Finding economic feasibility in electrified LTL transportation systems

Identifying opportunities in electric LTL transportation flows

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The road freight sector is currently undergoing a profound technological transformation, which might be regarded as one of the most significant disruptions in a century. As electric freight vehicles (EFVs) are demonstrating operational viability in practical situations, it is appropriate to challenge the conventional ways of finding economic feasibility in the sector[1].

Introduction and Background

Throughout history, technology shifts have had a significant impact on industries and their practices. These shifts not only provide opportunities for new processes of value creation, but also challenge conventional practices in the industries disrupted. Integration of, and adapting to, innovation is paramount to business success[2].

The introduction of EFVs along with the approach of autonomous road freight will transform the road freight industry as well as challenge conventional ways of working for any adjacent industries. The adoption of EFVs is propagated both by business necessity and policy decisions[3]. As such, the potential of inefficiencies appearing increases and questioning conventional ways of finding profit becomes essential[4].

Purpose and Theoretical Context

The purpose of this thesis is to develop an understanding of the financial consequences of LTL routing strategies using EFVs, contrasting it with current less-than-truckload (LTL) practices. At the time of writing, research on EFVs as it pertains to LTL and full-truckload routing is lacking. The extended purpose of this thesis was therefore to extract and collate any conventional research in adjacent subject areas which could be generalized and applied on EFVs. Thereafter, it will be combined with knowledge gained from the employees and practices of The Case Company, a company currently operating electric full-truckload routes.

Methodology

To allow both the researcher and the reader to get a grasp of the theoretical environment of the subject, the theory was collected before the methodology was in place. Thereafter, the study itself began. Using the insights gained from the

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[1] Taefi, M., Reischauer, A., & Schilling, O. (2016). Comparison of electric freight vehicle initiatives in Europe. Transportation Research Part D: Transport and Environment, 45, 23-33.

[2] Tongur, T. & Engwall, L. (2014). The impact of technology shifts on manufacturing firms. Technological Forecasting and Social Change, 82, pp. 10-20.

[3] European Commission, Directorate-General for Research and Innovation, (2020a) Ethics of connected and automated vehicles : recommendations on road safety, privacy, fairness, explainability and responsibility. Publications Office. https://data.europa.eu/doi/10.2777/035239

[4] Chui, M. (2017). "The impact of automation on jobs and the economy." McKinsey & Company.

theory a theoretical framework was created, to later allow for empirical data collection and continuous analysis. Leveraging the conclusions, scenarios were created to analyze a potential electric LTL system against a conventional LTL system. These results brought about an insightful and enlightening discussion around the subject matter, both qualitative and quantitative in financial terms.

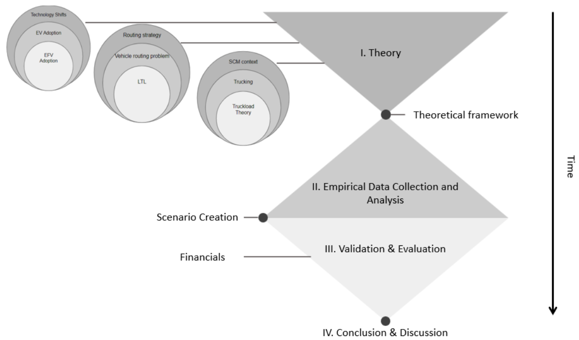

Figure 1: The methodology framework

The Technology Shift and its Implications

The adoption of electric vehicles has paved the way for EFVs. However, the success of electric vehicles can not be solely attributed to its own merits as incentive programmes have been a significant factor in their success. Similarly, EFVs will most likely rely on both coercive and non-coercive incentive programmes to gain a foothold in the road freight market.

A literature review conducted as a part of this thesis suggests that most of the barriers facing electric vehicle adoption can be generalized to electric freight vehicle adoption. The barriers to adoption which are shared between electric vehicles and EFVs were identified as driving range, pricing, charging infrastructure, and geographical limitations such as topology and unfavorable climate. The limited literature on electric freight vehicle adoption suggests that there are three key barriers to adoption specific to EFVs, these are, payload capacity, lack of servicing, and vehicle performance such as range and charging time. While the lack of servicing will be addressed as EFVs gain market share, conventional freight vehicles will most likely keep their advantage in terms of payload and vehicle performance for the foreseeable future. Though, even with barriers specific to EFVs identified one can argue that the common barriers, such as lacking infrastructure, still should be the primary focus when aiming to ensure adequate accommodation of this major technology shift and to guarantee overall profitability.

The Implications of Routing Strategy

An opportunity identified for electric LTL routing was derived from the high fixed cost and low variable cost of EFVs. The conventional routing strategy, shortest-distance (SD) routing, for LTL is for a set number of trucks to perform all pick-ups in one area to deliver it to a sorting terminal, while driving the shortest possible distance. This will be compared to destination-based (DB) routing, which entails that pick-ups are done in such a way that a trailer is filled only with goods heading to the same destination, eliminating the need for sorting. To illustrate the difference EFVs have on the comparison between SD and DB routing, a scenario analysis was performed.

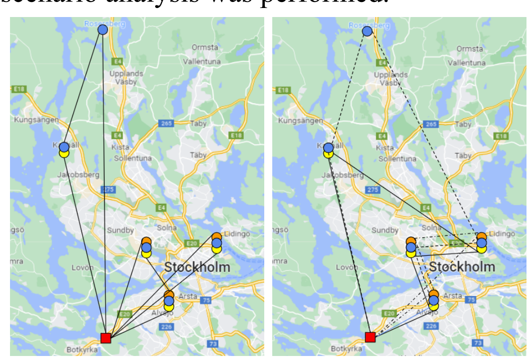

Figure 2: Shortest distance & Destination based routing

The scenario was created under the assumption that a set number of pick-ups were to be performed from industrial areas in Stockholm. For this, three routes were created using either routing strategy where calculations were made for diesel and electric propulsion.

The implications of these scenarios were threefold, as presented using relative diagrams.

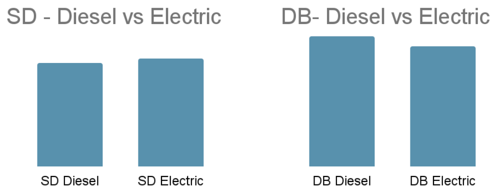

Figure 3: Relative cost of propulsion choice, same strategy

A key implication shown in figure 2 is that there is no major cost difference between propulsion chives given that the routing strategy is the same. Though, there is a cut-off point in distance driven where electric is cheaper than diesel – this point is highly utilization dependent.

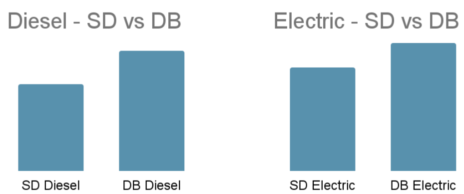

Figure 4: Relative cost of strategy choice, same propulsion

It is clear that DB routing is significantly more expensive, but that this effect is worse for diesel trucks. This would suggest that for a DB system with no sorting, EFVs are preferred.

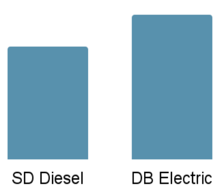

Figure 5: Status quo compared to proposed alternative

When comparing SD Diesel routing, representing the status quo, to DB electric we can conclude that DB electric is about 28% more expensive in the scenario analyzed in this thesis. This would suggest that for this routing strategy to be realistic, the cost reduction of decreased sorting has to surmount the increased cost of longer distances for specific routes.

Conclusion

This paper concludes that leveraging the low variable cost of EFVs by challenging common LTL routing practices could increase the profitability of transportation systems, and that this should be done on a route-per-route basis.