Towards an adequate methodology for GHG emissions accounting in logistics

A CASE STUDY AT HEINEKEN

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Abstract—There is no globally harmonised calculation methodology for GHG emissions in place, which hampers the ability to measure and report the environmental impact of logistics operations. This paper is aimed at developing an adequate GHG emissions accounting methodology for cross-border multi-modal logistics at Heineken and at generalising the findings to a broader context. It investigates current developments and challenges by means of a literature study and an in-depth case study at Heineken, accompanied with interviews with similar industry players. The numerous challenges that are identified within this research relate to the assessment boundaries, the calculation and allocation approach, the internal activity data, and the external default data. In an effort to deal with the challenges, the GLEC framework has been developed to create a universal framework for calculating logistics emissions by integrating existing methods and tools. The GLEC framework is applied as cornerstone for the design of an updated methodology. Moreover, its ability to positively contribute to the accounting principles; materiality, completeness, accuracy, comparability and verifiability, is assessed. The findings indicate that the alignment with the framework solves some of the challenges, but others remain unresolved. The reported total carbon footprint of Heineken’s outbound transport is increased with 7.5% if the operational improvements with regards to the GLEC alignment are implemented. Additional operational and strategic improvements are suggested, which require effort from Heineken and other stakeholders within the supply chain: political parties, research institutes, LSPs, carriers, and shippers. The majority of the suggested improvements can be generalised to industry peers with a multi-modal and cross-border supply chain. Moreover, the findings contribute to the scientific field of research by indicating that the GLEC framework has potential to increase the ability to adequately account for GHG emissions of logistics operations. However, enhancements to increase its potential are proposed.

Keywords—accounting, calculations, GHG emissions, logistics, methodology, standardisation, supply chain, transportation

I. INTRODUCTION

Greenhouse gas emissions have a significant impact on the atmosphere and in order to avert climatic and ecological disasters, efforts dedicated to downsizing emissions have to be made (United Nations, 2015).

The transport sector is responsible for a major share in the global emission budget, as it contributes to an estimated 20-25 percent of the overall global CO₂ budget (Samaras et al., 2017). The Paris climate accord, signed by 197 countries and its predecessor the Kyoto Protocol have been the prime motives to start reporting GHG emissions (United Nations, 2015).

As a consequence, over 140 calculation methods and tools have come forward as a result of individual initiatives (Ehrler, Davydenko, Kiel, & Lewis, 2016). These methods are lacking in various ways by either focusing on a specific region, not specialising in transport in particular, only providing high-level guidelines and not being entirely comprehensive (Davydenko, Ehrler, de Ree, Lewis, & Tavasszy, 2014). Due to different starting points, intentions and various calculation approaches, these developments are often incomparable and incompatible in their results (Auvinen et al., 2014). There is only one official international standard for emission calculation of transportation in supply chains: the EN 16258 (Davydenko et al., 2014). Even though the EN 16258 is acknowledged by the industry as a promising starting point, it still contains some challenges as the standard balances between the desire for precision and scientific rigour (Ehrler et al., 2016).

Companies have acknowledged the necessity to reduce emissions for their long-term survival and are, therefore, eager to find an applicable methodology for their emission accounting (Katiyar, Meena, Barua, Tibrewala, & Kumar, 2018). However, their ability to do so is limited by the absence of a globally harmonised GHG emissions accounting methodology and complicated by the complexity of multi-modal logistics, underlying a wide variety of characteristics. The most essential exacerbating factors are the scale of operations, the international nature, the prodigious amounts of data and the dynamic stakeholder interactions within supply chains (Davis & Caldeira, 2010) (Fritz, Rauter, Baumgartner, & Dentchev, 2018).

The wide variety of available calculation methods and standards together with the complexity of the accounting context indicates the long road that still has to be taken towards adequate and globally harmonised GHG emissions accounting in logistics.
In an effort to deal with the challenges of current GHG accounting practices, the GLEC framework has been developed to create a universal framework for calculating logistics emissions by integrating existing methods and tools (Bynum, Sze, Kearns, Polovick, & Simon, 2016). It covers all important ingredients for evolving methods by focusing specifically on transport, covering all transport modes, having full regional applicability and incorporating the entire transport chain (Davydenko et al., 2014). The framework seems to be a promising development to contribute to the absence of a harmonised methodology, but to the best of the author’s knowledge, no scientific research has investigated the potential of the framework in business environments. This paper aims to fill this scientific gap by examining the potential of the GLEC framework in a practical business environment.

In this paper, Heineken is chosen as the practical business environment to assess the potential of the framework and to identify the current accounting challenges. Heineken has complex and extensive supply chain, due its strong global presence, its multi-modal supply chain and its highly scattered and mostly outsourced transport operations. The characteristics of Heineken’s supply chain reinforce the complexity of current accounting practices. Heineken is about to define a new baseline and to update their accounting methodology (Heineken, 2017a). Heineken has, like many other companies, acknowledged the necessity to reduce emissions for their long-term survival and they aim to find an adequate methodology for their emissions accounting to measure and quantify physical GHG emissions (Katiyar et al., 2018).

The objective of this research is: 'developing an adequate GHG emissions accounting methodology for cross-border multi-modal logistics at Heineken and generalising the findings to a broader context.'

With the aim of achieving the objective, this research uses the GLEC framework as a cornerstone for the development of an updated accounting methodology. In order to comprehend how to develop an adequate methodology, knowledge ought to be gained on the current developments and challenges arising from both scientific literature and business environments. Following the identified research gaps and exploration, the subsequent research question is formulated:

**Which improvements in GHG emissions accounting practices in cross-border multi-modal logistics can be identified, based on a case study at Heineken?**

Moreover, all steps within the GHG accounting process are included in this research to shed light on the different challenges per accounting step.

This paper is structured as follows. First, the methodology is outlined which describes how the results of this research are obtained. In section III, the theoretical base is discussed. In section IV, current accounting practices at Heineken are examined. Section V presents the main findings of this research. The last section, section VI, provides the concluding remarks.

II. METHODOLOGY

A two-tiered approach is applied to answer the main research question, whereby insights from both literature and practice are combined.

First of all, scientific and grey literature is studied to examine the most important and used methodologies by the industry and to understand why it has appeared to be difficult for companies to correctly take responsibility for the emissions their operations are accountable for. The deep dive in literature also looks at scientific papers about the financial accounting profession to investigate if there any meaningful lessons that can be applied to the environmental accounting profession.

Second, insights from practice are gained by performing an in-depth case study at Heineken. The insights are accomplished with external interview sessions with similar large international shippers. The analysis aims at identifying current accounting practices and to discover the main challenges arising from the business environment.

Third, a comparative analysis is performed which parallels the Heineken methodology with the GLEC framework. A gap analysis identifies the gaps between both methodologies and hence discovers improvement areas. The analysis explores the impact of aligning Heineken’s methodology with the GLEC framework. The impact on the carbon footprint of outbound transport is quantified per suggested improvement.

Last, an assessment session is organised with three experts on GHG emissions accounting from Heineken. During this session, the improvements are assessed based on the accounting principles, and two additional criteria: the ability to influence and the required effort.

III. THEORETICAL BASE

This section provides the theoretical foundation for this research. It scrutinises what the main developments are pertaining to the harmonisation of GHG emissions accounting. It elaborates on the main initiatives and the multiplicity of methods and tools that exist today. Moreover, it summarises how the complexity of GHG emissions accounting gives rise to challenges, as identified from the literature. In addition, learnings of the financial accounting profession are investigated and the harmonised GLEC framework is introduced.
A. CURRENT DEVELOPMENTS AND CHALLENGES

A major problem, as addressed in chapter I, is the absence of a globally harmonised calculation methodology, and consequently the multiplicity of methods that exist and are in use today (Kellner, 2016). There is one official guidance for accounting GHG emissions in logistics, but it encounters challenges when being applied because of the standard balances between the desire for precision and scientific rigour (Ehrler et al., 2016). Moreover, it should be pointed out that the EN 16258 is a European norm and that it could, therefore, be difficult to be accepted on a global scale (Ehrler, 2017). As a result, methodologies have been developed based on industry-based initiatives to act upon the absence of an adequate methodology, as illustrated in figure 1. Suitable elements for adequate carbon footprint calculations are available, but methodological challenges are still present (Auvinen et al., 2014). The present methods are lacking in various ways by either focusing on a specific region, not particularly specialising in transport, only providing high-level guidelines, and not being entirely comprehensive (Davydenko et al., 2014). The level of granularity of the input data required also greatly differs and none of the methods is officially put forward by any government or institution (Ehrler et al., 2016).

![Methods and Data Sources](image)

Fig. 1: The most important methods, tools and data sources for the future alignment process (Auvinen et al., 2014)

Exacerbating factors that complicate the alignment process are legislation, mode-specific characteristics, company-specific data handling, the reliance on subcontractors, and variations in data availability and quality (Davydenko et al., 2014). The growing international nature of large companies also reinforces the complexity of finding an adequate methodology which is able to cope with all the complicating factors of cross-border operations (Davis & Caldeira, 2010).

The biggest challenges that arise due to the absence of a harmonised methodology and the current accounting context are: the great discrepancy in the availability, quality, and granularity of data (1), the large degree of freedom with regards to the definition of system boundaries (2), the shortage of guidance on the retrieval of emission factors (3), and the lack of fairness due to incomparability of environmental performances (4) (Ehrler et al., 2016; Auvinen et al., 2014; Davydenko et al., 2014).

B. THE FINANCIAL ACCOUNTING TREATMENT

Environmental and financial disclosures are integrated increasingly, since stakeholders no longer focus only on the magnitudes and trends of profits, but also how these were obtained (Gallego-Alvarez, Martínez-Ferrero, & Cuadrado-Ballesteros, 2016). Though there is no regulation that requires disclosure of the sustainable reports and these are published only on voluntary basis (Cuadrado-Ballesteros, Martínez-Ferrero, & García-Sánchez, 2017). As mentioned before there is no universal standard, which causes that the growing trend for sustainability reporting has not been accompanied by an increase in information credibility and accuracy (Cuadrado-Ballesteros et al., 2017). Along with that, there can be argued that the level of the control environment for GHG emissions reporting is less mature and robust than for financial accounting. Extracting information from bookkeeping systems seems to be a vastly different story than the results on environmental performance obtained by a multitude of different information sources. However, despite the current differences, it appeared that the financial accounting professions encountered similar problems in the past (Zeff, 2013). The financial sector managed to remedy most of these problems by the implementation of the International Financial Reporting Standards (IFRS) (IASB, 2015). Therefore, it seems interesting to enhance the work of the financial auditing profession to improve the quality and reduce the divergences in emission statements by addressing some of the challenges as identified in the previous paragraph.

The main insight gained from the financial accounting profession is the use of the fundamental qualitative principles and the enhancing qualitative principles. These principles provide guidance on establishing useful financial information (IASB, 2015). Materiality, completeness, accuracy, comparability, and verifiability are applied to form a frame of reference throughout the paper. The principles are used as design criteria for an updated methodology for Heineken. Moreover, the principles are used as indicator for the quality of emissions accounting practices.

C. THE GLEC FRAMEWORK

The GLEC framework is created in an effort to develop a universally adopted framework for calculating logistics emissions by the Global Logistics Emission Council (GLEC) (SFC, 2015). It is a framework that specifically focuses on transport, integrates existing models and tools, covers all geographical regions, and all transport modes (Bynum et al., 2016). Due to these key ingredients, the GLEC framework seems to be a promising development to tackle the main challenges, as identified in paragraph III-A.

The main methodologies that serve as a cornerstone for the development of the framework are the EN 16258 and the GHG Protocol (SFC, 2015). Furthermore, the GLEC framework proposed macroscopic models which are broadly used by the industry (SFC, 2015).
The method for calculating and allocating emissions for transport journeys can be distinguished by a three-step approach (Oussoren, Inghels, Dullaert, Van Steendam, & Boute, 2018). First, the assessment boundaries should be defined. All transport chains start at the initial loading point, end at the final destination and consists of several elements called legs. The combination of all legs is called the Vehicle Operating System, and this includes all round-trips (Schmied & Knörr, 2012). The second step consists of partitioning the entire transport chain in individual elements, whereafter in the last step these elements can be categorised into different Transport Service Categories (TSCs). These TSCs are described by the GLEC framework as “groups of similar round-trip journeys that are considered over a 12 month period to represent the way freight transport services are procured and provided” (SFC, 2015). The emissions inventory can be established by calculating the emissions at the level of TSC, which are part of different transport elements (SFC, 2015).

The framework provides the only globally harmonised calculation methodology, focusing specifically on transport, covering all transport modes, having full regional applicability, and incorporating the entire transport chain (Davydenko et al., 2014). Due to these characteristics, it seems to have potential to contribute to the current challenges of GHG emissions accounting and to positively influence the ability to pursue the key accounting principles. It is applied in section V-B to assess its contribution to the design of an adequate methodology for Heineken.

IV. CASE STUDY AT HEINEKEN

This section presents the current accounting practices at Heineken. The accounting process can be described according to seven steps: define the business goals, define the accounting principles, designate the supply chain, set the assessment boundaries, collect the data, calculate and allocate emissions, and report the emissions inventory. The most important insights, which can be retrieved from the accounting steps, are presented in this section.

Heineken’s distribution accounts for 9% of the company’s total carbon footprint in 2017 (Heineken, 2018). To downsize the emissions from distribution within the supply chain, Heineken set the target to lower the emissions by 20% for the year 2020 compared to the 2010 baseline. The company is currently defining its new targets for 2030, along with a scope extension, setting a new baseline and defining an updated methodology (Heineken, 2017a). Heineken pursues accounting principles, which substantially overlap with those employed in the financial accounting profession. However, Heineken pursues two additional accounting principles: flexibility and practicality. It is of importance that the accounting practices are flexible to deal with the different characteristics of all parts of the supply chain. Moreover, practicality is important as companies have to avoid that accounting practices are cumbersome and resource intensive (SFC, 2015).

Heineken logistics operations are mostly outsourced, highly-scattered and are within the scope 3 boundaries (Heineken, 2018). Scope 3 refers to indirect emissions that are a consequence of the reporting company, but occur at sources owned or controlled by another company (SFC, 2015). Heineken accounts for CO₂-e, which is the common unit to describe greenhouse gases, from a Well-to-Wheel fuel life cycle perspective. Heineken’s operations cross many country borders as they run operations in more than 70 countries worldwide (Heineken, 2017a). Heineken partially defines the operational boundaries based on its operational control, but also incorporates transport flows that are not directly manageable (Heineken, 2017b). Heineken’s operational boundaries concern inbound transport of raw and packaging materials, outbound transport of finished goods, and last-mile delivery in 23 local operating units across the globe (Heineken, 2017b). Furthermore, Heineken transports their products via road, rail, and sea or inland waterways.

Data is collected on country level and provided by LSPs or collected from the internal global systems. The hierarchical level of the data, the quality and the availability, differs along the supply chain. This is mainly determined by the ability to manage different parts of the supply chain. Around 30% of Heineken’s environmental impact of distribution is generated by parts of the supply chain that are not directly under Heineken’s control and the other 70% which is managed by Heineken is merely outsourced (Heineken, 2018). In case fuel consumption data is available, the fuel-based approach is applied to calculate emissions. If this information is not available, the activity-based approach is applied or there is made use of extrapolation. The calculation models calculate emissions at macro- or meso-level, on a monthly basis. The most crucial parameters to calculate the emissions are distances, load factors, transported loads, fuel consumption, and default emission factors. The emission factors are classified per TSC. The default factors for ocean transport are retrieved from Clean Cargo Working Group (CCWG) and those for road, rail and inland waterways from EcoTransIT (CCWG, 2015) (EWI, 2018).

![Fig. 2: The carbon footprint of Heineken’s transport operations (Heineken, 2018)](image-url)
The last step in the accounting process is the reporting of the results: the total carbon footprint of Heineken’s transport operations. The results are reported, after they are internally and externally verified, on an annual basis (Heineken, 2017b). The verification processes assess the conformity of the reported information to the accounting principles: accuracy, comparability, completeness, flexibility, practicality, relevancy, and verifiability. An independent audit is provided of limited assurance on the non-financial reports.

V. MAIN FINDINGS

This section presents the main findings of the research. It presents the current challenges of GHG emissions accounting, which arise from the in-depth case study. These challenges are mirrored with the challenges arising from the scientific literature, as identified in section III-A. Additionally, the challenges are verified through external interview sessions with similar industry shippers. The shippers that can serve as resemblance are of similar size, operate in the consumer goods market and have a multi-modal supply chain that covers different geographical regions. Moreover, they have a similar level of advancement in GHG emissions accounting. After the challenges are identified, the potential of a designed methodology according to the GLEC framework is investigated. The last section proposes an outline for the design of an updated methodology and a roadmap to increase the adequateness of Heineken’s current accounting practices.

A. CURRENT CHALLENGES

The challenges, which are identified from the case study, relate to four elements: the assessment boundaries, the calculation and allocation approach, the internal activity data, and the external default data. The challenges arise if they create a deviation from the defined accounting principles and if they restrain accurate decision-making. An overview of all the identified challenges is presented in table I.

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Impact on accounting principle(s)</th>
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<tbody>
<tr>
<td><strong>The assessment boundaries</strong></td>
<td></td>
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<tr>
<td>Limited guidance on defining the methodological boundaries</td>
<td>Comparability and completeness</td>
</tr>
<tr>
<td>Limited guidance on defining the operational boundaries</td>
<td>Comparability, materiality, the completeness, and the accuracy</td>
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<tr>
<td><strong>The calculations and allocation approach</strong></td>
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<tr>
<td>Limited guidance on selecting an adequate sustainable performance metric</td>
<td>Comparability</td>
</tr>
<tr>
<td>Inconsistent use of assumptions</td>
<td>Verifiability and accuracy</td>
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<tr>
<td>Double counting of emissions</td>
<td>Accuracy</td>
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<tr>
<td><strong>The internal activity data</strong></td>
<td></td>
</tr>
<tr>
<td>Inability to designating the entire supply chain</td>
<td>Verifiability, completeness, and the accuracy</td>
</tr>
<tr>
<td>Inability to collect comprehensive operational data</td>
<td>Comparability, verifiability, completeness, and accuracy</td>
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<tr>
<td><strong>The external default data</strong></td>
<td></td>
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<tr>
<td>Finding adequate sources for default data</td>
<td>Comparability and verifiability</td>
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Firstly, the challenges related to the assessment boundaries pertain to defining both methodological and operational boundaries.

The lacking guidance on what the borders of the accountability of a company should be leaves the companies with this decision. If a company wants to take full responsibility for its direct and indirect impacts, concerns arise whether or not to also account for less material parts of the supply chain. Being complete is inevitably linked in the current accounting context to being less accurate, because the hierarchical level of the data, the quality and the availability, differs along the supply chain, as indicated in section IV. Heineken is left with questions like ‘Where does our accountability stop?’ and ‘What are the borders of a company’s accountability?’ The lack of guidance adversely impacts the comparability, the materiality, the completeness, and the accuracy.

Secondly, the identified challenges related to the calculation and allocation approach concern the selection of an adequate sustainable performance metric, the inconsistent use of assumptions, and double counting. The large-scale operations, the company-specific characteristics and the scattered processes make it difficult to find an adequate metric that best reflects sustainable improvements. It also makes it challenging to prevent double counting within the consolidation process. Moreover, due to the scale of operations and the complexity of the supply chain, it appears difficult to define standard approaches for dealing with certain data gaps and it imposes the need to make assumptions. The large data quantity and the spread responsibility within the reporting process also entail that not all assumptions are reported. A uniform way of reporting can only be checked at a limited level. These challenges have a detrimental effect on comparability, verifiability, and accuracy of the emissions inventory.

Thirdly, the challenges pertaining to the internal activity data merely relate to the availability, the quality and the granularity of data, as identified in the literature (WRI & WBCSD, 2004). Both Heineken and all other interviewed shippers indicated that obtaining accurate accounting information is a major challenge. The level of control, the dependency on third parties, and the ability to manage parts of the supply chain were factors mentioned in the external interview sessions that influence the visibility within the transport chain. The comparability, the verifiability, the completeness and the accuracy of the inventory are restrained.

Lastly, with regards to the challenge related to the external default data, it was evidenced from the case study that Heineken experiences difficulties to find comprehensive and credible sources for their cross-border logistics operations. The different sources for emission factors are aligned with varying methodological scopes, vary in specification level, might in some cases be outdated and are not regionally-specific. Moreover, it is hard to determine the trustworthiness, as the reasoning behind the final number is often not provided.
To conclude, it must be noted that the examined scientific research has a strong focus on the absence of a harmonised methodology, whereas from business environments it appears that data is a substantial issue. The overall conclusion is that the challenges, which are laid down in the case study, significantly overlap with those raised in the scientific literature as described in section III-A. Moreover, most of the challenges are confirmed by industry peers during the interview sessions.

B. ALIGNMENT WITH THE GLEC FRAMEWORK

The potential of the GLEC framework to contribute to the design of an updated methodology is evaluated, to resolve the current challenges and to positively contribute to pursue the accounting principles.

A gap analysis is preformed to identify the gaps between Heineken’s methodology and the methodology prescribed by the GLEC framework, to assure claims on the conformance criteria and the stage of implementation. The analysis is performed by assessing any differences in the principles and practices set out in the GLEC framework. The gaps between the methodologies shed light on possible improvements for the Heineken methodology. The results of the analysis are verified with Alan Lewis, the Director of the GLEC on the 24th of July 2018 through an email conversation (personal communication, 2018).

The overall conclusion from the gap analysis is that the methodologies are largely aligned on most aspects. Four central elements are analysed: the assessment boundaries, the calculation and allocation approach, the operational transport data, and the default factors. Besides the general assessment, potential differences between mode-specific guidelines are examined.

The largest methodological differences relate to the inclusion of logistics nodes and the different assessment boundaries for road and ocean transport. The effects of aligning both methodologies are examined by means of a comparative analysis. The suggested improvements are tested based on data of outbound transport operations of 23 countries in 2017. The explored applications are: updating ocean calculations (1), including empty running for road calculations (2), including logistics nodes (3), eliminating double counting (4), updating vehicle emission factors (5), and updating fuel emission factors (6).

The results of the comparative analysis indicate that the results are volatile to the suggested improvements. The quantification of the impact of completely aligning the methodologies is done based on transport activity data of outbound transport operations in 2017. The data is retrieved from 23 local operation units across different continents: North and South America, Central Europe, Northern Europe, Western Europe, and Eastern Europe. These 23 local operating units accounted in 2010 for 70% of the total emissions from the beverage production.

The local operating units report monthly on their logistics operations and obtain the data from both internal systems and from their LSPs. The reason to use data on outbound transport is that the data and the calculations of outbound transport are at the highest maturity level. The data availability is the most extensive; it is comprehensive, granular and at high levels of accuracy, which enables to perform detailed calculations.

The impact of the improvements on the global carbon footprint of outbound transport ranges from 0.02% to 5.7%. Aligning the different methodologies in all aspects results in an impact varying from -5% to +51% on the carbon footprint of outbound transport of local operating units, as indicated in figure 3. However, these significant effects cancel each other out on the global level. The reported global carbon footprint of outbound transport increases with 11% if Heineken’s methodology is completely aligned with the GLEC framework.

![Fig. 3: Impact of the suggested improvements on the carbon footprint of outbound transport of local operating companies](image-url)

However, to analyse to what extent the GLEC framework contributes to the identified challenges indicated that applying the GLEC framework solves some of the challenges. By aligning the methodologies, improvements are identified that contribute to the challenges related to the assessment boundaries, the calculation and allocation approach, and the default data. The ability to pursue the accounting principles comparability, completeness, accuracy, and verifiability is positively influenced. However, an assessment of the suggested improvements by three experts of Heineken indicated that not all suggested improvements increase the quality of the inventory. The suggested improvements are evaluated in an assessment session on their contribution to the accounting principles, and to two additional criteria: on Heineken’s ability to influence the improvements and the required effort needed to implement the improvements. The results of the session evidenced that not all suggested improvements increase the quality of the inventory. The conclusion of the assessment session was to incorporate some of the improvements for the updated methodology. This implies that the GLEC framework does not entirely assists in achieving perfect emissions accounting practices.
In an ideal environment, all accounting principles can be equally pursued. This entails that the emissions inventory is relevant, complete, accurate, comparable, and verifiable at the same time and that no principle goes to the detriment of another principle.

The suggested improvements are assessed by experts on their contribution to increase the quality of the inventory. The suggested improvements are evaluated in an assessment session on their contribution to the accounting principles, and to two additional criteria: on Heineken’s ability to influence the improvements and the required effort needed to implement the improvements. The results of the session evidenced that not all suggested improvements increase the quality of the inventory. The conclusion of the assessment session was to incorporate some of the improvements for the updated methodology, but to not implement all of them. This implies that the GLEC framework does not entirely assist in achieving perfect emissions accounting practices.

The preceding section exploits the possible consequences of the unresolved challenges. Operational and strategic improvements are proposed to overcome the unresolved challenges.

C. UNRESOLVED CHALLENGES

Some of the identified challenges still stay unresolved by the GLEC framework. Both strategic and operational improvements are identified to cope with these challenges and to further increase its ability to pursue the accounting principles. However, Heineken’s ability to resolve all the challenges is limited and there are challenges that have to be addressed by other entities. Recommendation are also proposed to other involved stakeholders. The unresolved challenge relate to the limited guidance on defining the operational assessment boundaries, inconsistent use of assumptions, inability to designate the entire supply chain, incapability to collect comprehensive operational data, and finding adequate sources for default data.

Limited guidance on defining the operational boundaries
Firstly, the GLEC framework partially solves Heineken’s challenge related to defining the operational boundaries, as mentioned in section V-B. It prescribes to account for the operations of all modes in Heineken’s fleet, for logistics nodes, to incorporate average load factors, and empty running. Nonetheless, it does not give any guidance on which flows should be incorporated, whereas this significantly impacts the results. Due to the lack of guidance on the operational assessment boundaries, Heineken is left with questions like ‘where does our accountability stop?’ and ‘what are the boundaries of our accountability?’. Answering these questions lies beyond this research, as the responsibility to decide upon these matters lies with policymakers. However, the advice to Heineken is to be complete and include all transport flows to be in line with their ‘From Barley to Bar’ philosophy.

Accounting for the entire supply chain is vital to drive sustainable decision making since you can not manage, what you can not measure.

The disadvantage of incorporating a wide range of operations is that it adversely impacts the accuracy, as explained in section V-A. Notwithstanding that, the high degree of freedom with regards to the definition of operational boundaries might not be a challenge in itself if a company reports what is included in the emissions inventory and what is not. To the best of the author’s knowledge, there are no regulations which permit companies to report what is included in their operational boundaries and there is no uniform guideline available which prescribes how to do this. This entails that in the current environmental accounting profession transparency of emission statements is lacking, adversely affecting the comparability.

The responsibility to solve these challenges goes beyond Heineken’s reach. International regulation is essential to support companies in defining their operational boundaries and clear guidance should be given on how to do this. As for the GLEC framework, it would be supportive if it defines minimum assessment boundaries for companies to be in accordance with the framework. Additionally, it is advised to the GLEC framework to prescribe documentation rules for the assessment boundaries. Moreover, it could contribute to solve this challenge by specifying a minimum level of materiality, which indicates when operations have to be included.

Inconsistent use of assumptions
The multiplicity of stakeholders which handle the data and are involved in the accounting process causes the inconsistent use of assumptions. The current accounting context is inherent to scattered responsibilities. The responsibility for solving this challenge lies with Heineken, their vendors, their carriers, and their LSPs.

Standardised assumptions in case of data gaps, should be laid down via a top-down approach. A questionnaire and mandatory documentation could assist to gain understanding of the most significant data gaps and the variety of assumptions that are made during the data handling processes. It is important to liaise with vendors, carriers, and LSPs on gaining more transparency on the exchanged information, as part of the responsibility to solve this challenge lies with them. Questions such as, ‘how are the distances determined?’ and ‘what are the load factors in case of shared operations?’ should be answered. In achieving more control of the data handling processes, verifiability and accuracy of the inventory can be increased.

Inability to designating the entire supply chain
Around 30% of Heineken’s environmental impact of distribution is generated by parts of the supply chain that are not directly under Heineken’s control and the other 70% which is managed by Heineken is merely outsourced (Heineken, 2018).
The consequence is that the visibility over the entire transport chain is limited. Solving this challenge requires to liaise and ally with external stakeholders.

Sharing more information amongst Heineken, its vendors, its LSPs and its carriers, is vital to ensure that the visibility is increased. This requires a long-term investment and a change in the strategic mindset of how to collaborate with partners. Data sharing should be incorporated into contracts, and mutual benefits should be emphasised. Making meaningful estimates on emissions of transport operations can only be enabled if Heineken is in the position to map the entire supply chain. Both Heineken and their partners play a vital part in achieving more transparency, which increases the ability to verify and to be more accurate.

Incappability to collect comprehensive operational data
The most decisive factor for the adequateness of the emissions inventory seems to be the quality of the data. Most of the transport operations in Heineken’s supply chain are either managed by external stakeholders or outsourced to LSPs. The responsibility to increase the ability to collect high-quality operational data and to decrease the uncertainty level of current activity data, rests with both Heineken and the external partners. The suggested improvements assist to increase the comparability, verifiability, completeness, and accuracy of the inventory.

With regards to the internal improvements, business processes can be refined to increase the ability to collect the operational data. Two improvements are suggested. The first suggestion relates to the way of cooperating with both vendors, LSPs, and carriers. Different agreements have to be made on data sharing and a minimum level of data sharing should be included in the contracts. This increases the ability to incorporate sustainable performance as an assessment criterion and to define mutual targets. The second suggestion relates to the data gathering process. Automation of data collection would limit manual efforts and the risks of inaccurate adjustments or losses of data. Along with that, it would be interesting to increase the promotion of the installation of telematics systems on vehicles. This enables Heineken to capture real-time and primary data on operations. The alignment of systems and privacy concerns are, in this case, pressing matters to take into consideration. Both the automation and the incorporation on tracking technologies, as well as different contractual arrangements are long-term recommendations that should first focus on the most carbon polluting supply chain parts. The recommendations aim to increase the verifiability, completeness, and accuracy.

Another important short-term recommendation is the division of Heineken’s input data into different data quality levels. Both the financial accounting profession, as mentioned in section III-B, and the GLEC framework propose such a classification.

Applying ratings for the accuracy of estimations is also proposed in the scientific literature (Davydenko et al., 2014). The GLEC framework has recently identified five updated types for input data: entry, estimated, modelled, based on measured input data, and consignment level data (SFC, 2018a). To appraise verifiability and accuracy, it is advisable to distinguish between different levels of data according to the GLEC framework. Moreover, strict indicators for the data quality should be defined. In doing so, measurement uncertainty is disclosed, the mix of measured and estimated data is acknowledged, and the relevance of the results is not undermined.

A third recommendation, which aims at improving the accuracy and can be implemented on the short-term, is to increase the usage of static parameters. The impact of influencing parameters that are within Heineken’s reach can be more evident, by taking static average values for parameters that are merely external.

The last suggestions relate to an industry-wide context, referring to shippers and their collaboration with third parties. Heineken should, together with other shippers, make use of its strong global presence to raise awareness of the importance of sharing primary data. This is identified as crucial for the achievement of widely applied carbon footprinting (LEARN, 2017). It is remarkable that, in the current accounting context, shippers do not have ownership of primary data, whereas those are the driving force behind carbon footprinting (LEARN, 2017). Additionally, alignment between shippers on asking for the same information is essential to increase the willingness of carriers to provide the data. Shippers should also share best practices around internal processes. The reliance on third parties is now still experienced as a negative aspect. Whereas, supply chain collaboration and industry alignment are crucial to make business decisions which aim at downsizing the climate impact.

Finding adequate sources for default data
The challenge of finding credible and comprehensive sources for emission factors is partially solved by the GLEC framework, as mentioned in section V-B. Notwithstanding that, the framework still leaves a lot of freedom to companies on what sources to use and how to apply the emission factors, which adversely influences the comparability and verifiability.

Firstly, the recommendations for Heineken are presented. It is not possible to keep updating the emission factors, as a baseline is defined to monitor sustainable performance. The emission factors have a significant impact, which entails that the results are volatile to any updates. The updated methodology should be viable until 2030, as described in I. Future proof emission factors are, therefore, essential to guarantee that the results are still accurate over 12 years’ time. Heineken is compelled to use data from the most credible sources, hoping that the factors are still accurate in 12 years.
Secondly, recommendation are suggested to the GLEC framework and research institutes. By not strictly defining what sources have to be consulted, large discrepancies can occur in emissions inventories. The Smart Freight Centre investigated differences between vehicle emission factors of credible sources such as Defra, HBEFA, and the French decree. The analysis indicated that the emission factors for the same vehicle under the same circumstances could significantly differ, up to two times higher numbers (SFC, 2018). The GLEC framework should be more strict on what sources should be consulted. In addition, the significant discrepancies indicate that more resources are required for research institutes to determine default factors. Collaboration between shippers, carriers and research institutes would also be beneficial. Primary operational data could support to underpin and scrutinise the default factors. Moreover, no information is provided on the uncertainty rates and credibility of the provided default factors. It would increase the verifiability and accuracy, if this information would be provided.

Another important limitation of the framework is that it does not prescribe to document what aggregation level is used for the emission factors based on the TSC. The accuracy of the results that are based on the use of an average mode-specific emission factor is vastly different from results that are based on granular TSC specified per vehicle class, fuel type, and region. The same applies to fuel emission factors. The fuel quality strongly differs amongst regions, as indicated in the EN 16258 (CEN, 2012). Electricity in Norway emits 0.02 kg of CO$_2$ per kWh, whereas one kWh in Poland emits 1.16 kg of CO$_2$ (SFC, 2018b). This results in a 80% higher carbon footprint. This also applies to other fuel types. Neglecting geographical differences is in contradiction with the aim of achieving an accurate emissions inventory. A good enhancement for the GLEC framework would be to give more guidance on the granularity of default factors.

The third lack of guidance is that the GLEC framework does not prescribe the how frequent emissions factors have to be updated. Research on default emission factors is still in progress and the published figures are not set in stone. The figures become more accurate over time when these can be underpinned with more data from actual operations. The volatility of factors applies in particular to electricity emission factors, due to the fast decarbonisation of the sector (Spencer et al., 2017). It would be opportune to the GLEC framework to give more guidance on the regularity and sustainability of default factors.

All three limitations of the GLEC framework similarly apply to the policymakers. It is, therefore, advisable to increase the level of guidance upon these matters. Policymakers should also advocate giving more resources to research institutes.

D. TOWARDS AN UPDATED METHODOLOGY

The selected improvements for the alignment with the GLEC framework and the recommendations for the unresolved challenges as input for a final recommendation for the development of an adequate methodology. This section proposes an outline for the design of an updated methodology and a roadmap to increase the adequateness of their current accounting practices.

Firstly, it is recommended to align the design of the updated methodology with the GLEC framework, to increase the ability to pursue the accounting principles. However, it is advised to not align with the GLEC framework in all aspects, as not all improvements contribute to increase the overall quality of the emissions inventory. The suggested improvements which should be implemented are presented in table II.

TABLE II: Overview of the recommendations for the design of an updated methodology

<table>
<thead>
<tr>
<th>Type</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational</td>
<td></td>
</tr>
<tr>
<td>Improvements for the GLEC alignment</td>
<td>1a. Conversion to WTW and CO$_2$ for ocean transport</td>
</tr>
<tr>
<td></td>
<td>1b. Adding an average load factor for ocean transport</td>
</tr>
<tr>
<td></td>
<td>1c. Adding a distance supplement for ocean transport</td>
</tr>
<tr>
<td></td>
<td>2. Inclusion of warehouses.</td>
</tr>
<tr>
<td></td>
<td>3. Elimination of double counting.</td>
</tr>
<tr>
<td></td>
<td>4. Updated vehicle emission factors.</td>
</tr>
<tr>
<td></td>
<td>5. Updated fuel emission factors.</td>
</tr>
<tr>
<td>Improvements for the unresolved challenges</td>
<td>• Define strict assumption rules for all data gaps.</td>
</tr>
<tr>
<td></td>
<td>• Take a survey or impose to strictly document assumptions to identify the most significant data gaps.</td>
</tr>
<tr>
<td></td>
<td>• Incorporate the necessity to share operational data in the contracts.</td>
</tr>
<tr>
<td></td>
<td>• Automation of data collection.</td>
</tr>
<tr>
<td></td>
<td>• Increase the adoption of telematics systems on vehicles.</td>
</tr>
<tr>
<td></td>
<td>• Categorise data into different data quality levels, as prescribed by GLEC.</td>
</tr>
<tr>
<td></td>
<td>• Increase the use of static values for parameters that are outside Heineken’s control.</td>
</tr>
<tr>
<td>Strategic</td>
<td></td>
</tr>
<tr>
<td>Improvements for the unresolved challenges</td>
<td>• Liaise with vendors, LSPs and carriers to get more information on the associated assumptions of the shared data.</td>
</tr>
<tr>
<td></td>
<td>• Raise awareness by LSPs and carriers of the importance to increase transparency for mutual benefits.</td>
</tr>
<tr>
<td></td>
<td>• Make agreements on data sharing with supply chain partners.</td>
</tr>
</tbody>
</table>

Aiming to meet the research objective 'developing an adequate GHG emissions accounting methodology for cross-border multi-modal logistics at Heineken’, it is important to ensure that the updated methodology is adequate. By implementing both operational and strategic improvements, which are presented in table II, the ability to pursue the accounting principles is positively influenced. By striking the right balance between the accounting principles the updated methodology assist in decision-making on sustainable strategies.
Figure 4 indicates a quantification of the final impact of the improvements, which is based on the global carbon footprint of Heineken’s outbound transport. The reported total carbon footprint of Heineken’s outbound transport is increased with 7.5% if the operational improvements with regards to the GLEC alignment are implemented. The impacts of the suggested improvements are according to expectations, and the effects are directionally correct. The previous calculations underestimated the impact of ocean and road transport and did not include any estimates on operations at logistics nodes. For this reason, an increase in the calculated carbon footprint was assumed, which appeared to be true. The updated emission factors are more comprehensive, correctly applied, and updated according to the latest science. On beforehand there were no expectations with regards to the impact of these applications. Double counting is the only improvement which does not change the absolute emissions and only influences the KPI, kg CO₂eq / hl sold.

With regards to its flexibility to cope with future developments, there can be concluded that it is well aligned with the forecasted developments. The next revision of the methodology will be in 2030 and the accounting context will change. An expert on emissions accounting indicated in an interview that the biggest change relates to data availability. He stated ‘in the near future there will be an overload of real operational data’ (Swahn, 2018). The updated methodology is capable to cope with this development.

VI. CONCLUSION & FUTURE RESEARCH

The objective of this section is to conclude and discuss the research. The environmental GHG emission accounting profession is still evolving, and this research focuses on identifying the current difficulties and improvements.

A. MAIN FINDINGS

The objective of this section is to conclude this research by answering the main research question: Which improvements in GHG emissions accounting practices in cross-border multi-modal logistics can be identified, based on a case study at Heineken?.

The purpose of this research is twofold as it aims to identify improvements and to develop an adequate methodology for GHG emissions accounting at Heineken, but to also generalise the findings to a broader context. The main findings in which suggested improvements are proposed for these challenges, are divided in two sections.

Main findings for Heineken

The primary improvement which can be identified from this research is the alignment with the GLEC framework for design of the updated methodology. The framework is a promising improvement towards adequate emissions accounting. It brings about convergence by being the only globally harmonised calculation methodology, focusing specifically on transport, covering all transport modes, having full regional applicability and incorporating the entire transport chain (Davydenko et al., 2014). The GLEC framework significantly contributes to the challenges related to the assessment boundaries, the calculation and allocation approach, and the default data. Heineken’s ability to pursue the accounting principles comparability, completeness, accuracy and verifiability is increased by the implementation of the framework. It appeared that Heineken’s methodology and the GLEC framework are largely aligned. However, aligning Heineken’s methodology with the GLEC framework in all aspects indicated that emissions inventory is significantly impacted. Based on a quantitative analysis it appears that by increasing the quality of measuring emissions of outbound transport operations, Heineken’s carbon footprint is underestimated and results to be 11% higher. This result is not surprising as the GLEC proposes a wider range of responsibilities.

![Fig. 4: Overall impact of the recommended improvements on the carbon footprint of outbound transport](image-url)
However, the research also indicated that not all the improvements that resulted from the methodological alignment contribute to increase the overall adequateness of the inventory, based on the accounting principles. For this reason it is advised not to completely align with the GLEC framework. Moreover, the research brought to light that the GLEC framework is incapable to resolve all the identified challenges and that it is not the perfect solution. The most significant challenges which are not entirely addressed are the limited guidance on defining the operational assessment boundaries, the inconsistent use of assumptions, the inability to designate the entire supply chain, the incapability to collect comprehensive operational data, and finding adequate sources for default data. All these challenges adversely impact the accounting principles and restrain Heineken’s decision-making.

It is important for Heineken to limit the impact of the challenges related to operational data availability and processing, which is not solved by the implementation of the GLEC framework. Whereas, the most decisive factor for adequate accounting seems to be the quality of the data in the still immature and not robust accounting context. The quantification of carbon emissions is subject to inherent uncertainty due to the information gaps in operational data along with the usage of default factors. Additional operational and strategic improvements are required, which aim at improving accounting practices. The identified operational improvements aim at increasing the level of control and transparency, such as strict assumption rules for data gaps, incorporating data sharing in future contracts with partners, and categorisation of data quality levels. Nevertheless, the operational improvements have to be accomplished with strategic improvements. Heineken should seek to enforce supply chain collaboration by raising awareness on the importance of sharing primary data, by sharing best practices, by liaising with its partners and by collaborating with other shippers on uniform data requests.

Furthermore, Heineken’s and GLEC’s ability to resolve all the challenges is limited, and there are challenges that have to be addressed by political entities. First of all, more guidance is needed to support Heineken in answering ‘where does the accountability stop?’, and ‘what calculation and allocation methods should be applied?’. The complexity associated with the multiplicity of different guidelines that are at hand today is caused by the limited level of legally binding commitments to report emissions. Both national and international regulations are lacking, which acknowledge the GLEC as enforceable standard and strictly define a company’s responsibility. More political involvement of international organisations on the assessment boundaries, documentation and calculation approaches is of great importance.

To conclude, to reach climate goals, it is necessary to improve the current methodology and the accounting context to enable informed decision-making. The GLEC framework is a great improvement to increase adequate accounting, but it is not perfect and additional efforts are necessary.

Generalisation of the results
The findings that arise from the previous section do not only apply to Heineken, but can also be generalised to other companies in the consumer goods market with a cross-border and multi-modal supply chain. First, vouching to align the design of the updated methodology with the GLEC framework applies to all reporting entities. The success of the GLEC framework and its contribution to harmonised GHG accounting is dependent on its recognition as an enforceable and globally accepted reporting standard. The potential of the GLEC is confirmed within this research, but it will only improve the environmental accounting context if it is widely accepted and employed.

Moreover, the research indicates that the GLEC is not the all-encompassing solution to resolve all identified challenges. The GLEC framework significantly contributes to the challenges related to the assessment boundaries, the calculation and allocation approach, and the default data. However, it does not contribute to the challenges related to the internal activity data, whereas this is identified as a major challenge. The challenges have a detrimental effect on the comparability, variability, completeness and accuracy of emissions inventory. Operational and strategic, quick wins and long-term improvements are identified to contribute to this challenge. It depends on the maturity of a shippers accounting practices and on the supply chain characteristics to what extent the improvements apply to them. The operational improvements with regards to the operational data availability and processing relate mostly to increase the level of control. Defining uniform rules for data handling and processing, along with documentation requirements are important examples. The strategic improvements, which focus on long-term changes of business processes and increased supply chain collaboration, can also be generalised.

Furthermore, the fact that some identified challenges are still unresolved and that the responsibility lies beyond shippers, similarly applies to other industry peers.

B. CONTRIBUTION OF THE RESEARCH

The research has both theoretical and societal contributions. Beginning with its scientific contribution, it contributes to assess the potential of the GLEC framework in a business environment. Based on the analysis, it makes recommendations for further enhancements of the GLEC framework to increase its contribution towards adequate emissions accounting, as presented in section 3. As for its societal contribution, the in-depth case study accomplished with the external interviews provide a present state overview of the most significant limitations in current accounting practices in section 3. Furthermore, the findings that conclude upon the main research questions relate to Heineken, but the majority of the findings can be extrapolated to a more industry-broad context.
C. Discussion

The main limitations of this research relate to several aspects: the use of the financial accounting principles, the choice to opt for the GLEC framework, the single case study research at Heineken, and the applied research methods.

First of all, the financial accounting principles are used to assess the potential of any suggested improvement, but the use of the principles as qualitative quality indicator allows for some degree of bias. The financial accounting profession also acknowledges that the use of the accounting principles brings about problems related to integrity, objectivity, professionalism, competency, due diligence, and confidentiality (NBA, 2018). Secondly, the research is marked by the choice to opt for the application of the GLEC framework. It does not investigate the potential of any other guidelines. Thirdly, the results are merely based on a case study at Heineken with a limited contribution of other similar industry players, which impacts the ability to generalise the findings. Fourthly, the quantification of the alignment of Heineken’s methodology with GLEC is based on outbound transport operations in limited geographical regions. This entails that the results are less applicable to accounting contexts with different characteristics. And lastly, the applied research methods all have some limitations. The most significant limitation of the case study, the expert interviews, and the workshop session is that these methods allow for bias. The main limitation of the comparative analysis is that the applications could not be tested with the same level of certainty.

D. Suggestions for Future Research

There are several recommendations made for future research: (1) find ways to quantify the accounting principles, (2) compare the potential of several methodologies, opposed to only the GLEC framework, (3) perform in-depth case studies for a greater variety of companies to increase the validity to generalise the results, (4) make separate recommendations for the challenges of different accounting context, (5) investigate how and if companies experience allocation issues for shared fleets, as fairness is a big challenge within GHG emissions accounting (Auvinen et al., 2014), (6) analyse the role of future and current technologies for improving data quality and data sharing along the supply chain, (7) investigate the underlying effects of the structural uncertainty of GHG emissions inventories and the implications on the results, and (8) examine the accounting principle neutrality to identify to possible risks of biased reporting and ambiguities appertaining to the freedom of the reporting entity.

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