BRAIN-TRAINS: INTEGRATING THE LCA METHODOLOGY IN AN INTERDISCIPLINARY PROJECT

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Abstract

BRAIN-TRAINS is a project supported by the Belgian Federal Government that deals with the possible development of rail freight intermodality in Belgium, approaching this transport issue from an interdisciplinary perspective. Life Cycle Assessment (LCA) methodology is used to analyse the sustainability impact of rail freight intermodality. The rail freight system has been divided in three sub-systems: rail transport operation, rail infrastructure and rail transport equipment (locomotives and wagons).

First, a SWOT analysis of the intermodal rail freight transport has been performed to identify internal characteristics and possible external trends of the intermodal rail freight transport. The most important elements identified in the SWOT analysis have been selected through a Delphi-technique with the collaboration of a panel of expert. Thirdly, the selected elements have been translated into clear and measurable parameters, defining for every parameter an input value to quantify the scenarios. The parameters are measured in "tonne-kilometre".

Finally, three divergent Belgian scenarios with a time horizon set in 2030 have been built for further analysis. These scenarios are directly linked to the third strategic goal of the European Commission's White Paper on transport (2011), which aims to shift the 30% of road freight over 300 km to other modes such as rail transport by 2030. As a result, a best, worst and medium case scenarios have been developed, depending on whether the 30% shift has been successfully accomplished, the status quo has been maintained or the goal has not been completely reached by 2030, respectively.

The direct transport emissions and energy consumption during the rail transport activity have been determined using the LCA methodology. These LCA results have been used to improve the accuracy of existing commercial databases as Ecoinvent for the Belgian situation.

Keywords

Rail freight transport, SWOT analysis and LCA.

1. INTRODUCTION

In 2011, the European Commission decided that by 2030, 30% of road freight over 300 km in Europe should shift to other modes of transport more energy-efficient such as rail or waterborne transport. In Belgium, according to the Eurostat statistics for the year 2012, road transport was responsible for 58.3% of the total inland freight expressed in tonne-kilometres, representing the dominant mode of the three major inland transport modes. Inland waterways accounts for 24.3% and rail transport for 17.5% [1].

In order to increase the market share of rail freight transport, the BRAIN-TRAINS project analyses the current situation of the rail freight intermodality through the involvement of a multidisciplinary research team encompassing five areas of research: the optimal corridors and hub development, the macro-economic impact of intermodality, the effective market regulation, governance and organization for a well-functioning intermodality, and the environmental sustainability of intermodal rail freight transport.

2. METHODOLOGY

2.1 SWOT analysis and scenario creation

In order to identify the current state of intermodal rail freight transport in Belgium, a SWOT analysis was performed related to the five different fields of this study mentioned above. The internal characteristics and possible external trends of the intermodal rail freight transport have been identified, detecting 93 elements, including 18 elements related to the use of the LCA methodology in the environmental impact assessment of the intermodal rail freight transport.

According to this SWOT analysis, the most important internal strengths of the LCA methodology as a tool for environmental analysis are the reputation of the LCA methodology due to its standardisation at the international level by ISO 14040 and 14044 and its capacity to be updated. It should be noted that the LCA methodology has already been applied to transport issues in several studies. Furthermore, the available software and commercial databases allow a preliminary screening to identify the most important processes in the transport activity. However, some weaknesses need to be addressed to achieve the objectives of the study such as enhancing midpoint environmental impact categories relatives to accidents damage, noise impact or land use and the missing data related to rail transport in Belgium in commercial databases. The existence of 12 rail freight operators in Belgium and the regionalization of data complicate the collection of specific data concerning the state-of-the-art for Belgian freight transport including transport emissions. In contrast, the use of the LCA methodology presents the opportunity to improve existing commercial databases and to develop a Belgian specific database with the obtained results [2].

Due to the difficulty of including these 93 SWOT elements in the development of different scenarios, hence the most important elements in terms of impact and likelihood of happening in the future have been selected through a Delphi-technique with the collaboration of a panel of experts, resulting in a reduced list of 33 elements. Then, by clustering the interrelated elements, a final selection of 17 SWOT elements related to the intermodal rail freight transport has been achieved. To translate the 17 final identified elements into clear and measurable parameters for the scenario development, a full list of 68 possible parameters (of which 19 related with the sustainability of intermodal transport) and corresponding values were defined to quantify the scenarios [3]. The functional unit “tonne-kilometre” has been chosen in agreement among all project partners to measure the parameters in the same unit, making them more comparable, interpretable and usable.

Finally, with these parameters three plausible Belgian scenarios directly linked to the goal of the European Commission’s White Paper on transport (2011) of shifting the 30% of road freight over 300 km to other modes such as rail transport by 2030 have been built. As a result, a best, worst and medium case scenarios have been developed as follows (see Figure 1) [3]:

- The best case scenario takes into account a targeted 30% shift by 2030, with the shift from road transport over 300 km towards rail.
- The worst case scenario is based on the assumption of a status quo by 2030. This includes a rise in rail demand in absolute terms, but no additional shift from road tkm towards rail tkm for distances over 300 km.

- The medium case scenario is an in-between scenario, where the goal for the 30% shift is carried but not required to be completely reached by 2030.

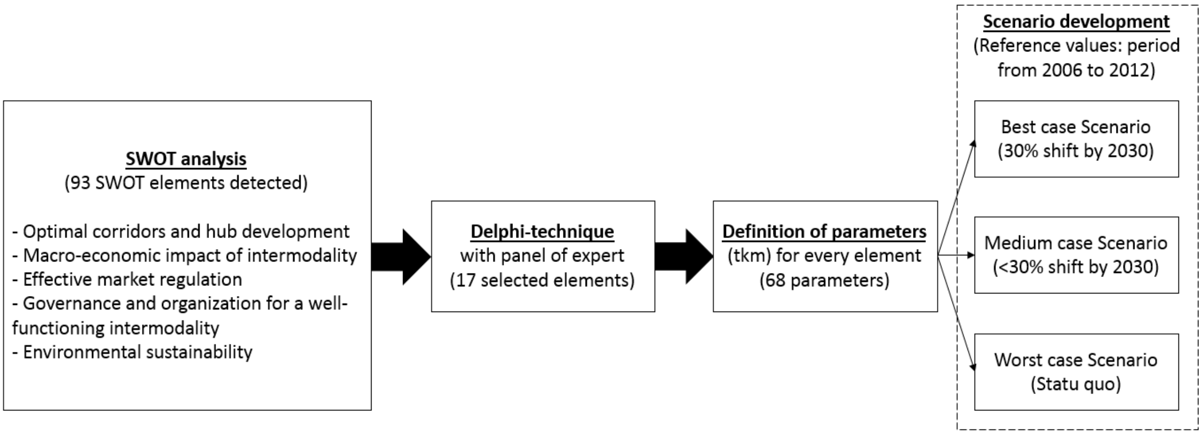

Figure 1: Scenario development process in the BRAIN-TRAINS project

2.2 Life Cycle Assessment

As mentioned above, the environmental impact of the rail freight intermodality has been determined using the LCA methodology. LCA methodology allows us to model as closely as possible the contribution of the pollutants emitted by the rail freight transport to midpoint environmental impact categories, such as climate change, resources depletion, acidification, human toxicity or ecotoxicity for example. Then, the influence of these midpoint categories to endpoint categories such as damage to human health, damage to ecosystem diversity and resource scarcity can also be evaluated.

As shown in Figure 2, the rail freight system has been divided in three sub-systems: rail transport operation, rail infrastructure and rail transport equipment (locomotives and wagons). The application of LCA methodology on the rail freight transport allows us to analyse not only the transport emissions related to the energy consumption during the operation of the train, but also the emissions related to the construction and manufacturing of rail infrastructure and rolling stock, and maintenance and disposal of both sub-systems [4].

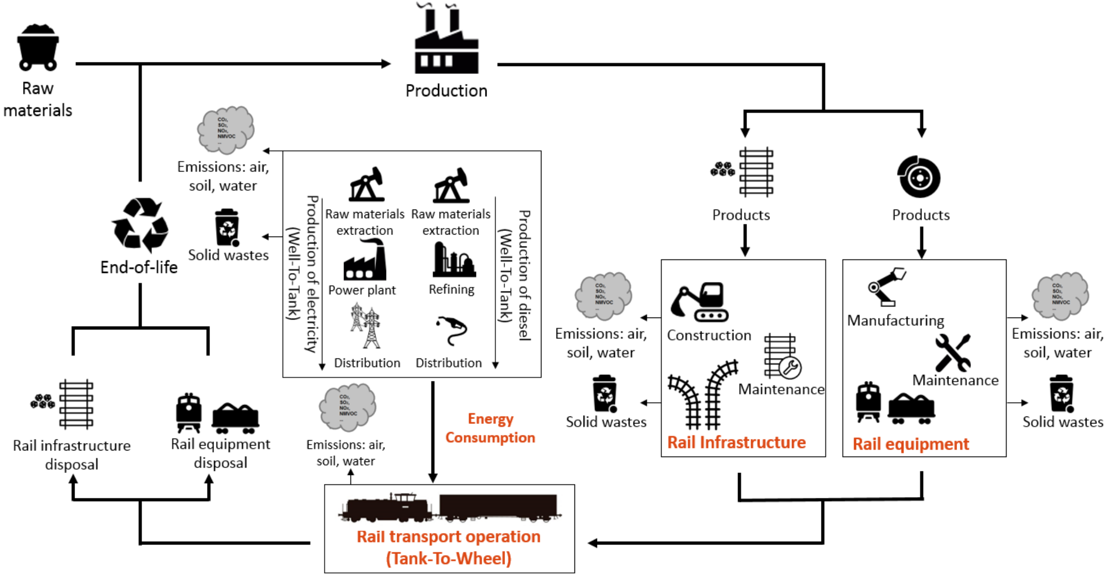

Figure 2: Railway system boundaries. Source: Own elaboration

3. RESULTS

The energy consumptions and direct transport emissions during the rail transport activity have been determined using data from the period 2006 to 2012. The LCA results from this evaluated period are taken as reference values to develop the three Belgian scenarios previously defined. These LCA results obtained on energy consumption and transport emissions during the rail transport activity have been used to improve the accuracy of existing commercial databases as Ecoinvent, which is based on Swiss rail transport data.

The specific energy consumption of electric and diesel trains has been determined separately on the basis of the total annual energy consumption of electricity and diesel and the total annual rail freight moved by each energy traction. In order to adjust as closely as possible the environmental impact related to the yearly electricity consumption, and since the electricity supply mix varies widely over the years, our LCA study uses the electricity supply mix in Belgium corresponding to the appropriate year (from 2006 to 2012). Direct emissions produced during the rail transport activity have been determined, including exhaust emissions to air related to the diesel combustion in locomotives, emissions to soil from abrasion of brake linings, wheels, rails and overhead contact lines and the sulphur hexafluoride (SF_6) emitted during conversion at traction substations related to electricity consumption.

In a next step, the environmental impact related to the sub-systems rail infrastructure and rail equipment will be analysed. Information relative to rail infrastructure such as allocation between passengers and freight transport, tunnels and bridges of the rail network, materials and energy used in the construction, renewal and disposal of tracks (rails, sleepers, fastening systems, switches, track bedding and noise protection system) has been collected. At the same time, information relative to rail equipment such as type of locomotives and wagons used for goods transport in Belgium and the energy and materials consumption for their maintenance and disposal have also been collected.

4. CONCLUSIONS

A careful SWOT analysis generated throughout a collaboration of several study fields and the creation of the three different scenarios with a time horizon set in 2030 will allow policymakers to take decisions for the development of rail transport in Belgium. Moreover, the LCA results of the complete rail freight system will be used to update and improve the accuracy of existing databases, developing a specific Belgian transport database to allow a better modelling in future studies and therefore to improve the regionalization of the results.

ACKNOWLEDGEMENTS

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