Freight transportation - today and tomorrow

An in-depth look at logistics and traffic flow in Gothenburg and Shanghai

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AN IN-DEPTH LOOK AT LOGISTICS AND TRAFFIC FLOW
IN GOTHENBURG AND SHANGHAI

FINAL REPORT

A project on behalf of Autoliv Development AB

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Preface

The project team, Joel Lindqvist Ivarsson and Emil Thunberg would like to thank all parties who contributed to the success of the project; our supervisor at Halmstad University, Leif Nordin, our supervisor at Autoliv, Per Gustafsson, as well as Autoliv’s Shanghai office and representatives of the businesses which contributed to the ability for us to create realistic scenarios.

The project has been a learning process. Being able to take part in a development process for a product that is both innovative yet likely to be seen in the future has been a fun and valuable experience. The project team has learned how research and development works at an international business, an experience which will be an important lesson for future endeavors.

Finally, we would like to thank Autoliv for giving us the opportunity to undertake the project. Working with Autoliv has been a very pleasant experience – the project team was given a great degree of freedom when developing ideas and methods, but could always rely on the vast knowledge base of the company when needed.

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Abstract

The project team has, on behalf of Autoliv Development AB, analyzed transport flow and logistics in Gothenburg and Shanghai as well as its effects on the society and environment.

The project team looked in-depth at different logistics operations, which served as basis for different scenario simulations. Key points of interest in the simulation were traffic safety (including congestion and noise exposure), efficiency, cost and the environmental effect.

Due to confidentiality, the original text has been removed. The text above gives a brief overview of different parts of the project.
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1 Introduction

1.1 Project Background
The project team was assigned an already existing project, to be carried out for Autoliv Development AB. The project as a whole was already ongoing and the project group was asked to evaluate different aspects of the product.

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1.2 Project Aim
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The aim of the project is to investigate the state-of-the-art freight systems used today and how typical freight transports look on a regular basis. Furthermore, the project will look into how the shift in transportation hours would affect both the flow of goods as well as traffic flow and what impact the shift would have on traffic safety.

1.3 Project Goal
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In order evaluate the possibility of the project being successful, the project team has been asked to evaluate the following points:

- The number of freight vehicles (trucks) that pass through given cities (Gothenburg and Shanghai) per day and the volume and weight that these vehicles carry.
- What level of security/safety that is needed, regarding:
  - Crash safety/prevention
- To develop guidelines regarding demands on the equipment
- Recommendations regarding product design.

1.4 Project Limitations
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Limitations for the project are primarily regarding safety issues – for this project, only safety questions in regards to logistics and vehicle flow/accessibility will be examined.
2 Method

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In order to work towards results for the given points, the project has been analyzed in three different subsets, describing methods used; Research, Conceptualization and Risk.

The knowledge gained through research will provide valuable insight into developed concepts and design specifications provided to Autoliv. Finally, the risk phase analyzes both risks towards the implementation of the concept as well as risks towards the success of the project.

In order to deem the project worthy of implementation or not, a certain degree of simulation will be necessary. This will be handled in the conceptualization phase, where data acquired through research will be used as a base for these calculations.

2.1 Research

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2.2 Conceptualization

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2.3 Product Risk

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2.4 Project risk

2.4.1 Knowledge Gaps

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An additional significant knowledge gap is the project team’s lack of experience regarding automotive engineering. In order to successfully model different problems involving simple aerodynamic-, motor power-, torque- and battery capacity calculations – as well as programming them in Wolfram Mathematica 10.0, was a learning/re-learning process.

2.4.2 Data/Information

One of the largest risks to the project as a whole, and the scenarios in particular, is the retrieval of credible data/information.

For the first phase of the project, data regarding freight volumes that pass through the two cities is needed – this is a lesser problem regarding Gothenburg as Sweden has a wide array of public records and government agencies that provide accessible information. To retrieve credible data
for Shanghai is a tougher task, as most of the government agency websites are in Chinese. To ease this burden, the Autoliv Shanghai office provided some simple figures for freight volumes.

Developing realistic scenarios involves contacting enterprises regarding data on their goods, logistics setup, freight volumes etc. which can cause problems when dealing with the project confidentiality, as well as initiating a dependency on a third party for information which is important for the progression of the project.

2.4.3 Time
All projects have set start and end dates – in this case the start date was in the middle of December, and the end date in the end of May. This provided the project team with roughly 6 months to complete the task.

The biggest risk to the completion of the project in the given time interval is the project team’s time management as well as not acquiring adequate data from third party sources to create realistic scenarios. In order to overcome these problems, the project team used Gantt charts to plan activities ahead of time – this enabled the team to have an overview over the progression of both critical parts of the project as well as the project as a whole.

3 Theory
3.1 The title of this chapter has been changed due to confidentiality
3.1.1 The need for freight transportation

The development of a global market has forced corporations to develop a global supply chain management and to redesign their distribution system - new markets and economies have risen and borders are blurring. Developments in information technologies and accessibility has led to the implementation of e.g. flexible manufacturing and EDI (electronic data interchange)-messaging. Where traditional logistics generally had predictable orders and mainly dealt with business-to-business, many businesses today deal with a demand-driven, pull-oriented business-to-customer relation.

Speranza, *New Trends in Distribution Logistics*, (1999), argues that flexible manufacturing has caused the distribution of goods to be an integrated part of the final product. The customers of today can customize their goods as they wish and expect a just-in-time delivery. For this to work effectively, distribution networks need to be set up to accommodate flexibility and quality for the transportation service. One of the most important factors for customer service is speed, and the reduction of lead time. For a company to reduce their lead time, transportation is a vital factor.
In Van Binsbergen & Visser’s report *New Urban Goods Distribution Systems,* (2012) they state that, despite causing noise, air pollution, physical hindrance (congestion) and decreased traffic safety, urban goods transportation is a crucial aspect in maintaining a prosperous city, especially as a means of providing shopping areas with goods - which in turn attracts consumers.

In order to maintain an attractive city center, city officials need to take proactive steps regarding urban planning to limit problems regarding accessibility and logistical inefficiency for goods transportation. These problems contribute to increased travel times, and less effective logistic systems.

For most urban areas, goods transportation is fully reliant on motorized road transportation – trucks, cars or vans distribute and collect goods. The spatial characteristics (street layout, bridges, sharp turns etc.) and high amount of human presence (pedestrians, workers, tourists) in cities can be classified as a relatively uncontrolled environment, hence, a certain set of demands are made on intra-city transport vehicles.

Goods transport by road and rail often mix with other traffic flows, however, rail transportation is rarely used for intra-city transportation. Some infrastructure in urban areas can be reserved for goods transportation (e.g. specific lanes).

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A different approach to the reasoning for the development of sustainable transportation systems is the *SEVS Project.* SEVS incorporates trends in areas outside possible technological advances and the transportation system itself as factors which have even greater influence on shift in forms of transportation. The project has analyzed electro-mobility as one of the prime solutions for possible transportation systems, and used Gothenburg (a smaller European city) and Shanghai (an Asian megacity) as references (Grauers, A et al. 2016)

There is a strong trend towards developing a sustainable society, in which transportation systems is a big factor. Changing transportation systems is often viewed as a question of developing new vehicles or fuels, but the main driving force for a transition in transportation systems can be found outside the system itself, and is also subject to change. The rate of change for these forces is also different for different geographical factors, which also contributes to the development of road transportation systems.
The demand for sustainable transportation will change not only the vehicles, but business models, development- and production processes, services, technology, education, supply chain management and so on. However, to reach this change requires the collaboration of several of these different sectors.

The project produced a number of “difficult questions”:

- Which are the most important driving forces and indicators for electro-mobility?
- How will policies and rules develop within freight transportation – e.g. distribution terminals, night-time deliveries and zero-emission zones?
- What is needed to change the (currently slow) rate in consumer behavior towards electro-mobility?
- Which technological crossroads will we be forced to face?

By analyzing the different questions a number of driving forces were identified and summarized in six main groups:

1. Political/Legal
2. Economical
3. Spatial: land use/city planning
4. Social: values, ideas, behavior
5. Technological
6. Environmental

SEVS developed a number of different scenarios for freight transportation as well as passenger vehicles. When developing the scenarios, the driving forces were ranked in order of how much they would influence future development of transportation systems as well as with which degree of certainty they could be predicted. Their findings showed that the development of some of the critical factors are also very uncertain, which indicates an uncertain future.

Some driving forces are, on the other hand, rather predictable. In their work, the SEVS team used two main dimensions to develop their scenarios:

- Proactive vs. Reactive political systems
- Radical change of transportation patterns due to lifestyle choices vs. no change in transportation patterns due to lifestyle choices.

According to SEVS, the development of scenarios is an effective tool to analyze different solutions from a wider perspective and creates a common ground for people to test ideas and to discuss different aspects.
Grauers, A et al. (2016) finalized their report with a number of research/demo areas that were of interest for the future, including:

- How would technologies, such as autonomous systems, affect society and what requirements are required for it to happen? What signifies solutions which have a high probability to be implemented? How are solutions or breakthroughs affected in different scenarios – and how is traffic safety affected?
- Traffic safety – How will traffic safety be affected when cities are planned for a number of different vehicles as well as a demographic shift towards a greater population of elderly?
- What solutions or combinations of solutions are the most profitable and under what conditions? What would be required in order to implement solutions that have been tested in a larger scale?

3.1.3 Technology today – Passenger vehicles

In 2015, Mike Bell, the director of connected cars at industry pioneers Jaguar Land Rover, claimed that the industry was at level 1 or 2 (according to their model, the level of automation of vehicles can be broken down into 6 different levels, 0 through 5. These 6 levels can be seen in figure 1.). Jaguar Land Rover aims to reach the final product in different steps, shown in figure 2. The company was one of the first to develop autonomous systems with adaptive cruise control in 1996, which is a predecessor to the newer technologies.
According to Mike Bell, the challenges for today’s industry is to get the different technologies that control acceleration, steering, braking and sensors that collect data about the surroundings to work in unison. This is currently the level of intelligence that differentiates the machines from a human driver. The vehicles can follow tracks or maneuver around a highway, which is relatively predictable, but moving around a busy urban environment, with pedestrians and certain traffic situations that even pose challenges to human drivers today are a big challenge.
Besides Jaguar, there are several other companies that have developed plans of implementing autonomous vehicles in urban areas. Volvo, Google, Tesla and Nissan are all experimenting with driverless cars and different levels of autonomy. Volvo’s IntelliSafe project will test 100 self-driving cars on public roads in 2017. Their vision is that nobody will be seriously injured or killed in a new Volvo by 2020. For further insight into state of the art delivery systems, see appendix VI.

In the United Kingdom, tests are being made in four different cities regarding the implementation of autonomous vehicles. KPMG’s report *Connected and Autonomous Vehicles – The UK Economic Opportunity*, (2015) states that the autonomous vehicle industry is estimated to have halved the number of vehicle accidents caused by human errors by 2030 (which accounts for 94% of traffic accidents today). Furthermore, the reports states that the industry will reduce freight and travel costs, facilitate a better use of space in cities, improve energy management, have a positive
impact on property values and increase revenue growth for a range of industries. All in all, the report states that the AV industry will have a £51 billion impact by 2030.

3.1.4 Technology today – Industrial applications
*This chapter has been removed due to confidentiality purposes.*

3.2 Safety

3.2.1 Vehicle speed
The relationship between speed and crashes is complicated, yet the general picture is very clear: speed is one of the basic risk factors in traffic. A higher driving speed results in a higher collision speed, which leads to a greater injury severity. Furthermore, high speed gives human beings less time to react and requires longer breaking distances, resulting in a lower possibility of avoiding collisions. To govern this, speed limits are set. However, even speed limits do not fully clarify the picture of what speed is “safe” in a given situation, e.g. rain or high traffic congestion would change what a safe speed really is for a given road.

To give an overview of the relationship between speed and crashes, the problem can be broken down into two main points.

The relationship between collision speed and the severity of the crash
A general rule for this relationship is that the higher the collision speed, the more serious the consequences in terms of injury and material damage (Law of physics the quantity of kinetic energy is converted into e.g. heat and matter distortion). The human body is very vulnerable in comparison to the force of a collision.

Besides speed, mass of the vehicle is an important factor for the outcome of the crash. In collisions between vehicles of different mass, the lighter vehicle and its occupants are considerably worse off than the heavier vehicle and its occupants. The difference in mass determines which vehicle absorbs which part of the released energy. The difference in vehicle mass can differ greatly, i.e. by a factor of 10 for cars and trucks.

When comparing vehicle collisions to collisions between a vehicle and a vulnerable road user (e.g. pedestrians, cyclists) the severity is much larger. The mass difference factors are much greater, as well as the fact that the material protection of these groups being lower. Studies have shown that the fatality risk increases exponentially as impact speed increases – at a collision speed of 20km/h almost all pedestrians survive, at 40km/h 90% of pedestrians survive, as the impact speed reaches 80km/h and 100km/h the number of pedestrians that survive decrease to fewer than 50% and 10% respectively.
The relationship between speed and the risk of a crash

A general rule is that the faster a vehicle is driven, the higher the risk of being involved in a crash – partly due to breaking distance and partly due to human beings information processing limitations. The relationship between speed and crash rate/risk is much less direct and a lot more complicated than the relationship between speed and the severity of a crash. As for the relationship between speed and crash severity, the crash ratio increases exponentially as a function of impact speed.

The absolute speed of a vehicle has an effect crash rate and severity - Nilsson described the effect of a change in average speed on a road and its relationship to the number of injury crashes as (Swovn1, 2012).

\[
LO_2 = LO_1 \left( \frac{V_2}{V_1} \right)^2
\]

- \( LO_2 \) = The number of injury crashes after the change in speed
- \( LO_1 \) = The initial number of injury crashes before the change
- \( V_2 \) = The average speed after the change
- \( V_1 \) = The average speed before the change

With this relationship as a basis, further research enabled a distinction between urban and rural roads – the conclusion was that an increase or decrease of speed on a rural road had a greater effect than on an urban road.

In addition to absolute speed having an effect on the crash rate, the speed difference between vehicles plays an important part. This has been studied in two different ways –the first way being a comparison between roads that have a large speed variance and roads with relatively stable...
speeds. The general conclusion to draw from this study area is that the roads with greater speed variances are less safe.

The second study area compared the speeds between the vehicles that were involved in the crash and all the other vehicles. Early studies in the 1960s concluded that vehicles that travelled both slower and faster than other vehicles were at a higher risk of being in an accident. Later studies have contradicted the result regarding slower-moving vehicles being at risk.

### 3.2.1 Environmental impact

Road traffic produces a high amount of CO$_2$-emissions which has a negative impact on the environment, its inhabitants and its nature.

For humans, air pollution contributes to an increasing amount of emergency admissions in hospitals, mainly due to heart- and vascular disease. Some inhabitants, such as the elderly, children, and people with heart- and/or vascular/bronchial disease or asthma are at greater risk for further complications due to the exposure. Air pollution has further shown to contain cancerous substances and can decrease the average life expectancy of the population. People who live in urban areas are in general at greater risk than those who live in rural areas.

Besides the effects air pollution has on human beings, it also has drastic effects on the environment. Effects include impacts on cloud formation, radiation balance in the atmosphere, haze, bad odors, acidification of water and landscapes, damage to plant life, inhibitory effects on the growth of important crops and the corrosion of materials, e.g. rust on buildings and cars (Goteborgs stad, 2016).

Road transportation in Sweden accounts for roughly 30 percent of the total CO$_2$-emissions, a growing number due to the increasing amount of road traffic. Older cars produce a greater amount of CO$_2$-emissions, and as these are taken out of commission and replaced with more environmentally-friendly vehicles, this number will drop. For a continued decrease in emissions, vehicles in use need to be more energy efficient, the number of environmentally-friendly vehicles and fuels need to increase, all while the current increase in traffic needs to decrease (Naturvardsverket, 2015). Transportation trucks are mainly fueled by diesel, and therefore emit less CO$_2$ than vehicles powered by petrol. This does however come at a price, as they instead emit hazardous particles, hydrocarbons, nitrous oxide and carbon monoxide.

The Chinese counterparts to these figures are not as easy to come by. Knörr & Dünnebeil (2008) notes that energy consumption for transportation is only partly documented in official Chinese statistics. The reasoning for this being that energy consuming-activities are not registered according to its consumption but to its originating sector (e.g. freight transport with trucks does
not register as transport, but as industry). Exact numbers are not available but qualified estimates place them around 1/3 higher than the official statistics.

From 1990 to 2005, the final energy consumption of the transport sector in China rose by a factor of 3.5. The energy usage is broken down into diesel (52%), gasoline (33%), fuel oil (8.7%), kerosene (5.6%) and electricity (1%). The qualified estimates place the total energy consumption of the transportation sector in comparison to all other activities at 17% - a high figure due to the sheer size, yet lower than the equivalent of Europe’s 27%.

Furthermore, road traffic causes noise pollution – in Sweden, over two million people are exposed to a noise pollution level greater than 55dBA, which the government has set as a maximum standard for noise pollution while in the proximity of their homes. Over 1.5 million people claim that the noise level is intrusive. As the traffic level increases, so does the noise pollution.

A growing road network and road transportation also contributes to societal aspects – traffic routes can act as barriers between different city districts and between homes, schools and the workplace. To cross these barriers, or to avoid placing themselves or their family in a perilous situation (e.g. their children crossing a road on their way to their school), people may choose to take their car instead of walking or bicycling. In order to obtain and maintain a sustainable and environmentally-friendly city, these factors need to be taken into account early on in the city planning/infrastructure level (Naturvardsverket, 2015).

3.3.1 Gothenburg

Gothenburg is the second-largest city in Sweden and the fifth-largest in the Nordic countries. Situated in the southwest of Sweden, its location which is halfway between the Danish capital Copenhagen and the Norwegian capital Oslo, as well as its vicinity to the Kattegat sea area has helped the city develop into a significant trading city. Due to the Gulf Stream, the city has a mild/oceanic climate with moderately heavy precipitation. According to Statistiska Centralbyråns, the Swedish government agency responsible for producing official statistics regarding Sweden, the city center had a population of 541,145, while the Gothenburg region had a population of 970,912 in 2014.

Gothenburg is host to a well-established transportation and logistics industry, as well as many international corporations with large goods volumes. The city also hosts the largest port of Scandinavia, which handles a considerable part of Sweden’s exports and imports and has direct lines to 140 destinations around the world. Half of the industrial capacity of Scandinavia can be found within a 300 km radius of Gothenburg. If extended to 500 km, this proportion increases to 70 per cent of Scandinavia’s industrial capacity.
Although these are great factors in regards to establishing Gothenburg as the logistics capital of Scandinavia, the large transportation needs do exert its toll on socioeconomic and climate perspectives. The transportation load on roads and railroads must be more efficient, which may be increased by having a higher packing density of transported goods, distributing vehicle movement across both day and night and by having clear, predefined directions of which routes goods traffic should take.

3.3.2 Infrastructure

The municipality of Gothenburg has developed a transportation strategy involving a series of major infrastructure projects to be undertaken until 2035. The strategy was adopted by the Urban Transport Committee in 2014 and is presently in effect.

In the report, titled *Gothenburg 2035 – Transport strategy for a close-knit city*, (2014) estimates are made that by 2035 Gothenburg will have 150,000 more residents and 80,000 more jobs, as well as being the core of a labor market region with 1.7 million inhabitants. This will produce both challenges as well as opportunities to create a well-working city that lives up to ambitious environmental objectives.

The transport strategy highlights three main areas of significance – travel, urban space and transport of goods - that are to be assessed in order to generate quality of life, competitiveness and sustainable development.

These three areas are crucial to Gothenburg’s role as a hub and a driving force for the entire region. *Travel* focuses on developing an easily accessible regional center. *Urban space* focuses on how developments can contribute to more attractive city environments where people want to live, work, shop, study and meet. Finally, *Transport of goods* has a primary focus of securing Gothenburg as the main logistics center of Scandinavia, facilitating the development of both new as well as existing industries without compromising quality of life, sustainability and accessibility.

A more detailed look at the goods transportation strategy shows a focus on three primary points of interest:

1. *Ensuring good accessibility for goods transport in Gothenburg while at the same time reducing negative local environmental effects.*

This point focuses on securing a smooth and risk-free flow of goods through the city. The report states that there currently is no reasonable alternative to trucks, and since transportation of goods is a value-adding activity, these must be given certain benefits, such as specific lanes and signal systems. Furthermore, the city will promote combined transport in the form of unit loads to
optimize the use of transportation modes. This involves developing several combined transport terminals in strategically chosen locations.

In addition to focusing on optimizing transportation, there is a focus on minimizing the negative consequences goods transportation has on people and the environment. Emissions, noise and road safety all have a great influence on people’s health and sense of security and are to be taken into consideration.

2. **Collaborating regionally in the establishment of logistics centers and transport-intensive operations.**

The city aims to include goods transport in the urban planning system - access to new manufacturing units, warehouses and stands as well as road access are crucial at early stages of planning. The aim is to direct goods producing or consuming activities to the city’s periphery or specified industrial estates. Ferry terminals in the city center with a large amount of truck traffic will be moved to external locations with the possibility of rail access. Furthermore, the environmental impact of heavy traffic is to be given serious consideration when planning infrastructure, as well as reducing conflict between residential housing and major industrial activity.

3. **Stimulating innovation in collaboration with academic institutions and businesses.**

Gothenburg is to be at the leading edge of logistics, characterized by innovation and drive. There are clear goals set, such as being a world leader in climate-smart goods handling.

By working proactively with heavy goods transportation, the industry will benefit from the development of both new and existing activities. The city is to promote development by offering trial activities and test environment for new transport systems, as well as encouraging the development of alternative fuels and engines. There are plans to present innovative projects, such as electrified roads for the transportations of goods.

In addition to the three points regarding travel, the road safety program aims to have halved the number of injured and killed by 2020.

3.3.2 **Freight**

Data regarding freight volumes transported through the Gothenburg region today has been analyzed from different sources; Trafikverket, Västra Götalandsregionen, Statistiska Centralbyrån, Trafikkontoret and Göteborgs Stad, who are all government agencies. All of the agencies forwarded the question towards TrafikAnalys, a company who is contracted by the government to supply data and knowledge regarding traffic issues.
TrafikAnalys has published public reports regarding truck traffic in Sweden, its counties and major city regions. The volume of cargo loaded/unloaded in the Gothenburg region in 2014 can be seen in figure 4. These state that around 28 600 000 tons of cargo was loaded and 27 600 000 tons of cargo was unloaded in Gothenburg, with a 95% confidence interval. 75 percent of the cargo loaded and 76 percent of the cargo unloaded had a destination which is in the same county as Gothenburg.

![Figure 4: Cargo loaded/unloaded in the Gothenburg region (2014)](image)

Another report, *Godstransportstrategi för Västra Götaland*, (2015) published by Västra Götalandsregionen, states that companies in Västra Götaland, the county Gothenburg is located in, consumes 75 000 000 tons of cargo and produces 74 000 000 tons of cargo. Out of these figures, 30-40% belongs to the Gothenburg region.

A simple calculation, shown below, demonstrates that the figures from the two different sources correlate with each other (i.e. 28 600 000 tons loaded is in the region of 22 000 000 – 30 000 000 tons produced). Since the values only differ slightly and the reports are for 2014 and 2015 respectively, the figures were deemed credible enough to provide a base for future calculations.

**Consumed amount of cargo:**

- $75\,000\,000 \times 0.3 = 22\,500\,000$
- $75\,000\,000 \times 0.4 = 30\,000\,000$
Produced amount of cargo:

\[ 74\,000\,000 \times 0.3 = 22\,200\,000 \]
\[ 74\,000\,000 \times 0.4 = 29\,600\,000 \]

Unit: Tons

### 3.3.3 Freight Transportation

In the report *Västgods – kunskapssammanställning om godstransporter i Väst, (2013)* WSP, a technology consultant company, charted the major industrial areas as well as the main routes truck traffic takes through Gothenburg. The report showed that there are two main clusters of loading terminals – the major hub in the port and a second cluster of terminals following the northern stretch of the E6 highway. These clusters can be seen in figure 5.

The report states that the highway E6N has a freight traffic flow in excess of 6000 vehicles per day, of which 11 percent can be classified as “heavy”, weighing more than 3.5 tons. In the same report, a prognosis over future freight traffic flow in 2050 resulted in predictions that highways E6N and E6S would remain as the most densely trafficked roads, with a predicted increase of 67 and 83 percent respectively.
3.3.4 Environmental goals for Västra Götaland

Environmental goals for the county have been developed by Länsstyrelsen in collaboration with Skogsstyrelsen and the Västra Götaland county office (Lansstyrelsen västra götalands län, 2015). The goals are based on national environmental goals but have been specified, and are updated continuously, for regional and local levels. The extensive goals set (15 in total) include:

- **An economy that is non-dependent on fossil fuels**
  - By the year of 2030, the economy of western Sweden should no longer be dependent on fossil fuels and the inhabitants and businesses have adopted a secure, long-term sustainable supply of energy.
  - Residency, transportation and production as well as consumption of goods and services are resource-efficient, energy-efficient and based on renewable energy.
  - These factors will contribute to a strong economy and an innovative and competitive business sector.

- **Reduced emissions of greenhouse gases**
By the year of 2020 all businesses will contribute to an overall decrease of greenhouse gases by a 40 percent margin compared to 1990 figures. By 2030, this number should reach 80%. This decrease will be reached by the following reductions:

- Agriculture: 40 percent decrease by 2020.
- Energy- and industrial processes: 40 percent decrease by 2020, 80 percent decrease by 2030.
- Machinery: 25 percent decrease by 2020, 80 percent decrease by 2030.

- Increased share of renewable energy
  - By 2020, usage of renewable energy sources shall increase to at least 60 percent of total usage. By 2030, this number shall increase to at least 80 percent.

- A good sound environment
  - By 2020, the amount of people who are exposed to noise pollution above the government-set standard shall be reduced annually.

### 3.3.5 The current environmental state

Despite solid efforts by the included parties, the set goals for 2020 are very unlikely to be reached. Out of the 15 goals set, only one single goal will be reached by 2020 – The protection of the ozone layer. Two other goals, Subsoil water of good quality and A safe radiation environment, are, or will be, partially accomplished. The remaining 12 environmental goals set are not deemed reachable by 2020.

Emissions of greenhouse gases in the county have reduced, but the reduction is not in line with the goals set. A sustainable community planning in addition to efficient management of resources is central to reaching the goals. To protect the health of inhabitants, the work towards improving air and water quality and a non-toxic environment in general needs to continue.

Länsstyrelsen has deemed that their instruments to handle the situation are limited in their current state. The possibility to finance and take responsibility for measures is critical points for the future, as well as working on a shift of attitude in society.

### 3.4 Shanghai

Shanghai is the most populated city in China with a population of 24 million in 2014. As a result of the British victory over China in the First Opium War, the city was one of five who were opened to foreign trade. Due to its favorable port position (located in eastern China, in the Yangtze River delta) and economic potential, the city flourished as a center for eastern-western trade and became the undisputed financial hub in Asia Pacific in the 1930s. As the communist party took over in 1949, the global influence of Shanghai was greatly reduced; this decline was
eventually reformed into a new area of development and foreign investment by the economic reforms in China in the 1990s. Today, Shanghai has once again established itself as a global financial center and hosts the worlds’ biggest container port.

Shanghai has a humid subtropical climate with four distinct seasons – chilly and damp winters, hot and humid summers (with occasional thunderstorms and a risk of typhoons), rainy springs and sunny and dry autumns.

3.4.1 Infrastructure
According to Xiao Hui and Gu Yu’s report *Development of Shanghai Integrated Transport*, (2015) The Goals for Shanghai is to build a modern international metropolis, while at the same time working towards an environment-friendly, integrated transportation infrastructure in order to build a world-class integrated transportation system.

Currently, the transportation infrastructure focuses on three main points: *Ports, Highways and Networks*.

Shanghai’s port has been ranked as the busiest port in the world for the past six years, and with continuous development has a bright future. In 2010, 29 million TEU-containers, or 650 million tons of cargo passed through the port. In the same year, air freight that was processed through Shanghai’s air hubs reached 3.72 million tons, ranked third in the world.

*Networks* include a developing rail network as well as highways and roads. The road network measures 12,000km, whereof around 800km is expressways. These roads rank as the most traffic-dense roads in China. The express ways have been designed from a “15’, 30’ and 60’-plan”. This means that from any suburban area, you can reach an expressway in 15 minutes, travel to the city center in 30 minutes, and reach another suburban area by car in 60 minutes.

Currently, the annual growth of inhabitants in Shanghai is 350,000, which means that Shanghai may have broken the 25 million inhabitants mark in 2015. This population is increasingly adopting motorized vehicles as means of transportation, which poses challenges to transportation development as well as exerting a heavy load on roads and the environment.

The strategy for Shanghai in 2015 has been to increase the focus on transportation hubs, functionality and networks. This includes establishing the Shanghai international shipping center, establishing itself as an Asia-Pacific aviation hub and finally, *enhancing its position towards the national railway and road hubs*.

By looking at the last point in further detail, the plan is to adjust passenger and freight transportation by rail and road to urban development. New road efficiency goals are for average
travel times to be based on a “45’, 60’ and 90”'-plan, meaning that the average time for travel in the city center is to be no more than 45 minutes, that vehicles travelling from newly developed suburban areas should be able to reach the city center in 60 minutes, and finally that travelers from major cities in the Yangtze River Delta can reach Shanghai in 90 minutes. This goes hand-in-hand with new safety and green transportation goals – to reduce the amount of traffic fatalities and energy consumption.

### 3.4.2 Freight
Data regarding freight volumes in the Shanghai region has been provided by Autoliv’s Shanghai office, citing the official Ministry of Transportation website (http://www.mot.gov.cn/) as their data source. The figures can be seen in figure 6.

![Table](image)

Figure 6: Roadway freight in China and Shanghai respectively (2015).

Further statistics regarding roadway freight in China (2014):

- Total freight transported by road: 33.328 Billion Ton
- Freight turnover: 6,101 Billion Ton-Km
- Average transportation distance: 183.08 km
4 Implementation

4.1 Preliminary simulation

This chapter has been removed due to confidentiality purposes. The simulation explicitly describes trade secrets belonging to Autoliv Development AB.

4.2 The title of this chapter has been changed due to confidentiality

Parts of this chapter have been removed due to confidentiality purposes as it explicitly describes trade secrets belonging to Autoliv Development AB

In order to generate different scenarios, the team initiated a brainstorming session where different industries, in which implementation might be beneficial, were analyzed. The different business sectors that emerged were a result of both the logical reasoning of the project team and tutor, regarding where it might be possible to implement, as well as taking into account statistics of what type of goods were transported, and in what volumes (TrafikAnalys).

4.2.1 Grocery wholesalers

Parts of this chapter have been removed due to confidentiality purposes as it explicitly describes trade secrets belonging to Autoliv Development AB

To retrieve information regarding logistics setups and freight volumes that wholesalers manage, the project team contacted three major grocery stores (ICA, Hemköp, Willys). The response from ICA was not very positive – they did not feel comfortable sharing any information regarding their logistics operations. The response from Hemköp and Willys was better – through communicating with store owners the project team was guided to make contact with a suitable representative of Dagab, the wholesaler supplying goods to Hemköp and Willys as well as Tempo, three large grocery store corporations.

Based on the data received and communication with the representative of Dagab, the project team constructed a simple, yet realistic scenario.

4.2.2 Small-scale package delivery

Parts of this chapter have been removed due to confidentiality purposes as it explicitly describes trade secrets belonging to Autoliv Development AB

To retrieve data for a small-scale package delivery service the project team contacted representatives for the project Stadsleveransen. Being a smaller project/company, maintaining a line of communication and receiving data was swift and accessible.
Based on the information received, the project team constructed a scenario. Stadsleveransen delivers small package goods inside the moat of Gothenburg, an area stretching roughly 2 times 1 km.
5 Result
The results have been removed due to confidentiality purposes. The results highlight advantages and disadvantages regarding different real operations as well as simulated scenarios.

6 Conclusion

6.1 Sustainable development
Parts of this discussion have been removed due to confidentiality purposes. The discussion describes specific details regarding the project.

Social aspects that the project could improve if implemented are:

- Residential opportunities – if the need for broader roads is reduced, or if city planning is adapted to the new system, areas which are currently covered by roads could be used to build residential buildings.
- Health and quality of life – Since Autoliv’s main focus is to save lives, and to do so by minimizing any negative aspects on the environment, health aspects, as well as the overall quality of life is taken into account early on in the development process. The specific product can provide a further reduction in emissions, noise pollution, congestion, and reduce the risk of severe crashes within a city center.

Economic aspects that the project would impact if implemented are:

- A further increase in technologies that can be used to save lives, increase efficiency and open doors to further technological leaps.

Environmental aspects that the project would impact if implemented are:

- A reduction in emissions, hazardous particles, noise pollution, congestion and an overall risk of severe injuries via vehicle crashes.
- By doing so, the system would increase the possibilities to preserve biological diversity and eco systems.
- A reduction in the use of finite fuels.

6.1.1 Ethics, morals, equality and work environment
Since the project is in a research phase, and it is not yet decided if and/or how the project will proceed, these points are not relevant for the project.
6.1.2 Conclusion and discussion

The conclusion has been removed due to confidentiality purposes. The conclusion include trade secrets, analyzes and simulations based on confidential information received from several different companies. Furthermore, specific product details and proposals are discussed.
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Due to confidentiality, all appendices have been removed. The appendices include trade secrets, analyzes and simulations based on confidential information received from several different companies. Furthermore, specific product details and proposals are discussed.
24-year old from Gothenburg.

27-year old from Gothenburg.