

# NEW PERSPECTIVES ON SUSTAINABLE URBAN FREIGHT DISTRIBUTION: A POTENTIAL ZERO EMISSION CONCEPT USING ELECTRIC VEHICLES ON TRAMS

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## ABSTRACT

Purpose: This paper aims to analyse the potential use of trams and Electric distribution vehicles (EDVs) as cargo carriers in intermodal urban freight distribution. Transporting goods in urban areas, where most logistics chains start or end, is an activity that increasingly generates severe problems for all stakeholders, for instance, local authorities, the logistic industry, customers, as well as the society in general. New transport solutions are necessary in order to decrease traffic congestion, noise and traffic pollution, e.g., emissions of greenhouse gases and other pollutants in urban areas. Furthermore, distribution activities are not only the foundation of our society, but the cause of environmental and social problems as well. A possible solution to these problems is to transform the current freight distribution system within cities, for example by favouring the enhancement of intermodal transport alternatives, i.e. combining road and rail transport. Information has been collected through a literature review and interviews in Amsterdam and from these results a conceptual model is presented, as well as a potential zero emission scenario using electric vehicles on trams in Gothenburg.

*Keywords: light rail, tram, electric distribution vehicles, EDV, transport efficiency, sustainability, urban freight distribution, intermodal city freight distribution, urban rail freight transport*

*Acknowledgements: I would like to thank the students Fawad Awais, Patric Lindquist and Rafael Serrado for their valuable input in the creation of this paper.*

## **INTRODUCTION**

The present configuration of freight distribution systems in urban areas is reaching unsustainable levels in terms of economic efficiency and the impact on quality of life, as stated by for instance the TADIRAM project (2006) and others. "Business as usual" simply does not make the cut anymore.

The scientific evidence points to an increase risk of serious, irreversible impacts from climate change associated with business-as-usual (BAU) paths for emissions. (Stern report, 2006)

A Delphi study conducted by DHL (2009) provided us with some guidance about in what direction we are heading. According to the over 900 professionals and researchers interviewed many believe a proof of energy efficiency will be necessary to ensure a product's acceptance and marketability. Nevertheless, there are differing opinions regarding the extent to which "global warming" represents a genuine business opportunity, but the interviewees in the study also believe that "An enormous amount of money can be earned with the right answers to 'global warming.'" (DHL, 2009 page 25).

With the focus on the manifold not singular; answers not the answer. As there is not yet a single renewable fuel that can replace oil, but many, as well as no one logistic solution that can replace current practice. In this paper, one suggestion is presented for urban freight distribution that would potentially help decreasing emissions significantly for parts of urban freight distribution, but also help the logistic companies to become more profitable.

Logistics companies that want to be green and stay in the 'green' race as well as to become or remain market leaders will need to constantly set new standards. It will not be enough to react; they will also need to adopt a proactive position. Only in this way will it be possible to operate profitably with their 'green' ideas – at least until these ideas become the legal standard. The timeframes during which it is possible to make a profit with sustainable efforts will become shorter, according to the DHL report. The report further states that the logistics company that offers the most intelligent low CO<sub>2</sub> solutions will emerge as the market leader. However, it will only be able to maintain its market leadership if it constantly improves these solutions. Thus, logisticians need to continuously set new standards if they want to experience financial gains from the sustainability trend over the long term. It is presently truer than ever that merely reacting is not sufficient. Logistics companies must be actively involved in the formulation of standards and thus assume a leadership role in the economy.

An explicit definition of what is meant by light rail does not exist. In the literature many definitions are found. According to Priemus, (2001) a common feature seems to be that light rail is a rail associated transport system that can be positioned in the triangle between train, tram and metro.

To use the more general term *light rail* avoids incompatibilities in American and British English. The word *tram*, could mean aerial tramway in American English but streetcar in British English, whereas aerial tramway is called cable car (Merriam-Webster online dictionary, 2009-09-23). Cable car in North America usually refers to a trolley pulled along by subterranean cables. Trolley in American

English typically refers to streetcar, while in British English this word means a (shopping) cart (Merriam-Webster online dictionary, 2009-09-23).

Trams and street cars are commonly classified as a subtype of light rail, but this is not always true. There is a significant amount of overlap between these technologies. Light rail is mostly separated from other traffic with dedicated lanes and rights-of-way, passengers get on and off at stations rather than in the street, and the speeds are faster than for trams. In this paper, no distinction is made between *trams* and *light rail* for the sake of simplicity, variation and to facilitate keyword search.

According to Merriam-Webster online dictionary there is no significant difference between the use of *cargo* and *freight* anymore. Historically the use of cargo, from Spanish *cargar* used to refer to ships and later airplanes, but now also includes land-based vehicles. Freight, of mixed English, Dutch and German heritage, is somewhat more of a generic term, often attributive as in substituting transportation in transportation costs but also often referring to land based vehicles. The use of CarGoTram in Dresden is a pun, supplying car parts to the Volkswagen factory. In this paper, no distinction is made between *cargo* and *freight* for the sake of simplicity, as well as no distinction between *transportation* and *distribution*, for the same reasons as above.

The paper consists of five main parts. Firstly, the nomenclature of the terms appearing in the paper is discussed. Secondly, a comprehensive literature review was conducted on the previous projects using light rail in Europe followed by a literature review of the use of electric distribution vehicles in Europe. Thirdly, the four major projects using trams are presented. Information from Dresden, Vienna and Zurich is derived from a literature review and information from Amsterdam originates from empirical data from interviews. Fourthly, a discussion is held based on comparing differences and similarities between the cities. Lastly, barriers and recommendations are identified and an analysis of a possible future concept for the example city of Gothenburg is presented. The scope of this paper is to present where we are and lessons learnt from the Amsterdam case study together with the other cities presented and construct a fictive scenario for Gothenburg drawing on these lessons.

## **LIGHT RAIL FREIGHT AND CARGO TRAMS IN THE LITERATURE**

In this section some of the most recent research focusing on urban freight distribution in relation to light rail is presented. The major projects in which this type of research has been evident are Bestufs, Civitas, Eltis and Sir-C. Goods have been carried on rail vehicles through the streets since the 19th century and the use of rail in urban freight has been the focus of researchers and practitioners for the last century. Projects aimed at using rail in urban freight in Europe have emerged over the last decades, some with the aim to partly eliminate road freight transport, like in Amsterdam, whilst others are of more limited application. The system in Dresden is a privately owned operation running between two points whereas Zurich and Vienna are non-commercial municipal services focusing on waste recycling and freight transport for the retail industry respectively.

According to Mortimer (2008), rail in urban freight has been on the decline in favor of better suited road transport, with regards to supply patterns, land use planning and regulations. Some of the known limitations of rail are the lack of door to door capability, difficulties in the integration of road and rail and the differences in economic mass. On the other hand, rail has a good weight/volume capacity, low energy and environmental impact, a good network linkage between cities and in some cities – trams and undergrounds. Today the vast majority of urban freight service is performed by trucks and vans on road and to a lesser extent through intermodal services. Transportation is a vital part of our society but at the same time considered to be a major contributor of emissions and thus also a major impact on the environment. This has triggered planning authorities all over the world to impose a variety of restrictions and constraints on road transport, e.g. access times, weights, dwell times, noise limits and emissions etc. Light rail, much like rail and road, is considered to be conservative and the business model primarily focuses on passenger transport with generic constraints also with regards to coverage and access.

In the Italian TADIRAM project, ending in 2006, research activities have been performed with the aim to identify new organizational and technological solutions for the optimization of freight distribution process. One part of this project studied the cargo tram concept in a feasibility demonstration. The TADIRAM project partners demonstrated a new prototype designed for goods assembled onto load units. A new version of SIRIO Cargo Tram (light rail), the same type of tram ordered by Gothenburg municipality, has been studied. This type of tram is module-based and can also be coupled with passenger trams. Furthermore, the tram has a drop centre design, with a flatcar in the middle with 350 mm from the rail plane to the passenger floor.

The OLS-ASH project has generated knowhow on designing automated underground freight transportation systems that can be used for future UFT projects (Pielage, 2000). Royal Mail have been operating its own automated underground transport system called Mail Rail, with the aim to move mail across London very successfully since 1927 (Bliss, 2000). A few other researchers who have contributed to this area are; D. Bous, Reinhard Dorner, Monika Dönnhöfer, Axel Eisele, Peter Foyer, Mark Robinson and Dieter Wild.

## **ELECTRIC DISTRIBUTION VEHICLES IN THE LITERATURE**

The electric vehicle is not a new concept; it actually precedes the internal combustion model. The deficient factors identified so far are: the same ability to accelerate and go fast, and to provide the same reach and ubiquity of the gasoline car. (Lesser, 2009; ELCIDIS, 2002). Henry Ford mentioned the electric car in his book "My life and World" in 1921:

"Practically no one had the remotest notion of the future of the internal combustion engine, while we were just on the edge of the great electrical development. As with every comparatively new idea, electricity was expected to do much more than we even now have any indication that it can do. I did not see the use of experimenting with electricity for my purposes. A road car could not

run on a trolley even if trolley wires had been less expensive; no storage battery was in sight of a weight that was practical. An electric car had of necessity to be limited in radius and to contain a large amount of motive machinery in proportion to the power exerted. That is not to say that I held or now hold electricity cheaply; we have not yet begun to use electricity. But it has its place, and the internal combustion engine has its place. Neither can substitute for the other-- which is exceedingly fortunate." (Ford, 1921)

The ELCIDIS, 'Electric vehicle city distribution systems', project succeeded in verifying the principal advantages of using electric distribution vehicles (EDVs), hybrid as well as electric, in urban delivery concepts. ELCIDIS has provided proof that there are no predominant objections to the use of hybrid and electric vehicles in urban distribution, neither from company managers nor from drivers, and certainly not from local authorities (ELCIDIS, 2002). However, they stress the need for further development of the next generation of electric vehicles and hybrids. Furthermore, the project states the necessity of 'home-recharging' equipment close to the city centre for battery-run electric vehicles.

A study was carried out in the Brussels capital region by Van Mierlo *et al* (2003) and was also presented in Macharis *et al* (2007) that investigated the environmental benefits of electric heavy duty vehicles in which the Ecoscore or environmental damage rating was calculated. The methodology was based on a well-to-wheel analysis of emissions by calculating the impacts related to global warming, health, buildings and noise. The electric vehicle in the analyzed example was an electric bus and it had more than three times lower environmental impact compared to a diesel truck and twice as low as an LPG truck.

The study does however not describe how these figures were calculated. It would be interesting to know if the electricity was produced by coal, renewables (not likely) or a mix. Also, future research on the potential rebound effect of moving in the direction of smaller electrical vehicles is needed. The price of petrol is likely to drop since demand ought to be lowered? Will we ever manage the oil dependency?

## **LIGHT RAIL FREIGHT AND CARGO TRAMS IN EUROPE**

At the dawn of the 21st century, transportation companies in the EU and around the world are trying to combine economic sustainability with finding green solutions for transport. As suggested by industry and researchers, one way of doing this is to apply transport efficiency, a set of measures to resource efficiently move goods, as a means to minimize externalities. One resource efficient way to move goods is by using tram systems with or without electronically driven vehicles. This paper will investigate the issue from a European perspective. One could argue that it could have a broad applicability in Europe, as carrying goods on rail (train) in Europe has its roots from the 19<sup>th</sup> century. The current known tram examples include Dresden which now has a regular Cargo tram service run by the world's longest train sets, 59.4 meters. Cities of Vienna and Zürich are using cargo trams as freight transport and mobile depots for recycling used goods respectively.

Amsterdam has developed this concept the furthest in the group, regarding the applicability of trams as freight movers, including a wide variety of consumer goods and the sheer economic size of the project is well exceeding the economic size of the other three projects combined. That is the main reason why Amsterdam was chosen as case in this study. In the following sections a short description of three of these projects precedes the results from the analysis of the Amsterdam case. Strengths and weaknesses of the experience from these cities may help if the stakeholders in the city of Gothenburg would decide on developing a feasible concept and sustainable implementation.

## **1. DRESDEN – VOLKSWAGEN PROJECT**

Volkswagen planned to build an eye catching transparent factory in the city centre of Dresden in the late 1990s. A prerequisite of the Dresden municipality, as the city centre is small and sensitive to heavy trucks, Volkswagen needed to seek another solution of the goods flow, if the factory was to be built at this site (P Hendriks, 2010).

Volkswagen together with Transportation Services of Dresden came up with an idea to utilize cargo trams. At the new factory access to a local tram line was possible as well as for the distribution centre four km away, this made the cost for additional infrastructure low with only short connection tracks needed. The project with the Cargo Trams started in Dresden on 16 November 2000 and made its first test run in January, 2001.

The trains run every hour on a fixed route that is five km long (this can be increased to every 40 min). It takes approximately 15 min for each trip and the cargo is unloaded in 20 min by forklifts at the factory. DVB's operations system is controlling all public trams and the Cargo trams takes advantage of gaps in the regular schedule of the passenger trams. One trip of the 'CarGoTram' eliminates three truck rides through the city center. The project 'CarGoTram' is unique in Germany (Civitas, 2005). Every day transports equal of 60 trucks is sent by the Cargo tram to the Volkswagen factory. Over the year this is the same as 200 000 km by road, according to VW AG's own calculations. The environmental impact is accordingly reduced drastically.

The CarGoTram have been successful since the start in 2000 but it is a purpose-built project with very specific conditions, the project facilitates one customer on one route only at this point. DVB is looking for further applications for their cargo trams; one is to serve a newly built city center shopping mall with over a hundred stores (ptua.org, 2008).

## **2. VIENNA – 'GÜTERBIM' PROJECT.**

The project considered as a modern solution to urban logistics for transporting goods within the city using the existing rail network, 'GüterBim', examined the basic infrastructure required for operating a cargo tram in Vienna. The aim was to use the existing, well developed public transport network to switch goods traffic from the roads to rail. (Vienna Consult, 2006). The project investigated

potential applications, e.g. hospital or waste disposal logistics, and a pilot operation on a selected route. In 2004, the project started and was finally implemented in the context of a demonstration event.

Moreover, in 2005, possible combination of rail and tram freight transport (container transshipment) was tested, in order to introduce a rail bound city logistics solution for densely populated areas. The municipal public transport operator of Vienna carried out freight transport for its own internal purposes. The 'GüterBim' transports spare parts between the main workshop and its satellites. These initial demonstrations across the city of Vienna in 2005 had the intention of exploring options for further traffic applications, and study the needs for designing a feasible telematics system under an open interoperable based platform.

In normal circumstances, the transport would have been carried out by special road equipment causing considerable traffic congestion, pollution, and noise, on the inner-city road network.

In 2005, representing the government, the Austrian Ministry of Transport, Innovation and Technology proposed a joint-venture called 'GüterBim', composed by key players, such as, the Wiener Linien, the railway undertaking Wiener Lokalbahnen (WLB) and the two consulting companies TINA Vienna Transport Strategies and Vienna Consult, to carry out the respective research, and subsequently led the project team to develop follow-up projects ([web22.wien.gv.at](http://web22.wien.gv.at), 2004).

Lately, tests have been performed within the supply chain of different retail companies, to find low-cost solutions for a reliable delivery of their stores and sales points in the City of Vienna, for instance, developing techniques for fast handling.

### **3. ZURICH PROJECT**

The Cargo tram in Zurich is a project that took only a few months to be converted into a pilot after its conception. It was the CEO of "Entsorgung und Recycling Zürich" ERZ (municipal public waste disposal and recycling company Zurich), Mr. Gottfried Neuhold, who initiated this innovative project in April 2003. Along with its future implementation in a daily operating basis, starting with four stops, and by 2004 extending them to eight. The initial approach was to collect bulky waste from households along the city's outskirts, near the trams' turn around points. Afterwards in 2005, the collection of disposal electronic home and industrial equipment followed. According to Bestufs (2005), the way Cargo tram started to operate was based upon the collection of waste in two standard refuse containers, but the normal containers turned out to have an insufficient capacity for bulky goods. Therefore, a new container was developed, incorporated with a press for bulky goods, which in turn were carried on flat wagons, pulled by a converted tram.

ERZ jointly with the tram company VBZ used the actual infrastructure and the surplus tram units. They started by investing 32.000 Euros, in order to convert old trams and wagons into a functional unit, by adding standard parts. It is necessary to realize that Zurich has a broad tram network

servicing the majority of the city areas. There are also many sidings not used by regular services which could be suitable. An equivalent road vehicle would have been harder to purchase due to initial funding and environmental constraints (proaktiva.ch, 2005). By strictly following the pre-condition of the system, which is neither disturbing nor slowing down the public transport for passengers, the Cargo tram serves, nowadays, nine different tram stations in the city area of Zurich. Hence, the positioning of Cargo tram is at those stations where additional tracks already exist, mostly turning points at the end of a tram line, where residents can leave bulky items for free. It has been estimated that collecting the same amount of waste by road transport equals 5 020 kilometers covered by lorries (which need about three times longer to move across the heavily congested city during peak hours) which in turn equals 960 running-time hours, hence 37 500 liters of diesel per year. (Bestufs, 2005). According to these calculations, the solution of disposing waste by Cargo tram has achieved a reduction of 37 500 liters of diesel annually, thus, avoiding equivalent emissions of harmful substances.

In short, Cargo tram not only makes a contribution towards reducing traffic congestion, traffic pollution and noise, it also provides a valuable service to Zurich' residents, offering a low cost service, but faster, moving commodities of low or null intrinsic value that commonly is not time sensitive.

## **RESULTS FROM CASE STUDY**

### **4. AMSTERDAM – CITY CARGO PROJECT**

The Amsterdam City cargo tram project is by far the biggest of the four investigated projects. The following Amsterdam section is based on a literature review as well as five interviews in Holland conducted in January 2010 with Peter Hendriks (2010-01-15), CEO Cargo tram, Michael Hendriks (2010-01-19), Financial Manager Cargo Tram, Jan Dijkstra (2010-01-18), Municipality Project Manager, Juijijn Haffmans (2010-01-18), Public affairs Cargo Tram and Stefan Saalmink (2010-01-18), MindsinMotion.net.

#### **Description of the city center**

The city of Amsterdam has been significantly important in the history of Europe. As for many European cities the construction of the city centre with its narrow streets during the seventeenth century did not provide a favourable situation for the modern day vehicles. At the dawn of the twentieth century the city was adapted to the needs of motor vehicles by filling in many canals of the city. However during the process major canals still remained intact. All administrative officials in all cities follow the same agenda in formulating development plans for a city; pollution and noise caused by the traffic ought to be reduced, traffic safety ought to increase and quality of space available for general public ought to be enhanced. This emphasizes the need to develop measures in order to reduce traffic congestions and reduce the effect of cargo transport on the environment.



However, in doing so maintenance of a smooth flow of goods and securing economic profits is also a considerable concern.

## **Process**

Cargo trams in Amsterdam were expected to start their operations in 2008. The rationale of these trams was to shift the traffic load from trucks on the road to the trams for distribution of goods among the various stores and restaurants in the city. Also the restrictions on truck access would pave the way to implement the operations of cargo trams. The trams would provide service to the small distribution centers to reduce traffic load on the roads and would help improve the environmental aspects of the city transport. The door to door service could be maintained by the carrying of goods from the stations through the use of EDVs. In the month of March 2007 the test phase of this project included running of the cargo trams without loads from Osdrop to central Amsterdam. The trams used for this test phase belonged to GVB trams and after this test phase the trams were planned to be running with goods (Technisch Weekblad, 2007; P Hendriks interview, 2010).

Amsterdam's project regarding the Cargo trams is becoming a reality with the accomplishment of the test phase as it was carried out in March 2007. During this test phase the trams ran without goods but from 19<sup>th</sup> March they were supposed to run with cargoes from De Aker to the city. Cargoes included Heineken beer for pubs in the city and clothing for the Mexx store. During the last week of the phase waste paper was also carried in the opposite direction. (Cargotrams Yahoo group, 2007)

According to M Hendriks, the city council of Amsterdam allowed City Cargo to carry out trial operations whereas the full scale operations were expected to start in 2012. The trams were responsible for delivering goods to the city business companies. These cargo tram operations were restricted to the lines which have enough capacity to avoid problems with passenger trams. The operations were also limited within the time frame of 07:00-23:00 to avoid noise disturbances during the night. This project could result in the reduction of 2500 lorry movements within the city per year and the particle pollution in the air by 15 percent according to calculations made by the company. The trams used for these initial trials belong to GVB trams whereas in the later stages of the project City Cargo would use its own designs (M Hendriks, 2010). The economics of the operations were calculated to save almost 15 percent compared to a conventional set up with trucks (Haffmans interview, 2010).

## **Operations**

According to a press release of Amsterdam tourist information dated 17 July, 2007, a joint venture of City Cargo BV with Amsterdam municipality, signing a 10 year contract to launch a cargo transport project employing freight trams running on the existing tram tracks used for public transport. According to P Hendriks (2010), ten cargo tram units were planned to start working by mid 2008. To ensure that the freight trams did not disrupt or alter the existing passenger tram schedule, a pilot was tested in March.

Jupijn Haffmans, City Cargo spokesman told the press after the test that this was the municipality's main concern and they demonstrated that by using 'follow mode' with the passenger trams, hindering the existing passenger tram schedule could be avoided. The 'follow mode' could easily be performed since the cargo trams did not have to stop to pick up passengers. The contract requires close collaboration between Amsterdam tram company GVB and City Cargo which uses GVB's schedule to establish when and where they can operate.

As the central Amsterdam is still reminiscent of its medieval times having only narrow streets and canals, the municipality allows heavy vehicles only between the hours of 7:00-11:00 hence stores and businesses are in need of a quicker and efficient supply system (M Hendricks interview, 2010).

Haffmans (interview, 2010) also highlighted the future plans of expansion, City Cargo did aim to increase its number of trams from ten to fifty in the next four years. This was expected to half the daily truck load in the inner city.

The project employs a system of a number of strategically located distribution centers or cross docks situated in western suburbs near the Schiphol airport. Therefore the inbound goods arriving at Schiphol airport could also be transported onboard the freight trams. At cross dock locations goods would be transferred from trucks to trams, after being sorted in the delivery area, and transported to inner city transshipment hubs.

Sophisticated networks of electric distribution vehicles were to deliver the goods to their final destination. Although the cargo trams took fifteen minutes extra compared to direct transport trucks, the City Cargo claimed that it cuts the cost by fifteen percent (P Hendriks interview, 2010) and accordingly being significantly more useful for small businesses like restaurants and boutiques.

Peter van der Sterre, policy consultant of EVO, a Dutch organization of companies dealing with cargo transport, as part of their core business acknowledged and appreciated City Cargo's initiative and its usefulness to small companies but at the same time pointed out the limitation of its use for larger companies like supermarkets. EVO, have lent only conditional support to City Cargo so as to make sure those companies are not forced into using the tram system and still have the freedom to choose between the two.

Meanwhile, Haffmans unfazed by Peter Van Der Sterre's cautious approach told the media that City Cargo has received encouraging feedback from around the world. Tokyo and San Francisco showed an interest in addition to many European states like the Netherlands and Germany to mention a few. He also stressed the need of expanding the tram network to all the metropolitan areas of Amsterdam in order to be truly successful. While for smaller cities like Utrecht or Rotterdam a single company may be enough. He went on to quote the examples of some other European cities employing the cargo trams, like Dresden (DPA, 2007; Haffmans interview, 2010).

After the successful trial, the company faced a problem with financial stability. The company board admitted they were not yet stable. As Peter Hendricks pointed out "almost no company is profitable from the start", similarly City Cargo would have needed at least three years to be profitable

according to Hendricks. According to Driessen (2007).and Dijstelbloem (2010), the municipality gave the City Cargo a three weeks' notice to come up with a bank guarantee in November 2008. Having failed to meet the 1st December deadline, City Cargo was declared bankrupt.

## **ANALYSIS OF CASE STUDY – REASONS FOR FAILURE**

The people at Cargo Tram they identified two reasons for failure; inability to acquire adequate finance for investments and politics. Cargo Tram, through Peter and Michael Hendriks, focused on receiving finance from major banks. The timing with the financial crisis was, to put it mildly, not working in favour of the project. Furthermore, the banks would much rather invest in bigger projects according to Mr P Hendriks, thus one of the reasons for the project not starting out small scale and then scaling up. The business plan estimated the project costs to 70 million Euro, ten percent of this amount was Peter's private money (M Hendriks interview, 2010). The investment included trams, EDVs, new infrastructure, tracks and a cross dock central.

Others additionally identified a lack of understanding between Alderman<sup>1</sup> Marijke Vos and Peter Hendricks, two people at the opposite ends of the political spectrum. It was 'unfortunate' that Mr Hendriks went to the meetings with Mrs Vos in a big car with a personal driver, while Mrs Vos herself chose the bicycle.

The municipality, through Jan Dijstelbloem, identified finance as the main reason for failure, the lack of finance led up to the bankruptcy of this start up at the end of 2008. Up to the end of 2008 the municipality, through Aldermen, had helped Cargo tram by allocating a project group working with the company as well as fast tracking many of the necessary adjustments and changes in regulations, all in all, much more than normally provided for a new private company. City Cargo was amongst the projects the City embraced. One of the things the City did was extending the concession from the usual six years to ten years to give the company more time to become profitable. In addition, the municipality seriously considered the question of City Cargo to financially partake in the project. In the end the City made a proposal for City Cargo in what way the City would participate (financially) in the project. This proposition was never realised as City Cargo went bankrupt during these discussions (Dijstelbloem interview, 2010).

This was one of the reasons for the city refusing to contribute to the construction of extra tracks that were going to be needed. The city administration was interested in the project without including any additional subsidy. On the other hand, according to Mr Hendriks, City Cargo had already collected 69 million Euros from various companies like Nuon and Rabobank and had asked the city administration for a contribution of 6 million Euros for the construction of extra tracks (Dutchnews.nl and Railway Gazette, 2009).

The cargo trams use the passenger tram lines for transport and the no longer used tramways, called 'dead tracks', were used as parking lanes and loading and unloading bays. Being electrically

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<sup>1</sup> An alderman is a member of a municipal assembly or council.

run they have the added advantage of low carbon emissions and replacing the trucks on the roads and reducing the city congestion, especially at the motorways to and from the city. City council also admits to this benefit, pursuing a policy of adopting measures to reduce air pollution (Dijstelbloem interview, 2010). Dijstelbloem stressed that the municipality took this project onboard and really supported the company with an extended concession mentioned above and the support of a project group to help City Cargo in all their affairs with the municipality.

The company director Peter Hendriks revealed that the municipal transport company GVB has objected to the use of dead tracks by City Cargo. The GVB claimed these tracks to be 'calamity tracks' and therefore could not be provided to City Cargo (P Hendriks interview, 2010). He continued by stating that this meant that City Cargo had to build its own parking track which is an expensive ordeal with a cost around one million euro per kilometre, *ibid* (2010). The extra tracks were difficult to finance for City Cargo since, by law, all tracks being built were owned by the municipality and a privatization of the trams or its tracks was not on the agenda at this point.

## **CONCLUDING DISCUSSION**

An electric vehicle has more than three times lower environmental impact compared to a diesel truck and twice as low impact compared to an LPG truck according to Van Mierlo *et al* (2003).

One way to summarize is to present a table with differences and similarities between the cities presented in the paper. From the table one could argue that an evident conclusion on a business plan that works in all cases is quite hard to identify. Comparing the only two ongoing projects at the moment one comes to the conclusion that **starting small** seems to be the only common denominator between the two projects. The sample could be argued to be too small and the context, e.g. size of city and logistics character, is different from case to case making it difficult to compare the different cities.

<b>City</b>	Amsterdam	Dresden	Wien	Zurich
<b>Key factors</b>				
Project owner	Private (City Cargo)	Private (VW)	Municipality	Municipality
Funding	Banks/Private	VW	Municipality	Municipality
Size of project	Large	Medium	Small demonstration	Small
Type of goods	Commercial, parcels etc	Automotive parts	Commercial, mainly retail	Electronic Waste
Type of customers	Commercial	Private (VW)	Commercial/Public	Public
Logistics character	Logistic service provider	Internal Logistics	Commercial/Recycling Logistics	Recycling Logistics
Infrastructure investments	Large	Small	Small	Small
Current status	On hold, bankrupt late 2008	Ongoing	On hold	Ongoing

Table 2 – Cargo tram projects in Europe

Other barriers identified are not to interfere with personal traffic (all), high initial investments (Amsterdam, Dresden), limitations in battery technology (Amsterdam), resistance to try something not tried before (initially all), number of actors cooperating (Amsterdam). It is important to repeat that the two identified reasons for failure of the Amsterdam project were: inability to acquire adequate finance for investments (supported from interviews by both Cargo Tram and the municipality) and, to a lesser extent, politics (supported only by Cargo Tram).

Cost calculations for any type of set up need to be conducted before any new projects are considered. The business plan for the Amsterdam operations were calculated to save almost 15 percent on an operational basis compared to a conventional set up with trucks according to Haffmans interview, (2010). Unfortunately the author of this paper did not get the opportunity to have a look at these numbers. The "15 percent" is thus **secondary information**. Let us end by stating some things that might be useful to bear in mind when conducting potential future calculations:

Tram costs are higher than truck cost when one considers distance. Tram and truck costs are usually calculated in cost/km but for a city distribution scenario one of the advantages of an all day delivery tram is to partly avoid the busy hours in the morning and in the afternoon, which a delivery truck cannot since it usually makes one round trip per day<sup>2</sup>. It is therefore suggested that both cost for trucks and trams are calculated in hours instead of km. Also, the cost for trams is divided on a set of 2-3 wagons and that some of the variable costs, if one tram is used, ought be adjusted accordingly. Lastly, and possibly most importantly, a discussion and an awareness of the risk of pricing this type of set up cheaper than the current set up. This ought to be avoided; possibly

<sup>2</sup> Interviews with Schenker and DHL

resulting in an increase of attractiveness for and use of urban freight transport in general by the laws governed by the rebound effect. It is thus important that the solution is priced in pair with or even higher compared to current solution with trucks.

Future research: According to Zunder (2004) trucks produce over 40 percent of pollution (congestion) and noise in cities although only accounting for 10 percent of operations in urban areas. What are the reasons behind this congestion? How much of the truck's contribution to congestion can be deduced from size? How would a decrease in size and increase in numbers of distribution vehicles effect congestion?

In the appendix a comparison between Gothenburg drawn mainly from the results from Amsterdam due to its close realization of implementation, business orientation and because of these two cities many geographical and political similarities is presented. The barriers and obstacles are manifold and the success of a cargo tram project is ambiguous. The author of this paper is optimistic to the idea of trying out a small scale test, for the simple reason that it has never been tried out commercially before.

## **APPENDIX – SCOPE FOR A NEW PROJECT?**

Some do claim that one part of research is to investigate and compare projects and concepts and see if it is possible to learn from potential mistakes or change some of the parameters in order to acquire a different result? In the following appendix the author will therefore try to do this in the case of Cargo Tram moved to a new setting. One might ask why Gothenburg is chosen as a possible arena for future implementation, apart from being the author's hometown. The city of Gothenburg is almost the same size as Amsterdam, according to "Research and statistics", 500 thousand inhabitants versus 760 thousand. Gothenburg city is with its 450 km<sup>2</sup> bigger than Amsterdam, 219 km<sup>2</sup>. A coincidental fact is that the city was heavily influenced by the Dutch. Dutch city planners had the necessary skills to build in the marshy areas around the city and were contracted to build the city to have canals, using Amsterdam as a blue print, according to Henriksson *et al* (1994). The tram system in Gothenburg is extensive covering an area of 3700 km<sup>2</sup> (Amsterdam 1800 km<sup>2</sup>) and dates back to 1879. One could argue that the tram is synonymous with Gothenburg but also with its culture. Many of the tram tracks in Gothenburg are integrated with the street around the tracks, unlike for instance train tracks. This would literary pave the way for the RoRo technique presented in the next section.

Willy Nicklasson (2009), a technical manager at the Gothenburg tram company, revealed that a great number of old tram models but fully functional trams, known as M28 and M29<sup>3</sup>, are available to a fraction of the price for a new tram. And as identified from Amsterdam, the cost of the trams together with the cost of new infrastructure, tracks and cross dock centrals, are by far the most

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<sup>3</sup> M28 and M29, are high floor trams, which makes it harder for older people to board than the newer dropcentre design. But on the other hand the floor is flat on the inside allowing for up to three electric distribution vehicles no wider than 2600 mm to fit.

expensive investments in a cargo tram project. The low cost of trams would support a low cost and small scale approach.

From the four cities presented, even though different from one another in many respects, a set of barriers has been identified, and together a concept for Gothenburg is derived.

The most important feature of a future concept is that in order for it to work it cannot hinder personal traffic or, as learnt from Amsterdam; not to interfere too much with the daily city picture of urban space and life – **Barrier 1**.

Building add-ons, or sidings, to tracks for loading and unloading in the city center are very costly as learnt from Amsterdam, according to Peter Hendriks one million Euros per kilometer. Partly, also one reason to why City Cargo started filing for bankruptcy in the end of 2008, see section on Amsterdam. The funding of the project was estimated at an impressive 70 million €, not a small scale endeavor – **Barrier 2**.

“An electric car had of necessity to be limited in radius...” (Ford, 1921) – **Barrier 3**.

From the interviews some agreement was received, but not from all, on a potential opposition from the other logistics competitors of the new, now bankrupt, company: City Cargo. The transportation industry is argued, for example, by Behrends *et al.* (2008), to be particularly resistant to change. In a report on Intermodal City Distribution from WSP (2008) a great concern was the lack of interest and motivation among the stakeholders – **Barrier 4**.

The number of actors involved in the decision process is greater in light rail freight than traditional freight by truck set-up, thus making the implementation and cost-benefit division amongst the actors more complex. Unfortunately, excerpts from conducted interviews with the logistics industry in general do portray a similar picture. Phrases like "we were forced to cooperate" have been recorded – **Barrier 5**.

One proposed recommendation to the barriers presented in this paper could be to use the same distribution strategy as used in Amsterdam, but with three fundamental differences identified through the study of the four cities in this paper: RoRo technique, small scale and open source:

In order to minimize the building of sidings and maximize the use of existing infrastructure the EDVs could catch a ride, 'piggy-back', on a rebuilt tram from the tram end point into the cities, rather than waiting in the city centre and re-loading from tram to EDVs. This way one would decrease the risk of **barriers 1-2**. By using a rebuilt distribution wagon, type M28 or M29, in 'follow mode'<sup>4</sup> the time for rolling off and on the trams in the city centre and at the tram end stations would be the time between the existing trams in the system, varying between twelve to twenty minutes depending on route and time of day (Nicklasson. 2009). This would also mean no necessary investments in infrastructure. So, why did Amsterdam not use this method? The trams in

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<sup>4</sup> See Amsterdam section

Amsterdam are quite narrow because of the narrow streets of the city. They are about thirty centimeters more narrow than in Gothenburg, and the design of the trams are not suited for a roll on and roll off scenario. The old versions have a drop center design meaning that the middle wagon is lower than the other two and the new ones are built for disabled people with low entrance possibilities throughout the entire tram, requiring the wheels to be built in and sticking up in the compartment. Thus making it impractical to drive EDVs on and off without a complete rebuild of the tram. The floor of a M28/M29 on the other hand is flat from the back to the front and fifteen meters long.

**Barrier 2** is potentially the most important lesson from Amsterdam; to try this concept in a more small scale fashion, allowing for test and necessary changes before a possible scale up. Lessons learnt from Dresden and Zurich, the only ongoing projects at the moment, it seems sound to start small scale and gradually scale up. Furthermore, a test could be carried out for a limited time period with normal express diesel or renewable fuel vehicles commonly used today, like MB Sprinter, instead of EDVs. This could be an inexpensive way of trying out the concept in a real life situation before investing large amounts of money on EDVs.

By using RoRo technique, where the EDVs drive onto the tram on a ramp in the back, also means that the EDVs could charge their batteries inside the tram on their way to the city centre, thus resolving **barrier 3**. Allowing for these EDVs to drive onto the trams would also mean that they are not obstructing traffic on the motorways to and from the city.

Rather than creating a new competitor and in order to increase the chances of the recommendations to be implemented in Gothenburg by decreasing initial investments and to tackle **barrier 4**, the recommendations ought to be presented to the already existing distribution companies, as well as the municipality and tram operator after a thorough cost-benefit analysis has been made. By doing this, additional competition in an already competitive industry as well as a 'not invented here' mentality is avoided. An "open source" mentality, with its origin from the internet, would be preferable until falsified.

Unfortunately, there is no other way of resolving **barrier 5** other than to call for an increase in cooperation between the logistical actors, municipality and the Gothenburg tram company.



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