

Future Problems in Logistics Due to Demographic Change

Matthias Klumpp, Sascha Bioly and Christian Witte

Abstract

This research paper describes the impact of demographic change on the transport and logistics sector. Therefore, besides a literature review and a management option discussion in the end, the paper contains the following two main sections and methods: First an empirical report of a 2014 survey conducted in the research project “DO.WERT” regarding the working conditions of truck drivers in Germany (working hours, wages, motivation, qualification; n=483). Second, an optimization prognosis (GAMS conceptualization) for the German truck driver labor market in 2030 including increased traffic volumes, restricted carbon dioxide emissions as well as a market-based wage cost function draft. Existing research has shown that major disruptions in the “triangle” of increasing traffic volumes, decreasing populations and also politically intended decreases in carbon dioxide emissions have to be expected, for example for logistics wage and also freight rates markets.

Keywords: demographic change, transport volume simulation, road transport wage simulation, transport mode prognosis

1. Introduction

Demographic change in the form of less people and population shares within the workforce age will hit Germany and other European countries in the next 30 to 50 years. This may have severe consequences for specific economic sectors and industries as for example Thun, Größler and Miczka report for the German manufacturing industry (2007). First discussions are also starting regarding the logistics industry (e.g. Bioly, 2014; Kutlu, Klumpp and Bioly, 2013), highlighting the obviously increasing conflicting targets of economic growth, increasing traffic volumes and carbon reduction objectives while facing a shrinking workforce in logistics.

Therein the crucial occupational group of truck drivers in road transport has received special attention, for example as Min and Emam have shown for the impact on business results in the USA (2003). At the same time, especially this group is facing unfavorable social and working conditions already today (de Croon et al., 2004) - which will worsen due to a general lack of motivated and available people to enter this specific job segment in logistics: In Germany alone, up to 300.000 of altogether 800.000 truck drivers are expected to be retired in the next ten years - without proper concepts and ideas how and with which persons to replace them (BAG, 2012). As the most recent report from the European Commission outlines in April 2014, this problem is increasing due to time pressure, technological developments and requirements as well as health and security risks in road transportation (Europäische Kommission, 2014, p. 21). This may well further increase the already significant cost differences in trucking and road transport throughout Europe (figure 1).

Therefore, this research contribution outlines the significance of this occupational group for the whole logistics industry by discussing empirical results regarding working conditions 2014 in Germany (section 2), combining this with a draft simulation study regarding expected wage effects of demographic change (section 3) and a first draft of possible countermeasures and human resource concepts specifically for this group (section 4).

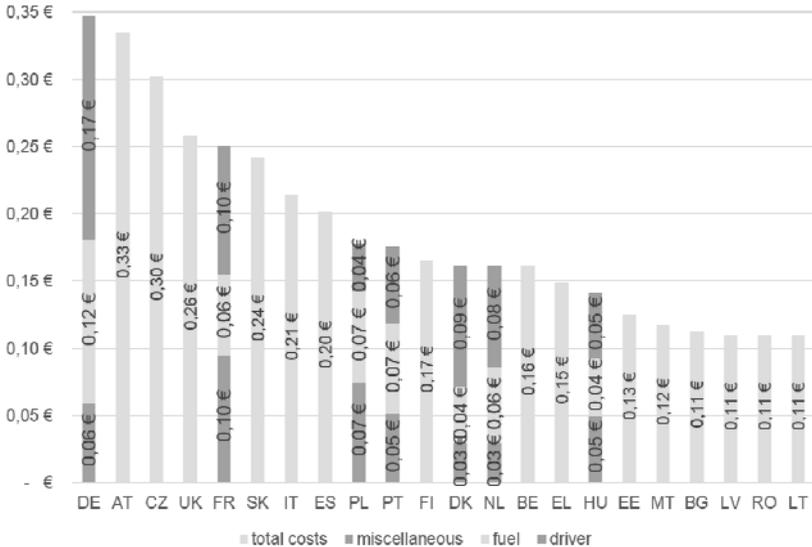


Fig. 1: Variable costs for trucking in Europe (Europäische Kommission, 2014, p. 12, 16)

2. Empirical Status Quo Description

During the first half of 2014 a survey was conducted in the research project “DO.WERT” regarding the working conditions of truck drivers in Germany regarding working hours, wages, motivation and qualifications. Truck drivers were asked in personal sessions at their work place, in trainings and seminars as well as e.g. in driver evening meetings (organized by the German police). Altogether 483 persons took part in the survey; the following results are reporting some highlights from the study.

(a) Gender: 96.4 % of drivers with professional experience are male, 3.6 % of them are female. With a view to the trainees, the proportion of female drivers with 6.3 % is twice as high. The proportion of male trainees here is 93.7 %. In the sophisticated examination of the group of trainees it is significant that 16.9

% of them are female trainees for becoming specialists in driving vehicles, but the proportion of professional female drivers in training is only 1.5 %.

(b) Appreciation: The appreciation which is brought to the trainees and the drivers with professional experience, by this it is assessed overall mediocre to negative. Altogether, the surveyed drivers feel despised by the society. About half of the respondents (55.3%) indicate that they were 'rather little' to 'very little' or to 'none' appreciated by the society (figure 1). Only 14 % feel 'very much' or 'rather much' appreciated by the society. 31 % valued this with 'mediocre'. On average, the rating is 3.6 on a scale from '1 = very much' to '5 = very little/none'. The standard deviation is 1.1.

With an average of 3.2 the respondents on side of the customers feel better appreciated. A quarter said that they are 'very much' or 'rather much' appreciated by customers, almost 40 % rate this as 'mediocre', 37 % feel 'rather little' or 'none' appreciated (next figure).

The appreciation the dispatcher have given to the drivers is rated on average with 3.1 and with a standard deviation of 1.2.

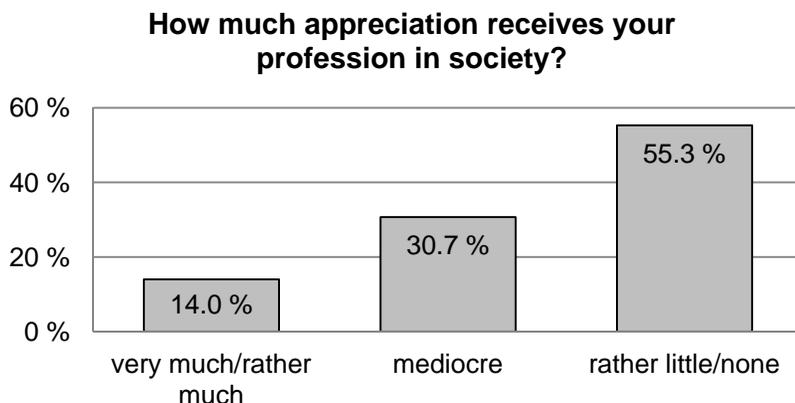


Fig. 2: Appreciation of vehicle drivers in society

How much appreciation do you receive from your customers?

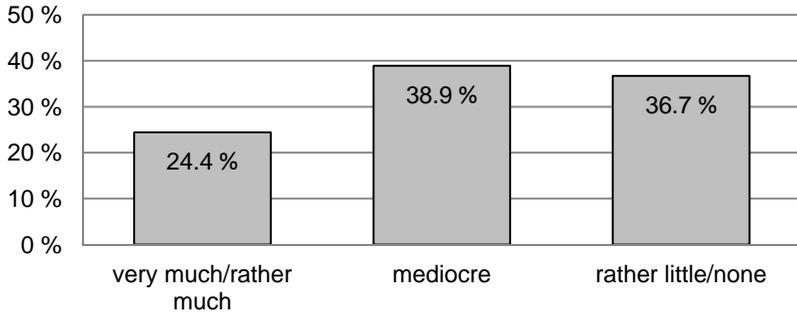


Fig. 3: Appreciation of customers

Nearly a third of the respondents is appreciated 'very much', 'rather much' or 'mediocre' by this group of people. 36 % feel 'rather little' or 'none' appreciated at this point.

How much appreciation do you receive from the dispatcher?

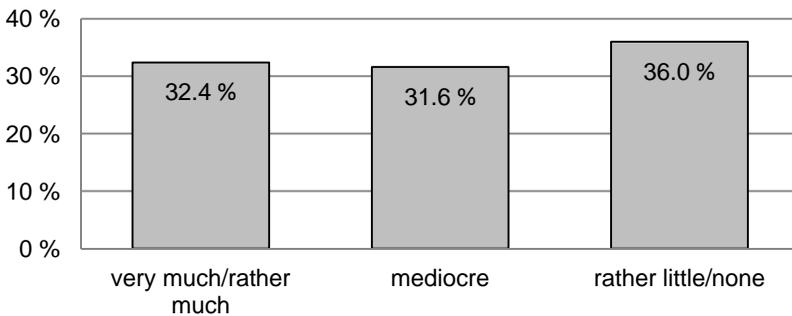


Fig. 4: Appreciation of dispatchers

(c) Career shifting: In figure 4 the result of the survey concerning the total entire professional and the period of professional experience in the current activity is shown. 0.9 % of all drivers specified that they had gathered more than 5 years of professional experience. 18.3 % of the respondents have been working for more than 5 years as a truck driver. This leads to the conclusion that a majority of the drivers completed an apprenticeship in this. Similar statements can be made in the groups of 6-10 years and 11-20 years. 9 % of the respondents have 6-10 years of professional experience. However, 19.7 % of the respondents work in their current work as a truck driver. 23 % possess between 11 to 20 years of professional experience. 28.4 % said that they have the same professional experience in their current activity. In the groups of 21-30 years and more than 30 years the proportion between the two surveys changes. The duration in the current job is shorter than the entire professional practice years. The greater the professional experience, the shorter the duration in the current job. This suggests a high proportion of career changers.

(d) Income and wages: The following figure shows the result of the survey with drivers regarding their monthly gross income. The monthly gross income regarding this survey is normally distributed. The majority of the drivers have a monthly gross income between 2000 € to 2499 € per month. These are 43 % of all surveyed drivers. 22.7 % of all drivers have a gross income between 1500 € to 1999 € and 23.7 % earn 2500 € to 2999 € per month. The minority of the drivers feature less than about 1499 € and more than 3000 € gross income per month.

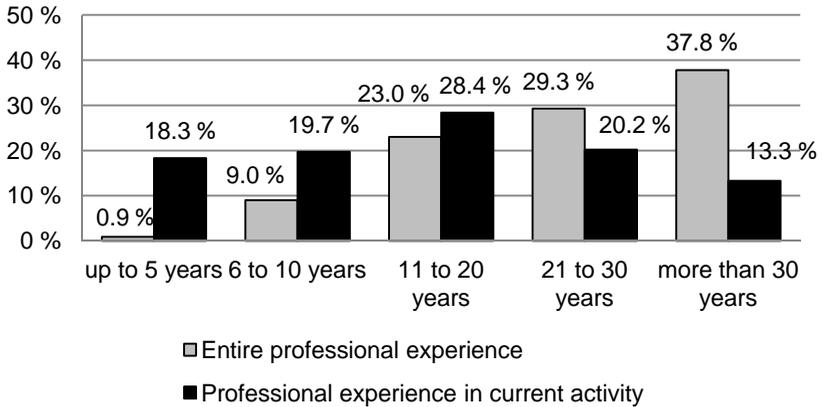


Fig. 5: Professional experience of vehicle drivers

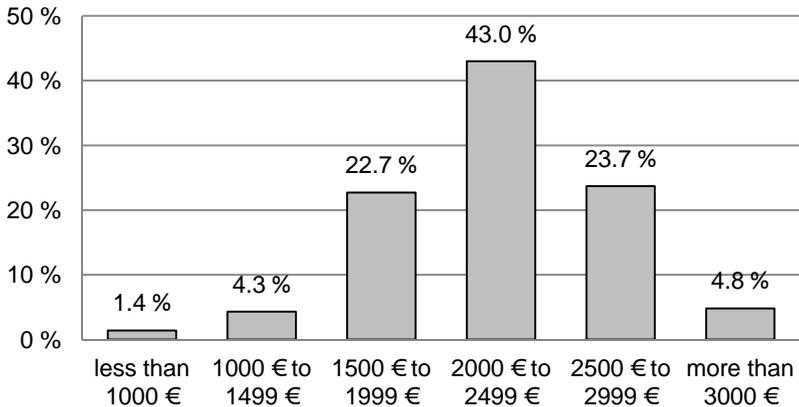


Fig. 6: Monthly gross income of vehicle drivers

3. GAMS Model Driver Wages - Outline

Already in 2013, a general GAMS model integrating the overall traffic volume, carbon emission restrictions as well as estimated per-kilometer-cost for the

European land transport modes road, rail and water (inland waterways) has been developed.

The General Algebraic Modeling System (GAMS) is a high-level modeling system for mathematical programming and optimization. It consists of a language compiler and a stable of integrated high-performance solvers. GAMS is tailored for complex, large scale modeling applications, and allows you to build large maintainable models that can be adapted quickly to new situations. GAMS allows the user to concentrate on the modeling problem by making the setup simple. The system takes care of the time-consuming details of the specific machine and system software implementation. GAMS is especially useful for handling large, complex, one-of-a-kind problems which may require many revisions to establish an accurate model. The system models problems in a highly compact and natural way. The user can change the formulation quickly and easily, can change from one solver to another, and can even convert from linear to nonlinear with little trouble (GAMS, 2014).

The model formulation is provided here in order to acknowledge the intended changes and extensions later in the chapter (Bioly, Klumpp, 2013):

GAMS Model (2030)

SETS

i modal capacity 2030 / road2011, train, ship, road2015, road2020,
road2025, road2030 /

j modal use 2030 / use /;

PARAMETERS

a(i) capacity in mio. tkm

/ road2011 371000, train 230000, ship 191000, road2015 44000,
road2020 42000, road2025 39700, road2030 371000 /

b(j) demand

/ use 1000000 /;

TABLE d(i,j) co2 emissions in gr per tkm

USE

road2011	45.75
train	24
ship	28
road2015	45.75
road2020	45.75
road2025	45.75
road2030	45.75;

TABLE e(i,j) costs per tkm

USE

road2011	0.0500
train	0.0550
ship	0.0350
road2015	0.0512
road2020	0.0554
road2025	0.0623
road2030	0.0721;

PARAMETER c(i,j) co2 per mode;

$$c(i,j) = d(i,j);$$

PARAMETER f(i,j) costs per mode;

$$f(i,j) = e(i,j);$$

VARIABLES

x(i,j) co2 emission per mode

y(i,j) costs per mode

w costs in total

z co2 in total;

POSITIVE VARIABLE x

POSITIVE VARIABLE y;

EQUATIONS

co2total co2 emission over all

coststot costs in total

```

supply(i)          obtain limit per mode
demand(j)         demand of transport;
CO2TOTAL ... sum((i,j), c(i,j)*x(i,j)) =l= 9999999999;
SUPPLY(i) ... sum(j, x(i,j)) =l= a(i);
DEMAND(j) ... sum(i, x(i,j)) =g= b(j);
*COSTTOT ... sum((i,j), f(i,j)*x(i,j)) =l= 46500;
COSTTOT ... z =e= sum((i,j), f(i,j)*x(i,j));
MODEL TRANSPORT /all/;
SOLVE TRANSPORT using lp minimizing z;
DISPLAY x.l, x.m;

```

In an extension this model is enlarged by replacing the generally assumed fixed cost rates per ton kilometer per mode with a dynamic variable cost function (at least for the road transport mode) including a volume-sensitive wage part for truck drivers. The basic groundwork and possible functions for this wage cost equation to be included in the overall cost minimizing model are described as follows: (i) The overall cost-minimizing objective function is kept as before; (ii) the specific cost determination function is separated / enhanced for the transport mode road; (iii) included in the road transport cost function is a wage determinant for truck drivers, according to the empirical total cost share of personnel cost in the road transport sector (EU data); (iv) the wage cost rate is defined further as standard linear function of a fixed wage set and an increasing wage share depending on the overall freight volume transported on roads and hitherto the overall demand for truck driving personnel (according to standard market assumptions for labor markets); (v) the overall road transport cost function is determined per ton kilometer in order to allow the model easily to shift transport volume between modes (though in many cases costs may actually be "step-fixed" due to full/empty running complete trucks, a linear approach for each single ton kilometer is practically not feasible but within this linear model).

In the previous model the transport rates per ton-km are fixed by 5 cents for the road, 5.5 cents for the train and 3.5 cents per ton-km for the ship. A more realistic representation includes dynamic prices, which are influenced by offer and demand, at least in the medium and long term view. The composition of cost to road transport for Germany includes personnel costs of 56%, fuel costs of 35% and other costs (17%). A very similar structure of costs exists in the Netherlands and in Denmark (NL: 47%, 35%, 18% DK: 56%, 26%, 18%). Other European countries deviate from this, however, the division in Poland provides 20% personal, 38% fuel and 42% other costs (c.p. Europäische Kommission (2014), p. 12).

When modeling in GAMS corresponding country specifics have to be taken into account. Following parameters for Germany are assumed for the rest and in addition, to optimize the fuel and other costs are represented as fixed: transport costs on the road (0.05 euros per tkm), means personnel costs (56%) in amount of 0,028 euros per ton-km. The labor costs can have different progressions and varied methods of calculation are possible:

On the one hand, labor costs can be linear with increasing demand. Here are virtually only positive slope of the straight (blue line). The second is a function with jumps for the labor costs at certain intervals, then jump to the next pay level upon reaching a critical demand for a certain amount and interval are fixed again (red line). Another possibility is an exponential curve, as demand increases, the pool of potential drivers is getting smaller (green line).

Apart from the different developments then arises the question of the calculation. Conceivable here are two basic approaches: one is the integral from 0 to the transport capacity m_1 (blue dotted area). Here, it is assumed that results in an increase in personnel costs have no direct impact on the other drivers. On the other hand, you can argue the total cost as a square with the two multipliers p_1 price in Euro and haulage capacity m_1 in ton-km. The latter is a rather longer-term view, which assumes the price adjustment develop (here in the form of higher wage costs) over time throughout the system homogeneous.

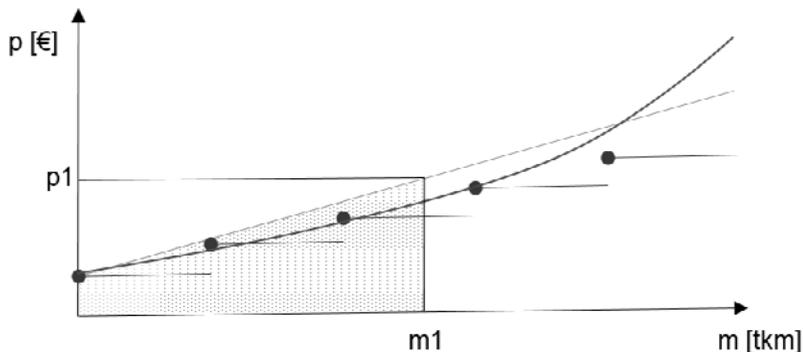


Fig. 7: Possible forms of a dynamic truck driver wage function

The two questions (history of wage cost function and calculation of the total cost in the system) should be clarified before from the previously (with static prices) provided GAMS model into a dynamic GAMS model. These mode-specific functions must be determined individually for all modes of transport. For this purpose, among other things it has to include the future offer of operators (drivers) - which directly affects the slope of the graph.

The traffic forecast for the coming years give of course no exact figures of future traffic flows. But almost certainly it can be assumed that compared to today the traffic performance continues growing because of a growing economy.

In the economic policy debate the need of maintenance for roads and bridges occurs and it is talked about the inescapable expansion of infrastructure in the future. In Germany this is accompanied immediately to the discussion about the origin of funds and the use of funds for these activities. And there is a dispute for necessary future modal splits which are satisfying the demand while being sustainable.

For decades now the demographic change is observed and analyzed. The discussions about the more or less acute shortage of skilled labor, which will sooner or later hit Germany, are in full swing. Even today forwarders and

logistics service providers complain in general about staffing problems. But what exactly will that mean for logistics in Germany?

It is to suggest that a shortage of offer (in infrastructure and transport capacity) with a simultaneous increase in request (growing of traffic) will have medium and long term impact on the price of transport services. The infrastructure issue will need to be clarified in state custody - maybe by toll systems to increase revenue or new or other taxes. However, there is another aspect: the driver and not the individual drivers in itself, but the (personnel) costs.

What is the cost development at the different modes of transport? It is undisputed that the different transport modes are more or less labor intensive. While a truck driver can move 24-25 tons at 8-9 hours a day, train drivers or boaters can accordingly provide other (higher) transport services per day. It is assumed that an increase in the price (air traffic is not taken into account here) road freight per ton-kilometer is therefore highest burdened.

4. Measures and Concepts for the Future

In order to mitigate the described effects of demographic change in the logistics labor market, companies would have to develop measures that tackle this development. According to the following figure there are four areas theoretically discernible in order to deal with the problem area, alas shortages of available labor in general (Bioly, Sandhaus, Klumpp, 2014, p. 4; Stölzle, Ivisic, 2013).

First it is obvious, that the enlargement of the weekly or monthly productive working time (e.g. driving for truck drivers) is a major optimization field and chance to tackle the described problems (i). Furthermore, a second approach is the (ii) increase of the total workforce by attracting more and new personnel for logistics and driving professions. Third, working efficiency within the dedicated working hours may (iii) be improved especially by support structures and instruments, e.g. computer and software support e.g. for planning and control (navigation, communication). Furthermore, a second approach is the (ii) increase of the total workforce by attracting more and new personnel for

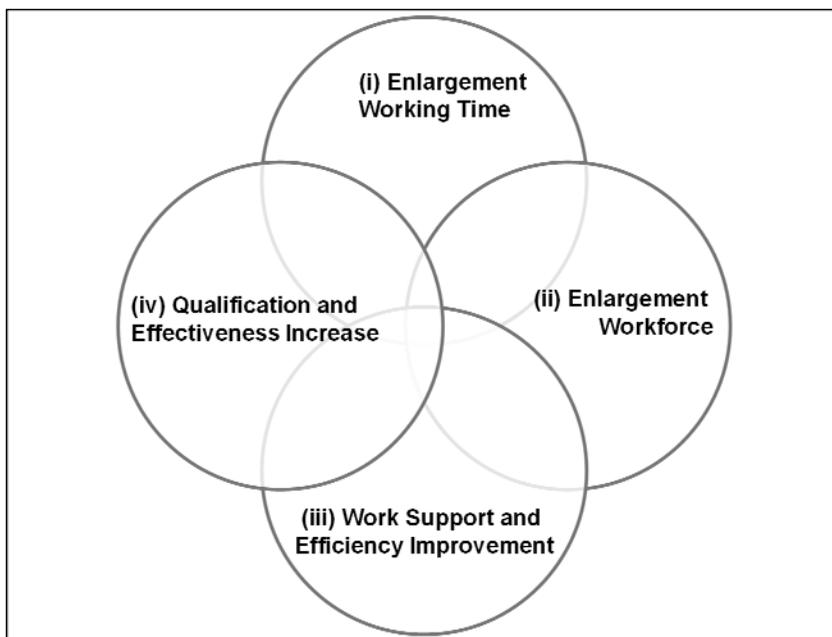


Fig. 8: Potential fields for measurements

logistics and driving professions. Third, working efficiency within the dedicated working hours may (iii) be improved especially by support structures and instruments, e.g. computer and software support e.g. for planning and control (navigation, communication). Last but not least, (iv) the qualification and therefore overall effectiveness of the logistics and driving personnel may be enhanced by specific measures (training, qualification, testing). Altogether these measures are also inclined to "support" each other, respectively to strengthen their individual benefits, e.g. when higher qualified personnel may work more efficient with navigation and fleet management equipment at even a "progressive" improvement rate as navigation support and added knowledge e.g. regarding customer specifics may help each other to find even more effective ways in transport and logistics (e.g. by suggesting "cumulative" transport intervals once per week instead of daily deliveries). For the first of

these areas (i) a case report is outlined in order to explain this structural approach:

In order to extend the available productive working time e.g. for truck drivers, only the productive working time per week may be a feasible option as other approaches regarding the extension of "total life working time" at the beginning (shorting school/education times) and at the end (postponing retirement) may are not applicable (Bioly, Sandhaus, Klumpp, 2014, p. 13-15). During one week with a maximum of 45 hours driving time according to the relevant EU legal framework, only 22.7 hours are actually used for driving in the present situation (average across all fields of short and long distance truck drivers). Therefore, especially at the beginning and the end of driving shifts per day a change and optimization is feasible, e.g. for the question of loading and unloading vehicles at the depot (i.e. CEP services). At this phase, other personnel or even the implementation of automated loading and unloading equipment may be a solution: Automated truck loading systems (ATLS) are technically implemented since the 1980s (IPL, 2008). But the crucial point and process of actual truck loading - inside the truck - is not yet implemented in significant numbers (less than 1 percent of all cases), in contrast to many practical automated intralogistics systems ("Fahrerloser Transportsysteme - FTS"). Though suppliers of such systems as e.g. the Dutch "ANCRA" corporation advertise these systems with their manifold advantages, leading in essence to a reduction of loading times from 40 minutes on average to a minimum of 5 to 8 minutes:

- Reduction of overall handling costs (compared to forklift handling);
- Less personnel required;
- Less moving equipment to be purchased and maintained;
- Less handling "ramps" / gates necessary;
- Smaller total handling space required (smaller hub buildings);
- Less quality problems and damaged goods;
- Increased security for personnel (reduced number and severity of accidents).

This is naturally highly dependent on the total handling and transport volume; though the most interesting advantage besides the reduced number of required personnel in the above described context also the further advantages especially regarding security are important. According to different sources up to one fourth of all accidents with logistics personnel are happening in transition handling with forklift trucks (UK numbers by "Health and Safety Executive"). Therefore a strategic investment and switch to automated loading systems may be a general quality and effectiveness driver. First implementation corporations are e.g. Procter & Gamble in Tapeji del Rio (Mexico), Unilever in Chicago (USA) and Heineken in Zoeterwoude (Holland), examples and video descriptions are available (<http://goo.gl/ZgT9OH>). Though it has to be highlighted for this case application that specific restrictions e.g. for security have to be incorporated, no matter which person or even machine is actually loading and unloading the truck (secure loading and unloading as responsibility of the industry as well as logistics company according to § 22 StVO and HGB in Germany:

"According to the German Commercial Code (HGB), the carrier must provide a so called 'reliable loading.' This implies that the vehicle complies with the prescribed dimensions, weights and axle loads according to the transported goods. Based on the Employment Protection Act the carrier also has to ensure that the driver knows and observes the rules of proper cargo securing."

This has to be observed even when other personnel or machines are implementing the loading, implying that significant checking and controlling times have to be allocated to the driver anyway.

5. Conclusion and Outlook

The presented article has shown the dominant importance of demographic change for the logistics sector, exemplified with the core part of truck drivers and their work for logistics.

The described empirical results highlight the problems already today, especially general and professional appreciation towards truck drivers. This situation will probably worsen and then again increase the labor gap and therefore imply possible shortages in trucking supply for logistics. This would imply significantly rising transport rates as well as driver wages as indicated in the outlined GAMS optimization model as a first draft.

For further research and also the impact on business practice and public policy, the main effects as identified here have to be supported and tested by further inquiries, maybe also in a combination of empirical testing and quantitative simulation as outlined in this paper.

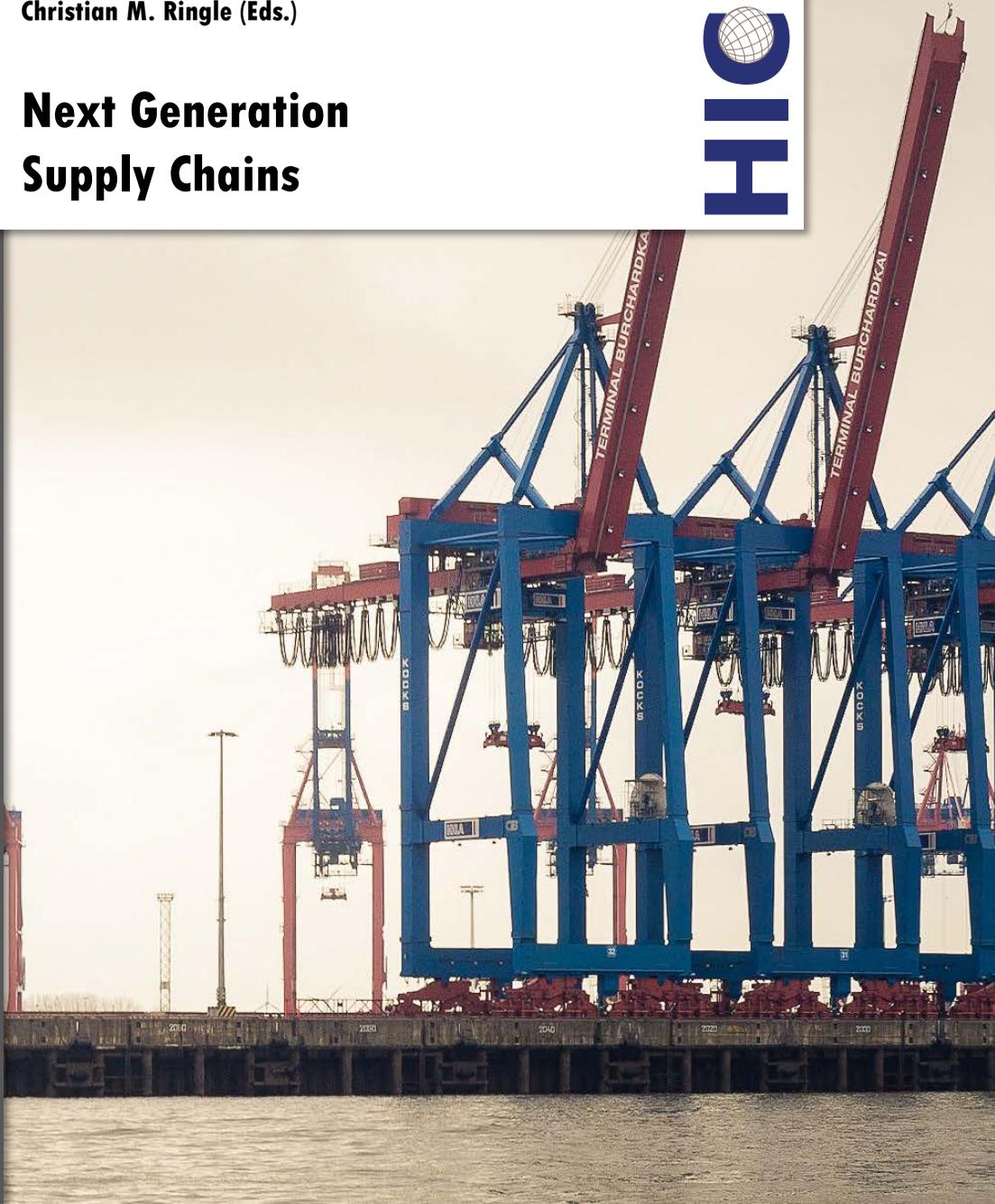
In any case, the question of availability, motivation and qualification of logistics personnel as for example truck drivers is a keystone of the future development of logistics in Germany and Europe.

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Christian M. Ringle (Eds.)**

Next Generation Supply Chains



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Next Generation Supply Chains

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Preface

Today's business environment is undergoing significant changes. Demand patterns constantly claim for greener products from more sustainable supply chains. Handling these customer needs, embedded in a sophisticated and complex supply chain environment, are putting the players under a constant pressure: Ecological and social issues arise additionally to challenges like technology management and efficiency enhancement. Concurrently each of these holds incredible opportunities to separate from competitors, yet also increases chain complexity and risks.

This book addresses the hot spots of discussion for future supply chain solutions. It contains manuscripts by international authors providing comprehensive insights into topics like sustainability, supply chain risk management and provides future outlooks to the field of supply chain management. All manuscripts contribute to theory development and verification in their respective area of research.

We would like to thank the authors for their excellent contributions, which advance the logistics research progress. Without their support and hard work, the creation of this volume would not have been possible. We would also like to thank Sara Kheiravar, Tabea Tressin, Matthias Ehni and Niels Hackius for their efforts to prepare, structure and finalize this book.

Hamburg, August 2014

Prof. Dr. Dr. h. c. Wolfgang Kersten
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About HICL

Since 2006 the annual conference Hamburg International Conference of Logistics (HICL) at Hamburg University of Technology (TUHH) is dedicated to facilitate the exchange of ideas and contribute to the improved understanding and practice of Logistics and SCM. HICL creates a creative environment which attracts researchers, practitioners, and industry thinkers from all around the world.



Innovation is increasingly considered as an enabler of business competitive advantage. More and more organizations focus on satisfying their consumer's demand of innovative and qualitative products and services by applying both technology-supported and non technology-supported innovative methods in their supply chain practices. Due to its very characteristic i.e. novelty, innovation is double-edged sword; capturing value from innovative methods in supply chain practices has been one of the important topics among practitioners as well as researchers of the field.

This volume, edited by Thorsten Blecker, Wolfgang Kersten and Christian Ringle, provides valuable insights into:

- Innovative and technology-based solutions
- Supply chain security management
- Cooperation and performance practices in supply chain management

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