klimabilanz der im Hafen ansässigen Unternehmen. Angesichts des wachsenden Umweltbewusstseins der Kunden spielt dieser Faktor bei der betrieblichen Standortentscheidung eine immer größere Rolle. Auch der Betreiber profitiert als Flächeneigentümer von der Umsetzung der Energieautarkie, da er ein Alleinstellungsmerkmal gegenüber anderen Standorten schafft und sich zukünftig als grüner Knotenpunkt in multimodalen Supply Chains positionieren kann.

[41] Vgl. für die angegebenen Kostensätze Schlesinger et al. (2010), S. A 1-31; Nitsch et al. (2004), S. 39f. Die marktüblichen Bezugskosten des Kraftstoffs berechnen sich aus den Kosten für einen Liter Diesel multipliziert mit dem energetischen Dieselwert: 1,34 €/l = 10 kWh. Es ist geplant, die E-Fahrzeuge mit PV-Strom zu versorgen. Hierfür fallen keine variablen Erzeugungskosten an, da der Strom durch die Sonnenstrahlung erzeugt wird. Kosten für Wartung und Betrieb sind bereits in den jährlichen Fixkosten enthalten.

6 Literatur

Adam, M. (2003): Regenerative Energien, in: Schwister, K. (Hrsg.): Taschenbuch der Umwelttechnik, Leipzig, S. 456-488.

Bandulet, M./Morasch, K. (2005): Would You Like to be a Prosumer? Information Revelation, Personalization and Price Discrimination in Electronic Markets, in: International Journal of the Economics of Business, Vol. 12, No. 2, S. 251-271.

BDEW (2011): Abschätzung des Ausbaubedarfs in deutschen Verteilungsnetzen aufgrund von Photovoltaik- und Windeinspeisungen bis 2020, http://www.bdew.de/internet.nsf/id/44DBCA3C5A6D2227C125785B003CE0B6/$file/Kurzfassung_BDEW_Ad-Hoc Gutachten Abschätzung EEG-bedingter Netzausbaubedarf in Verteilungsnetzen.pdf, Stand: 16.07.2011.

Berlin.de (2011): „Heizkraftwerk Berlin Mitte“, http://www.berlin.de/sen/umwelt/klimaschutz/aktiv/kwk/projekte/de/heizkraftwerk_berlin_mitte.shtml, Stand: 20.06.2011.

BMU (2007): Das Integrierte Energie- und Klimaprogramm der Bundesregierung, http://www.bmu.de/files/pdfs/allgemein/application/pdf/hintergrund_meseberg.pdf, Stand: 16.07.2011.

BMU (2011a): Gesetzentwurf der Bundesregierung – Entwurf des Dreizehnten Gesetzes zur Änderung des Atomgesetzes, Berlin.

BMU (2011b): Erfahrungsbericht 2011 zum Erneuerbare-Energien-Gesetz, Berlin.

Bundesregierung (2009): Nationaler Entwicklungsplan Elektromobilität der Bundesregierung, Berlin.

Clasmeier, H.-D. (2009): Masterplan für den Hafen Emden, in: Arbeitsgruppe für regionale Struktur- und Umweltforschung GmbH (Hrsg.): Positionen – Die Küste boomt – Ökonomische Perspektiven und ökologische Herausforderungen, Oldenburg, S. 92-105.

Deutscher Wetterdienst (2010): „2010- Jahreskarte - flächendeckende Jahressumme der Globalstrahlung für das Jahr 2010“, http://www.dwd.de/bvbw/generator/DWDWWW/Content/Oeffentlichkeit/KU/KU1/KU12/Klimagutachten/Solarenergie/Globalkarten__entgeltfrei/Jahressummen/2010,templateId=raw,property=publicationFile.pdf/2010.pdf, Stand: 23.06.2011.

Erdmann, G./Dittmar, L. (2010): Technologische und energiepolitische Bewertung der Perspektiven von Kraft-Wärme-Kopplung in Deutschland, Berlin.

Fischer, R./Foißner, P. (2002): Raumordnung, Stadtentwicklung und Städtebau in den Niederlanden – Ein Blick über die Grenze, in: Standort – Zeitschrift für Angewandte Geographie, 24. Jg., H. 4, S. 153-158.

Forschungs-Informations-System (2011): „Modal-Split-Anteil und Bedeutung des Kombinierten Verkehrs“, http://www.forschungsinformationssystem.de/servlet/is/306347/, Stand: 30.06.2011.

Grünig, G. (2011): Die ökologisch-leisen Liefer-Laster, in: Verkehrsrundschau, Heft 23/2011, S. 50-52.

Höpfner, U./Pehnt, M. (2009): Kurzgutachten – Wasserstoff- und Stromspeicher in einem Energiesystem mit hohen Anteilen erneuerbarer Energien: Analyse der kurz- und mittelfristigen Perspektive, Heidelberg.

Hufnagel, S. (2010): Photovoltaik in der Stadt- und Regionalplanung, Hamburg.

juwi Holding AG (2011): „Nächste Schritte – die Roadmap für juwi und SolarFuel“, http://www.juwi.de/forschung_entwicklung_rd/speichertechnologie_solarfuel/roadmap.html, Stand: 26.06.2011.

Kolodziej, A. (2009): Daten zum Verkehr – Ausgabe 2009, Dessau-Roßlau.

Kortlüke, N./Pieprzyk, B. (2010): Klimafreundliche Elektromobilität: Finanzielle Hürden zur Markteinführung, Studie des Energie Impuls OWL e.V., Bielefeld.

Mester, B. (2005): Strukturwandel in den Seehäfen, in: Lemper, B. (Hrsg.): Märkte im Wandel– mehr Mut zu Wettbewerb: Festschrift zum 65. Geburtstag von Rolf W. Stuchtey, Frankfurt am Main, S. 41-51.

Nitsch, J./Krewitt, W./Nast, M./Viebahn, P./Gärtner, S./ Pehnt, M./ Reinhardt, G./Schmidt, R./Uihlein, A./Barthel, C./Fischedick, M./Merten, F. (2004): Ökologisch optimierter Ausbau der Nutzung erneuerbarer Energien in Deutschland, Stuttgart.

Normann, R. (1984): Service Management – Strategy and Leadership in Service Businesses, New York.

Pelte, D. (2010): Die Zukunft unserer Energieversorgung: Eine Analyse aus mathematisch-naturwissenschaftlicher Sicht, Wiesbaden.

Quaschning, V. (2009): Regenerative Energiesysteme: Technologie – Berechnung – Simulation, 6. Aufl., München.

Radgen, P. (2007): „Zukunftsmarkt Elektrische Energiespeicherung", http://www.umweltdaten.de/publikationen/fpdf-l/3448.pdf, Stand: 20.06.2011.

Reuss, M. (2003): Saisonale Wärmespeicherung im Untergrund – eine Lösung für die effiziente Wärmenutzung auch bei Biogas?, in: „Portrait C.A.R.M.E.N. Biogasmärkte der Zukunft", http://www.carmen-ev.de/dt/portrait/sonstiges/reuss.pdf, Stand: 30.06.2011.

Schlesinger, M./Hofer, P./Kemmler, A./Kirchner, A./Strassburg, S./Fürsch, M./Nagl, S./Paulus, M./Richter, J./Trüby, J./Lutz, C./Khorushun, O./Lehr, U./Thobe, I. (2010): Energieszenarien für ein Energiekonzept der Bundesregierung, Basel.

Schlomann, B./Gruber, E./Eichhammer, W./Kling, N./Diekmann, J./Ziesing, H.J./Rieke, H./Wittke, F./Herzog, T./Barbosa, M./Lutz, S./Broeske, U./Merten, D./Falkenberg, D./Nill, M./Kaltschmitt, M./Geiger, B./Kleeberger, H./Eckl, R. (2004): Energieverbrauch der privaten Haushalte und des Sektors Gewerbe, Handel, Dienstleistungen (GHD), Karlsruhe.

Sterner, M./Specht, M./Saint-Drenan, Y.-M./Gerhardt, N./Stürmer, B./Zuberbühler, U. (2010): Erneuerbares Methan – Eine Lösung zur Integration und Speicherung Erneuerbarer Energien und ein Weg zur regenerativen Vollversorgung, in: Solarzeitalter, Ausgabe 1/2010 (April), S. 51-58.

Toffler, A. (1980): Die dritte Welle Zukunftschance – Perspektiven für die Gesellschaft des 21. Jahrhunderts, München.

Völler, S. (2010): „Optimierte Betriebsführung von Windenergieanlagen durch Energiespeicher", http://elpub.bib.uni-wuppertal.de/servlets/DerivateServlet/Derivate-1486/de0906.pdf, Stand: 20.06.2011.

Wesselak, V./Schabbach, T. (2009): Regenerative Energietechnik, Berlin.

Potenzielle Verlagerungseffekte im maritimen Kombinierten Verkehr – Aktuelle Entwicklungen und Anforderungen an Markt und Politik am Beispiel Kontinentaleuropa

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Abstract

Content of the following paper is the investigation of the development of the maritime intermodal transport market in Continental Europe. Thereby the focus lies on the identification of potential infra-structural bottlenecks in ports and on Hinterland corridors and the analysis of subsequent shifting effects on the market. Further the consequences of these shifting effects on the container market will be analyzed and potential recommendations for market players and policy will be developed.

1 Einleitung

Ein typisches Merkmal der rasant voranschreitenden Globalisierung in den vergangenen Jahren ist die damit einhergehende Containerisierung. Erst die Erfindung des Containers und das Einsetzen der standardisierten, stapelbaren Boxen im internationalen Warenaustausch hat die Globalisierung wie wir sie heute kennen ermöglicht.[1] Seit dem Zusammenbruch des Eisernen Vorhangs haben sich neue Logistikmärkte erschlossen und das Gros des Welthandels hat sich von der klassischen Handelstriade Nordamerika – Westeuropa – Japan – weiterentwickelt, China ist im Jahr 2010 zum Exportweltmeister aufgestiegen.[2]

Beim Betrachten Kontinentaleuropas fällt auf, dass sich das Containerumschlagsvolumen von rund 32 Millionen TEU im Jahr 2000 auf über 60 Millionen TEU in 2008 fast verdoppelt hat. Während die Transportinfrastruktur dieses Wachstum über die vergangene Dekade noch problemlos aufnehmen konnte, so ist davon auszugehen, dass es bei einer Fortsetzung dieses Wachstums in der nächsten Dekade zwischen 2011 und 2020 zu Engpässen in der Infrastruktur kommen könnte. Diese könnten sowohl in den Seehäfen als auch auf den Seehafen-Hinterland-Korridoren auftreten. Um die steigende Transportnachfrage bedienen zu können und gleichzeitig die Umweltbelastung zu minimieren, sind auch die Schiffsgrößen über die vergangenen Jahre rasant angestiegen. Konnte das größte Containerschiff der Welt im Jahr 1994 gerade 5.000 TEU transportieren, so sind es heute bereits 14.000 TEU und in naher Zukunft ab 2013/14 werden bereits die ersten Schiffe mit einer Kapazität von 20.000 TEU ausgeliefert werden. Die Engpasssituationen in den Seehäfen und im Hinterland könnten durch größere Schiffseinheiten zusätzlich verschärft werden, da diese Schiffe aufgrund ihres Tiefgangs nicht alle Häfen anlaufen werden können.[3]

Aufgrund der beschriebenen Problematik könnte sich der Containermarkt in Kontinentaleuropa nachhaltig verändern. Diese Veränderung könnte insbesondere durch die Verlagerung von Containermengen gekennzeichnet sein. Solche Verlagerungseffekte könnten zwischen Seehäfen, Hinterlandachsen oder Verkehrsträgern auftreten. Entsprechend sollten die beteiligten Marktakteure und die Politik auf diese Entwicklung vorbereitet sein und entsprechende Handlungsalternativen erarbeiten.

Daher soll im Rahmen dieses Artikels zunächst aus makroökonomischer Perspektive der kontinentaleuropäische Containermarkt im Vorkrisenjahr 2008 vorgestellt werden. Dabei soll aufgezeigt werden, wie er sich seit dem Jahr 2000 verändert hat. Auf dieser Basis sollen dann mögliche Verlagerungseffekte analysiert werden. Schließlich sollen die sich aus diesen potenziellen Verlagerungseffekten ergebenden Herausforderungen an die Marktakteure und an die Politik abgeleitet werden.

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[1] Vgl. Johnson/Garnett (1971), S. 11-15; Obermaier/Müller/Braun (2007), S. 337-341; Nuhn (2005), S. 114f.
[2] Vgl. Kummer/Schramm/Sudy (2009); S. 20-32.
[3] Vgl. Rössler (2009); S. 4 zur Thematik „Engpässe im Hinterland".

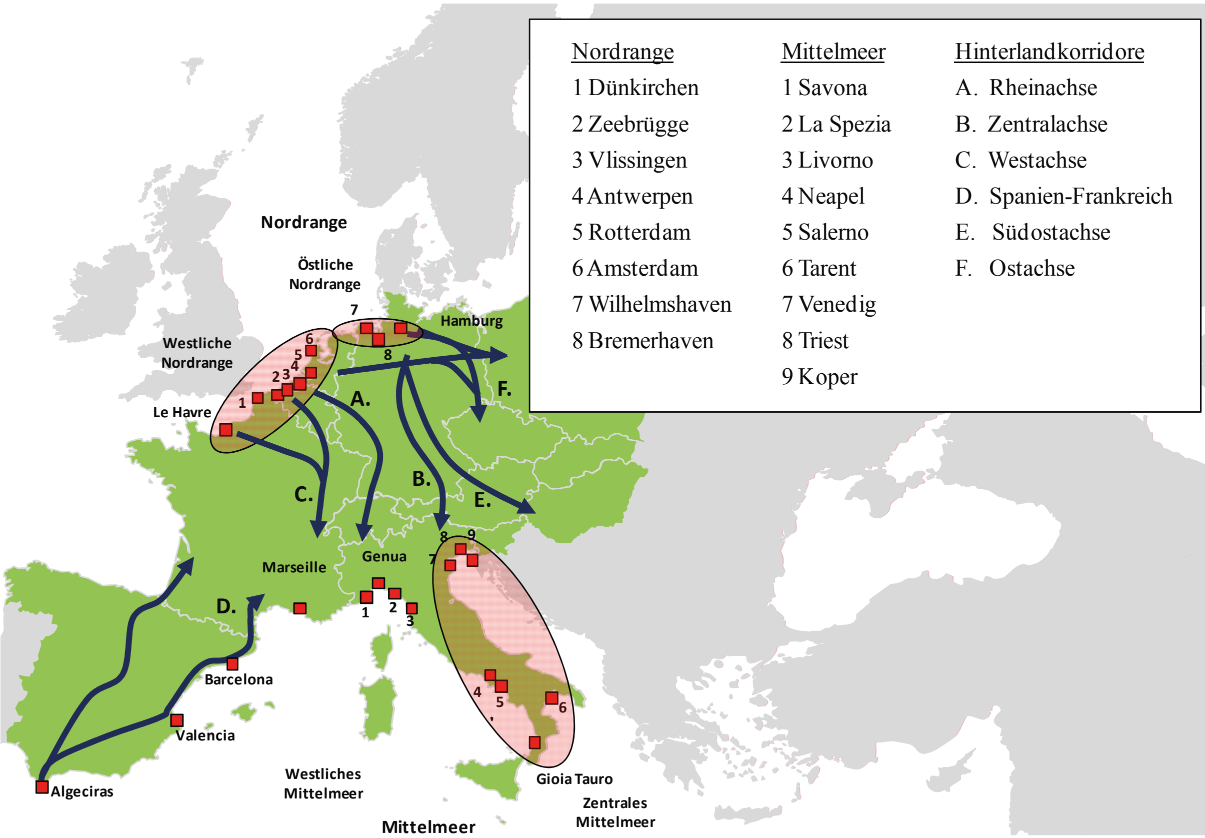
2 Ausgangslage: Der Vorkrisen-Containermarkt

Ziel dieses Kapitels ist die Vorstellung des Containermarktes in Kontinentaleuropa. In diesem Zusammenhang soll zunächst die Infrastruktur des Containermarktes vorgestellt werden. Dabei werden die wichtigsten Überseehäfen und Hinterlandkorridore vorgestellt. In einem zweiten Schritt wird dann auf die Marktentwicklung eingegangen. Diesbezüglich werden Volumen-, Kapazitäts- und Auslastungsentwicklungen präsentiert.

2.1 Die Infrastruktur des kontinentaleuropäischen Containermarkts

In diesem Unterkapitel werden die kontinentaleuropäischen Seehäfen und Hinterlandkorridore vorgestellt.[4] **Übersicht 2-1** präsentiert das kontinentaleuropäische Hinterland mit seinen Seehäfen und Hinterlandkorridoren. Die Seehäfen unterteilen sich in der ersten Stufe in die Nordhäfen[5] und Südhäfen (Mittelmeerhäfen). Die Nordhäfen erstrecken sich entlang des Ärmelkanals von Le Havre über die Nordseeküste hinweg bis nach Hamburg an der Elbe. Die Südhäfen hingegen verlaufen entlang der Mittelmeerküste von Algeciras an der Straße von Gibraltar bis in die Nordadria nach Koper.

Übersicht 2-1 Der kontinentaleuropäische Containermarkt



Quelle: Eigene Darstellung. Kartenmaterial auf Basis von TransCare AG.

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[4] Vgl. zur Definition und Funktion von Seehäfen z.B. Maenning/Sames (2000), S. 164-166.

[5] Auch Nordrange oder Hamburg – Le Havre Range genannt [vgl. z.B. Notteboom (2007), S. 108 ff.; Niennemann (2006), S. 7f.; Robinson (1988), S.13ff.].

Die Häfen der Nordrange und des Mittelmeers lassen sich in maritime Cluster einteilen. So ist bezüglich der Nordhäfen zwischen den Clustern westliche- und östliche Nordrange zu differenzieren. Zu den Häfen der westlichen Nordrange werden Rotterdam, Antwerpen, Zeebrügge, Le Havre. Dünkirchen, Amsterdam und Vlissingen gezählt. In der östlichen Nordrange liegen die Hafenstandorte Hamburg, Bremerhaven und Wilhelmshaven. Im Mittelmeer soll zwischen westlichen und zentralen Mittelmeerhäfen unterschieden werden. Zum Cluster der westlichen Mittelmeerhäfen sollen die spanischen Häfen Algeciras, Valencia und Barcelona, der französische Hafen Marseille, sowie die in Italien gelegenen Häfen Genua, La Spezia, Salerno und Savona gezählt werden.

Die in den Seehäfen umgeschlagenen Containermengen sind in Transshipment- und Hinterlandmengen zu unterscheiden. Im Falle von Transshipmentmengen werden die Container im Hafen zwischen zwei Seeschiffen umgeschlagen. d.h. die Container erreichen den Hafen über den Seeweg und verlassen ihn auch wieder über den Seeweg. Von Hinterlandmengen hingegen wird gesprochen, wenn ein Container zwischen einem Seeschiff auf einen Landcarrier (LKW, Bahn oder Binnenschiff) umgeschlagen wird.[6] Ein entscheidendes Kriterium für die Wahl eines Hafens ist die Anbindung an das Hinterland. Von Vorteil sind die Anbindung aller Inlandsverkehrsträger (Schiene, Straße, Binnenschiff) und die geografische Lage an einem der Haupthinterlandkorridore. Kontinentaleuropa verfügt über sechs wesentliche Hauptkorridore, welche die Seehäfen mit dem Hinterland verbinden.[7]

Eine besondere Bedeutung kommt den schienengebundenen Hinterlandachsen zu Gute. Die Schiene kann im Vergleich zur Straße deutlich mehr Einheiten transportieren und ist wesentlich flexibler als das Binnenschiff, welches auch in Konkurrenz zu den Seeschiffen um die Liegeplätze in den Häfen steht. Daher hat die Schiene ihren Anteil am Hinterlandvolumen in den letzten Jahren deutlich ausbauen können. Auf der anderen Seite sind Engpässe im Hinterland fast ausschließlich mit dem Verkehrsträger Schiene verbunden. Auf Flüssen und Straßen kommt es kaum zu Engpässen, da auf dem Rhein, der Hauptwasserstraße Europas von Rotterdam bis Karlsruhe keine Schleusen existieren. LKW können Verkehrsengpässe (Staus) durch flexible Fahrzeiten oder Routen entgehen. Die Fahrtrassen auf der Schieneninfrastruktur hingegen sind bereits durch Personenzüge und konventionelle Güterzüge stark ausgelastet, so dass an einigen Stellen im Schienennetz nur noch eine begrenzte Aufnahmekapazität vorhanden ist. In Kontinentaleuropa zählen die Rheinachse, die Zentralachse, die Westachse, der Korridor Spanien – Frankreich, die Südostachse und die Ostachse zu den bedeutendsten Hinterlandanbindungen.[8]

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6 Vgl. Reise (2004), S. 15 und die dort genannten Quellen.

7 Vgl. z.B. http://ec.europa.eu/transport/rail/doc/2008_05_21_comparison_corridor_reseaux.pdf; Seite abgerufen am 12.06.2011.

8 Vgl. Übersicht 2-1.

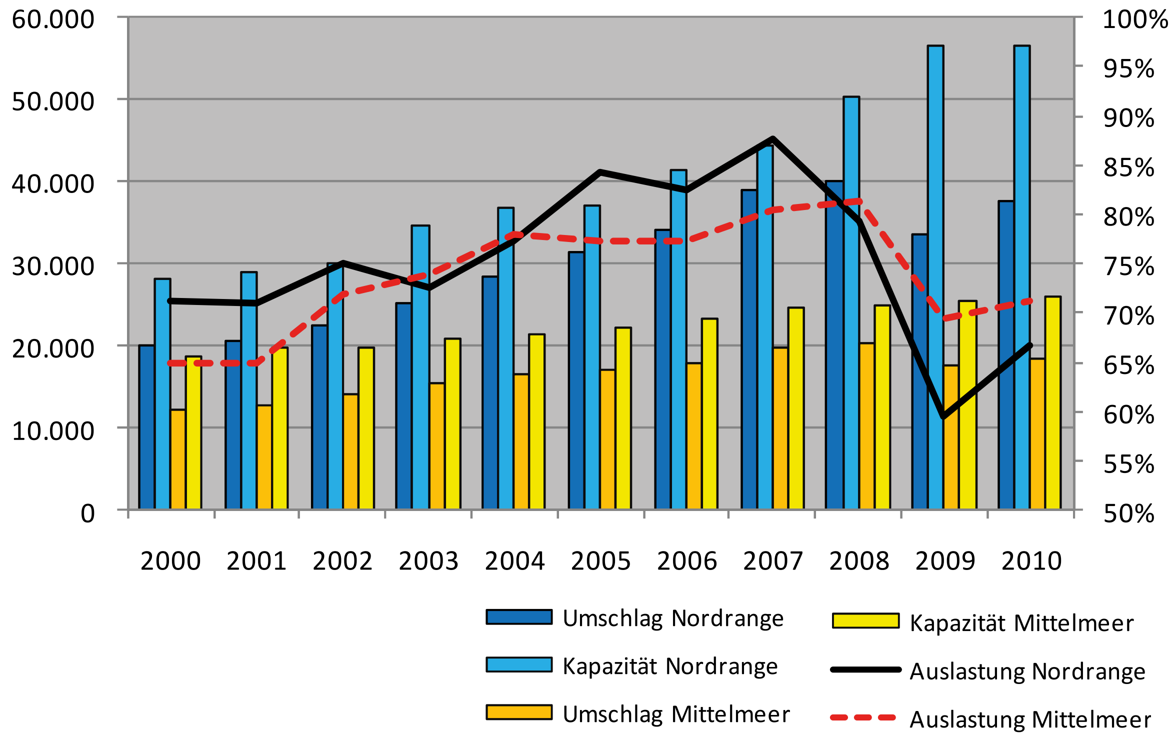
2.2 Die Entwicklung des Containermarkts

Untersuchungseinheit dieses Unterkapitels ist die Entwicklung der Umschlagsmengen in den kontinentaleuropäischen Seehäfen und auf den Hinterlandkorridoren im Zeitraum von 2000 bis 2010.[9]

a. Hafenseitige Entwicklung

Im folgenden Abschnitt soll die Entwicklung von Umschlagsmengen, Kapazitäten und Auslastung der kontinentaleuropäischen Seehäfen aufgezeigt werden. Dabei soll zwischen der Entwicklung in den Nordhäfen und im Mittelmeer unterschieden werden. **Übersicht 2-2** stellt die Marktentwicklung zwischen 2000 und 2010 grafisch dar.

Übersicht 2-2 Entwicklung des kontinentaleuropäischen Containermarkts 2000-2010



Quelle: Eigene Darstellung auf Basis der Angaben der Hafenbehörden und Containerisation International, Werte für 2010 teilweise geschätzt.[10]

Die Auslastung der Umschlagskapazitäten in den Häfen der Nordrange ist von rund 70 Prozent im Jahr 2000 auf über 85 Prozent im Jahr 2007 angestiegen. In den Mittelmeerhäfen ist sie im Zeitraum von 2000 bis 2008 von gut 65 Prozent auf über 80 Prozent angestiegen. Zwar ist die Auslastung im Krisenjahr 2009 stark gesunken, während gleichzeitig in der Nordrange neue Kapazitäten entstanden sind, was sich jedoch be-

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[9] Auch wenn die statistischen Daten bis 2010 vorhanden sind, so stellt ein Vergleich zwischen den Jahren 2000 und 2008 ein aussagekräftigeres Ergebnis aufgrund der Wirtschaftskrise, welche insbesondere das Jahr 2009 geprägt hat, dar.

[10] Legende:
- Linke Ordinate: Containervolumen in 1.000 TEU p.a.
- Rechte Ordinate: Durchschnittliche Auslastung in Prozent.
- Umschlag und Kapazität :Summe der Häfen von Nordrange und Mittelmeer (vgl. Übersicht 2-1).
- Kapazität: Theoretische Umschlagskapazität.

Vgl. Containerisation International (2000-2009).

reits mittelfristig ändern könnte. Bei einer durchschnittlichen Wachstumsrate von sechs Prozent p.a. könnte sich das Umschlagsvolumen innerhalb der nächsten zehn Jahre verdoppeln. Wird dabei davon ausgegangen, dass nicht alle Häfen für die Tiefgänge der künftigen Schiffe ausgelegt sind, so könnte es bereits in den kommenden Jahren zu ersten Engpässen in den wichtigsten Tiefwasserhäfen kommen.

b. Hinterlandseitige Entwicklung

Ziel dieses Abschnitts ist es, die Entwicklung der Hinterlandmengen in Kontinentaleuropa aufzuzeigen. **Übersicht 2-3** stellt die Entwicklung der Hinterlandmengen sowie die Aufteilung der Mengen auf die Verkehrsträger Binnenschiff, Schiene und Straße (Modal Split) dar.

Übersicht 2-3 Entwicklung des Hinterlandvolumens und des Modal Splits 2000-2010

Verkehrsträger	Jahr 2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Modal Split	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Binnenschiff	10%	10%	11%	11%	11%	11%	11%	11%	12%	13%	14%
Schiene	22%	22%	23%	22%	22%	23%	24%	23%	24%	26%	23%
Straße	68%	68%	67%	67%	67%	67%	65%	65%	64%	62%	64%
Umschlag in 1.000 TEU	**21.029**	**21.650**	**23.967**	**24.950**	**28.100**	**30.021**	**30.449**	**36.413**	**34.804**	**28.941**	**30.107**
Binnenschiff	2.132	2.175	2.544	2.739	3.093	3.216	3.475	4.131	4.099	3.632	4.175
Schiene	4.643	4.816	5.448	5.519	6.193	6.773	7.187	8.451	8.488	7.402	6.803
Straße	14.254	14.658	15.975	16.692	18.815	20.032	19.788	23.832	22.216	17.907	19.129

Quelle: Eigene Darstellung auf Basis der Angaben der Hafenbehörden, Werte teilweise geschätzt.[11]

Das Hinterlandvolumen ist von rund 21 Mio. TEU im Jahr 2000 auf über 36 Mio. TEU im Jahr 2008 vor Beginn der Wirtschafskrise angestiegen, was einer Zunahme um über 65 Prozent entspricht.[12] Davon konnten insbesondere die Hinterlandverkehrsträger Binnenschiff (plus 92,2 Prozent) und Bahn (plus 82,8 Prozent) profitieren. Wird davon ausgegangen, dass ein Containerzug durchschnittlich mit 72 TEU beladen ist und ein Jahr in 300 Verkehrstage unterteilt ist, so ist die Anzahl der täglich verkehrenden maritimen Containerzüge in Kontinentaleuropa zwischen 2000 und 2008 von 215 Zügen auf 393 angestiegen.[13] Bei konstanter Entwicklung der Hinterlandmengen und gleichzeitigem Anstieg des Modal Splits der Schiene könnte so bereits mittelfristig eine Nachfrage von rund 1.000 täglich Verkehrenden maritimen Containerzügen in Kontinentaleuropa entstehen.[14]

[11] Hinterlandvolumen entspricht der Umschlagsmenge aus Übersicht 2-4 abzüglich der Transshipmentvolumina.

[12] Diese Zunahme wäre vermutlich noch höher ausgefallen, falls es im vierten Quartal 2008 nicht zum Einbruch der Weltwirtschaft gekommen wäre.

[13] Dabei wird eine 75 prozentige Auslastung bei einer Stellplatzkapazität von 96 TEU je Zug angenommen. Ferner werden 50 Arbeitswochen mit jeweils sechs Betriebstagen unterstellt.

[14] Eigene Berechnungen. Die Anzahl der Containerzüge ergibt sich aus dem Modal Split am Containerumschlagsvolumen in den einzelnen Seehäfen. Dabei wird angenommen ,dass nachfolgender Anteil je Hafen über die sechs Achsen an den jeweiligen Engpassstellen fließt:
Rheinachse: Rotterdam, Amsterdam je 85%, Antwerpen, Zeebrügge je 60%, Genua 10%, Gioia Tauro 5%,
Zentral-/Südostachse: Hamburg, Bremerhaven je 80%, Koper, Venedig, Triest je 10%, Gioia Tauro 5%,
Westachse: Marseille: 75%, Barcelona 30%, Le Havre, Dünkirchen je 25%, Antwerpen, Zeebrügge je 20%,
Spanien-Frankreich: Barcelona: 50%, Marseille: 20%, Le Havre, Antwerpen, Zeebrügge je 5%,
Ost-West-Achse: Hamburg: 15%, Rotterdam, Bremerhaven je 10%.
Kalkulationsbasis: 72 TEU je Zug und 300 Betriebstagen im Jahr.

Es ist festzuhalten, dass insbesondere auf der Rhein- und Zentral-/Südostachse sowie der Ostachse das Containerzugaufkommen überproportional angestiegen ist. Dies ist auf die in den letzten Jahren entwickelten effizienten Schienenkonzepte in den Nordhäfen, insbesondere Hamburg, zurückzuführen. Jedoch sind die freien Trassen für weitere Züge begrenzt. **Übersicht 2-4** zeigt auf, wie sich die Trassenauslastung unter Berücksichtigung den konventionellen Güterverkehrs und des Personenverkehrs in den vergangenen Jahren entwickelt hat.

Übersicht 2-4 Entwicklung der Streckenauslastung auf den Hauptachsen 2000-2010

Streckenauslastung in %	Korridor	Jahr 2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Rheinachse	A	85,1%	85,3%	86,3%	81,6%	84,3%	84,3%	91,4%	95,6%	93,6%	84,8%	90,5%
Zentral-/ Südostachse	B/E	69,3%	69,9%	70,6%	70,6%	73,5%	76,3%	78,7%	81,6%	80,9%	75,8%	79,6%
Westachse	C	67,1%	65,8%	65,7%	65,1%	64,7%	61,7%	62,3%	63,6%	63,4%	55,9%	60,5%
Spanien - Frankreich	D	60,3%	60,8%	60,4%	62,6%	66,4%	60,2%	58,5%	62,6%	62,0%	60,6%	63,3%
Ostachse	F	69,4%	68,8%	70,1%	70,8%	70,9%	72,7%	74,7%	78,4%	78,0%	72,3%	74,6%

Quelle: Eigene Berechnungen.[15]

Die Auslastung auf der Rheinachse ist zwischen 2000 und 2008 von rund 85 Prozent auf knapp 94 Prozent angestiegen. Auch auf der Zentral-/Südostachse betrug die Auslastung in 2008 bereits über 80 Prozent. Hierbei wird deutlich, dass die Schienenkapazitäten der Rhein- und Zentral-/Südostachse in den kommenden Jahren nur noch begrenzt über ausreichend Kapazitätsreserven verfügen.

3 Auswirkungen aufgrund des zu erwartenden Volumenanstiegs und potenzielle Verlagerungseffekte

In diesem Kapitel sollen in einem ersten Schritt die Auswirkungen des zu erwartenden Volumenanstiegs auf den kontinentaleuropäischen Containermarkt aufgezeigt werden. In einem zweiten Schritt sollen dann die sich aus den Auswirkungen ergebenden potenziellen Verlagerungseffekte präsentiert werden. **Übersicht 3-1** stellt die Situation grafisch dar.

3.1 Auswirkungen aufgrund des zu erwartenden Volumenanstiegs

Aufgrund des zu erwartenden generellen Volumenanstiegs im Containerhandel könnte es zu Auswirkungen auf die Schiffsgrößenentwicklung, auf den Umschlag in den Häfen und auf die Hafen-Hinterlandanbindungen kommen.[16] Diese Effekte ihrerseits könnten zu Volumenverlagerungen auf dem Kontinentaleuropäischen Markt führen.

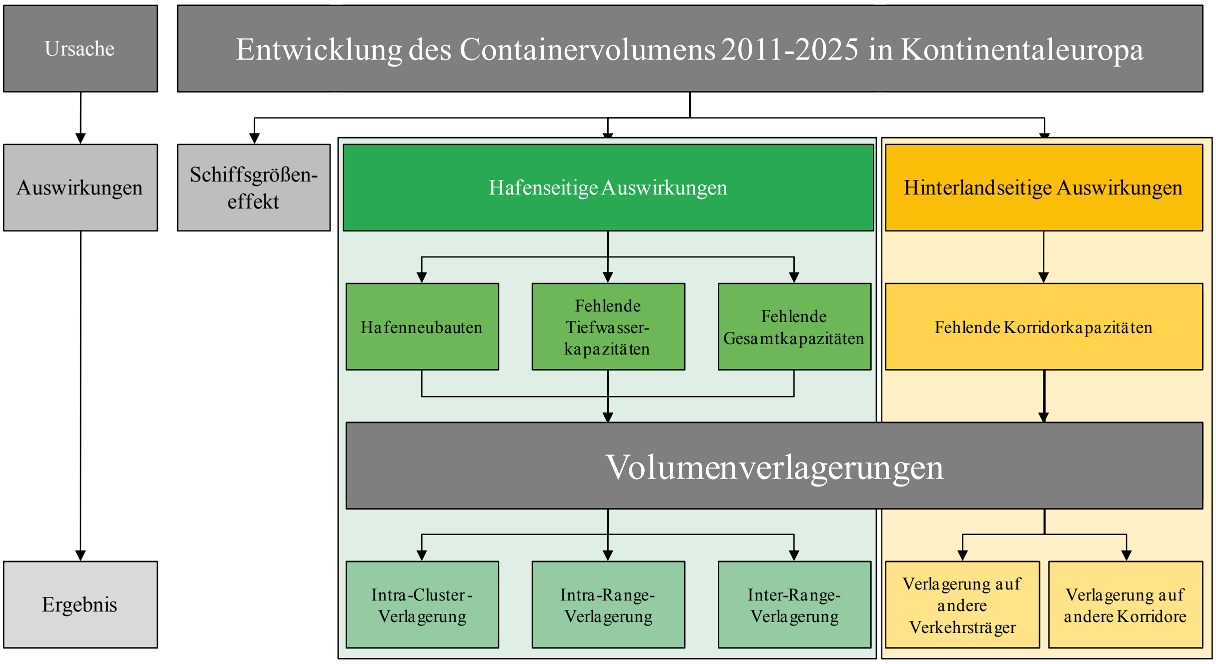
[15] Interne Studie der Universität Bamberg: Die Streckenauslastung beschreibt das Verhältnis zwischen der theoretisch verfügbaren Anzahl an Fahrtrassen und der theoretisch genutzten Anzahl Fahrtrassen. Bei der theoretischen Kapazität wurde unterstellt, dass je Gleis alle zehn Minuten je ein Zug fahren kann an 300 Tagen im Jahr. Von dieser Kapazität wurden dann jeweils zehn Prozent abgezogen (für potenzielle Zugverspätungen oder Sanierungsmaßnahmen. Im Rahmen des Zugaufkommens werden neben den Containerzügen auch Personenfern- und Nahverkehrszüge sowie konventionelle Güterzüge betrachtet. Das Personenzugaufkommen wurde dem Fahrplan entnommen, das Güterzugvolumen auf Basis von Eurostat ermittelt.

[16] Vgl. HWWI (2006), S. 64-70; DLR (2008), S. 6-8.

a. Schiffsgrößeneffekt

Der Schiffsgrößeneffekt bezeichnet die Tatsache, dass die Schiffe in den kommenden Jahren, wie die Vergangenheit zeigt, immer größer werden. Betrug im Jahr 1990 die maximale Kapazität eines Containerschiffs rund 5.000 TEU, so waren es 2010 bereits 14.000 TEU. Für das Jahr 2014 werden Schiffe mit einer Kapazität von 20.000 TEU erwartet. Diese Schiffe stellen ihre Anforderungen an die Umschlagseinrichtungen in den Häfen und an die gesamte Hinterlandlogistik.[17]

Übersicht 3-1 Potenzielle Verlagerungseffekte



Quelle: Eigene Darstellung.

b. Hafenseitige Auswirkungen

Zur Gruppe der hafenseitigen Auswirkungen zählen Auswirkungen durch Neubauten, fehlende Tiefwasserkapazitäten und fehlende Gesamtkapazitäten.

Auswirkungen durch Hafenneubauten umfassen sämtliche Effekte auf das bestehende Marktsystem, die durch den Bau neuer Hafenanlagen in Kontinentaleuropa entstehen. Derzeit entstehen neue Häfen in Wilhelmshaven, Vlissingen und Savona.[18]

Auswirkungen durch fehlende Gesamtkapazitäten drücken hingegen sämtliche Effekte auf das bestehende Marktsystem aus, die durch das Fehlen von Umschlagseinrichtungen in bereits existierenden Häfen entstehen.

Dagegen bezeichnen Auswirkungen durch fehlende Tiefwasserkapazitäten sämtliche Konsequenzen, die entstehen, falls ein Hafen zwar über ausreichend Umschlagskapa-

[17] Vgl. z.B. Alphaliner (2011).

[18] Wilhelmshaven: Vgl. http://www.jadeweserport.de/cms/index.php?idcat=26, Seite abgerufen am 13.05.2011. Vlissingen: Vgl. http://www.zeelandseaports.com/nl/projecten/project:wct.htm, Seite abgerufen am 08.04.2011. Savona: Vgl. Autorità Portuale di Savona (2005), S. 4-5, http://www.porto.sv.it/english/Autorit--P/Progetti/ilfuturo_uk.htm_cvt.htm, Seite abgerufen am 26.03.2011.

zitäten verfügt, aber aufgrund des begrenzten Tiefgangs keine Containerschiffe der neuesten Generationen abfertigen kann. So wäre es gegenwärtig unmöglich, dass 20.000 TEU Schiffe beispielsweise Hamburg anlaufen könnten.[19]

c. Hinterlandseitige Auswirkungen

Unter hinterlandseitigen Auswirkungen werden sämtliche Konsequenzen verstanden, die aufgrund mangelnder Kapazität auf den Hafen-Hinterlandkorridoren im Schienengüterverkehr, d. h. mangelnde Trassenkapazitäten entstehen.

3.2 Potenzielle Verlagerungseffekte

Die beschriebenen Auswirkungen aufgrund der zu erwartenden Volumenzunahme auf dem kontinentaleuropäischen Containermarkt bringen, wie bereits zu anfangs des Artikels erwähnt, Verlagerungseffekte mit sich einher. Diese können sowohl im Hafen als auch im Hinterland in Erscheinung treten. Verlagerungseffekte sind die Folge von Engpässen in den Häfen oder im Hinterland. Ein Engpass ist grundsätzlich dadurch gekennzeichnet, dass das Angebot geringer ist als die Nachfrage. Dies bedeutet, dass die Nachfrage eines Akteurs nach einer Leistung, also etwa einer Transport- oder Umschlagsleistung nicht vollständig oder nur zu höheren Kosten befriedigt werden kann. Ist ein Akteur nicht bereit diese Mehrkosten zu tragen, so kommt es unter Berücksichtigung des Wirtschaftlichkeitsprinzips zu Verlagerungen.[20]

a. Potenzielle Hafenseitige Verlagerungseffekte

Die potenziellen hafenseitigen Verlagerungseffekte sollen im Rahmen dieser Arbeit in drei verschiedene Gruppen unterteilt werden:

1. Regionale Verlagerungseffekte (Intra-Cluster-Verlagerungen)
2. Überregionale Verlagerungseffekte (Intra-Range-Verlagerungen)
3. Globale Verlagerungseffekte (Inter-Range-Verlagerungen).[21]

Regionale Verlagerungseffekte, auch als Intra-Cluster-Verlagerungen bezeichnet, definieren sämtliche Verlagerungen von Umschlagsvolumen zwischen Häfen in unmittelbarer geografischer Nähe, also zwischen Häfen, die innerhalb eines gemeinsamen sogenannten maritimen Clusters liegen. Diese Häfen sind in der Regel über den gleichen Hinterlandkorridor mit dem Hinterland verbunden. Als Beispiel ist das maritime Cluster Östliche Nordrange mit den Häfen Hamburg und Bremerhaven sowie dem 2012 eröffnenden Jadeweserport zu sehnen. Diese Häfen haben alle als Haupthinterlandverbindung die Zentralachse gemein. Es könnte mit der Eröffnung des Jadeweserports zu Volumenverschiebungen von Hamburg und Bremerhaven hin nach Wilhelmshaven kommen.

Überregionale Verlagerungseffekte, auch als Intra-Range-Verlagerungen, definiert, drücken die Volumenverschiebungen zwischen zwei maritimen Clustern aus. Diese Cluster verfügen üblicherweise über verschiedene Hinterlandkorridore. Auch dieser

[19] Vgl. Tiedemann (2011), S. 10.
[20] Vgl. Aberle (1994), S. 90ff.; Frass (2006); S. 6f.
[21] Vgl. zur Verlagerungsthematik Verhoeff (1977), S. 271-274; Hinricher (1990), S. 55-60.

Sachverhalt soll anhand eines kurzen Beispiels erläutert werden: So steht das Cluster Östliche Nordrange mit den Häfen Hamburg, Bremerhaven und Wilhelmshaven im Wettbewerb mit dem überregionalen Cluster Westliche Nordrange. Dazu zählen insbesondere Rotterdam, Antwerpen, Zeebrügge und Le Havre. So könnte beispielsweise die Eröffnung des Jadeweserports auch zu Volumenverschiebungen aus der Westlichen Nordrange nach Wilhelmshaven, also zur östlichen Nordrange, führen. Dies würde auch zu einer Volumenverlagerung auf den Hinterlandkorridoren führen. So würde im Falle der beschriebenen Verlagerung auch im Hinterland eine Verlagerung, von der Rheinachse auf die Zentralachse erfolgen.

Globale Verlagerungseffekte, auch als Inter-Range-Verlagerungen definiert, stellen die Wettbewerbsbeziehungen zwischen allen Häfen Kontinentaleuropas dar. Dabei geht es um die Verschiebungen zwischen den Häfen der Nordrange und dem Mittelmeer. Der Sachverhalt soll mit Hilfe eines kurzen Beispiels verdeutlicht werden. Ein Container mit Abgangshafen Schanghai und Zielort München könnte künftig aufgrund von Kapazitätsengpässen in den Häfen der Nordrange bereits in Triest im Mittelmeer umgeschlagen und via Bahn über die Alpen nach München transportiert werden. Es würde zu einer Volumenverschiebung von der Nordrange hin zum Mittelmeer kommen.

b. Potenzielle Hinterlandseitige Verlagerungseffekte

Potenzielle hinterlandseitige Verlagerungseffekte können in zwei Gruppen unterteilt werden:

1. Verkehrsträgerverlagerungen
2. Korridorverlagerungen

Von Verkehrsträgerverlagerungen wird gesprochen, wenn es zu einer Verschiebung von Containervolumen von einem Verkehrsträger auf einen anderen kommt, ohne dabei den Hinterlandkorridor zu wechseln. Als Beispiel wäre die Verlagerung von schienengebundenem Hinterlandvolumen auf das Binnenschiff, etwa auf der Rheinachse, falls es zu schienenseitigen Kapazitätsengpässen auf der Rheinachse kommen würde.

Korridorverlagerungen hingegen bezeichnen die Volumenverlagerung auf einen anderen Hinterlandkorridor. Diese geht häufig, jedoch nicht zwangsweise mit einer Intra-Range-Verlagerung einher.

4 Konsequenzen für Marktakteure und Politik

Inhalt dieses Kapitels ist es, zunächst Beispiele für potenzielle Abhängigkeiten der Akteure auf dem Markt durch Verlagerungseffekte zu untersuchen. Weiter sollen die sich aus den Abhängigkeiten ergebenden Herausforderungen für Marktakteure und Politik analysiert und schließlich potenzielle Lösungsansätze aufgezeigt werden.

4.1 Beispiele für Abhängigkeiten

Zunächst stellt sich die Frage, welche Verlagerungseffekte einen Einfluss auf das Handeln der Marktakteure und der Politik ausüben könnten. In diesem Artikel soll aufgrund der Komplexität der Materie jedoch nur auf Beispiele von Auswirkungen auf die Marktakteure durch potenzielle Verlagerungseffekte eingegangen werden. In diesem Zusammenhang sollen im nächsten Schritt zunächst die Marktteilnehmer anhand ihrer Funktion im Kombinierten Verkehr definiert und kurz skizziert werden. Für den weiteren Verlauf dieser Forschungsarbeit sollen als Marktteilnehmer für den kontinentaleuropäischen Containermarkt Reeder, Hafenbehörden, Terminalumschlagbetriebe, Eisenbahnverkehrsunternehmen, Binnenschifffahrtsunternehmen, Straßengüterverkehrsunternehmen und die Politik bezeichnet werden.[22] **Übersicht 4-1** charakterisiert die genannten Marktakteure anhand ihrer Funktion in der intermodalen Transportkette (ITK).

Übersicht 4-1 Charakterisierung der Marktakteure anhand ihrer Funktion in der ITK

Funtkion in der ITK	Hauptlauf	Umschlag	Vor-/Nachlauf
Ort	See	Seehafen	Hinterland
Marktakteure	- Reedereien	- Hafenbehörden - Umschlagbetriebe	- Eisenbahnverkehrsunternehmen - Binnneschifffahrtverkehrsunternehmen - Straßengüterverkehrsunternehmen
	- Politik	- Politik	- Politik

Quelle: Eigene Darstellung.

Am Hauptlauf sind die Reedereien beteiligt[23], am Umschlag sind es Hafenbehörden und Terminalumschlagbetriebe. Im Nachlauf sind Eisenbahn-, Binnenschifffahrts- und Straßengüterverkehrsunternehmen am Markt aktiv.[24] Die Politik vertritt die Interessen der Öffentlichkeit, also der EU, eines Staates, eines Landes oder einer Gemeinde. Daher soll sie als funktionsübergreifender Marktakteur betrachtet werden.[25]

Im nächsten Schritt soll nun beispielhaft untersucht werden, inwiefern die einzelnen Marktakteure von den in Kapitel drei aufgezeigten Verlagerungseffekten in einem Abhängigkeitsverhältnis stehen könnten. **Übersicht 4-2** stellt die beispielhafte Verlagerungseffekt-Marktakteur-Abhängigkeits-Matrix dar.

Der Schiffsgrößeneffekt und Intra-Cluster-Effekte könnten sich auf das Handeln von Reedern, Hafenbehörden und Terminalumschlagsbetrieben auswirken. Größere Schiffe oder die Verschiebung von Umschlagsmengen zwischen zwei Häfen innerhalb eines Clusters könnten beispielsweise die Umlaufplanung der Reeder einerseits aber auch die Infrastrukturplanung der Hafenbehörden und Terminalumschlagbetriebe andererseits beeinflussen.

Intra-Range- und Inter-Range-Effekte könnten neben den Auswirkungen auf Reedereien und Umschlagbetrieben auch zusätzliche Auswirkungen auf die Betriebsplanung

22 zum Unterschied zwischen Hafen und Terminalumschlagbetrieb vgl. Stopford (2009), S. 81-83.

23 Von Non Vessel Operating Common Carriern (NVOCC) soll bei dieser Betrachtung abgesehen werden, da diese auch bei eigener Hauptlaufplanung auf die Reeder angewiesen sind. [Vgl. zum Thema Anbieter im Hauptlauf auf Seefrachtmärkten z.B. Biebig/Althof/Wagener (2008), S. 122].

24 Auch einige Reeder organisieren den Hafen-Hinterlandverkehr teilweise in Eigenregie.

25 Auf einem detaillierten Level könnten auch die Interessen eines Landes oder einer Gemeinde betrachtet werden. Auf diesem Detaillevel könnten jedoch die Interessen verschiedener Politikgruppierungen durchaus divergieren, wovon in diesem Artikel allerdings abgesehen werden soll.

von Eisenbahnverkehrs- und Binnenschifffahrtsunternehmen haben. So könnten durch überregionale Volumenverschiebungen die Produktionskonzepte der Hinterlandcarrier beeinträchtigt werden. Während Straßengüterverkehrsunternehmen jedoch in der Lage sind, auf diese potenziell veränderten Rahmenbedingungen flexibel zu reagieren, so wären Binnenschiffer auf die Seehäfen mit Binnenwasserstraßenanschluss angewiesen. Eisenbahnverkehrsunternehmen hingegen müssten neue Trassen und Slots in den Häfen anmelden.

Übersicht 4-2 Beispielhafte Auswirkungen potenzieller Verlagerungen auf die Marktakteure

	HL	Umschlag		Vor-/Nachlauf			
	Reedereien	Hafenbehörden	Umschlagbetriebe	Eisenbahn	Binnenschifffahrt	Straßengüterverkehr	Politik
Schiffsgrößeneffekt	x	x	x				x
Intra-Cluster-Effekte	x	x	x				x
Intra-Range-Effekte	x	x	x	x	x		x
Inter-Range-Effekte	x	x	x	x	x		x
Verkehrsträgerverlagerungen		x	x	x	x	x	x
Korridorverlagerungen				x			x

Quelle: Eigene Darstellung.

Verkehrsträgerverlagerungseffekte im Hinterland könnten sich auf das Handeln von Umschlag- und Nachlaufakteuren auswirken. Hafenbehörden und Terminalumschlagbetriebe müssten gewährleisten, dass ihre Infrastruktureinrichtungen ausreichend Kapazitäten für die Abfertigung der entsprechenden Hinterlandcarrier aufweisen. Für die Hinterlandcarrier würde eine Verlagerung hin zu ihrem Verkehrsträger zusätzliche Geschäfte und damit andere Produktionsplanungen bedeuten. Dagegen würde eine Verlagerung von ihrem Verkehrsträger weg auf einen alternativen Verkehrsträger ein Verlust des eigenen Marktanteils bedeuten.

Korridorverlagerungen im Hinterland könnten sich besonders auf die strategische Planung von Eisenbahnverkehrsunternehmen auswirken, da die Sicherung von Trassenkapazitäten auf den Hinterlandkorridoren das entscheidende Kriterium für das Produktionskonzept Schiene im Kombinierten Verkehr darstellt.[26]

[26] Die Anzahl freier Trassen auf den Hinterlandkorridoren ist begrenzt. Ferner stehen die Eisenbahnverkehrsunternehmen im Wettbewerb um die Trassen mit dem konventionellen Güter- und Personenzugverkehr. Vgl. Scharfschwerdt (2010), S. 9.

Wie bereits zu Beginn dieses Unterkapitels erwähnt, nimmt die Politik eine Sonderrolle ein. Ihre Aufgabe besteht in der Regulierung der freien Marktwirtschaft und der Sicherung der langfristigen Interessen aller Akteure. Somit ist es ihre Aufgabe, die Marktbedingungen konstant zu halten. Daher ist ihr Handeln durch eine Abhängigkeit sämtlicher Verlagerungseffekte gekennzeichnet.

Nach Vorstellung einiger Beispiele zur Veranschaulichung sich ergebender potenzieller Abhängigkeitsverhältnisse sollen im nächsten Schritt die sich hieraus ergebenden Herausforderungen an die Marktakteure untersucht werden.

4.2 Herausforderungen an die Marktakteure und die Politik

Untersuchungseinheit dieses Unterkapitels ist das Aufzeigen der sich aufgrund der in Kapitel 4.1 aufgezeigten Verlagerungseffekten ergebenden Herausforderungen für die einzelnen Marktakteure. Dabei wird zunächst auf die die aktiven Marktteilnehmer und im Anschluss auf die Politik eingegangen.

Im Rahmen dieses Vorgehens soll unter einer Herausforderung ein *„Aktiver Eingriff in die bisherige Strategie oder das Fortsetzen der bestehenden Strategie unter zusätzlichem Ressourcenaufwand verstanden werden.“* In diesem Zusammenhang ist jedoch zu berücksichtigen, dass eine potenzielle Herausforderung für einen Marktakteur nicht zwangsläufig eine Herausforderung für einen anderen Akteur bedeuten muss.

a. Marktakteure

Bei den Marktakteuren ergeben sich generelle Herausforderungen an alle Marktteilnehmer, die sich jedoch auch spezifisch für die jeweilige Branche formulieren lassen. Daher werden zunächst die generellen Fragestellungen, präsentiert, im Anschluss daran wird auf die spezifischen Herausforderungen für die einzelnen Marktakteure eingegangen. Folgende **generelle Herausforderungen** könnten sich aufgrund der aufgezeigten Verlagerungseffekte an die aktiven Marktakteure ergeben:

- Von welchen Engpässen bin ich direkt oder indirekt betroffen? Welche Verlagerungseffekte sind die Ursache dafür?
- Wie werden sich künftig meine Produktionskosten entwickeln?
- Werden meine Kunden aufgrund des Volumeneffekts künftig trotz Engpässen über Preissenkungserwartungen verfügen?
- Wie kann ich die Qualität meines Produkts (Transport, Umschlag) langfristig sichern?
- Wie verhält sich die Konkurrenz?
- Wie habe ich aufgrund dieser Entwicklungen meine Strategie auszurichten und welche operativen Anforderungen ergeben sich daraus?

Aus diesen allgemeinen Fragestellungen könnten sich beispielsweise folgende spezielle Fragestellungen für die einzelnen Marktakteure ableiten lassen:

Reeder:

- Welche Häfen sollen wir künftig anlaufen?
- In welche Schiffstypen sollen wir investieren?

Hafenbehörden:

- Wie kann der Marktanteil in unserem Hafen/Cluster/Range trotz potenzieller Engpässe mindestens konstant gehalten werden?
- Welche Maßnahmen sind konkret in welchem Zeithorizont zu Ergreifen?

Terminalumschlagbetriebe:

- In welchen Häfen müssen wir uns künftig strategisch positionieren?
- Welche Erweiterungsmaßnahmen haben wir an unseren bestehenden Terminals zu ergreifen, um mit der Entwicklung der Flottenstruktur unserer Kunden mithalten zu können?

Eisenbahnverkehrsbetriebe:

- Wie können wir uns auf Schienenkorridoren mit potenziellen Engpassrisiken langfristig Kapazitäten sichern?
- Welche Alternativen stehen uns zur Verfügung, falls die benötigten Kapazitäten auf den Hinterlandachsen nicht mehr ausreichend sind?

Binnenschifffahrtsunternehmen:

- Was für Maßnahmen sind zu Ergreifen, falls es zu Verlagerungen von den Häfen mit Anschluss an das Binnenwasserstraßennetz zu Häfen mit ausschließlichem Schienen- und Straßenzugang auf der Landseite kommt?
- Wie kann der Modalsplit in den bestehenden Häfen erhöht werden?

Straßengüterverkehrsunternehmen:

- In welchen Häfen wird er künftig aufgrund von Engpässen im Schienennetz verstärkt zu einer steigenden Nachfrage nach Straßentransporten im Hinterland kommen?
- Welche Auswirkungen haben steigende Schiffsgrößen auf die flexible Nachfrage nach Straßentransportleistungen?

Nach Untersuchung der Herausforderungen für die Marktteilnehmer sollen im nächsten Schritt die Auswirkungen auf die Politik aufgezeigt werden.

b. Politik

Auch auf Seiten der Politik gibt es unterschiedliche Akteure, die ihrerseits unterschiedliche Interessen wahrnehmen, welche nicht immer zwangsläufig in Zielharmonie zueinanderstehen. So könnten als etwaige Politikgruppen in Kontinentaleuropa Gemeinden, Länder, Staaten oder auch die EU auftreten.

Inhalt dieses Kapitels ist es jedoch, die Anforderungen, die sich generell aus volkswirtschaftlicher Sicht ergeben, aufzuzeigen und keine Unterteilung der Interessen nach verschiedenen Politikgruppen vorzunehmen. Unter diesen Voraussetzungen könnten sich beispielsweise folgende **generelle Herausforderungen** an die Politik ergeben:

Wirtschaftspolitik:

- Ist der unbeschränkte Warenaustausch langfristig ohne Einschränkungen möglich?
- Welche Mengen würden im Falle von Engpässen über alternative Umschlagspunkte oder Korridore laufen?
- Welche Einschränkungen hat der Binnenverkehr aufgrund erhöhter Transitaufkommen zu befürchten?
- Wie kann ein fairer Wettbewerb bei allen Funktionen und Verkehrsträgern gewährleistet werden?

Arbeitsmarktpolitik:

- Wie können die Arbeitsplätze in der Transport- und Hafenwirtschaft langfristig gesichert werden?

Umweltpolitik:

- Wie können Supply Chains von anderen Kontinenten nach Kontinentaleuropa nachhaltig aufgebaut und CO_2 minimiert werden?
- Wie kann der vermehrte CO_2 Ausstoß durch ein erhöhtes Transportaufkommen gesenkt werden?
- Wie können die Kosten für vermehrten CO_2 Ausstoß verursachungsgerecht zugeordnet werden?

Sozialpolitik:

- Wie wird sich die Lärmbelästigung in Wohngegenden an Schienenkorridoren und Fernstraßen künftig entwickeln und welche Gegenmaßnahmen sind zu treffen?

Nach Aufzeigen der Herausforderungen, welche sich für die Marktakteure und die Politik aufgrund von Verlagerungseffekten ergeben könnten, sollen im nächsten Schritt potenzielle Lösungsansätze kurz vorgestellt werden.

4.3 Potenzielle Lösungsansätze

Ziel dieses Kapitels ist das Aufzeigen potenzieller Lösungsansätze für die in Kapitel 4.2 beschriebenen Herausforderungen. Dabei ist zu beachten, dass es sich bei denen im Rahmen dieses Kapitels formulierten Positionen um erste unverbindliche Denkansätze handelt, vor deren Umsetzung es einer spezifischeren Prüfung bedarf. Es werden zunächst potenzielle Lösungsansätze für die aktiven Marktakteure und im Anschluss für die Politik aufgezeigt.

a. Marktakteure

Ein entscheidender Grundgedanke für einen potenziellen Lösungsansatz ist das Erkennen und Betrachten der gesamten intermodalen Transportkette von der Quelle bis zur Senke als ein Produkt. Um die Zufriedenheit des Endkunden, also des Auftraggebers der Containertransportkette zu gewährleisten und damit auch langfristig die Kundenbindung zu sicheren, ist es notwendig sicherzustellen, dass die gesamte Transportkette reibungslos verläuft. Im Rahmen dieses Artikels sollen zwei Wege vorgestellt werden, wie dieses Ziel erreicht werden könnte. Dabei wird zunächst der Ansatz der vertikalen Kooperation und anschließend der Ansatz der Erweiterung des Produktportfolios entlang der Wertschöpfungstiefe vorgestellt.

Vertikale Kooperationen:

Kerngedanke der vertikalen Kooperation in der intermodalen Transportkette ist das Zusammenarbeiten von mindestens zwei Parteien aus den verschiedenen Bereichen Hauptlauf-, Vor- /Nachlauf und Umschlag.[27] Durch die Kooperation würden Informationsasymmetrien abgebaut und die Planungssicherheit der Akteure würde steigen.[28] So könnten beispielsweise komplette Transportketten in Zusammenarbeit von Reedern und Hinterlandoperateuren geplant werden, um eventuell entstehende Wohlfahrtsverluste in der Transportkette durch potenzielle Verlagerungseffekte zu minimieren oder sogar kompensieren. [29]

Erweiterung des Produktportfolios entlang der intermodalen Transportkette (Vertikale Integration):

Ein weiterer Ansatz zur Reaktion auf potenzielle Verlagerungseffekte wäre die Erweiterung des Produktportfolios entlang der Wertschöpfungskette. [30] In diesem Fall würde zwar ein Akteur das Risiko von Markteintrittskosten in einen anderen Bereich (Hauptlauf, Umschlag, Vor-und Nachlauf) eingehen, aber dem würde eine unabhängige Transportplanung über die gesamte Transportkette entgegenstehen. So gibt es beispielsweise bereits heute Reedereien, die über ihre eigenen Terminals oder Nachlauf-carrier-Gesellschaften verfügen. Für diesen Ansatz wäre jedoch eine gewisse Mindestgröße am Markt erforderlich, um steigende Kosten in den neuen Segmenten durch niedrige variable Kosten bei dem bestehenden Segment gewährleisten zu können.[31]

b. Politik

Der Instrumentenkasten der Politik verfügt über eine Vielfalt von Möglichkeiten, um die gewünschten Ziele zu erreichen. In diesem Artikel sollen potenzielle infrastrukturelle und gesetzliche Maßnahmen vorgestellt werden.

Infrastrukturelle Maßnahmen:

Bezüglich der infrastrukturellen Maßnahmen ist die Politik auf ein zusätzliches Finanzbudget angewiesen, welches es zur Lösung der in Kapitel 4.2 beschriebenen Problematik zunächst zu bewilligen gilt. Hierzu zählen sämtliche Maßnahmen zur Erweiterung der Kapazität von Wasserstraßen, Schienenkorridoren und Fernstraßen. Als konkretes Beispiel in Kontinentaleuropa wäre wasserseitig die Elbvertiefung von der Mündung bis Hamburg zu nennen. Schienenseitig wären alternative Bahntrassen parallel zu Rhein- und Zentralachse zu entrichten oder alte Bahntrassen zu sanieren, um die zu erwartenden Aufkommen bewältigen zu können.

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[27] Vgl. zum Thema Kooperation z.B. Picot/Dietl/Franck (2008), S.173ff.
[28] Wörnlein (2008) sieht in Kooperation künftig sogar nur das einzige Mittel gegen Engpässe in Häfen.
[29] Vgl. zum Thema Kooperation in intermodalen Transportketten: Hoffmann (2007), S. 284ff.
[30] Vgl. zum Thema vertikale Integration z.B. Riordan (1995), S. 356ff. Child/Faulkner (1998), S.120ff.
[31] Vgl. z.B. Szafera (2005) , S.81ff.

Gesetzliche Maßnahmen:

Durch die Anpassung der Gesetzeslage könnte der kontinentaleuropäische Containermarkt weitaus effizienter werden. Dazu zählen unter anderem folgende Punkte:

- Freier und einheitlicher Schienennetzzugang in der EU zur Steigerung der Effizienz auf den Schienenkorridoren mit hoher Auslastung. [32]
- Einheitliche europäische Standards auf allen Schienenkorridoren zur Erhöhung der Durchflussgeschwindigkeit und der Reduzierung von Engpässen. [33]
- Neutralität in Rangierbahnhöfen um Umwegfahrten zu alternativen Rangierbahnhöfen zu vermeiden und damit die Trassenkapazität im Schienennetz zu erhöhen.
- Zulassung von Doppelstockcontainerwagen auf ausgewählten Strecken zur Erhöhung der Kapazität.[34]

Förderung alternativer Verkehrskonzepte in Unabhängigkeit der bestehenden Marco Polo Standards.

5 Schlussbetrachtung

In diesem Artikel wurden die Auswirkungen für Marktakteure und die Politik aufgrund potenzieller Verlagerungseffekte auf dem kontinentaleuropäischen Containermarkt und potenzielle Lösungsansätze vorgestellt. Hierbei wurde zunächst der kontinentaleuropäische Containermarkt und seine Entwicklung zwischen 2000 und dem Vorkrisenjahr 2008 präsentiert. Im Anschluss daran wurden die sich aufgrund des künftigen Mengenwachstums ergebenden Verlagerungseffekte dargeboten. Ferner wurden beispielhaft die sich aus diesen Effekten ergebenden Konsequenzen für die Marktakteure und die Politik aufgezeigt und potenzielle Lösungsansätze präsentiert.

Es bleibt festzuhalten, dass das Thema Containerisierung in der kommenden Dekade voraussichtlich massiv an Bedeutung gewinnen wird. Dies bedeutet für die Wissenschaft und Forschung, den Containersektor als festen Bestandteil der Beschaffungslogistik zu integrieren und die Forschung auf diesem Gebiet zu intensivieren. Insbesondere die in Kapitel 3 beschriebenen Verlagerungseffekte gilt es künftig im Detail zu prüfen. Darüber hinaus sind die in Kapitel 4.2 beschriebenen Auswirkungen vertieft zu prüfen und konkrete Lösungsansätze auf Basis der in Kapitel 4.3 beschriebenen Ansätze zu entwickeln.

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[32] Begründet durch die Tatsache, dass in einigen europäischen Ländern das Schienennetz nicht vom Betrieb getrennt ist (z.B. in Deutschland, wo vier der sechs wichtigsten Hinterlandachsen durchlaufen), werden potenzielle freie Trassen nicht an private EVU vergeben, sondern zurückgehalten; vgl. hierzu Hedderich (1996), S. 60-63.

[33] Hierzu zählen unter anderem europaweite einheitliche Strom- und Zugsicherungssysteme auf allen Hauptstrecken.

[34] z.B. auf der Strecke Wilhelmshaven – Ruhrgebiet. Hier wurde bereits im Jahr 2006 eine Machbarkeitsstudie von der Firma TransCare AG im Auftrag des niedersächsischen Verkehrsministeriums angefertigt [vgl. TransCare (2006); Schiffahrt und Technik (2006), S. 34; DLR (2008, S. 68; S. 106)].

6 Literaturverzeichnis

Aberle, G. (1994): Verkehrsinfrastrukturpolitik und deren Auswirkung auf die Unternehmenslogistik, in: Isermann, H.: *„Logistik: Beschaffung, Produktion, Distribution"*, 1. Aufl. Landsberg a. Lech.

Alphaliner (2011): Weekly Newsletter, Issue 4, Paris.

Biebig, P. Althof, W.; Wagener, N. (2008): Seeverkehrswirtschaft, Kompendium, 4., bearbeitete und aktualisierte Auflage, München.

Containerisation International (2001-09): Yearbook 2001-09, London.

Child, J; Faulkner, D. (1998): Strategies of cooperation: Managing alliances, networks, and joint ventures, Oxford und New York.

DLR Deutsches Zentrum für Luft- und Raumfahrt e.V. (2008): Hafenhinterlandanbindung – Sinnvolle Koordination von Massnahmen im Schienenverkehr zur Bewältigung des zu erwartenden Verkehrsaufkommens. Abschlussbericht, Braunschweig.

Frass, J. (2006): Kapazitätsanalyse von Hinterlandverbindungen ausgewählter europäischer Seehäfen, Schriftenreihe des Instituts für Transportwirtschaft und Logistik, Nr. 4, Wirtschaftsuniversität Wien, Wien.

Hamburgisches Weltwirtschaftsinstitut HWWI (2006): Maritime Wirtschaft und Transportlogistik, Band A: Perspektiven des maritimen Handels – Frachtschifffahrt und Hafenwirtschaft, Hamburg.

Hedderich, A. (1996): Vertikale Desintegration im Schienenverkehr: theoretische Basisüberlegungen und Diskussion der Bahnstrukturreform in Deutschland, Hamburg.

Hinricher, M. (1990): Die Zukunftschancen kleiner und mittlerer Seehäfen. Eine Untersuchung am Beispiel ausgewählter Seehäfen der Hamburg-Antwerpen-Range, Göttingen.

Hoffmann, A. (2007): Unternehmensübergreifendes Kostenmanagement in intermodalen Prozessketten, Köln.

Johnson, K. M.; Garnett H. C. (1971): The Economics of Containerisation, Oxford.

Kummer, S.; Schramm, H.-J.; Sudy, I. (2009): Internationales Transport- und Logistikmanagement, Wien.

Maenning, W.; Sames, M. (2000): Determinanten der Seehafenwahl, in: *„Zeitschrift für Verkehrswissenschaft"*, 71. JG, Heft 2, Köln.

Ninnemann, J. (2006): Seehafenwettbewerb in Europa – Eine empirische Analyse der Wettbewerbsdeterminanten am Beispiel ausgewählter Containerhäfen der Nordrange und im Mittelmeer, Hamburg.

Notteboom, T. (2007): Spatial dynamics in the container load centers of the Le Havre-Hamburg range, in: *„Zeitschrift für Wirtschaftsgeographie"*, Jg. 51, Heft 2, S. 108-123, Halle (Saale).

Nuhn, H. (2005): Internationalisierung von Seehäfen. Vom Cityport und Gateway zum Interface globaler Transportketten; in: Neiberger, C.; Bertram, H.: *„Waren um die Welt bewegen. Strategien und Standorte im Management globaler Warenketten."*, S. 109-124, Mannheim.

Obermaier, R.; Müller, F.; Braun, H. (2007): Der Container als Artefakt eines Transportparadigmas: Akteure und Diffusionsphasen; in: Otto, A; Obermaier, R.: *„Logistikmanagement – Analyse, Bewertung und Gestaltung logistischer Systeme."*, S. 309-345, Wiesbaden.

Picot, A.; Dietl, H.; Franck, E. (2008): Organisation, 5. , aktualisierte Aufl., Stuttgart.

Riordan, M. H. (1995): What Is Vertical Integration?, in: *„Transaction cost economics. Theory and concepts"*, Volume 1, S. 356-373, Cheltenham, Camberley und Northampton.

Robinson, D. (1988): Serving the European Hinterland – A look at ports as distribution centres and the extensive European transportation network, in: *"North European Ports Study, The Hamburg – Le Havre Range"*, Colchester.

Rössler, T. (2009): Kapazitätsbedarf verdoppelt sich; in: *„DVZ Deutsche Verkehrs-Zeitung"*, 63. JG, Nr. 134, S. 4, Hamburg.

Scharfschwerdt, J. (2010): Schiene zentraler Wettbewerbsfaktor; in: *„DVZ Deutsche Verkehrs-Zeitung"*, 64. JG, Nr. 116, S. 9, Hamburg.

Schiffahrt und Technik (2006), 25. Jg., 4. Ausgabe, St. Augustin.

Stopford, M. (2009): Maritime Economics, 3. Edition, Abingdon.

Szafera, S. (2005): Multimodale Transportketten – Wertschöpfung durch Systemintegration. in: *„50 Jahre Innovationen in maritimer Wirtschaft und Logistik 1954 – 2004. Jubiläumsveranstaltung zum 50jährigen Bestehen des Instituts für Seeverkehrswirtschaft und Logistik"*, S. 81-91, Bremen.

Tiedemann, J. (2011): Wo können 18.000-TEU-Schiffe noch festmachen?; in: *„DVZ Verkehrsrundschau"*, Nr.9/2011, S. 10, München.

Transcare AG (2006): Machbarkeitsstudie zur Doppelstock-Container-Verladung, Wiesbaden.

Verhoeff, J. M. (1977), Seaport Competition: An Analysis of its Nature, in: *„International Journal of Transport Economics"*, Vol. IV, 2000, S. 271-284.

Wörnlein, P. (2008): Nur Kooperation hilft der maritimen Wirtschaft; in: *„DVZ Deutsche Verkehrs-Zeitung"*, 62. JG, Nr. 53/54, S. 1, Hamburg.

Internetquellen

http://europa.eu/legislation_summaries/environment/tackling_climate_change/l24465_de.htm, Seite abgerufen am 13.06.2011.

http://ec.europa.eu/transport/rail/doc/2008_05_21_comparison_corridor_reseaux.pdf; Seite abgerufen am 12.06.2011.

http://www.jadeweserport.de/cms/index.php?idcat=26, Seite abgerufen am 13.05.2011.

http://www.porto.sv.it/english/Autorit--P/Progetti/ilfuturo_uk.htm_cvt.htm, Seite abgerufen am 26.03.2011.

http://www.zeelandseaports.com/nl/projecten/project:wct.htm, Seite abgerufen am 08.04.2011.

Mobility in a globalised world - BMW

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Abstract
BMW is faced with a changing environment which is clustered in six main drivers. They are: Environment, economy, urban development, culture, politics and customer relationships. The following paper deals with a short impression of future challenges and explains how BMW succeeds to be one of the world's leading companies to deal with these global impacts in the automotive industry.

1 Introduction

Nowadays the industrial world is in a process of change. Especially the car industry has to build products that fit perfectly to their customers' expectations. To extract the needs it is necessary to cluster the facts of influence as shown below.

After giving a short summary of the main drivers of *project i*, the focus will be on products and sub products, which will be a revolution in driving with electric power.

1.1 Externality Environment

The climate change is one of the most important drivers for the automotive sector. The car seems to be one of the highest polluting factor in the system. Not only because it is producing CO2 output also because it is burning up a limited commodity. Considering recent numbers cars are producing 10% of the CO2 output globally[1] which seems to be quite low but bearing in mind that the number of people who are going to have cars is increasing rapidly, it is unavoidable to start changing the situation.

1.2 Economy

Through the shortage of resources the oil price is increasing rapidly. This leads to customers looking for alternatives to stay mobile. On a long-term view it is also important for companies to optimize the way of travelling for their employees. Changing to a sustainable way of transportation is very important. It helps to reduce costs, get involved in corporate social responsibility and keep the company attractive for employees with a similar sense for social and environmental responsibility.

1.3 Urban development

Every country from the BRIC to the G8 countries are faced with the fact of getting aware of mega cities. This brings the public to search for small, efficient and secure cars. These should also fit into their digital environment. Things like linking the car to the smart phone on the one hand and planning routes by checking traffic jams online on the other hand is getting a part of the daily business.

1.4 Culture

People tend to be more sustainable and socially responsible. This drives BMW to build a car, which fulfils the social needs of the potential customers. Using alternative and regenerative materials for building the car is the base where electric driving cars are based on to be fully sustainable.

[1] cf. Page 8, M. Nyenhuis

1.5 Politics

Especially in Germany it is regulated and charged depending how much CO2 output the car has. An electric car is tax free in the first 5 years.

1.6 Customer relationships

BMW reacts quickly to meet their customer's expectations: After realising that the demand for alternative energies is increasing rapidly, BMW responded with an innovative concept for future mobility. This pioneer work has a great impact on brand commitment and is therefore crucial for good customer relationships in the future.

2 BMW i. Born Electric.

The long term goal of BMW Efficient Dynamics is to combine efficiency with increased driving pleasure. Through continuous optimization of the vehicles, such as systematic weight reduction, innovative aerodynamics and engine efficiency measures, as well as the use of alternative drivetrain solutions and the research of new technologies, the goal is to provide sustainable mobility.

Following the BMW Efficient Dynamics approach – less emissions, more driving pleasure, BMW i develops visionary vehicles and technologies for the mobility of tomorrow. While making use of a wide range of existing BMW Efficient Dynamics technologies, BMW i goes one step further. BMW i takes a holistic approach with purpose-built vehicle concepts for electric mobility, a focus on sustainability throughout the development chain and a range of complementary mobility services, thereby redefining the understanding of personal mobility.

With two new vehicle concepts BMW i creates a new world of visionary mobility. On the one hand there is the BMW i3 Concept. Previously known as the Megacity Vehicle, the BMW Group's first series-produced all-electric car focuses on the mobility needs in urban areas and, as the first premium electric vehicle, reinvents the BMW attributes for the future. The second concept is the BMW i8 Concept, the most progressive sports car – modern in design, intelligent and innovative. Its unique eDrive plug-in hybrid design brings together a combustion engine and an electric drive system to create an extraordinary driving experience complemented by extremely low fuel consumption and emissions.

One of the great advantages of electric mobility is zero tail pipe emissions. Since electric engines use electric current rather than fuel to create propulsion, no climate-harming gases are created when fully electric vehicles and plug-in hybrids are driven in electric mode. If the energy to drive the vehicle is obtained from a renewable source, e.g. from wind or hydroelectric power, fully electric vehicles are climate-neutral and conserve natural resources. In addition, electro-mobility also raises the bar in terms of driving experience. Electric engines are extremely agile and a joy to drive.

2.1 Intelligent Mobility.

BMW i goes beyond the car – Mobility Services, an integral part of BMW i in addition to the vehicles, is an offering of comprehensive and custom-designed services that can be used independently of the vehicle itself. These mobility services focus, for example, on solutions that make more efficient use of existing parking space, intelligent navigation systems that can also offer location-based information, an Intermodal Route Planning service and premium car-sharing. In addition to developing and offering its own services, BMW i also provides services in partnership with other companies and makes strategic investments in mobility service providers. With this in mind, BMW I Ventures was founded. The goal of the company is to extend the product portfolio of BMW i by investing in high-potential service providers such as "MyCityWay".

Proactive Front Protection In both of the concept vehicles the camera-based proactive Front Protection system provides active safety which is designed to help prevent accidents or mitigate injuries. The system, which operates across the entire speed range, can detect a collision risk with preceding vehicles and warns the driver in good time, so that he can sharply reduce his speed and, if possible, still avoid an accident. In the speed range from 0 to 37 mph the system can now also detect pedestrians in addition to warning the driver in the event of an impending collision. It also assists by performing automatic emergency braking.

Driver assistance systems for urban driving – Parking Assistant and Traffic Jam Assistant.

Since the BMW i3 Concept is designed mainly for urban operation, the vehicle features two further driver assistance systems – the Parking Assistant and the Traffic Jam Assistant. The Parking Assistant now relieves the driver of the entire parking manoeuvre, performing acceleration and braking automatically. If multiple manoeuvres are required, the vehicle can also switch between forward and reverse direction without the driver's intervention.

The Traffic Jam Assistant – "Go with the flow"

Traffic jams are a part of everyday driving especially in megacities. The Traffic Jam Assistant makes driving less stressful under monotonous road conditions. By letting the vehicle "go with the flow", it allows the driver to get to his destination in a more relaxed state of mind. The Traffic Jam Assistant maintains a specified following distance from the vehicle in front and in particularly heavy traffic can autonomously control the speed of the vehicle right down to a standstill while providing active steering input. This enables the vehicle to help the driver stay on course right up to a speed of 25 mph – provided he keeps at least one hand on the steering wheel.

The BMW i remote functions.

Thanks to mobile devices, our digital life has long gone beyond home computers, taking place outside of our homes as well on the road - and through the application-based integration of mobile devices in the context of BMW ConnectedDrive.

Now available inside the vehicle this seamless integration of application-based remote functions allows the car to be accessed using a smartphone, to perform familiar functions such as remote locking and unlocking of the car, Car Finder and Google Local Search.

For the BMW i3 Concept and the BMW i8 Concept new features designed specifically for electric vehicles have been added to the known remote functions of BMW Connected Drive. These specific e-vehicle functions include remote-controlled charging and remote-controlled thermal preconditioning of the battery pack and vehicle interior. Remote-controlled charging allows the user to start the charging process at a time that can be determined by setting the start time. This function also allows the user to check the current battery charge status at any time, as well as how much longer the car will need until charging is completed.[2]

3 BMW i and Sustainability

Sustainability has played a defining role in the BMW Group's strategy and operations ever since the early 1970s. Since that time, many production processes have been optimised and many innovative BMW Efficient Dynamics technologies incorporated into the company's vehicles, which have significantly reduced emissions both during the manufacturing process and during the useful life of the vehicle.

But sustainability is not confined solely to environmental issues. The BMW Group addresses all three dimensions of sustainability: environmental, economic and social. Just how successful the BMW Group has been in its actions to promote sustainability is clear not least from its position in the Dow Jones Sustainability Index: in 2011 the BMW Group headed this ranking list for the seventh time running, making it the most sustainable company in the automotive sector.

For BMW i, sustainability is of fundamental importance throughout the entire value chain. From the earliest strategic and planning stages, therefore, clearly defined sustainability targets were set for the BMW i vehicles. All three sustainability aspects were addressed across the entire spectrum, from purchasing, development and production to sales and marketing.

The BMW i3 Concept proves beyond doubt how successfully these sustainability targets were achieved. The life cycle global warming potential (CO2e) of the BMW i3 Concept, assuming a European electricity mix (EU 25), is at least a third lower than

[2] http://www.bmw-i-usa.com/en_us/concept/

for a comparable highly efficient combustion-engine vehicle in the same segment. If the vehicle is powered by renewable electricity, the improvement increases to well over 50 per cent. This is reflected in a large number of innovative measures relating to the development, production and recycling stage. Some of these solutions were developed by suppliers. In this way BMW i is setting new standards of sustainability across the entire value chain. [3]

4 References

BMW (2011), Homepage: www.bmw-i-usa.com.

Nyenhuis, Mate (2007): Wirtschaftspolitische. Steuerungsmöglichkeiten zur CO2- Emissionsreduktion im Automobilsektor, Grin Verlag Norderstedt

[3] http://www.bmw-i-usa.com/en_us/concept/

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The term mobility has different meanings in the following science disciplines. In economics, mobility is the ability of an individual or a group to improve their economic status in relation to income and wealth within their lifetime or between generations. In information systems and computer science, mobility is used for the concept of mobile computing, in which a computer is transported by a person during normal use. Logistics creates by the design of logistics networks the infrastructure for the mobility of people and goods. Electric mobility is one of today's solutions from engineering perspective to reduce the need of energy resources and environmental impact. Moreover, for urban planning, mobility is the crunch question about how to optimise the different needs for mobility and how to link different transportation systems.
The conference "Mobility in a Globalised World" took place in Iserlohn, Germany, on September 14th – 15th, 2011. The aim of this conference was to provide an interdisciplinary forum for the exchange of ideas among practitioners, researchers, and government officials regarding the different modes of mobility in a globalised world, focusing on both domestic and international issues.
The proceedings at hand document the results of the presentations and pursuing discussions at the conference.

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