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Opportunities to improve data quality of scope 3 emissions in the context of carbon neutrality: the case study of LUT University

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Abstract

Purpose – This study aims to assess the greenhouse gas (GHG) Protocol scope 3 categories and evaluate data sufficiency from a university's point of view. The specific purpose was to determine whether the current carbon footprint information can be used to plan emission reductions at LUT University.

Design/methodology/approach – This study uses the GHG Protocol's accounting and reporting principles, namely, relevance, completeness, accuracy, consistency and transparency. In addition, opportunities aimed at improving the data quality of activity data and emission factors for scope 3 are suggested.

Findings – The results of data evaluation at LUT University in Finland show that the bulk of scope 3 emissions suffers from lack of data accuracy. Data unavailability and poor data quality result in over- or underestimation of carbon footprint and, more importantly, they hinder universities in their efforts to effectively manage and decrease their emissions.

Practical implications – Given their leading role in society, universities are in a unique position to tackle the emissions through directing a share of their educational and research activities towards actions aiming to improve data quality and completeness related to scope 3 emissions. Appropriate mitigation actions can only be derived from such improvements in data. The intellectual contribution of the university sector has substantial potential to manage and mitigate emissions of other organisations and to lead the way in the transition to global carbon neutrality.

Originality/value – To the best of the authors' knowledge, this study is among the first to make specific suggestions on how higher education institutions can facilitate improved quantitative measurement of scope 3 emissions and enhance green supply chain decision making.

Keywords University's carbon footprint, Scope 3 emissions, Data quality assessment, Opportunities to improve data quality, Carbon neutrality

Paper type Research paper

1. Introduction

The climate goal of the Paris Agreement is to keep the global average temperature increase below 2°C and to pursue further efforts to limit it to 1.5°C above pre-industrial levels.

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Halting global warming requires annual net zero CO_2 emissions at some point in time (Rogelj *et al.*, 2015). The IPCC defines net zero CO_2 emissions (also referred to as carbon neutrality) as the state when anthropogenic CO_2 emissions are balanced globally by anthropogenic CO_2 removals over a specified period (IPCC, 2018). However, net zero is more than a scientific conception and it is used as a framework/benchmark for climate actions (Fankhauser *et al.*, 2022).

Setting voluntary, entity-level net-zero targets has become prevalent. In recent years, many universities around the world have set carbon neutrality targets. Over 1,100 higher education institutions (HEIs) so far have committed to the Race to Zero for Universities and Colleges, a campaign that aims to halve greenhouse gas (GHG) emissions by 2030 and reach net zero emissions by 2050 at the latest (EAUC, 2023). HEIs have a critical role in society and are increasingly challenged to have a leading role in sustainability issues (Rosa *et al.*, 2024). Da Silva *et al.* (2023) argue that their influence in sustainability issues is greater than "any other sector in society". Throughout history, they have been centres for education, research, knowledge creation and innovations. Cortese (2003) argues that there is an unambiguous relationship between education, research, university operations and external community, and total integration across the parts is essential for achieving a transformative change and creating a sustainable future.

1.1 Carbon footprint assessment

To determine GHG emissions, identify reduction opportunities and track performance over time, universities have been calculating their carbon footprint. The term "carbon footprint" is defined variably across different studies and contexts (Alvarez *et al.*, 2016); however, it is generally understood to encompass the full range of GHG emissions, both direct and indirect, associated with an activity or accumulated over a product's life cycle (Wiedmann, 2009). In the organisational context, the GHG Protocol Corporate Accounting and Reporting Standard, hereafter citied as the GHG Protocol Corporate Standard, helps companies and organisations conduct a "GHG inventory" – defined as an organisation's emissions of the six Kyoto Protocol GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6), expressed in metric tonnes of CO_2 equivalent (CO_2e) (WRI and WBCSD, 2004). The GHG Protocol Corporate Standard, originally developed for businesses, has become a widely used accounting standard among universities. Published in 2001 and revised in 2004, it classifies emissions into three scopes: Scope 1 includes direct emissions that occur from sources owned or controlled by the organisation, Scope 2 accounts for indirect emissions from purchased energy consumed by the organisation and finally Scope 3 refers to other indirect emissions. Furthermore, in 2011 the GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard (WRI and WBCSD, 2011), hereafter citied as the GHG Protocol Scope 3 Standard, a supplement to the GHG Protocol Corporate Standard, was released. As noted in this standard, Scope 3 emissions are divided into 15 upstream and downstream activity categories. The use of the GHG Protocol Standards is voluntary.

Voluntary reporting standards are gradually being replaced by mandatory requirements. The EU Corporate Sustainability Reporting Directive (CSRD) requires companies (i.e. large companies and listed small and medium-sized enterprises in Europe as well as non-EU companies that generate significant income on the EU market) to report on Scopes 1, 2 and 3 emissions for financial years starting on or after 1 January 2024 [Corporate Sustainability Reporting Directive (CSRD), 2022]. Companies covered by the CSRD will be required to report in line with the European Sustainability Reporting Standards (ESRS). The ESRS E1 Climate change acknowledge that scope 3 may constitute the largest share of a company's

GHG inventory and may significantly contribute to its transition risks. For Scope 3 reporting, the ESRS recommend using the 15 categories identified by the GHG Protocol Scope 3 Standard, or alternatively, the indirect GHG emissions categories outlined in ISO 14064-1:2018 [European Sustainability Reporting Standards (ESRS), 2023]. Introduction of mandatory reporting such as the CSRD will increase the availability and accuracy of information to stakeholders.

1.2 Scope 3 emissions of higher education institutions

Most publications on the carbon footprint of HEIs originate from the USA, the UK, China and Australia (Li *et al.*, 2021). There are only few scientific studies available from Nordic countries (Kiehle *et al.*, 2023; Larsen *et al.*, 2013; Stridsland *et al.*, 2023). It is important to note that many HEIs publish their carbon footprint in grey literature, typically in sustainability reports. In some countries, national-level reporting on environmental metrics in HEIs is available. For example, the UK's Higher Education Statistics Agency (HESA) publishes consistent environmental information for HEIs across the UK, including Scope 1 and Scope 2 emissions, as well as selective Scope 3 emissions related to waste, water supply and wastewater treatment (HESA, 2024).

A number of studies have reported that Scope 3 emissions are the most significant portion of a university's carbon footprint (e.g. Herth and Blok, 2023; Ozawa-Meida *et al.*, 2013; Varón-Hoyos *et al.*, 2021). Although the figures of carbon footprints cannot be directly compared between the universities due to factors, such as differences in emission coverage, organisational boundaries, university size, geographical location, institutional profiles, among others, the share of Scope 3 reflects the relative magnitude of indirect emissions. Scope 3 emissions are often calculated using the spend-based method (environmentally extended input-output), which relies on the economic value of purchased goods and services, or the average-data method, which uses secondary emission data, such as national average emission factors, industry average emission factors, etc. For instance, emission from purchased goods and services are often estimated using the spend-based method, which relies on university's financial accounts (Herth and Blok, 2023; Larsen *et al.*, 2013; Ozawa-Meida *et al.*, 2013; Stridsland *et al.*, 2023). Business travel emissions are typically calculated using travel distances by mode of transportation, combined with national emission factors (e.g. Herth and Blok, 2023; Kiehle *et al.*, 2023), or alternatively based on expenditure data for business travel (e.g. Ozawa-Meida *et al.*, 2013; Clabeaux *et al.*, 2020). Emissions from commuting are commonly estimated using data collected through commuting surveys, alongside national emission factors corresponding to various transportation modes (e.g. Herth and Blok, 2023; Kiehle *et al.*, 2023).

In an analysis of carbon management at English research-intensive universities, Robinson *et al.* (2015) indicated that the means of collecting data for carbon footprint calculations as well as methods for evaluating Scope 3 emissions fall short and need refining and standardisation. The authors suggested that HEIs should focus on reducing inaccuracies when assessing their emissions to tackle carbon management (Robinson *et al.*, 2015). Stridsland and Sanderson (2023) reported that universities allocate varying levels of attention to different Scope 3 categories in their GHG inventories. A recent study by Ahonen *et al.* (2024) investigated practices of carbon footprint calculations within Finnish HEIs. The cross-institutional analysis of Ahonen *et al.* (2024) revealed that certain Scope 3 categories, such as business travel, waste, procurement were more frequently accounted for and reported than others, such as emissions from commuting. Excessive data collection, concerns about data reliability and the lack of standardised carbon footprint framework for HEIs were identified as the major challenges in carbon footprint calculations within Finnish HEIs

(Ahonen *et al.*, 2024). Similarly, Robinson *et al.* (2018) concluded that the most significant barriers to assessing and reporting Scope 3 emissions in HEIs in the UK are time constraints, limited staff resources and data reliability.

Patchell (2018) questioned accounting and reporting requirements of the GHG Protocol Scope 3 Standard and their practicality. In the study, Patchell (2018) highlighted that due to the complexity of Scope 3 emissions and an unprecedented need to understand value chain interactions, there is a rather little likelihood of full emissions data reporting. The author pointed out that reporting organisations might be at risk of using up corporate resources for pursuing requirements of the GHG Protocol Scope 3 Standard rather than allocating resources for emission mitigation efforts. Six factors were identified that inhibit effective measurement and management of GHG emissions in value chains. However, the propositions offered seem more applicable to a competitive business environment than the type of value chain relations that are typical of universities. As such, HEIs could promote sustainability dialogues with external stakeholders that improves participation, target setting and identity of indicators of success (Rosa *et al.*, 2024). It is therefore worthwhile to investigate the role of universities in removing such barriers.

Sustainability reporting requirements are growing and HEIs are increasingly being assessed according to their sustainability performances (Bullock and Wilder, 2016). More recent attention has focused on the inclusion of carbon neutrality targets in university rankings. The Times Higher Education (THE) Impact Rankings, that assess universities against the United Nations' Sustainable Development Goals (SDGs), recognise both the year for achieving the target and scope coverage according to the GHG Protocol (Times Higher Education, 2022).

Little is discussed about data quality and data sufficiency of Scope 3 emissions and their importance in the light of effective emission reduction measures and reaching carbon neutrality, predominantly through emission abatement. Scope 3 emissions make up a large majority of the carbon footprint in the case of universities. This indicates a need to understand challenges related to Scope 3 accounting and to develop a comprehensive approach to data quality improvements (Schmidt, 2022; Thurston and Eckelman, 2011).

The objective of this study is to assess Scope 3 categories based on the GHG Protocol's accounting and reporting principles and evaluate data sufficiency from a university's point of view. The key research question of this study was whether the current carbon footprint information can be used to decrease emissions. In addition, measures that aim to improve data quality of Scope 3 emissions are suggested. The relevance and novelty of this work is fivefold. First, it is clear that many universities have been progressive in reducing Scopes 1 and 2 emissions and that most of the low-hanging fruit has already been harvested. For this reason, it will become progressively more difficult to reduce emissions, and sharing best practise in a scientific forum is essential to achieving efficient mitigation. Second, methods to overcome difficulties in Scope 3 reporting must be increasingly analysed on a case-by-case basis to likewise share best practise. Instead of viewing universities as a homogeneous institutional global entity, greater accuracy will come from reporting according to the type of university, its size, its geographic location, and its relations with stakeholders and its value chain. Third, accurate mitigation efforts can only be managed through effective measuring of emissions, and this, too, becomes more progressively difficult as universities approach net zero. Efforts to compensate emissions can also be improved, thereby reducing the risks of either over or under compensating emissions. Fourth, due to the need to observe the more heterogeneous nature of individual universities with regards to Scope 3 emissions, an accurate accounting of emissions can result in more fairness in determining university rankings, which are at least partially determined by carbon footprint. Those universities that have not even begun meaningful emissions accounting or mitigation efforts can be identified, and potentially be inspired by the work of others. Finally, universities are in an excellent position to lead the way for other types of corporations as emission reporting and mitigation efforts become more difficult as the world moves closer to net zero targets. This "critical role" described by Cortese (2003) must not only be seen on a global scale, but will likewise be needed on national, regional and local levels. Furthermore, universities may be in a novel position to assist in overcoming many of the barriers to accurate Scope 3 emission reporting described by Patchell (2018) due to their extensive networks of cooperation and potential abilities to establish meaningful sustainability. For these reasons, the case-study approach taken in this investigation is appropriate.

This paper has been organised in the following way. Section 2 is concerned with the methodology used for this study. The third chapter begins by laying out a case study. The fourth chapter presents the results. The fifth chapter includes a discussion of the implication of the findings. Finally, the conclusion gives a brief summary.

2. Methodology

The carbon footprint of LUT University was calculated in accordance with the GHG Protocol Corporate Standard and the GHG Protocol Scope 3 Standard. Data were gathered from multiple sources and all data refer to the year 2023. Supplier-specific (where available) and average emission factors were applied to activities expressed in physical units, and the environmentally extended input-output (EEIO) approach was used to estimate GHG emissions from procurement based on the economic value of goods and services purchased and relevant industry average emission factors. Emissions were divided into scopes and categories (in the case of Scope 3 emissions) following the classification used in the GHG Protocol Scope 3 Standard. The carbon footprint calculations as such are not the aim of this study. Instead, the aim is to use an analysis of the current calculations to suggest methods of data sufficiency and data quality improvements. For this analysis, the carbon footprint for the year 2023 was sourced from LUT University's sustainability report (LUT University, 2024).

Following the completion of carbon footprint calculations, a process of improving the quality of activity data and emission factors was developed by adapting the life cycle assessment framework defined in ISO 14044 Environmental management. Life cycle assessment. Requirements and guidelines (ISO, 2006) (Figure 1).

To identify the carbon footprint of LUT University, firstly, goal and scope were defined including boundary setting and considering intended applications of the results (Figure 1), following the GHG accounting and reporting principle of relevance.

Relevance serves as a prerequisite – for a Scope 3 category to be included in the assessment and undergo data sufficiency evaluation, the category itself must be relevant. Relevance directs the setting of appropriate inventory boundaries considering the essence of an organisation and the purpose of carbon footprint information. Relevant emission categories should be included in the carbon footprint calculations. Relevance aims to answer the following questions: Which emission categories are suitable for/relevant to a particular purpose, e.g. carbon footprint reporting or carbon neutrality? Should emissions resulting from activities inherent to universities (e.g. laboratory equipment, buildings and other goods necessary to conduct research and provide education) be included? Should emissions from activities beyond the intrinsic nature of universities be accounted (e.g. investments)? (WRI and WBCSD, 2004)

The products of universities tend to be information, innovations, degrees and graduates, all of which could potentially have significant impacts on future emissions (both positive and negative), especially as the graduates of today become the leaders and agents of change of

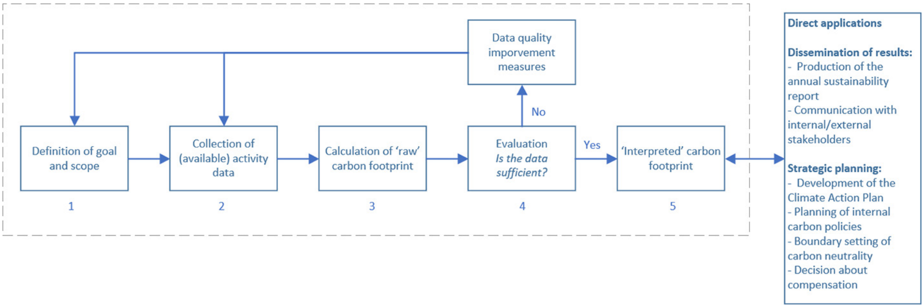

Figure 1. Carbon footprint calculation mechanism adapted from the life cycle assessment framework (ISO 14044)
Source(s): Authors' own work

tomorrow (da Silva *et al.*, 2023). However, this category has questionable relevance and has been deemed irrelevant in this study due to the impossibility of actually measuring these impacts.

Next, the data for a one-year period was collected. Once the data were gathered, a so called "raw" carbon footprint (based on the available data) was calculated. The calculated emissions were then assessed according to the GHG accounting and reporting principles of completeness, consistency, transparency and accuracy (WRI and WBCSD, 2004), which are key elements of the data sufficiency evaluation (Figure 2).

Completeness is directly derived from the above-mentioned relevance and refers to accounting for all emissions within the selected inventory boundaries (WRI and WBCSD, 2004).

Accuracy assures the credibility of data and refers to both activity data and emission factors. A carbon footprint should, to the greatest extent, represent actual emissions and any related uncertainties should be reduced as far as feasible. This principle intends to answer the following questions: Is the activity data exact? Are there any possible/practical improvement measures that would ensure greater accuracy of the activity data? Does the emission factor accurately represent the activity in terms of technology, time and geography? Can the data be used for decreasing the carbon footprint for this category? (WRI and WBCSD, 2004).

Additionally, the GHG Protocol Scope 3 Standard introduces data quality indicators for emission factors, assessing the representativeness of data. For activity data, these indicators also include completeness and reliability (WRI and WBCSD, 2011).

Consistency enables tracking and comparing the carbon footprint information of an organisation over time. Uniform calculation methodologies and consistent inventory boundaries provide useful information about trends of GHG emissions. Any changes to the inventory boundaries, methodology, data etc. should be recorded and justified (WRI and WBCSD, 2004).

Transparency refers to any public disclosure of the information on inventory, methodology choices, assumptions, limitations, etc. for the purpose of an internal review and an external verification (WRI and WBCSD, 2004).

The ratings of the evaluation criteria were used for a decision-making process – whether the data quality is considered to be sufficient or whether it requires further improvements. In case of data insufficiency, data quality improvement measures were introduced in collaboration with internal and/or external stakeholders. The improvements might lead to a

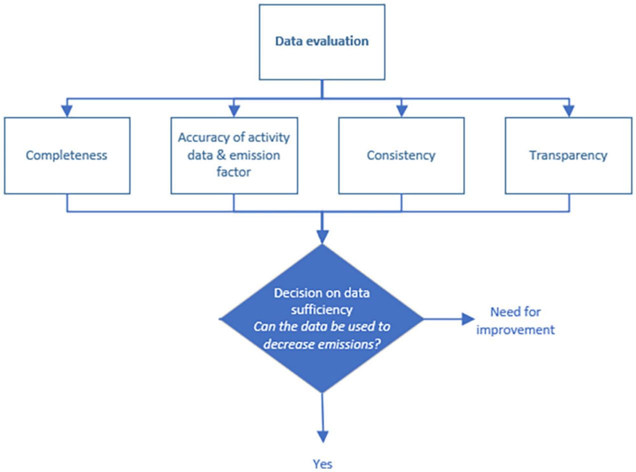

Figure 2. Data evaluation based on the GHG accounting and reporting principles
Source(s): Authors' own work

redefinition of the initial goal and scope, or a more extensive collection of data and/or recalculation of carbon footprint. Once the data on the carbon footprint was believed sufficient, it was interpreted in accordance with the goal and scope definition. The interpretation explained the uncertainty of the results in detail, including any limitations and assumptions associated with methodological choices and data input.

Information on GHG emissions can be used to achieve various purposes, for instance, carbon footprint reporting, boundary setting of carbon neutrality, etc. It is also worth noting that time can be a limiting factor in the proposed paradigm. Often, a carbon footprint is calculated on an annual basis since organisations are required to report their emissions every year. Due to time constraints, there is a finite number of data quality improvement measures that can be implemented in one calculation period and organisations are frequently obligated to disclose insufficient information. The ultimate goal should be to be able to publish only sufficient results. Therefore, the process should be repeated regularly (preferably every year) until reaching the desired data sufficiency. The definition of sufficiency in itself is not rigid and can evolve over time. A case study approach was used to allow an effective testing of the mechanism.

3. Case study: LUT university

LUT University, also known as Lappeenranta-Lahti University of Technology, was established in 1969. It has two campuses based in Lappeenranta and Lahti and two regional units in Mikkeli and Kouvola, southern Finland. LUT University has approximately 7,300 students and 1,400 staff members (Education Statistics Finland, 2022). The university consists of three academic units: the Business School, the School of Energy Systems and the School of Engineering Science. The occupied buildings are not owned by LUT University. Instead, in the case of LUT University and most of the Finnish universities, campuses are owned and operated by the University Properties of Finland Ltd (SYK), of which each participating university is a stakeholder.

In 2011, the LUT Green Campus was established, featuring a solar power plant and a smart electricity network (Greenreality, 2025). Since 2012 LUT University has been awarded a WWF Green Office certificate (LUT University, 2024). Like most universities, LUT University has a well-developed network of international research and education partners. It is also a member of the Greenreality Network, a consortium of local and regional companies and organisations in the energy and environment sectors. This positions the university as a key player in sustainability at local, regional, national and international levels.

LUT University has a history of sustainability reporting. The first report on sustainability was published in 2015 and has been produced every year since then. In addition, LUT University has been successful over the years in international university rankings. In 2023 LUT University was ranked among the top 101–200 universities in the Times Higher Education (THE) Impact Rankings that assess universities against the SDGs and as the world's top 26 educational institutions in the SDG 13 Climate Action (Times Higher Education, 2023). Perennial involvement in environmental management and recognition from the international community make LUT University a suitable case study for the purpose of this research.

3.1 Definition of goal and scope

The goal of the carbon footprint calculations was to account for and grasp the scale of all GHG emissions that were considered relevant to LUT University. The intended application of the carbon footprint results was primarily the annual sustainability report. In addition, the GHG emission information was used to draw up the Climate Action Plan towards reaching the carbon target and foster communication between the university management team and the research unit responsible for the carbon footprint calculations.

The study aimed to include three scopes defined in the GHG Protocol Corporate Standard. However, not all Scope 3 emissions categories were considered relevant/applicable to the LUT University case (Table 1). Moreover, it was decided that the most appropriate approach for accounting for emissions from district heating was to include them under Scope 3, particularly in Category 8 – upstream leased assets, in accordance with the GHG Protocol Scope 3 Standard (WRI and WBCSD, 2011). It is important to clarify that LUT University leases its premises from University Properties of Finland Ltd (SYK), with heating included in the lease. Since LUT University does not own the district heating licence (and thus lacks operational control over the leased buildings), SYK reports these emissions under their Scope 2. This approach prevents double counting of the same emissions under Scope 2 by multiple entities.

3.2 Collection of activity data and emission factors

The primary aim was to collect the most granular information available, preferably measured activity data expressed in physical units. Data for this study were gathered from multiple sources at various time points (due to the fact that some data were already available in the beginning of the calendar year whilst other data were made public after a few months). In-house data providers were the property managers, the business travel administrator, the campus restaurant manager, the bookkeeper and the sustainability manager. Data were retrieved from internal systems (e.g. financial statements) or was drawn up by external service providers (e.g. business travel data). However, not all data were practicable to acquire in terms of time and human resources needed, for example, data concerning business travel booked outside the recommended travel management company. Even though not all data met the original quality requirement, they were used for calculating a "raw" carbon footprint.

Table 1. Summary of the evaluation process (including GHG accounting and reporting principles of relevance, completeness, accuracy and the assessment of data sufficiency)

Scope and category	Carbon footprint *t* CO_2eq.	Share of carbon footprint (%)	Relevance	Completeness	Accuracy (activity data and emission factor): Type of activity data	Units	Type of emission factor	Source of emission factor	Data sufficiency (current status)
Scope 1	9.4	0.1	Yes	Complete	Measurement (meter reading)	km travelled by vehicle	Primary data (supplier-specific)	Car manufacturer	Sufficient
Scope 2	3.2	0.0	Yes	Complete	Measurement (utility bills)	kWh of electricity	Primary data (supplier-specific)	Electricity provider	Sufficient
Scope 3		99.9							
1. Purchased goods and services	964.9	5.9	Yes	Incomplete	Financial records	€ per procurement category	Secondary data (industry-average)	Statistics Finland	To be improved
2. Capital goods	N/A	N/A	Yes	Incomplete	N/A	N/A	N/A	N/A	To be improved
3. Fuel- and energy-related activities not included in Scope 1 or Scope 2	N/A	N/A	Yes	Incomplete	N/A	N/A	N/A	N/A	To be improved
4. Upstream transportation and distribution	N/A	N/A	Yes	Incomplete	N/A	N/A	N/A	N/A	To be improved
5. Waste generated in operations	45.8	0.3	Yes	Complete	Measurement (utility bills)	*t* of generated waste	Secondary data (regional average)	WWF green office calculator/Helsinki region environmental services HSY	To be improved
6. Business travel	621.7	3.8	Yes	Incomplete	Measurement	pkm travelled by airplane/train	Secondary data (industry-average)	Travel management company /national railway company	To be improved
						km driven by employee-owned vehicle for work-related purpose	Secondary data (national average)	Finnish transport emission database	Sufficient
						Number of room nights	Secondary data (regional average)	Hotel footprinting tool	To be improved

(*continued*)

Table 1. Continued

Scope and category	Carbon footprint $t\ CO_2$eq.	Share of carbon footprint (%)	Relevance	Completeness	Accuracy (activity data and emission factor) Type of activity data	Units	Type of emission factor	Source of emission factor	Data sufficiency (current status)
7. Employee and student commuting	689.2	4.2	Yes	Complete	Estimation	km/pkm travelled by vehicle	Secondary data (national average)	Finnish transport emission database	As sufficient as practicable
8. Upstream leased assets	75.7	0.5	Yes	Complete	Measurement (utility bills)	kWh of electricity/ district heating	Primary data (supplier-specific)	District heat/ electricity provider	Sufficient
9. Downstream transportation and distribution			No						
10. Processing of sold products			No						
11. Use of sold products			No						
12. End-of-life treatment of sold products			No						
13. Downstream leased assets			No						
14. Franchises			No						
15. Investments	13,945	85.3	No	Complete	Financial records	€ invested	N/A	Asset management and investment company	As sufficient as practicable

Source(s): Authors' own work

In addition, an online questionnaire was carried out in the beginning of 2024 to analyse commuting patterns of students and employees during 2023 and improve the accuracy of this data. With a response rate of 6% among students and 35% among staff members, the survey collected information on mode of transportation (single occupancy car, car share, bus, train, motorcycle, scooter, e-scooter, e-bike, bike or walk), distance between the university and residence, the number of commute days per week, fuel type and production year of vehicles.

For emission factors, the collection of primary data was prioritised whenever available. The supplier specific emission factors were gathered from car manufacturers, electricity and district heating providers to account for Scope 1, Scope 2 and Scope 3 (Category 8) emissions. For the remaining Scope 3 categories, secondary data were utilised (see Table 1). In these cases, the data most representative of the university's activities – considering technology, time and geography – were collected.

3.3 Calculation of "raw" carbon footprint

Carbon footprint was calculated based on the available activity data through the application of both primary (supplier specific) and secondary (industry-average, national average and regional average) emission factors. The supplier specific emission factors were used to account for emissions from the university fleet (Scope 1), purchased electricity (Scope 2) and district heating (Scope 3). The secondary data were applied to the remaining Scope 3 categories since primary data were not available. The secondary data approach does not allow to fully understand the scale of the carbon footprint and it is insufficient to keep track of emission reduction measures. However, it is considered sufficient for screening GHG emissions until more precise data become available (WRI and WBCSD, 2013). Scope 3 emissions compromised more than 99% of LUT University's combined emissions.

4. Results

4.1 Data evaluation

Table 1 shows the summary of the GHG accounting and reporting principles and data sufficiency assessments. The principles of consistency and transparency were not included in the table. The principle of consistency was not evaluated for emission categories in this study, as consistency is typically assessed when comparing carbon footprints across multiple years. Since this study focuses exclusively on a single-year calculation, applying the principle of consistency was deemed unnecessary. Moreover, the principle of transparency was considered inherent in the carbon footprint accounting and reporting practices at LUT University.

4.1.1 Relevance. Scope 3 emissions categories 9–14 were excluded from the inventory as they are not related to LUT University activities. Inclusion of investments (Category 15) was deemed to be somewhat ambiguous. According to the GHG Protocol's Technical Guidance for Calculating Scope 3 Emissions, Category 15 is primarily intended for private and public financial institution (WRI and WBCSD, 2011). Since universities are not, by definition, financial institutions, they are not obligated to account for and report emissions from investments under the current guidelines. However, after initial screening, emissions from investments represented a major share of LUT University's carbon footprint compared with other sources of emissions. The emissions were calculated using emission factors (average data) provided by the asset management and investment company. The data, providing that it is accurately measured, can guide decision making needs and reveal reduction opportunities.

The inclusion of emissions from investments in official carbon footprint reporting is currently being discussed among Finnish HEIs.

4.1.2 Completeness. In terms of completeness, Scope 1, Scope 2 and some Scope 3 categories were considered to be completely accounted for. The reasons for incompleteness of Scope 3 categories were: unclassified expenses (Category 1), limited data accessibility to the travel management system (Category 6), lack of data (Categories 3 and 4). Employee commuting (Category 7), included travelling between university and home by staff and students, was believed to be "fairly" complete due to an overall high response rate (35% among employees and 6% among students) in the commuting survey. The results of the survey were scaled up to the population of LUT University staff and students in 2023. As mentioned in Section 3, LUT University has campuses in two cities – Lappeenranta and Lahti. Current practices of recording data do not fully enable the calculation of carbon footprints separately for each campus.

4.1.3 Accuracy. The principle of accuracy was divided into two parts: accuracy concerning activity data and accuracy related to emission factors. Both factors are important to adequately reflect actual emissions and ensure that uncertainties are as low as reasonably practical. The type of activity data indicated whether gathered data were measured, estimated, or taken from financial records, whereas the type of emission factor demonstrated if primary or secondary emission data were used for calculating carbon footprint. The primary data (supplier-specific) were used in calculating Scope 1 and 2 emissions and one category of Scope 3 emissions (Category 8: upstream leased assets related to district heat consumption by leased properties). The majority of Scope 3 emissions were calculated using secondary data (average-data method) due to the unavailability of primary emission factors or difficulties in obtaining such data.

4.1.4 Data sufficiency. Based on the evaluation of the GHG accounting and reporting principles, a decision about data sufficiency of available data was made. This conclusion was drawn from the assumption that the current carbon footprint information would support the development and implementation of effective, impact-driven emission reduction strategies. Scope 1, Scope 2 and Scope 3 Category 8 were considered sufficiently accounted for due to precise (measured) activity data and supplier-specific emission factors. Furthermore, commuting was believed to be as sufficient as practicable at the time. Due to practical constraints, LUT University cannot provide comprehensive data on the commuting of each student and staff member at present. Emissions from purchased goods (Category 1), fuel- and energy-related activities (Category 3), upstream transportation and distribution (Category 4) and business travel (Category 6) were considered insufficient and need the most improvements in the future. Purchased goods and services form a large and diverse group and, at the time of writing this paper, the only available data concerning procurement comes from financial records. The spend-based method was used to estimate emissions, which does not accurately reflect emissions occurring in the university's supply chain. Data on the transportation of purchased products from a direct supplier to LUT University (Category 4) were not available, but have been in most cases included in the price of goods purchased.

It is important to bear in mind that collecting data is an iterative process (carbon footprint of LUT University is calculated annually) and the evaluation of the GHG accounting and reporting principles and data sufficiency should be carried out in parallel. With time, organisations should aim at improving data quality and replace generic emission factors with primary emission information from suppliers if such data becomes available. It should be acknowledged that aiming at 100% percent completeness may not be realistic or achievable.

4.2 Data quality improvement opportunities

Table 2 provides the breakdown of measures, involved parties and university-specific actions aimed at improving the data quality of Scope 3, and overcoming the barriers identified by

Table 2. Suggested opportunities to improve data quality of Scope 3 emissions

Scope 3 category	Measures to improve data quality	Involved parties	University-specific actions	Barriers
1. Purchased goods and services 2. Capital goods	Implementation of more detailed environmental reporting practices with a level of transparency equivalent to financial reporting to reduce reliance on the spend-based method for calculating carbon footprint	Procurement department, financial department, sustainability manager, researchers	Enhanced LCA teaching Student projects Student theses Internships Workshop sessions Trainings Research projects Research to business projects Idea competitions Supporting start-ups Carbon management plan Commuting surveys Progress reports	Transaction costs Value chain power Responsibility allocation Uncertainty Location Contingency economic Performance
	Review of procurement policies, e.g. the implementation of carbon footprint information requirements from suppliers, supplier engagement targets	Procurement department, sustainability manager, researchers		
	Sharing best practices between Hansel (a public central purchasing body) and the procurement department	Procurement department, Hansel, researchers		
	Participation in the university's supply chain, e.g. joint calculation of the carbon footprint of products/services, provision of expertise in carbon footprint reduction	Procurement department, sustainability manager, researchers, students		
3. Fuel- and energy-related activities not included in Scope 1 or Scope 2	Calculation of more accurate emission factors	T&D operators, researchers		
	Investigation of ways for electricity providers to offer low- and zero-carbon options for customers	Electricity providers, researchers		
4. Upstream transportation and distribution	Calculation and highlighting of the proportion of emissions related to transportation and distribution	Procurement department, transport providers, researchers		
5. Waste generated in operations	Calculation of more accurate emission factors	Waste management companies, researchers		

(*continued*)

Table 2. Continued

Scope 3 category	Measures to improve data quality	Involved parties	University-specific actions	Barriers
6. Business travel	Review of business travel guidelines, e.g. the implementation of carbon footprint information requirements from service providers	Travel department, sustainability manager, researchers		
	Improvements in accessibility to the internal data collection system and the integration of financial and environmental reporting within the system	Travel department, software provider, researchers		
	Investigation of low-carbon travel and accommodation options as key selection criteria	Travel management company, travel department, software provider, researchers		
7. Employee and student commuting	Conducting a commuting survey regularly for employees and students (at least once a year)	Administrative department, researchers		
	Implementation of remote employee monitoring	Administrative department		
	Implementation of a passive GPS tracking system (e.g. through a smartphone application)	Administrative department, researchers		
	Investigation of low-carbon commuting alternatives	Public transport providers, municipal government, administrative department, researchers, students		
15. Investments	Calculation of more accurate emission factors	Asset managers, financial department, researchers		

Source(s): Authors' own work

Patchell (2018). By leveraging their resources, expertise and a diverse talent pool, universities are well-positioned to implement initiatives that not only meet community needs but also advance sustainability efforts on both local and global scales (Leal Filho *et al.*, 2023). Establishing university-community partnerships, in which researchers and students collaborate directly with university departments (e.g. procurement, financial, travel departments), suppliers, organisations and businesses to apply their academic knowledge to real-world challenges, is widely recognised as vital across all categories. The essence of collaborative effort is for all actors to mutually benefit from working together. The university might acquire accurate carbon footprint information and companies might enhance their environmental performance, improve efficiency across the supply chain, gain recognition among industry peers or investors and become more attractive for customers looking for transparency and data integrity. In addition, a periodic review of procurement and business travel policies is suggested. Demanding carbon footprint information from suppliers, for instance in tendering processes, could support decision makers in selecting products/services with lower carbon footprint and therefore reducing the impact. Another important practical implication is improving data accessibility and automating data collection. It can accelerate the process (time and resource efficiency) and ensure data integrity.

5. Discussion

5.1 Responsibility for Scope 3 emissions

Organisations with a substantial share of indirect emissions in their carbon footprint have a rather limited influence over reducing them. A large part of Scope 3 emissions are, in fact, direct emissions (scope 1) of other organisations and in the light of "global" carbon neutrality it would be sufficient (in theory) if each entity would attempt to cut down emissions occurring from sources that are owned or controlled by the entity (WRI and WBCSD, 2004). Purchasing exclusively carbon neutral products and services is not yet possible due to the lack of maturity in decarbonisation technologies, and the transition to a carbon neutral society is a long-term process. Therefore, replacing products with lower emission alternatives appears to be a desired strategy nowadays. The results of this study show that a large majority of Scope 3 emissions suffers from a lack of data accuracy. Due to a lack of supplier-specific emission factors (for instance the Environmental Product Declaration), in particular for purchased goods and services, reporting organisations frequently calculate Scope 3 emissions using the spend-based method that has several limitations due to the nature of the approach. Without contextual emission factors (supplier-specific), it is difficult to realistically assess outcomes of the mitigation measures in annual carbon footprint calculations.

Procurement of goods and services generally comprise a large proportion of scope 3 emissions at universities (Ozawa-Meida *et al.*, 2013; Thurston and Eckelman, 2011), and the results of this study support this. The results also support that both accounting and reporting of these emissions are generally inaccurate and incomplete. Although procurement emissions are commonly included in carbon footprint assessments, they frequently fail to represent the full extent of the institution's procurement activities (Stridsland and Sanderson, 2023). Through research, teaching and general operations, universities could reduce these challenges, which also stem from reluctance or inability of supply chain stakeholders to account and report (ibid.).

Other examples of activities are business travel and commuting. With regard to business travel, introducing policies at an organisation-level aimed at limiting air travel and prioritising remote attendance and low carbon transportation could decrease emissions to some extent without restricting education and research outputs (Schmidt, 2022). Commuting, on the other hand, appears to be more challenging to influence. The choice of transportation modes between a workplace and home is a personal decision. Nevertheless, employers have the potential to nudge employees to use low carbon transportation modes, travel more efficiently (carpooling) or travel less (telecommuting) through introducing incentives. Employment benefits such as employer-subsidised commuter tickets or employer-provided bicycle benefits have been proved to be successful (Villanen *et al.*, 2023).

A following question arises regarding to what extent universities could reduce indirect emissions given their basic roles – education and research. As both roles involve rather special relationships with business, industry, staff, students and the public, perhaps universities are in an equally special position to influence both the quality of Scope 3 measurements shown in Table 2, and the success of management efforts. This special and often overlooked role is one that has already been shown to assist in making visions of sustainability on a wider scale become reality (Cortese, 2003). In this regard, universities have the potential to overcome the major barriers that inhibit effective measurement and management of Scope 3 emissions, as defined by Patchell (2018).

5.2 Further considerations

Townsend and Barrett (2015) claim that students are key stakeholders both within university communities and beyond. Teaching and research activities may aid in overcoming barriers related to the inherent complexity faced by suppliers to report emissions as well as the total costs of doing so. The student body can be seen as an available workforce and the educational budgets of universities can support cooperation in whole or in part. Bringing real-life problems to teaching environments may tap into a greater network of innovative thought at less cost. Establishing guest lectures, practical assignments, project work, internships and theses are just some of the ways that students can gain relevant hands-on experience which can also demonstrate direct benefits to the supplying companies of universities. Participating in such initiatives within a university may have broader implications to staff and students throughout their lives, and this can influence carbon management at other organisations and society as a whole (Robinson *et al.*, 2018).

Well-developed teaching and research activities can result in the development of both standards and guides to accurate reporting, which may reduce the transaction costs of reporting, especially for smaller supplying companies that lack the resources to do so. By working with universities, suppliers can possibly avoid the situation whereby their customers may stop working with them if they cannot supply accurate emissions data for their products. Some companies may even see an opportunity to improve their own environmental, social and corporate governance, which could have further positive implications. Furthermore, students and researchers can assist in identifying emissions hotspots, the most affordable mitigation efforts of a supplying company, or emissions of greatest concern (Herth and Blok, 2023). Reluctance to accurate reporting based on fear of disrupting power relationships between buyers and seller or reduced competitiveness on the part of suppliers can also be alleviated by universities identifying the competitive advantages of accurate reporting and mitigation efforts in the supply chain. Student and researcher activities can also assist in identifying solutions or alternatives that may otherwise be difficult to discover by suppliers independently. Such cooperation may overcome any perceived imposition or liability to mitigate emissions that can come from more accurate reporting by building a sense of common goals. Universities can be seen distinctly from other types of organisations that are more sensitive to profit margins and competitiveness, and where cooperation is less likely.

6. Conclusions

Setting carbon neutrality/net-zero pledges has been prevalent among businesses and other institutions such as universities, among others. Following a rule of "what gets measured, gets managed", the first step taken towards achieving the target is often calculation of carbon footprint. In the case of universities, carbon footprint mainly consists of indirect emissions. Scope 3 emissions are considered the most challenging to adequately measure and manage. The commonly applied spend-based method, used for calculating carbon footprint from purchased goods and services, is not sufficient to obtain comprehensive emission information. Data unavailability and poor data quality result in over- or underestimation of carbon footprint and, more importantly, they hinder universities in their efforts to effectively manage and decrease GHG emissions. The current figures of carbon footprint may lead to a false sense of managing emissions, therefore efforts should be channelled into improving the data quality of scope 3.

The findings enhance our understanding of challenges related to both calculation and mitigation of the Scope 3 emissions and suggest actions for raising data quality within scope 3. Getting accurate data is a laborious task involving a bilateral engagement with multiple stakeholders (manufacturers, suppliers, etc.), but eventually it is the only way to deliver meaningful and traceable emission reductions and consequently, credible carbon neutrality/net-zero targets. Universities, having necessary knowledge and resources, are in position to tackle these challenges. They have the possibility of directing a share of their educational and research-related activities towards actions aiming for improving data quality of Scope 3 emissions, within its own supply chain in the first place. Student theses, internships, idea competition, research projects, among others, could overcome the barriers identified by Patchell (2018) and promote the measurement and management of Scope 3 emissions.

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