CARBON FOOTPRINT OF TRANSPORT AND MOBILITY: THE CASE OF A HIGHER EDUCATION INSTITUTION

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ABSTRACT

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Abstract

The study of climate change, its consequences and implementing strategies to combat climate change are one of the current challenges of this century. Transport and mobility have been recognized as important contributors to the overall environmental carbon footprint of higher education institutions. Universities, as job and knowledge providers have a great stake to influence the indirect transport and mobility emissions of personnel and students.

In this study, carbon footprint evaluation was carried out to calculate the annual travel and mobility emissions produced by personnel and students of the University of Jyväskylä. Through the implementation of consumption-based carbon footprint, this study evaluated the emissions from commuting travels, long-distance leisure travels and unreported business travels. The study collected primary data to discover distances and transport modes to measure the emissions produced per person and to estimate the total transport and mobility carbon footprint of the University.

The findings revealed that personnel produced an average of 0.5 t CO_2-eq emissions per person per year while students produced an annual average of 0.3 t CO_2-eq emissions per person. Personnel produced 67% of the commuting emissions while students produced 85% of the long-distance leisure travel emissions. However, the majority of the emissions were produced by car use. Yet students produced 54% of the emissions while personnel produced 46%. The total estimated emissions production of students was 3,930.6 t CO_2-eq per year and personnel produced 1,363 t CO_2-eq emissions per year. Hence, the overall annual transport and mobility carbon footprint estimation of the University was 5,2293.7 t CO_2-eq.

The findings of this study suggest reducing the use of car and switch to a low-carbon transport. The study also recommends to implement soft policies, campaigns and incentives to reduce the use of cars as an important hotspot of the University. However, more research is required to find out the reasons of car use and to mitigate transport emissions in the future.

Key words
Climate change, emissions, CO_2-eq, transport, carbon footprint, University, Jyväskylä

Place of storage
Jyväskylä University Library

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1 INTRODUCTION

1.1 Research background

There is an ongoing global agenda to combat climate change. The study of climate change plays a critical role to address human activities, which result in anthropogenic emissions (greenhouse gases, aerosol) accumulated from pre-industrial period that cause the Earth to warm (IPCC, 2014b). Greenhouse gas (GHG) emissions have accounted for 1 °C increase in the global average temperature (IPCC, 2019). Some human activities include, but are not limited to, the burning of fossil fuels, agricultural activities, industrialization, and transportation (Shaikh et al., 2018) which emit GHGs such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), fluorinated gases, ozone and aerosols (World Meteorological Organization WMO, 2020).

The accumulation of GHGs pose great risks on Earth. Rapid changes in climate have been noticeable such as warming oceans, shrinking ice sheets, decreased snow cover, rising sea levels, extreme weather events and ocean acidification (NASA, 2020a). Such events pose a series of ecological, physical and health impacts (Shaikh et al., 2018) which affect human and health security, changes in the ecosystem, slowing of economies, rise of global hunger, natural hazards and the pollution and exploitation of marine resources (WMO, 2020). Thus, in order to combat climate change, being accountable for the past, present and future GHG emissions is vital.

To combat climate impacts, The UN Framework Convention on Climate Change (UNFCCC, 2015) invited nations to sign the Paris Agreement to join forces against the threat of climate change. The purpose of the agreement (2015) is to keep the global temperature increase below 2 °C above preindustrial levels with the intention to limit the temperature increase to 1.5 °C. The goal is to deal with the impacts of climate change while making sustainable finances and lowering GHG emissions to build a sustainable low carbon future (UNFCCC, 2015). Despite the current policies, the temperature rise is yet estimated to be 3 °C this century (UNEP - UN Environment Programme, 2020).

Transportation’s impacts on climate change accounts for 24% of the global GHG emissions (Shiying. G. M. Wang, 2019). Energy consumption of end-users, which takes place in urban areas, accounts for nearly 40% of the transport emissions produced (IPCC, 2014a). The aviation industry, as it is part of transportation, accounts for 2.5% of the global GHG emissions (Grimme & Jung, 2018) but its share of emission growth is increasing (Baumeister, 2019). Transport and mobility habits are central aspects within the GHGs production because they are considered to influence individuals’ journeys which can greatly impact climate change (Aamaas et al., 2013; Baumeister, 2020; Wiersma, 2020).

Transport behaviors have been studied as observations by Wilson (1973) suggest that this result is attributed to the elasticity of transport demand and monetary cost. Cooley (1984) argues that transportation is stimulated by various aspects which include personal income, comfort, urban development, and market price, among others. More importantly, several studies address that travel is expected to grow within short and long-distance travel range (Cooley, 1984; Minn, 2019; Shiying. G. M. Wang, 2019; Wiersma, 2020), which translates to an increase of GHG emissions.

The European Union has prepared a transformation strategy for a transition to net zero GHG emissions by 2050 (European Commission, 2018) having produced 4.4 megatons (Mt) of carbon dioxide equivalent (CO_2eq) in 2017 (EEA, 2019b). The transport sector plays a great role in the strategy as it produces a substantial share of emissions being dependent on oil (Joelsson & Gustavsson, 2010). More importantly, the European strategy is challenged by the EU emissions from transport which have remained high when compared data against emissions from 1990 (European Commission, 2020a). In fact, the transport emissions have increased 10% when comparing data from 1990 (Eurostat, 2019). The results can be, therefore, attributed to the increase of passenger-kilometers and tonne-kilometer of which aviation represents the highest rate with 129%, international shipping 32% and road transport 23% (EEA, 2019 2019a).

With the rise of passenger kilometers in the EU, transportation data is presented to account for 30% of the total EU emissions of which 72% originates from road transport (European Parliament, 2019). From the 72%, 44% are passenger cars, 19% heavy-duty vehicles and 9% light commercial vehicles (EEA, 2019a). In contrast, the European Parliament (2019) found that passenger cars are a major pollutant within transportation as it accounts for 60% of total GHG transport emissions because the majority are gasoline driven cars. However, Europe registered 287 million cars of which 44% were gasoline driven, 53% diesel and 2.7% alternative fuels (ACEA, 2016). The number of registered cars is a climate concern as it poses environmental challenges due to the use of combustion engines. In order to support the EU net-zero carbon strategy, transportation ought to be reduced by 60% lower than 1990 levels (European Commission, 2020d). Therefore, additional studies are needed to calculate the emissions of passenger cars as well as other transport alternatives in different geographical regions.

However, evaluating transport impacts is challenging. Carbon footprint is an environmental accounting tool used to calculate individuals', companies' and products' greenhouse gas emissions through a consumption-based method (Dahal & Niemelä, 2017; Wiedmann & Minx, 2008). This tool has been considered simple to understand for organizations and individuals and it has been widely used to combat climate change and global warming (Kulkarni, 2019). The Greenhouse Gas Protocol has proven to be an effective accounting method (Finnegan et al., 2018) to measure GHG emissions. The GHG Protocol helps to segment the emissions into three scopes: scope 1 (direct process emissions), scope 2 (indirect emissions from the purchase of energy) and scope 3 (other indirect emissions caused by the purchase of goods and services) (Loyarte-López et al., 2020; WRI

& WBCSD, 2015). Carbon footprint method is seen as an important analysis tool for indirect impacts like transport and mobility in higher education institutions (Ozawa-Meida et al., 2013).

Carbon footprint has been previously used in several research papers (Gómez et al., 2016) as it is found to be applicable on an organizational level, universities and faculties (Sippel, 2017). The three scopes demonstrate that GHG emissions highly influence the total carbon footprint of a product or service. However, studies have paid attention particularly to the inclusion of scope 3 as a study in a university proved that up to 79% of the total carbon footprint was attributed to scope 3 (Ozawa-Meida et al., 2013). Other studies found that scope 3 consists of more than 50% of total emissions of a university's carbon footprint (Alvarez et al., 2014). Similarly, a study at the University of Montreal found that academic mobility contributes more than 50% of the university's total emissions (Arsenault et al., 2019). In contrast, a study from the University of Leon reported that students and personnel traveling by car represented 95% of the total commuting emissions (Pérez-Neira et al., 2020). Thus, calculating indirect transport and mobility carbon footprint in higher education institutions forms an interesting case.

Although carbon footprint of indirect transport could be studied in various scales. Universities take part in the climate transport issue because they are often regarded as small-scale cities (Guerrieri et al., 2019) where transportation services are required (Robinson et al., 2018). Also, universities possess a great stake in matters like resource consumption (Amber et al., 2020) as a great number of students and personnel are involved (Robinson et al., 2018). Hence, universities could be considered as a relatively high contributor group of indirect transport and mobility emissions due to great number of people commuting and traveling long-distances for studies and work purposes.

Universities possess an important role to create a sustainable future to influence students and professionals (Bekaroo et al., 2019) through education and research programs (Larsen et al., 2013; Robinson et al., 2018). In addition, universities have taken a carbon management path for economic, social, and environmental benefits (Larsen et al., 2013; Ramos et al., 2015; Tuesta et al., 2020), as well as to promote more responsible habits like the use of low-carbon transport alternatives (Pérez-Neira et al., 2020). However, students, who represent a big traveling group in universities, are often indirectly connected to the university management. Despite the large number of students in universities, some studies do not report their travel emission production (Ciers et al., 2018; Gómez et al., 2016; Kulkarni, 2019; University Properties of Finland, 2020) while others fail to address certain travel types that increase the university emission production (Alvarez et al., 2014; Gómez et al., 2016; Larsen et al., 2013). These gaps create difficulties to manage the carbon footprint of universities. Thus, it is vital to include personnel and students into the calculation as well as the travel types that universities are responsible for to measure the total indirect transport emissions of universities and reduce hotspots.

1.2 Research purpose, aim and research question

The purpose of this Master's Thesis is to support the goal of the University of Jyväskylä to become carbon neutral by 2030, by measuring the transport carbon footprint of the University as well as to shed light on transport and mobility impacts. The objective of this research is to measure indirect travel emissions of commuting travels, long-distance leisure travels, which relate to the University, and unreported business travels. The scope is to concentrate on mobility patterns to estimate climate impacts. The main research question of this Master's Thesis is ''What is the transport and mobility carbon footprint of personnel and students of the University of Jyväskylä?''. In order to answer the research question, subquestions are outlined as follows:

- What are the transport modes used to commute, for long-distance leisure travels of personnel and students and unreported business travels of PhD students and Grant researchers? What are the total emissions of these?
- What is the total estimated carbon footprint of transport and mobility of personnel and students of the University?

1.3 Background of the University of Jyväskylä

The University of Jyväskylä (JYU) is based in the city of Jyväskylä, Central Finland. It was founded in 1863. Teacher training was one of its core functions. In 1934, the University was established as ''Jyväskylä College Education'' and offered academic degrees. This led to the opportunity to award master's degrees in education and dissertations in 1944 (University of Jyväskylä, 2019a). Since then, the University was continuously growing as a public educational institution.

Currently, the University has 12,798 registered students. There are 2,720 personnel which is comprised of teaching, research, other support personnel and teacher training school. The annual turnover in 2018 was €204.3 million (University of Jyväskylä, 2019d). The University has six main faculties as well as other independent institutes most of which are located in the city of Jyväskylä. However, only two of JYU institutes are located elsewhere: Konnevesi Research Station in Konnevesi municipality in Central Finland and Kokkola University Consortium Chydenius in Central Ostrobothnia region (University of Jyväskylä, 2019b). The University is spread throughout Jyväskylä city which offers several premises such as the main library near the city center, other libraries near other faculties, student cafeterias, study places, computer labs in each faculty, IT support, student union and sport facilities (University of Jyväskylä, 2019b).

The city of Jyväskylä is the largest city in Central Finland with a total population of 141,305 and covers 1,171 km^2 (Jyväskylä City, 2020). Central Finland has a total of 23 municipalities, 276,196 inhabitants (Regional Council of Central Finland, 2016) and an area of 16,703 km^2 (Regional Council of Central Finland, 2019). The city of Jyväskylä has 45,000 students and the University is the third biggest employer in the city (Jyväskylä City, 2020). Figure 1 on the left shows a map of Finland with the location of the University of Jyväskylä in Central Finland. The circle on the northwest is located in Kokkola. Figure 1, on the right side, shows the location of the University faculties in Jyväskylä city with colors. Some of the faculties share the same building hence, the bubbles have more than 1 color.

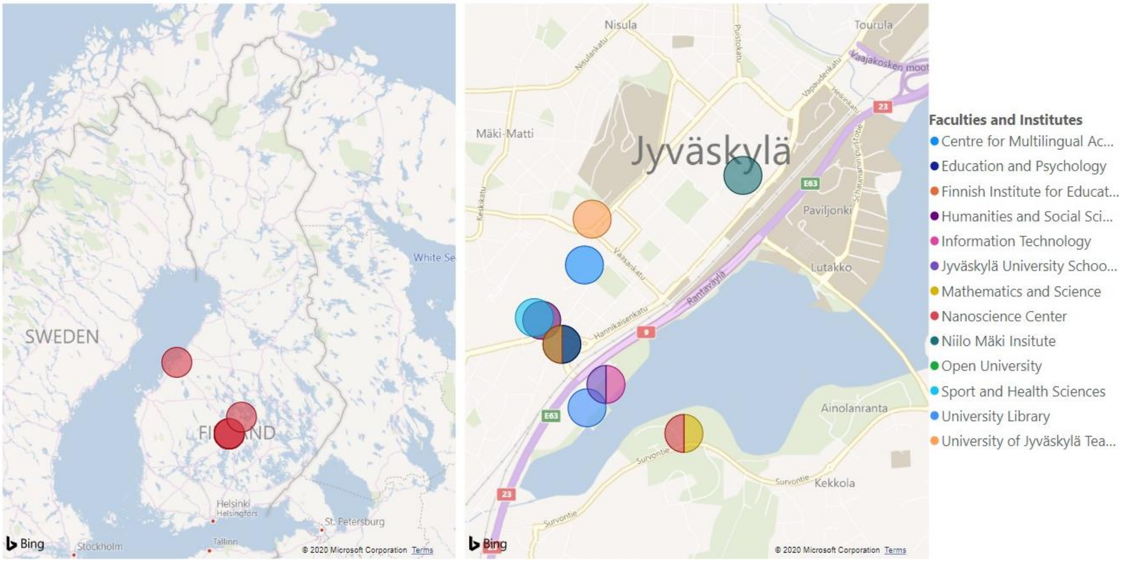

Figure 1. Location of the University of Jyväskylä and its faculties (JYU Faculties, 2020)

In 2018, the University of Jyväskylä signed the Global Climate Emergency Letter to combat climate change (University of Jyväskylä, 2019e). The University's climate strategy focuses towards a more responsible future by allocating resources to leverage knowledge of the environment and sustainability in the University and in the Central region. With that, the University aims to become carbon neutral by 2030 (University of Jyväskylä, 2019c). As an addendum, this Master's Thesis forms part of the indirect impact evaluation of the University to mitigate and compensate for the University emissions.

In 2015, the University of Jyväskylä calculated its personnel commuting travels through a survey of which collected 1,184 answers (Mobinet, 2015). The share of distance was divided in 4 groups: less than 5 km, 5-10 km, 11-20 km, and more than 20 km. Respectively, the percentage of respondents in each group were 58%, 22%, 11% and 9%. From the total commuting travels, 86% were within Jyväskylä city. The results showed that bicycle (43%), car (27%), walking (11%) and carpool (8%) were most common travels modes. However, 79% of the emissions stemmed from commuting by car alone, public transport accounted for 11% while carpool 9%. Collectively, this resulted in 851 tonnes of carbon dioxide emissions and 0.3 tonnes of carbon dioxide per University employee.

1.4 Thesis structure

The outline of this Master's Thesis consists of six chapters. The first chapter introduces the topic and the objective of the thesis. Chapter 2 presents theories of climate change, carbon footprint and transportation as a base of this research, while chapter 3 connects the aforementioned theories with universities and sustainable transport and mobility. Chapter 4 outlines the methodology used for the purpose of this research and chapter 5 presents the findings of the research. Lastly, chapter 6 answers the research questions and discusses aspects related to the topic based on the literature and results from the findings. The chapter proceeds by providing possible solutions followed by limitations and further research suggestions.

2 CLIMATE CHANGE, CARBON FOOTPRINT AND TRANSPORTATION IMPACTS

In this chapter, climate change and global warming are discussed followed by carbon footprint and transportation types and impacts as part the framework of this thesis chapter.

2.1 Climate change and global warming

The increased level of GHG emissions cause the Earth to warm (NASA, 2020a). As a result, long-term changes in climate can last for centuries (IPCC, 2014b). The increase in temperature stems from the fact that accumulated GHGs prevent heat from escaping through the atmosphere into space (NASA, 2020b). Currently, the concentration of CO_2 in the atmosphere is 412 parts per million (ppm) which has increased 47% since the beginning of the Industrial age, and 11% since 2000 (Buis, 2019).

GHGs remain in the atmosphere from few to thousand years (Shaikh et al., 2018), and the main GHGs that contribute to climate change are CO_2, CH_4, N_2O and chlorofluorocarbon (CFC) (NASA, 2020b; WMO, 2020). In order to measure GHGs, the global warming Potential (GWP) measures the radiative forcing of a GHG in comparison to CO_2 unit mass accumulated over a time horizon (IPCC, 2019). Table 1 shows some of these values.

Table 1. Greenhouse gases and Global Warming potential values (IPCC, 2014b)

GHG	Global Warming Potential	
	Cumulative forcing over 20 years	Cumulative forcing over 100 years
CO_2	1	1
CH_4	84	28
N_2O	264	265
CF_4	4880	6630

In Table 1, a radiative forcing unit of CH_4 is equivalent to 28 units of CO_2 over a 100-year period. This means that CH_4 is 28 times more powerful over 100 years than CO_2. In contrast to that, there are aerosols which represent a negative radiative forcing as a cooling effect as well as other aerosols that are influenced by black carbon and organic carbon which damage the Ozone layer (IPCC, 2014a). Yet, the IPCC (2014a) report states that there are debates whether these gases could impact the climate mitigation strategies. With that said, the increasing levels of GHGs in the atmosphere pose major driver of climate change (WMO, 2020).

Hence, the IPCC (2014b) refers to the term *climate change* as an environmental change process making the Earth potentially uninhabitable. Figure 2 presents the interlinks of several emissions and the impact on humans. The lines with colors represent the results that each activity generates.

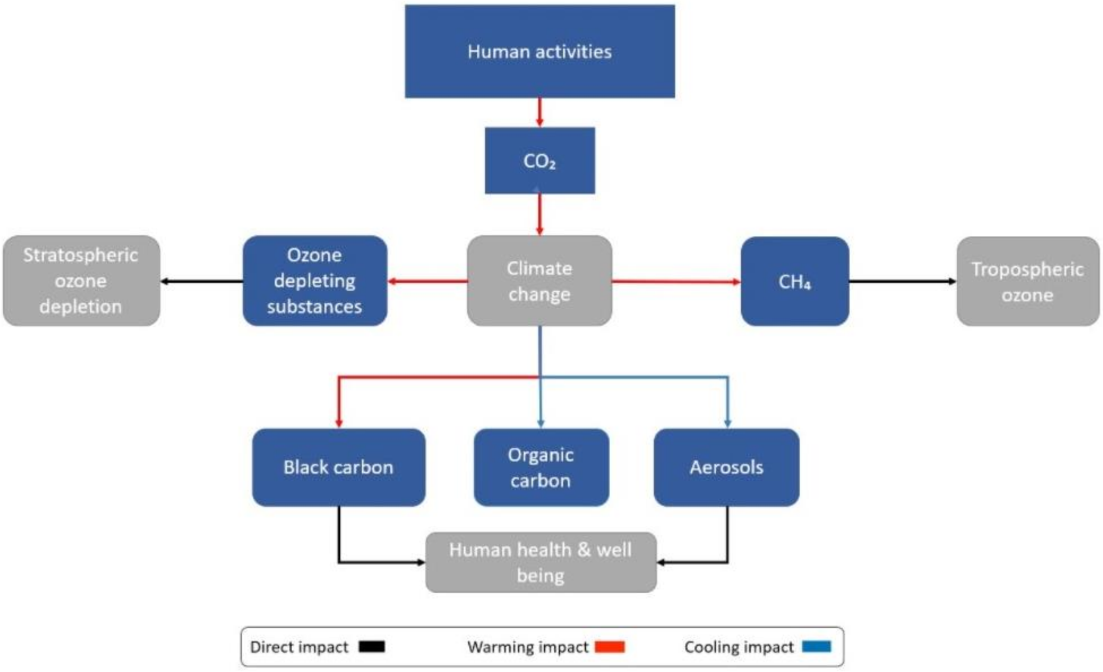

Figure 2. Interlinks of activities and GHGs emitted to the atmosphere (UNEP, 2012 as cited in IPCC, 2014a)

Because of excess GHGs in the atmosphere, 55% of GHG emissions are absorbed by the oceans and plants while the rest remain in the atmosphere (Riebeek & Simmon, 2011). Ocean acidification occurs when CO_2 dissolves in seawater which produces carbonic acids and decreases the level of acidity (pH) in the ocean (Murphy & Raisman, 2013). The authors (Murphy & Raisman, 2013) state that this process alters marine organisms. More importantly, when the water becomes more acidic, it could dissolve more rock and release carbonate ions which increase the ocean's capacity absorb CO_2 (Riebeek & Simmon, 2011). This means that over time, the sea is meant to absorb more emissions from air.

However, seawater is not the only ecosystem being affected by GHGs. The increased temperature extends the growing season and increases humidity (Riebeek & Simmon, 2011). Also, forest play an important role in the carbon cycle because forest can help absorb anthropogenic emissions, however, deforestation, which is caused by humans, inhibits this cycle through the reduction of trees (Ashton et al., 2012).

Transportation is considered a potential activity that contributes to climate change as around 14% of the global annual emissions originate from burning fossil fuels (Shiying. G. M. Wang, 2019). The transport emissions from energy consumption of end-users burn fossil fuels and release GHGs such as CO_2, CH_4, N_2O

and HFCs into the atmosphere (EPA, 2020). As an example, Finland produces 56.4 million tonnes CO_2eq (Statistics Finland, 2019a) of which 13 million tonnes belong to transportation (Ministry of Employment and the Economy, 2014). The Finnish Ministry of the Environment (2017) sates that 90% of the transport emissions are produced by road transport of which 58% is attributed to passenger cars having registered 3.4 million passenger cars (Statistics Finland, 2019b). Thus, emissions released by fuel engines of end-users is regarded a climate concern.

2.2 Carbon footprint

A method to estimate climate change and the global warming potential is through carbon footprint as it is a tool to assess GHG emissions of individuals, companies, countries services or products (Wiedmann & Minx, 2008). Therefore, it indicates the emissions associated with the activities that individuals, companies and institutions generate (Shaikh et al., 2018) through different sources such as agriculture, industries livestock, energy, transportation, and waste management (Loyarte-López et al., 2020). Moreover, carbon footprint is often associated with life cycle thinking and life cycle assessment, because it quantifies emissions produced during a product's or service's life cycle (Pihkola et al., 2010). This association may be because LCA assesses the environmental performance of a product or serviced based on the consumption of resources during every stage of the cycle *from cradle to grave* (Sambito & Freni, 2017).

Despite the similarity, carbon footprint is regarded as an accounting standard method to quantify GHGs based on the Kyoto Protocol (Laurent et al., 2012). It assesses environmental impacts of activities that accumulate GHGs over the life stages of a product (Sivaram et al., 2015). Therefore, studies have used carbon footprint consumption-based method because emission are generated from the utilization of goods and services, hence it is found to be a comprehensive calculation (Dahal & Niemelä, 2017). More importantly, this method has been continuously used for environmental performance of businesses and education institutions to optimize resource utilization related to the cost of the product or service (Kulkarni, 2019) as it is regarded as the base of carbon management (Sippel, 2017).

Carbon footprint has proven its validity as it is used in different standards such as ISO methodology (Sambito & Freni, 2017) and GHG Protocol to report emissions at all corporate levels (Finnegan et al., 2018). Because human contribute to GHGs through daily activities, it is important to evaluate this through carbon footprint to improve daily behavior (Bekaroo et al., 2019). This method evaluates various GHG emissions that contribute to the global warming potential, but the focus is mainly on CO_2 emissions as it is regarded as the main contributor among other gases (Choudhary et al., 2018). However, all possible gases ought to be included (Wiedmann & Minx, 2008) such as CH_4 and NO_2 which contribute to the global warming potential (IPCC, 2014b). Although Sambito & Freni (2017) states that carbon footprint typically considers six GHGs identified in the Kyoto

Protocol (CO_2, CH_4, NO_2, SF_6, HFCs, PFCs). However, the addition of GHGs depend highly on the source from where the gases originate.

Gases that contribute to the GHGs emission growth ought to be considered for the consumption-based carbon footprint tool. The selection of GHGs allows to measure the gases in CO_2-equivalent (CO_2-eq) as it is the mix of gases that derive from certain activities (Bekaroo et al., 2019). Therefore, passenger-kilometer (pkm) accompanies CO_2-eq as part of the transport standard units (IPCC, 2014b). CO_2-eq pkm is in relation to the contribution of GWP to measure the contribution of GHGs as a result of the emissions produced individually (Baumeister, 2019). Hence, the calculation of CO_2-eq from transportation includes CO_2, CH_4 and N_2O (IPCC, 2014b) with their cumulative forcing from Table 1 which results in Equation 1. Equation 1 shows CO_2 as the unit reference which is equal to 1 followed by CH_4 and N_2O with their respective radiative forcing over 100 years. The Technical Research Center of Finland (VTT) provides this measurement calculated in a variety of transport modes through the Lipasto dataset (2017). The dataset provides the measures in grams pkm, and the average of occupancy of the vehicles (VTT, 2017). This enables to study the GHG emissions in different units per pkm.

$$CO_2 - eq = CO_2 + CH_4 \times 28 + N_20 \times 265$$

Equation 1. CO_2 equivalent calculation (Adapted from IPCC, 2014b)

When the emission factors are defined, the calculation requires the travel distance of the vehicles. The distance is translated in kilometers traveled by transport mode (Pérez-Neira et al., 2020). Distance is a measure used to calculate the travel emission of various transport modes (IPCC, 2014b). However, the distance of single transport mode may be problematic to acquire. Often, this data can be collected as primary data or estimated with the help of other programs (Pérez-Neira et al., 2020). Distance relates to frequency due to the vehicle use which results in emissions produced (Cole-Hunter et al., 2015). Hence, vehicle utilization determines the emission production of single vehicles with the distance traveled.

When the units and emissions factors are selected, system boundaries need to be defined. System boundaries are meant to consider which processes are required to include in the carbon footprint evaluation (Rebolledo-Leiva et al., 2017). Based on the GHG Protocol, system boundaries are referred to *scopes* to enhance transparency within accounting and reporting carbon footprint (WRI & WBCSD, 2015).

There are three scopes: Scope 1 refers to direct emissions from combustion in owned or controlled by the organization. For instance, emissions from combustion in owned or controlled boilers, vehicles, chemical production in owned or controlled process equipment (WRI & WBCSD, 2015). Scope 2 consists of indirect emissions associated with the consumption of purchased electricity, heat, steam and cooling, while scope 3 consists of all indirect emissions that occur in an organization value chain (WRI & WBCSD, 2011). For instance, scope 3 includes the extraction and production of purchased materials and fuels, transportation and related activities from vehicles not owned or controlled by the organization (WRI & WBCSD, 2011). The latter example relates to business travels and commutes of employees in organizations as well as energy-related activities not covered in scope 1 and 2 (Finnegan et al., 2018; Loyarte-López et al., 2020; WRI & WBCSD, 2011).

Following the scope 3, the IPCC report (2014a) refers to scope 2 and 3 as indirect emissions with high influence on the total GHG emissions production. The omission of scope 2 and 3 demonstrate a gap in the total GHG emission production as emission had continuously grown over the years (IPCC, 2014a). This issue may be due to the interlink with sectors and human-related activities. Direct emissions, or scope 1, provide limited representation of emissions activities as it lacks to report the consumption from end-users (IPCC, 2014a). Therefore, this proves that reporting only scope 1 results in unsolved reporting activities. With that said, the IPCC (2014a) stresses the importance of indirect emissions specially in the building and transport sector due to their roles as indirect energy consumers of end-users. Figure 3 depicts the relationship of a company's value chain in relation to scope 1, 2 and 3. In Figure 3, scope 3 shows several services which results in GHG emissions.

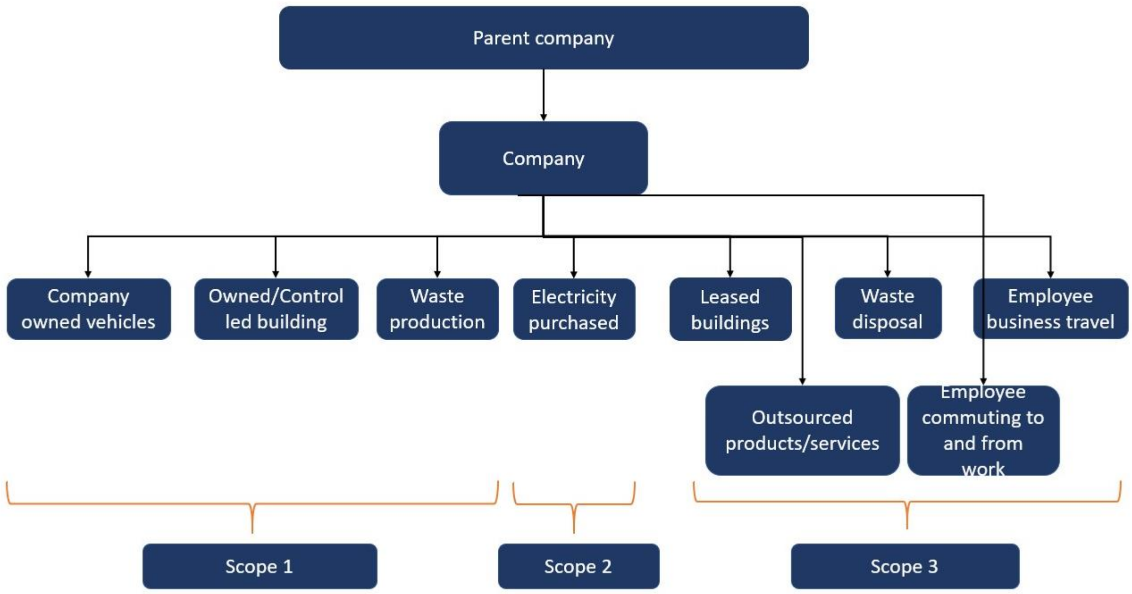

Figure 3. Scope relationship (Adapted from GHG Protocol, 2015)

Although reporting scope 3 remains a voluntary action in countries like The United Kingdom (Government UK, 2019), scope 3 is considered challenging to assess (Robinson et al., 2018) because of its high uncertainty and lack of correlations to fuel estimates (IPCC, 2014a). The study of Finnegan et al. (2018) agrees with this as the study fails to include scope 3 as part of the research due high risk of double counting from another company's emissions. Double counting often appears in broad GHG calculations which increases difficulty when defining system boundaries (Dahal & Niemelä, 2017). However, the study of Dahal and Niemelä demonstrates several double counting issues as the study was implemented in cities. In this matter, system boundaries are affected by companies' decisions to account for scope 2 and 3 because scope 2 and 3 are the scope 1 of other companies (Hertwich & Wood, 2018). With that said, the authors states that shared responsibility is given to both companies (Hertwich & Wood, 2018).

The use of frameworks give uniformity to calculate emissions. However, scope 3 provides a set of complex processes that related to resource extraction and supply activities which is challenging to include it in the GHG reports (Fallaha et al., 2009). According to Koh et al. (2013), complex processes across businesses require collaboration because a process often includes activities within supply chain. The authors state that identifying hotspots within supply chain is the key to reduce emissions (Koh et al., 2013). Despite the complexity, it is vital to include scope 3 because it arises from upstream activities (Fallaha et al., 2009). Therefore, scope 3 can be achieved by allocating environmental and social aspects and the members that belong in the supply chain to fulfilled social, environmental and economic criteria (Koh et al., 2013). In this regard, the study acquired a large amount of data to identify hotspots and encompass scope 3 (Koh et al., 2013). In contrast, the GHG Protocol provides a framework of upstream emissions that distribute GHG emissions in different categories which include a list of scope 3 emissions categories (WRI & WBCSD, 2011).

With the challenges, there shall be clearer boundary settings, data availability and reliability in the calculation to address scope 3 (Davies & Dunk, 2016). This idea turns GHG reporting more consistent with the current emission activities. Moreover, institutions intend to motivate companies to include scope 3 as part of reporting emissions by publishing documents and accounting reports of GHG emissions (Hill et al., 2019). Also, governments like the European Union (2013) provide guidelines to help companies address upstream emissions in order to have a common accounting method. In addition to that, the GHG Protocol (WRI & WBCSD, 2011, 2015) provides an accounting view on the matter as it shows guidelines for all scopes to differentiate each one of them.

As part of the positive side, the inclusion of scope 3 has provided substantial benefits in terms of emission allocations and reduction initiatives due to its contribution to GHG emission figures (Alvarez et al., 2014; Clabeaux et al., 2020; Dolf & Teehan, 2015; Robinson et al., 2018). Study examples demonstrates that scope 3 is a major contributor to GHG emissions from indirect travels (Arsenault et al., 2019; Edwards et al., 2016; Larsen et al., 2013; Loyarte-López et al., 2020; Pérez-Neira et al., 2020). However, the above-mentioned studies provide several analyses of scope 3 of different transport types involved.

2.3 Transport types and transport impacts

Transportation is defined as the movement of human beings from one place to another through a transport mode such as road, rail, air and marine (Bekaroo et al., 2019). The movement of people is stimulated by several factors as Ibarra-Rojas et al. (2018) state that people travel from one point to another to receive a service or meet a demand. Therefore, a form of travel is urban transport located within a territory of a city (H. Wang & Zeng, 2019). Even though there may be several reasons to travel, commuting belongs to this group as it is the movement between workplace and home (Sang et al., 2011). Another travel type is long-distance travel which is defined as a journey that covers more than 80 km (van Goeverden et al., 2016).

According to Caponio et al. (2015), the increased emissions from urban transport are attributed to the increase of passenger cars and slower growth mobility. Wang and Zeng (2019) state that commuting travels impact the emission growth due to the concentrated traffic and the high frequency of trips. Although Cole-hunter et al. (2015) consider urban infrastructure and the built-environment high influencers on the urban transport emission as the study evaluates the environment based on the traffic and the built area. However, the authors fail to specify the main source of emissions in urban transport (Cole-Hunter et al., 2015). In contrast, the study of Wang and Zeng (2019) prove that passenger cars are the main source of urban transport-related emissions.

To understand the emission production in commuting travels, Figure 4 depicts the process with some of the typical transport modes used. Thus, the emission production takes place between point A and B due to the utilization of transport modes.

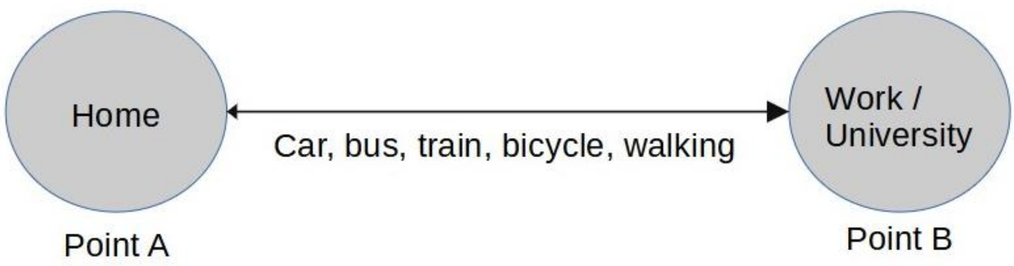

Figure 4. Commuting process home - University

Unlike commuting travels, long-distance travels require multimodal transport modes like buses, trains and metros for medium and long-distance transport services (Cheng & Chen, 2015). In addition to that, private cars also belong to this group (Minn, 2019) as well as airplanes (van Goeverden et al., 2018). The latter authors state that air transport represents a dominant role within long-distance travels due to its high speed, low fare, route length and demand density (van Goeverden et al., 2018). Thus, this means higher emission production. However, air transport is considered a high influencer on climate impacts due to its high impact per unit traveled (Aamaas et al., 2013) and its large energy intensity (Baumeister, 2020) making it the highest emitter per distance travelled (Baumeister, 2019). On the other hand, other studies showed that cars are the second largest emission contributor group within long-distance travels (Aamaas et al., 2013; Baumeister, 2019).

Following commuting and long-distance travels, buses and trains are used in both travel types. Bus is regarded as a low-carbon and economic mode with the capacity to reduce emissions per passengers (Liu et al., 2016) while trains are considered to have the least impact on climate (Baumeister, 2019). However, the study of Baumeister (2019) specifies that trains in Finland result in low-carbon emissions as they run on electricity from hydropower. Thus, the study provides limited information regarding trains with different energy sources.

The production of emissions within short and long-distances can be analyzed from different angles. Objectivity is required when comparing transport modes, multiple dimensions, and range of those dimensions (Minn, 2019). Minn (2019) states that all transport modes consume resources as they require infrastructure, connection lines, maintenance, among others. Thus, emissions from building transport infrastructure could be considered within the transport emissions (Liu et al., 2016). With respect to that, Barros et al. (2018) consider vital to invest in infrastructure in order to reduce the emissions from car transport and support sustainable options. However, the latter study focuses only on urban transport emission reduction which leaves long-distance travels out of the scope (Barros et al., 2018).

As a solution for transport emissions and infrastructure, Liu et al. (2016) present a combination of transport modes which result in great environmental effect. The study states that the combination of air and rail transport could produce 40% less emissions than traveling solo by car (Liu et al., 2016). In contrast to that, Minn (2019) supports Barros et al (2018) idea as Minn (2019) states that rail transport promises a low-carbon future capable to provide services within short and long distances with the right infrastructure.

Another aspect regarding the transport emission production is capacity. Capacity given according to the transport mode, and distance (Cheng & Chen, 2015). Although Minn (2019) states that the capacity of trains and buses vary by season due to multiple stops, the emission production are highly associated with passenger loading (H. Wang & Zeng, 2019). This means that the emissions produced by the transport type could be shared by the passengers. For instance, passenger cars can be efficient at full capacity as the emissions are shared for the distance of the trip (Liu et al., 2016). Even though passenger cars are one of the main contributors of transport emissions within short and long-distances travels (Caponio et al., 2015; Minn, 2019), the example of Liu et al. (2016) miss to explain the type of travel selected which could have a great impact when knowing the distance.

In contrast, small capacity affects air transport particularly in short-haul flights due to higher emission production per ton kilometer (Baumeister, 2019).

One of the latest global impacts in 2020 was the Coronavirus (COVID-19) pandemic. The pandemic caused countries to close borders which had a negative effect on the economy (Mazareanu, 2020). That in turn led to consequences on transport sector (Mazareanu, 2020). Therefore, this global impact causes restriction measures and lockdowns in countries which result in reductions of mobility, energy consumption and economic activity (Erbach, 2020).

The pandemic has caused a drastic decline in passenger transport demand as it affected all transport modes (International Energy Agency IEA, 2020). This resulted in a considerable reduction in people's mobility (Abu-Rayash & Dincer, 2020). By the first quarter of 2020, road transport activity was 50% below 2019 averages while commercial flights were 75% below (IEA, 2020). Declines in public transport have taken place since March 2020 (Daily, 2020). In addition to that, Eurocontrol (2020) predicts that flight expectations are said to be 55% lower than in 2019. In addition, coronavirus also caused consequences in the oil and gas industry as activities were postponed for next year (Oil & Gas Journal, 2020) which is meant to impact the transport activities. Similarly, the pandemic also affected the development of renewable energy as governments were forced to redistribute public funding to combat the virus (Sovacool et al., 2020).

In order to support the economy during the pandemic, the EU has launched a recovery plan to help the economy while also investing in the future (European Commission, 2020b). The International Energy Agency (2020) considers this plan as an opportunity to transform the EU's energy sector of which transportation can benefit from. More importantly, the European Parliament (2020) states that this recovery plan is a reconstruction package to help the economy and fight climate change as 25% of this budget is allocated to climate action through the European Green Investment Plan. The plan can impact the future transport emissions. For instance, Finland is estimated to receive 2.3 million euros for recovery and resilience facility in the form of grants which are to support public investments and reforms (European Commission, 2020b).

Despite the challenges, the IEA (2020) states that the crisis can considerably change people's behavior because it makes them evaluate the transport modes, costs and risks. During the lockdown, the European Data Portal (2020) reported a massive transport reduction in road and air travel which brings environmental benefits, emission reductions and energy saving (Abu-Rayash & Dincer, 2020). With the reductions, the EU (2020c) is prepared to launch a strategy for sustainable and smart mobility to include all possible stakeholders. The lockdown lends help to future sustainability and reliable transportation (Abu-Rayash & Dincer, 2020). For urban mobility, cities play a critical role to restructure the public good through policies to integrate a new approach towards sustainable mobility options (Daily, 2020). However, concrete ideas for sustainable transport and mobility are needed to support this initiative.

The pandemic has caused a positive impact on air quality. The European Environment Agency (2020) confirms a drop of NO_2 and particulate matter (PM10) in several European cities. Together with the EC, the Copernicus Atmosphere Monitoring Service (CAMS) and the Copernicus Climate Change Service (C3S) monitor the air quality in 50 cities in Europe (The Copernicus Programme, 2020). This method measures the total amount of NO_2 from the Earth's surface to the top of the atmosphere, however, this is related but not the same as the concentration of gases in the surface (Copernicus Programme, 2020). For instance, the data shows that NO_2 in Madrid has reduced significantly during lockdown, unlike Helsinki, which reductions have been at a minimum (The Copernicus Programme, 2020). However, it remains hasty to make conclusions based on these evaluations as the weather changes over time (European Dataportal, 2020).

However, other aspects are needed to take into account. According to Erbach (2020), when the economy resumes, emissions may rise even though a slight emission reduction is estimated in Europe. Therefore, emission reductions are not only dependent on weather conditions but also on the consumption of energy (Copernicus Programme, 2020) which means the behavior of individuals. Thus, the World Health Organization (2020) associates COVID-19 with emission production as both contain similar results: impact the global health security, enhance environmental risks, impact social wellbeing inequalities, and increase human socioeconomic costs.

With the types of travels, transport modes and impacts within transportation, it is also important to consider the destination. Job creation influences the reason to travel. However, Caponio et al. (2015) state that people who constantly travel between home and work or full-time study strongly contribute to the transport emission growth. In this regard, universities can be considered as small cities (Guerrieri et al., 2019), job creators and knowledge providers (Bekaroo et al., 2019) as people travel to universities for work or study purposes. Hence, people that travel to universities are responsible for transport emissions based on the type and mode of transport selected.

Transportation has been studied within universities through different travel types such as commutes, events and academic purposes like conferences (Achten et al., 2013; Arsenault et al., 2019; Barros et al., 2018; Dolf & Teehan, 2015; Larsen et al., 2013). The motive is likely due to the great number of people involved in universities as well as the increased economic growth (Robinson et al., 2018), which has encouraged to turn the focus on a low-carbon path (Guerrieri et al., 2019). In this regard, universities can generate great impacts and good habits by showing cleaner transport options such as the use of bicycles (Pérez-Neira et al., 2020). University policies, employment and economy in universities can impact the transport and mobility in people which could lead to decrease emissions from transport (Guerrieri et al., 2019; Pérez-Neira et al., 2020).

However, research studies of transport in universities show the impact on transport emission production depends on the travel type studied. The study of Pérez-Neira et al (2020) and Barros et al. (2018) show that the emission quantity of commuting travels differs from the emission quantity of long-distance travels

(Arsenault et al., 2019; Clabeaux et al., 2020). The studies on long-distance travels demonstrate that long-distance travels produce more emissions due to the transport mode and distance. However, the study of Barros et al. (2018) consider that the quantity of people that travel affects the emissions production albeit the travel type as more people travel means more emissions.

3 UNIVERSITY ASPECTS AND SUSTAINABLE MOBILITY

This chapter describes the current situation of higher education institutions in Finland. Then, university transport and mobility impacts are discussed followed by sustainable transport mobility topic.

3.1 Finnish higher education institutions

In Finland, higher education sector consists of universities and universities of applied sciences (UAS) of which universities focus on research and education while UAS provides education with focus on working requirements (Ministry of Education and Culture, 2020a). Altogether, there are 13 universities, 23 UAS, 6 university centers, and 13 state research centers (Vipunen, 2020). Universities are legally independent persons named as autonomous public institutions or as private foundation, whereas UAS are independent legal entities (Finnish Ministry of Education and Culture, 2015). However, the Finnish State remains the principal financier for the universities with 64% of a university's budgets originate from the government (EuroEducation, 2014).

The government invests 10.4% of its public expenditure of gross domestic product to education (Statistics Finland, 2020) of which universities receives a share funding through the Ministry of education and culture (2020b). Apart from that, the Finnish government funds a share to universities for research and development (Statistics Finland, 2018). In 2019, there were 153,767 students registered in universities in Finland (Statista, 2020). In 2020, 72,024 applicants accepted a study place at a higher education institution (Vipunen, 2020). Moreover, from 2016 onwards, there has been a slight increase in university staff which results in job creation with a slight increase in PhD students and research staff (Academy of Finland, 2018).

With Finland's main goal to achieve carbon neutrality by 2035, the education system is strongly expected to increase know-how skills (Ministry of the Environment, 2017) to reduce Finland's carbon footprint and to halt biodiversity loss (Finnish Government, 2020a). To support that, the Finnish Ministry of Education and Culture (2019) has planned to request carbon footprint data of work-related activities. However, the strategy defines new measures which are meant to support the development of higher education institutions: increase the level of competence among the Finnish population, provide opportunities for self-development, reinforce academic studies, strengthen transparency, provide different ways of learning, and open doors to other degree students (Finnish Government, 2020b).

The Finnish plan is seen dependent on whether the generation of high-level expertise enables the opportunity for new technology as it is linked to the creation of new jobs and trainings through universities (Ministry of the Environment, 2017). Hence, the social and technical innovations ought to be developed and connected to broad institutional resources and responses (Westley et al., 2011). However, the idea of Westley et al. (2011) requires capital investment to realize projects in connection to broad institutional resources.

3.2 Transport and mobility emissions of universities

Understanding carbon footprint of indirect transport and mobility is said to be important to estimate the total carbon footprint of institutions (Ozawa-Meida et al., 2013). GHGs emissions form part of human activities, therefore, managing individuals' emissions is valuable (Bekaroo et al., 2019). As part of this, university carbon management is considered significant due to the large number of people involved (Robinson et al., 2018), resource consumption, emission production, and economical and social activity (Amber et al., 2020). Apart from managing and reducing emissions, carbon management enhances the financial performance (Tuesta et al., 2020) to build a low-carbon economy (Robinson et al., 2018). However, to support this development, universities ought to evaluate their own footprint as an institution (Gómez et al., 2016).

Moreover, universities play a role to align carbon management to Sustainable Development Goals as SDG 13 exists to address climate change issues to raise human awareness (United Nations Sustainable development, 2015). According to Yañez et al. (2020), this can be a step to educate future generations in sustainability and environmental impacts. The United Nations (2020) considers the improvement of education as an advantage to enhance the capacity for climate change, mitigation, adaptation, and impact reduction. Therefore, universities, as public institutions, have a commitment to the environment and sustainable development (Mendoza-Flores et al., 2019). Hence, universities can impact people to educate future generations while focusing on climate impacts of the institutions.

Universities are regarded as environments to promote well-being, education, and good habits (Pérez-Neira et al., 2020). On the other hand, transport modes are used to move people to a certain location (Bekaroo et al., 2019). Regarding these aspects, universities are recommended to recognize all possible stakeholders that impact the university to become accountable for the emissions produced (Alshuwaikhat & Abubakar, 2008). Universities are needed to integrate personnel and students into the university's strategy (Berzosa et al., 2017). Personnel play an important role as they belong to universities as well as students as both groups are said to influence the university carbon footprint (Larsen et al., 2013). Moreover, studies consider personnel and students' transport and mobility great climate influencers as the topic has been studied within short and long-distance travel scales (Achten et al., 2013; Arsenault et al., 2019; Pérez-Neira et al., 2020).

Several universities have addressed personnel and students as part of their indirect transport and mobility impacts. De Montfort University's travel carbon footprint, which includes commuting trips, students' national and international travels, visitor travels, and business travels, is 14,689 tonnes (t) CO_2-eq (Ozawa-Meida et al., 2013). The study shows that indirect travels represent 29% of the annual emission production of the University (Ozawa-Meida et al., 2013). Similarly, a research of the University of Montreal shows that personnel and students' mobility contribute to 80% of the total University carbon footprint of which academic mobility produced approximately 65,774 t CO_2 emissions (Arsenault et al., 2019). However, the study of Arsenault et al. (2019) focus mostly on academic and international travels.

By comparison, a research of the carbon footprint of Clemson's University demonstrated that indirect transport, which consisted in commuting and academic-related travels of students and employees, produced 27,932 t CO_2-eq (Clabeaux et al., 2020). The study shows that indirect travels represented 29% of the total University emission production of which commuting travels represented 19% and academic travels 10% (Clabeaux et al., 2020). Another research at an engineering education institution in India reported the annual transport carbon footprint to be 846 t CO_2-eq, being 63.2% share of total institution carbon footprint (Sivaram et al., 2015). However, the study of Sivaram et al. (2015) refer to transport emissions as direct impacts having control of the transport fleet.

The Norwegian University of Science and Technology measured indirect travel emissions of students and employees resulted in 1,4720 t CO_2-eq and represented 16% of the total University carbon footprint (Larsen et al., 2013). However, the study of Larsen et al. (2013) only considers business travels such as attending conferences. The study of Alvarez et al. (2014) takes a similar scope to evaluate indirect transport impacts of the Technical University of Madrid. The results of the study shows that indirect transport contribute with 3% to indirect impacts of the University (Alvarez et al., 2014), while University of Castilla-La Mancha shows that transport represents roughly 5% from all indirect impact of the University (Gómez et al., 2016). However, the studies of Larsen et al. (2013), Alvarez et al. (2014) and Gómez et al. (2016) exclude commuting travels.

A college in India produced 3,636 t CO_2-eq during 2016-2017 academic year, of which transportation represented 33% of the total emissions (Kulkarni, 2019). Similarly, the University of Turku considered personnel in its carbon footprint calculation which resulted in 7,290 t CO_2-eq from business trips, and 500 t CO_2-eq from commuting trips and represented 28% of the annual carbon footprint of the University (University Properties of Finland, 2020). However, the study of the University of Turku (2020) and Kulkarni (2019) exclude students' indirect transport emissions. Another study at Swiss Institute of Technology Lausanne reported only academic air travels which produced 14,603 t CO2-eq emissions (Ciers et al., 2018). Yet, the study of Ciers et al. (2018) exclude students from the travel calculation.

Other university studies evaluate certain travels in which students were considered. The University of Leon, in Spain, calculated personnel and students' commuting travels which resulted in 5,280 t CO_2-eq (Pérez-Neira et al., 2020). The study of Pérez-Neira et al. (2020) showed that walking (41.5%), car (34.2%) and bicycle (13.8%) were the most popular transport modes, and car transport produced 95% of the total emission production. Also, the study of Barros et al. (2018) shows that passenger car produced 90% of the commuting emissions at the University of Technology – Parana, Brazil. The study showed that the University produced 1.4 t CO_2-eq commuting emissions in a year (Barros et al., 2018).

University of Applied Science Konstanz, in Germany, concentrated on students' carbon footprint of which public transport and aviation represented roughly 10% and 20% of the total average students' carbon footprint (Sippel, 2017). However, other universities focus on specific case events like the University of Arizona which studied home travels events and represented 77% of the event's total emissions in 2013 (Edwards et al., 2016). The study of Edwards et al. (2016) shows that the majority of the emissions are produced by air travels. Another transport event at the University of British Columbia produced 52% of the emissions from air travels (Dolf & Teehan, 2015). The studies of Edwards et al. (2016) and Dolf & Teehan (2015) prove that other motives, which require travel, can also have a great environmental impact.

Unlike the above-mentioned, other universities have focused on campus development. For instance, the University of Talca measured carbon footprint of commuting and staff trips which commuting represented 85% (2,742 t CO_2-eq) and staff trips 10% (322 t CO2-eq) of the total indirect emissions of the Talca campus (Yañez et al., 2020). The Autonomous Metropolitan University, in Mexico, calculated campus' carbon footprint of which commuting generated 51% (1,497 t CO_2-eq) of the indirect emissions (Mendoza-Flores et al., 2019). This represented 32% and 18% of the total University campus carbon footprint from commuting in public and private transport respectively (Mendoza-Flores et al., 2019). Even though the two studies focus on campus studies, the studies can help estimate the overall carbon footprint of indirect transport of a higher education institution (Mendoza-Flores et al., 2019; Yañez et al., 2020).

3.3 Sustainable transport mobility

Climate impacts related to transport and mobility and transport modes present linkages with physical activity (Jiang et al., 2017) through people's mobility, as mobility is defined as the ability to travel (Cheng & Chen, 2015). Mobility helps to evaluate the service experience and quality of transport modes (Cheng & Chen, 2015). With that said, transportation and mobility provide advantages in urban cities as cities provides various travel options (Wiersma, 2020). Although Wiersma does not consider other travel types, the idea of transport and mobility could also be applicable to long-distance travels as well.

One of the transport mobility options is bicycle as it is used in urban areas to provide easy access with the right built-infrastructure (Cole-Hunter et al., 2015). Although bicycling is used as an alternative to cover short and medium distances (Wiersma, 2020), it is still environmentally friendly as it produces ten times less emissions than motorized transport (Astegiano et al., 2019). Walking is another travel option used for short trips up to 2 kilometers (Okraszewska et al., 2017). Electrically-power bicycles (e-bikes) have also been found to be quite useful because it is similar to an ordinary bicycle (Astegiano et al., 2019) even though e-bikes use electricity to function.

The use of bicycle is a healthy choice (Jiang et al., 2017). According to the World Health Organization (2015), promoting healthy and sustainable mobility habits can highly reduce risks of developing diseases, mortality, and morbidity. Physical activity is often associated with mental and health benefits as it can help reduce the risks of diseases such as obesity, diabetes, and high blood pressure (Cole-Hunter et al., 2015). The use of bicycles and e-bikes could promote well-being while reducing the use of motorized transports, traffic, and pollution (Giles-Corti et al., 2016). In line with that, the UN SDGs (2015) include the promotion of a healthy life and well-being by making a safe, resilient, and sustainable environment. Therefore, the use of low-carbon transport modes and walking are aligned to build a sustainable future.

In order to promote sustainable transport and mobility, it requires technology (Jiang et al., 2017), policies (Giles-Corti et al., 2016) and infrastructure (Barros et al., 2018). The use of mobile technology to track location has been used to monitor the bicycle trips (Pratelli et al., 2020). This method is considered useful to provide incentives to change people's mobility behavior (Dio et al., 2020). On the other hand, environmental policies are considered a necessity for a transition to a low-carbon strategy (Wiersma, 2020) as well as to challenge society (Herrador et al., 2015). However, Dio et al. (2020) state that mobile phone applications could be considered as soft policies to stimulate people's mobility. More importantly, Barros et al. (2018) state that investment in infrastructure is required to support low-carbon transport and reduce the use of car in cities.

Nevertheless, to encompass short and long-distance travels, mobility is stimulated by the behavior of people (Wiersma, 2020), which is also seen as an advantage for a behavioral change to achieve more by enhancing mobility performance without cost and time (Dio et al., 2020). This behavioral change could be stimulated with the use of technology (Pratelli et al., 2020) and educational campaigns (Dio et al., 2020). Also, environmentally friendly travel options and infrastructure can highly influence the development of mobility (Dio et al., 2020). Moreover, low-carbon strategies are continuously growing as a great number of consumers have responded positively (Xia et al., 2018) to strategies like remote working (Arsenault et al., 2019) and video conferencing meetings (Burian, 2018). Even though Arsenault et al., (2019) do not consider remote work as a substitute, instead, as an opportunity to broaden possibilities for networking and meetings.

4 DATA AND METHODOLOGY

This chapter explains the research design methodology and the data collection methods used in this study. Also, data analysis is explained to describe the data handling and the categories that were used in this study.

4.1 Research design and methodology

This study focuses on a specific case organization, the University of Jyväskylä. The opportunity was given to me in early 2020, with the aim to support the University's development to become carbon neutral by 2030. The aim of this thesis is to find out the transport and mobility emissions of students and personnel when visiting the University for study or work purposes as well as travels for leisure that relate to the University. This thesis supports the University's development to calculate emissions from transportation in order to reduce and compensate for the emissions produced. For that, it is required to find the distances, transport modes and frequency of the commutes and long-distance leisure travels of University personnel and students.

Quantitative method is characterized as a technique to analyze data that uses numbers (Saunders et al., 2009). In other words, quantitative method is often used to understand behaviors, actions or events based on counting and numerical information (Hair et al., 2015). Due to the context of this thesis, the findings are meant to be numerical to have a precise conclusion concerning the emissions of commuting travels, long-distance leisure travels and unreported business travels. Thus, the result can be achieved through quantitative methodology, in which the numbers represent certain characteristics (Hair et al., 2015) with explanatory focus as the study is designed to evaluate certain situation (Saunders et al., 2009).

Due to the nature of this research, case study strategy is suitable for this thesis. Case study strategy involves empirical investigation of a phenomenon within real-life context (Saunders et al., 2009). Moreover, case study strategy entails to receive a complete information of the investigation in a real-life context. In addition, case studies enable opportunities to explore, describe and explain the topic case to develop knowledge and understanding about real-life events (Taylor & Thomas-Gregory, 2015). However, case studies may be specific studies which present challenges to compare among other studies (Hair et al., 2015). Despite the challenge, case study strategy is considered suitable to study various subjects to present them in a practical way (Eriksson & Kovalainen, 2008). Therefore, understanding real-life cases benefits the researcher to understand variables and the interaction within the data. Hence, case study is selected in this study to gain understanding of the current real-life phenomenon.

4.2 Data collection

To complete this study, the research requires data and as this study selected qualitative approach, then the data must be numerical. The aim of the study requires to acquire distances, frequencies and transport modes of University personnel and students. Survey was selected as it is considered a suitable method to receive data from a large number of individuals (Hair et al., 2015). According to Saunders et al. (2009), questionnaires are one of the most efficient ways to collect responses from a large sample. However, a good questionnaire requires accuracy to collect the desire data from sample, therefore, due to the large amount of data expected, a set of standard questions is needed with exclusive outcomes (Hair et al., 2015). This study launched a self-completion survey with a structured number of questions made specifically for students and personnel of the University of Jyväskylä.

The planning of the survey started in March 2020 and was meant to be built in Webropol. Webropol is an online software capable to collect data through surveys. The survey questions were created to collect data anonymously. Therefore, the survey was built in Finish and English language. When the survey questions were made, the first draft version of the survey was presented to the Sustainability for JYU Team. Feedback was given related to the structure, content, and language. In a second meeting, the questions were amended and were put in Webropol as a survey form. The content was discussed in order to build the questions according to the profile of the people. In another meeting, the survey was tested as it was sent electronically to the members of the Team. The Team discussed details such as the front page and data privacy. Data privacy and research notification aspects were handled by the project manager of the project. The project manager provided input throughout the creation of the survey. Lastly, the survey was published in May 2020, and students and personnel were reached through e-mail. Another e-mail was sent during the second week of May as a reminder to those who had not yet filled in the survey. The survey can be found in appendix 1 in Finnish and appendix 2 in English.

In the beginning of the survey, there was a page which explained the purpose of the survey and the plans of the University. The introductory page also explained how the survey ought to be answered as well as information regarding data privacy. In addition to that, the page explained the possibility to win lunch coupons by answering the survey. All in all, the survey had four main sections: the first section was designed to collect background information such as gender, age, role and study or work department. Section two consisted in collecting distances, frequencies and transport modes used for commuting travels to the University. Section three focused on long-distance leisure travels which was subdivided into two sections: personnel with two homes that travel for work and family purposes and students that travel for family and recreational purposes. Lastly, section four was meant to discover unreported business travels of PhD students and grant researchers and the mode and frequency of the trips. Although the survey was created to receive anonymous answers, the survey requested personal information in a different document for participants interested to win lunch coupons at the end of the survey.

The data was gathered during May and June 2020 and data cleaning and analysis started during July 2020. The respondents were 18 years and older and were divided by their gender as well as by their role and faculty. The survey had several multiple-choice questions as respondents were asked to select the choice that best suited their situation. For instance, what is your primarily transport mode when traveling to the University as well as precise questions like distance from home to the University.

Overall, the total number of respondents was 1,913 and most of the responses were deemed relevant for the aim of this thesis. The Finnish survey collected 1,765 responses while the English survey collected 147 responses.

4.3 Data analysis

In order to calculate the GHG emissions of students and personnel of the University, the study followed the IPCC Fifth Assessment Report (IPCC, 2014b) for the climate impact of local emissions. Hence, CO_2-eq is required for the calculation as well as passenger-kilometer (pkm) as indicators. The pkm measure indicates the distance travel of bus, coach, train, aircraft and ferry. Grams per kilometer (g/km) measures emissions per unit distance of passenger car and scooter which were taken from Lipasto emission dataset of the Technical Research Center of Finland (VTT, 2017). The CO_2-eq was used to indicate the GWP 100 years, and therefore, CO_2-eq was calculated based on Equation 2.

$$CO_2 - eq = CO_2 + CH_4 \times 28 + N_20 \times 265$$

Equation 2. CO_2 equivalent calculation (Adapted from IPCC, 2014b)

The CO_2-eq emission factor per passenger for train transport were calculated based on electricity production and consumption. On the other hand, g/CO_2-eq of aircraft were taken from CWT Analytics which is based on Defra's conversion guidelines. Table 2 gives a description of all the transport modes considered in this study followed by the transport type and their respective gases. Lastly, Table 2 shows CO_2-eq emission factors as the total of the three gases based on Equation 2.

Table 2. GHG emission passenger kilometer (g/pkm) of transport modes and average emissions per kilometer (g/km) of passenger cars and moped (Baumeister, 2019; Baumeister et al., 2020; Technical Research Center of Finland (VTT), 2017)

Transport mode	Type	g/CO_2	g/CH_4	g/N_2O	g/CO_2-eq
Passenger car	Gasoline	159.00	0.0021	0.0016	159.48
	Diesel	139.00	0.00029	0.0053	140.41
	Hybrid	127.2	0.0016	0.0012	127.56
	High-blend ethanol	30.00	0.00	0.00	30.00
	Electric car				69.63
	Biogas	0.00	0.00	0.00	0.00
Bus	Urban street ≤50km	54.00	0.00028	0.0018	55.00
	Urban city ≤100km	36.00	0.00014	0.0018	36.48
Coach	Highway ≥100km	39.00	0.00016	0.0015	40.00
Train	Electric intercity	4.59	0.162	0.00	9.13
Metro	Electric, commuting	6.04	0.213	0,00	12.00
Ferry	Gas driven	98.00	0.04	0.00057	99.02
Aircraft	Short haul ≤785				157.7
	Medium haul 785-3700				84.43
	Long-haul ≥3700				73.99
Moped		62.00	0.22	0.0010	68.00
Bicycle	Conventional	0.00	0.00	0.00	0.00
	E-bike	0.00	0.00	0.00	0.00
Walking	By foot	0.00	0.00	0.00	0.00

The next step required was to calculate the total distance traveled by the survey participants. In this case, the participants input the distance and frequency of the trips on weekly basis. Hence, to find the total distance, the numbers were multiplied for a whole year as follows:

$$TD = \sum(D \times 2 \times f \times 46)$$

Equation 3. Total distance

In Equation 3, D represents the one-way distance traveled per person multiplied by 2 as the return is also considered followed by the weekly (f) frequency of the trips multiplied by 46. 46 are the annual weeks used that participants travel for a year. This number was decided based on the official holidays as 4 weeks are for summer holidays, one week in autumn and one week for winter holidays results a total of 46 weeks of work in a year.

With the aforementioned data, this reveals the distances of individuals and their respective emissions of their selected transport. Therefore, when the two calculations are carried out, the results of those calculations are combined into one to calculate the total CO_2-eq of the specific transport modes and distances. Equation 4 below shows the calculation process.

$$TCO_2 - eq = TD \times CO_2 - eq$$

Equation 4. Total CO_2-eq

Equation 4 is used to determine the total CO_2-eq of commuting, long-distance leisure travels and unreported business travels of students and personnel of the University as the calculation translates the emissions of passenger travels for a whole year. However, in order to explain in-depth about the selected methods and assumptions of this calculation, each transport mode is explained in the following sub-sections.

4.3.1 Passenger car

Table 2 shows average of CO_2-eq of passenger cars by engine type. Therefore, there were six different types of engines: diesel driven, gasoline driven, gasoline driven hybrid, electric cars, high-blend ethanol and biogas driven cars. However, to make a precise calculation, passenger cars were also divided by the manufacturing year of the cars. Hence, the cars were divided into five groups to show the cars by the year as the model also influence the emission production from the car. The groups were: 2000 or older, 2001-2004, 2005-2008, 2009-20013 and 2014 or newer. With these two groups, emission per kilometer (g/km) was accurate to find the correct CO_2-eq emission. Also, based on the emission calculation of Lipasto dataset (2017), average emissions from highway and urban driving were selected and assuming that the car occupancy was 1.7 persons in each car. Additionally, E-cars emissions considered the energy consumption as well as emissions from electricity produced. Unlike E-cars, Biogas driven cars were assumed to emit 0 g CO_2-eq as the biomass energy has 0 value (WWF, 2020).

4.3.2 Bus and coach

Buses are referred to as a transport used in urban and avenues roads in Central Finland. Urban bus emissions were considered for distances up to 50 km, whereas avenue driven bus emissions were used for distances up to 100 km. Coach emissions were input when the distance was greater than 100 km. The emission indicators of bus and coach were based on diesel engine from Lipasto dataset (2017) as 98% of the buses in Finland run on diesel engines (Finnish transport and communications agency Traficom, 2020). More importantly, the g/pkm CO_2-eq was selected from Lipasto dataset (2017) as it was assumed that buses were half loaded with 18 passengers.

4.3.3 Long-distance train

In Finland, the rail transport is operated by Finnish Railways (VR) which is a stated-owned company. According to Baumeister (2019), the most common train is Intercity which runs fully on electricity supplied from hydropower. Due to its frequent use, this train type was considered in this study. The electricity consumption and emissions of electricity produced such as CO_2 and CH_4 were taken from Baumeister et al. (2020) in Table 2. N_2O was left out simply because the emissions are relatively small in boreal regions like Finland (Hertwich, 2013).

4.3.4 Aircraft

The travel survey collected travels of which were not reported to the University by PhD students and grant researchers. Therefore, the emissions for aircraft were divided depending upon the traveling type: short haul (less than 785 km), medium haul (785-3700 km) and long haul (greater than 3700km). This classification was taken from CWT as well as their respective CO_2-eq emissions. With this data, the participants were requested to fill the number of trips in a year. In addition to this, it was assumed that all the unreported trips were economy class.

4.3.5 Ferry

Table 2 shows CO_2-eq emissions for passenger ferry. The number was taken from the Lipasto dataset (2017), and therefore, it gives 80% of the emissions to passengers and 20% to freight. This study considered gas-driven ferry with a capacity of 2800 passenger which operates at an average speed of 18 knots (Technical Research Center of Finland (VTT), 2017).

4.3.6 Moped

Moped's CO_2-eq was extracted directly from Lipasto dataset (2017). The dataset provided an average CO_2-eq emission. The calculation used such number for all mopeds of the survey.

4.3.7 Bicycle

There were two types of bicycles: conventional bike and electric bike (e-bike). Conventional bikes were regarded with 0 emissions because it was understood that bikes do not require any sort of energy during its use. E-bikes, on the other hand, require energy, however, e-bikes were also designated to have with 0 emissions because e-bikes do not release emissions during its use.

4.3.8 Walking

Walking received the same CO_2-eq as bicycles. The reason was because it was assumed that walking requires 0 energy from fossil fuels.

5 RESEARCH FINDINGS

In this chapter, the findings are first explained generally to describe the type of respondents. Then, the chapter is divided into 3 sections: commuting travels, long-distance leisure travels, and unreported business travels. After this, the last sub-chapter shows the sum of all the emissions shown to calculate the total carbon footprint per person. To conclude, an estimation carbon footprint of the total number of students and personnel travels of the University is shown in the last section of this chapter.

5.1 Findings

The survey collected 1,913 responses of which 1,071 belong to students, 652 to personnel, 169 to PhD students and 21 to grant researchers. These figures represent a 12% response rate from the total number of students and employees of the University of Jyväskylä. The majority of the responses belong to the Finnish survey with 1765 responses and 147 from the English survey. Female respondents represented the largest share with 66.96%, males with 30.06%, 1.93% preferred not to say their gender and other genders represented 1.05%. The age of the respondents was divided into 6 groups shown in Table 3 below with their respective share.

Table 3. Share of respondents by age group

Age	Share of respondents
18-24	28.91%
25-34	31.94%
35-44	16.68%
45-54	11.34%
55-64	9.72%
65 and older	0.78%
Prefer not to say	0.63%

5.1.1 Commuting travels

The four groups (students, personnel, PhD students and grant researchers) commuted 6.1 million kilometers in a year. Personnel traveled 3.1 million kilometers in a year, students 2.4 million kilometers, PhD students 441 thousand kilometers and grant researchers 43 thousand kilometers. The annual average distance traveled was 2,962 km per student, 3,777 km per University employee, 2,611 km per PhD student and 2,076 km per grant researcher. The daily average distance traveled was 9.2 km per student, 11.7 km per University employee, 8.1 km per PhD student and 6.4 km per grant researcher.

The data demonstrates in Table 4 that bicycles are the dominant vehicle among students, PhD students and grant researchers and foot represented the second most dominant among students. In contrast to that, car was the most popular mode in the personnel group. Table 4 below shows the rest of vehicles by the four groups.

Table 4. Share of commuting transport mode by University groups

Share of transport modes								
	Bicycle	Foot	Car	Bus	Train	E-bike	Other	Moped
Personnel	9.51%	6.33%	13%	2.93%	0.89%	0.84%	0.52%	0.05%
Students	27.3%	16.68%	4.6%	4.86%	2.04%	0.20%	0.31%	0.00%
PhD students	4%	1.67%	1.4%	0.78%	0.52%	0.16%	0.21%	0.00%
Grant researchers	0.42%	0.26%	0.10%	0.05%	0.26%	0.00%	0.00%	0.00%
Total %	41.3%	24.94%	19.1%	8.62%	3.71%	1.20%	1.04%	0.05%

With the distance and transport modes described, the data can be converted into emissions produced for commuting travels. Figure 5 depicts the annual emission results of the four groups.

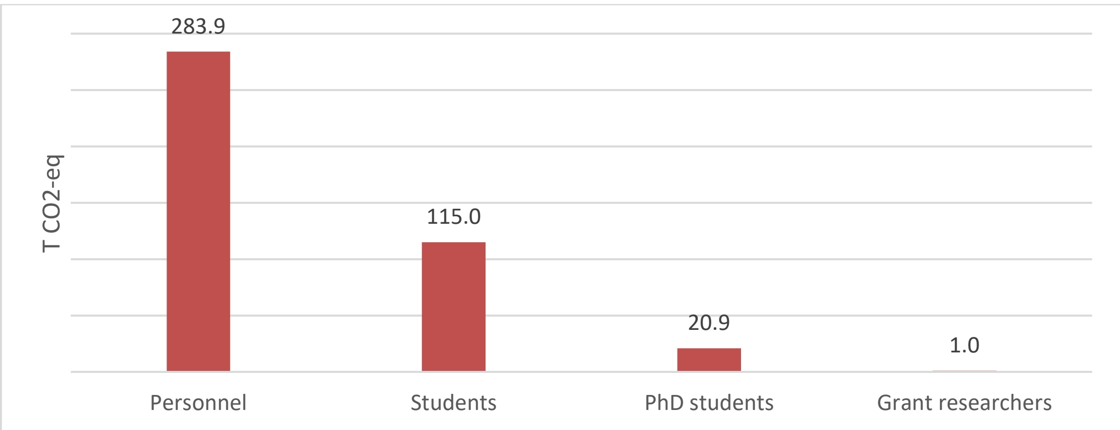

Figure 5. Annual commuting emissions of University members

The total annual commuting emission production was 420.8 t CO_2-eq while average commuting per capita is 0.22 t CO_2-eq. However, the data allowed to distribute the emission production per capita per group. Table 5 shows in summary the data from commuting divided by the groups, their respective emissions and emissions per capita. Furthermore, Table 6 below shows the share of emissions of the three most important transport emitters from each group. Table 6 shows that car plays a dominant role in the four groups.

Table 5. Distribution of emissions from commuting travels for personnel, students, PhD student and Grant researcher of the University

	Number of people	**t CO_2-eq**	**t CO_2-eq per capita**
Personnel	652	283.9	0.44
Student	1071	115.0	0.11
PhD student	169	20.9	0.12
Grant researcher	21	1.0	0.05
Total	1913	420.8	0.22

Table 6. Share of emission production per group per transport mode

Personnel	Car	Bus	Other	Total share of emission
	59.7%	6.1%	0.9%	67.4%
Students	Car	Bus	Train	Total
	21.1%	4.6%	1.5%	27.3%
PhD students	Car	Bus	Train	Total
	3.8%	0.9%	0.1%	4.9%
Grant researchers	Car	Bus	Train	Total
	0.12%	0.07%	0.04%	0.24%

The data can be extrapolated further. Figure 6 below depicts this as commuting emissions per respondents’ faculty.

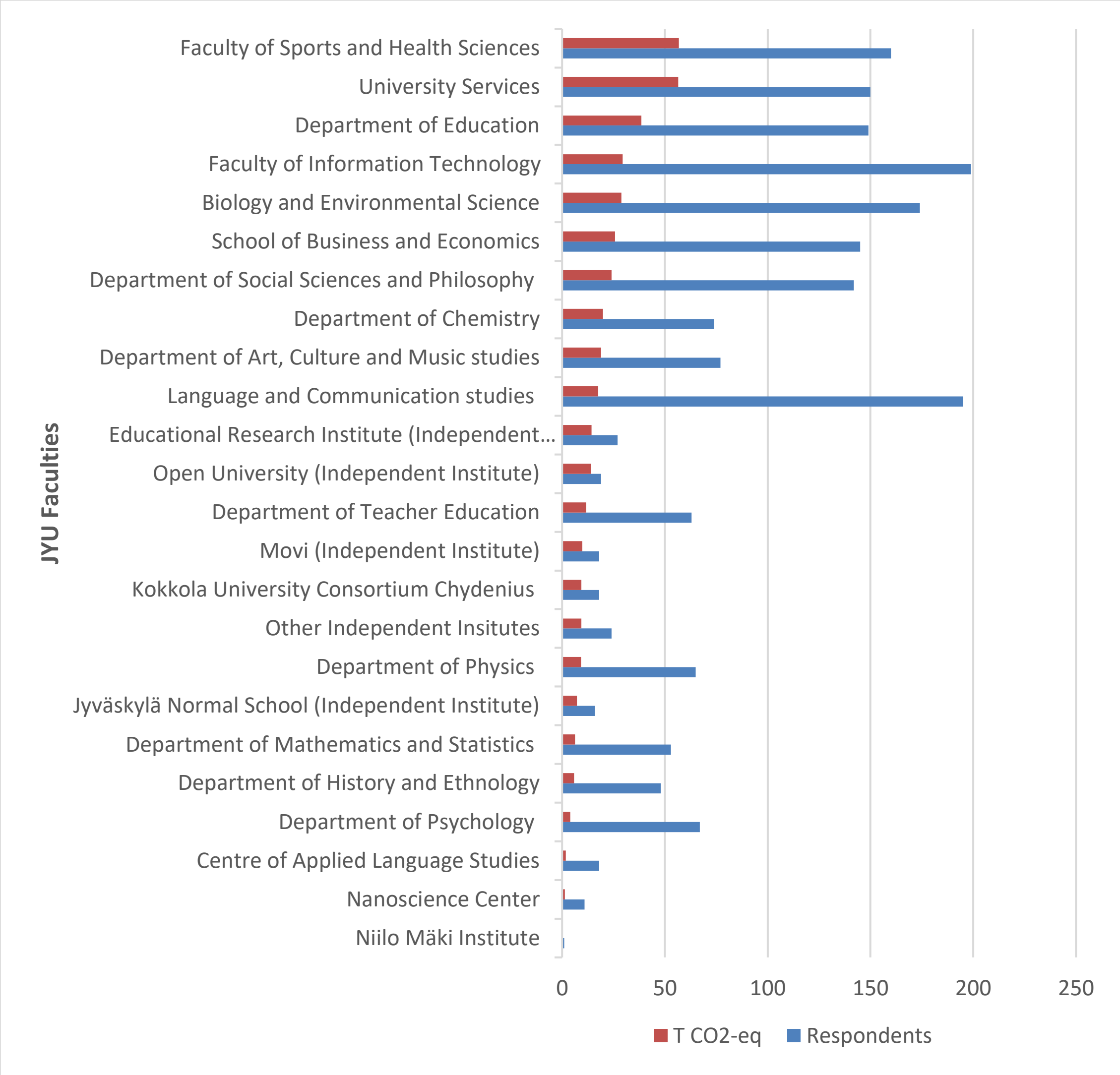

Figure 6. Annual commuting emissions produced per faculty member

Figure 6 shows the number of respondents, their respective faculties and the commuting emissions produced. The Faculty of Sports and Health Sciences represented 8.36% of the total respondents from the survey which produced 13.5% of the total annual CO_2-eq. University Services represented 7.84% of the respondents and produced 13.44% of the total annual CO_2-eq. The Department of Education had 7.79% of respondents which produced 9.18% of the total annual emissions.

The survey allowed even deeper analysis of groups into emissions by job title. Figure 7 shows the University personnel title with their respective emissions produced.

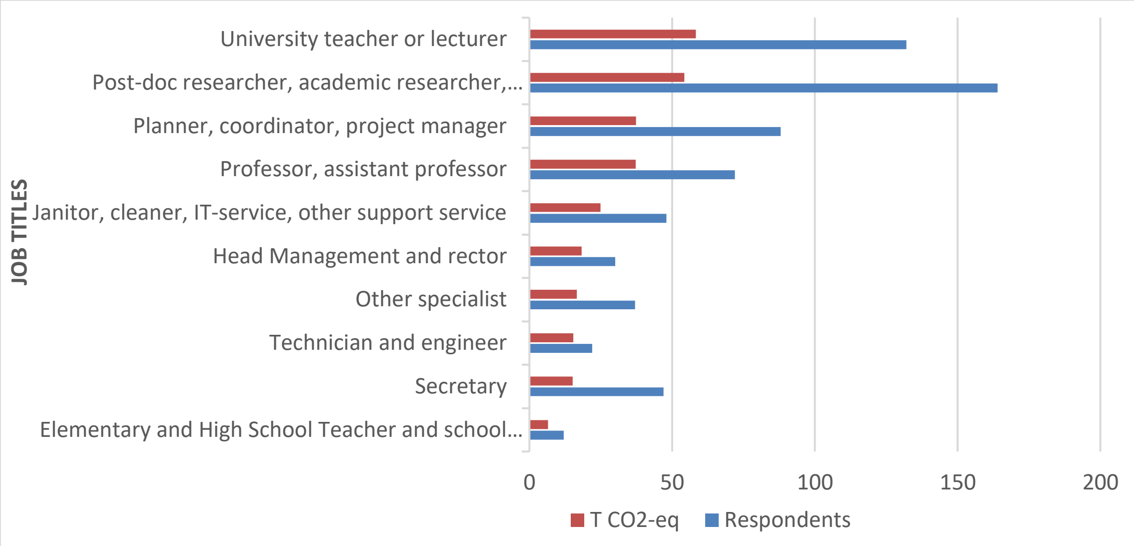

Figure 7. Annual emission of personnel by job title

Figure 7 shows that University teacher or lecturer group represented 20% of the personnel group that produced 20.5% of the total CO_2-eq emissions. Post-doc researcher, academic researcher group represented the second group with 25% and produced 19% of the total CO_2-eq emissions. Planner, coordinator, project manager group represented 13.5% which produced 13% of the CO_2-eq emissions from the personnel group. However, when analyzing the annual emission per person divided by job tittle, Figure 8 depicts the results from the personnel group. Figure 8 shows that technicians and engineer (0.7 t CO_2-eq), head management and rector (0.61 t CO_2-eq) and elementary and high school teacher (0.54 t CO_2-eq) groups produced most of the CO_2-eq emissions per person.

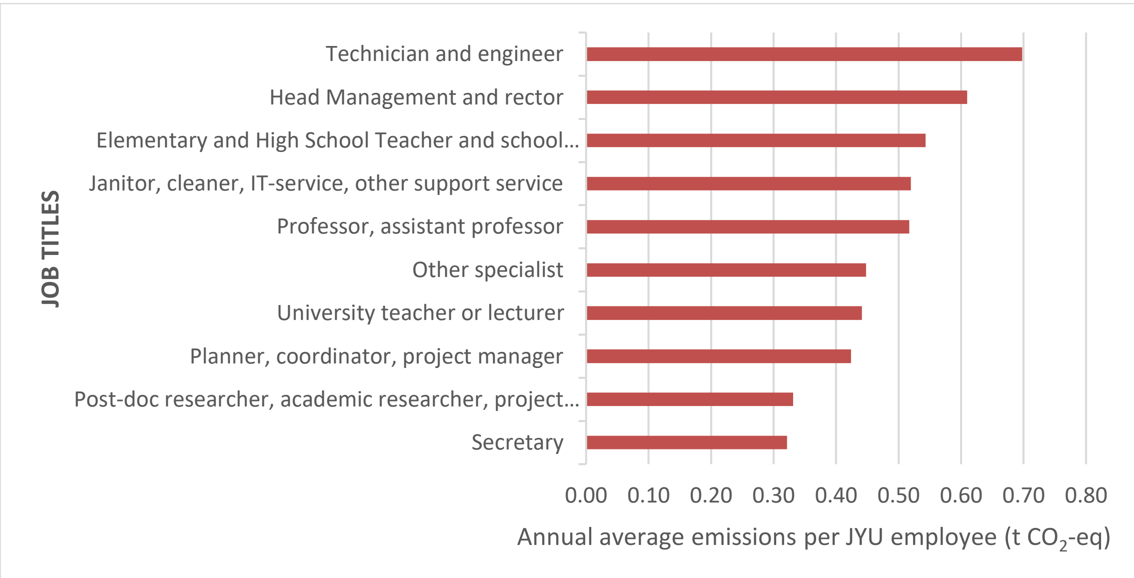

Figure 8. Annual average emissions per University employee

5.1.2 Long-distance leisure travels

In the survey, the University personnel was asked whether they live in cities other than Jyväskylä for work or family purposes. In this section, the survey collected 47 responses. The calculation discovered that the respondents traveled 1.4 million kilometers for a year. The average distance per person was 30,520 km. Bus represented the biggest share of transport with 36.1%. Train was the second with 29.7%, while car share was 23.4%. This resulted in 42.83 t CO_2-eq emissions per year with an average of 0.91 t CO_2-eq per employee per year. The total emission production is divided according to the transport modes used by the participants in Figure 9 below.

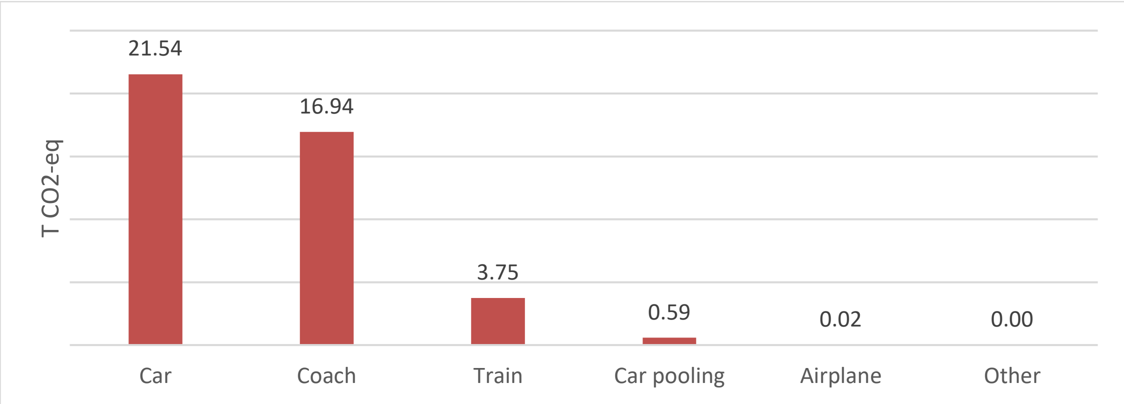

Figure 9. Annual long-distance trips of personnel by transport mode

Figure 9 shows that cars produced 50.28% of the total annual personnel long-distance leisure travels emission, coaches represented 39.55% and trains 8.7%. In another section of the survey, students were asked whether they travel for other reasons rather than study purposes. This section collected 687 answers. The result showed that students traveled 4 million kilometers in a year and an average distance of 5,936 km per student per year. Figure 10 depicts the breakdown of this group's long-distance leisure travels by transport modes.

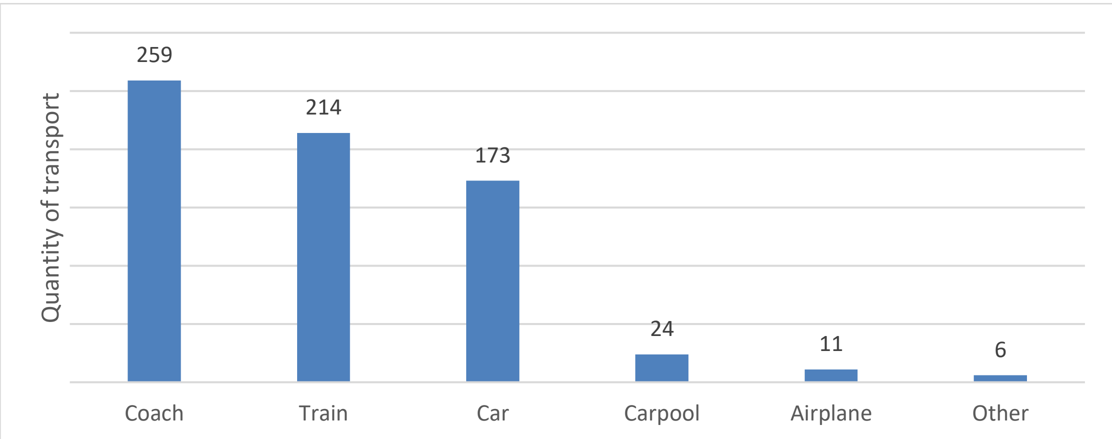

Figure 10. Annual long-distance student trips by transport mode

Figure 10 demonstrates that coaches represented 37.7% of the total the student's long-distance leisure travels while trains represented 31.1% and cars 25.1%. In total, this represented 221.6 t CO_2-eq emissions with an average of 0.3 t CO_2-eq emissions per student per year. Figure 11 shows the breakdown of this total emissions produced by transport modes. Figure 11 below shows that cars produced 60.8% of the total annual emissions, buses were the second transport as it produced 24.8% while carpooling represented 7.2%.

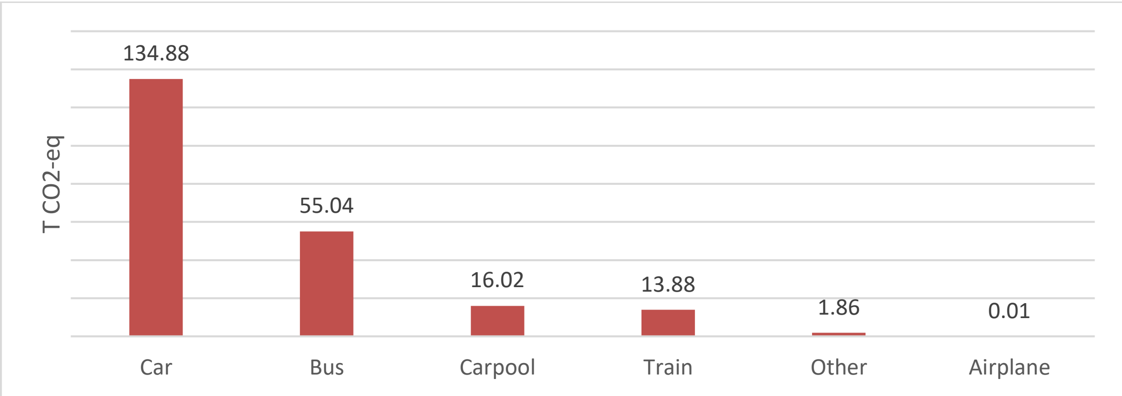

Figure 11. Annual long-distance student trips - Emissions per transport mode

5.1.3 Unreported business travels

In this section of the survey, PhD students and Grant researchers were asked whether they report their business travels to the University or not. This section was meant to collect information based on unreported business trips. The travel survey collected 60 answers. The total annual emissions production was 28.7 t CO_2-eq of which the average per person was 0.4 t CO_2-eq. Figure 12 depicts the emissions per transport type of this group. Figure 12 shows that cars represented 44% of the total emissions produced with 12.4 t CO_2-eq while airplanes produced 49% with 14 t CO_2-eq emissions. However, when dividing the airplane types, continental produced 31% of the emissions while intercontinental produced 12% and domestic 6%. Figure 12 shows that continental type had 47 flights during a year while intercontinental and domestic flight had 13 in each of them.

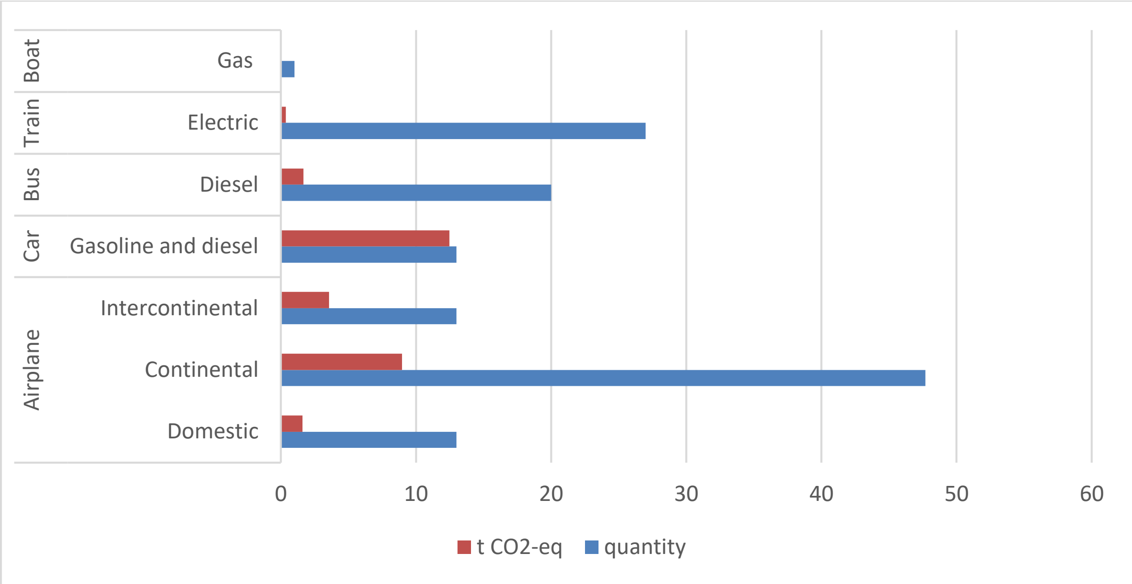

Figure 12. Total emissions and quantity of unreported business travels

5.1.4 Total transport and mobility emissions of the University

When the 3 travel types are calculated, this proceeded to calculate the total emissions of students and personnel based on the travel survey. Hence, students, PhD and grant researchers produced 387.2 t CO_2-eq while University personnel 326.7 t CO_2-eq. Altogether this total 714.03 t CO_2-eq for a year. The annual average emissions produced per student was 0.3 t CO_2-eq and 0.5 t CO_2-eq per University employee. Figure 13 depicts the breakdown of the emissions production by travel type.

Figure 13 depicts the two groups, students and personnel, and two travel types, commuting and long-distance leisure travels, to show the total annual emission production. As such, the student group represents 54% of the total annual travel emission production of which 19% belongs to commuting travels and 35% to long-distance leisure travels. University employees represented 46% of the total emission production. 40% belongs to commuting travels and 6% to long-distance leisure travels.

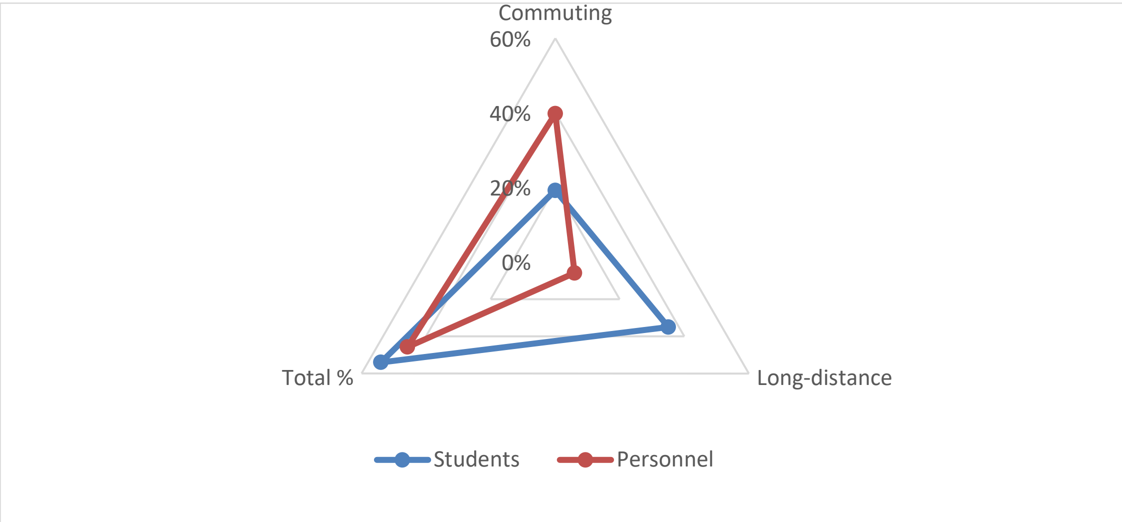

Figure 13. Annual share of emission production per group

In order to analyze the share of emission per travel type, Figure 14 compares the share of emissions per travel type. 67% of the commuting emission belong to the personnel group while 33% to students. In contrast to that, long-distance travel emissions show that 85% are derived from students' long-distance leisure travels while 15% to personnel group.

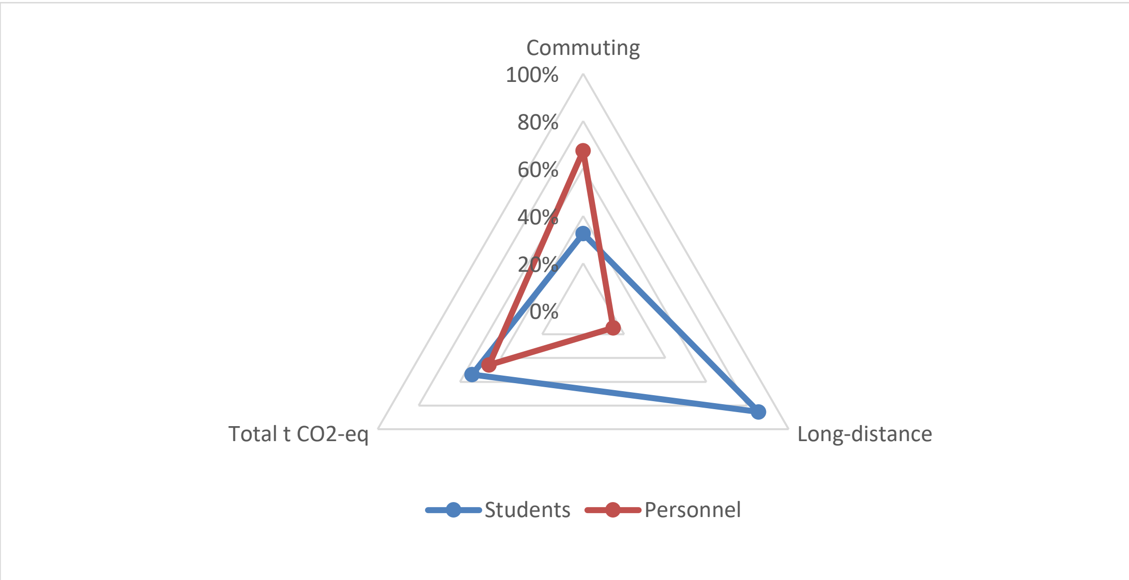

Figure 14. Annual share of emission production per travel type

Having calculated the total emissions of the participants based on the travel and mobility survey, the data can be extrapolated to form an aggregate figure for the entire University. The total number of University students produced 3,930.6 t CO_2-eq emissions per year while the personnel produced 1,363 t CO_2-eq emissions for personnel per year. Hence, the CO_2-eq emission production of the University based on commuting, long-distance leisure travels, and unreported business trips was 5,293.7 t CO_2-eq emissions per year.

6 DISCUSSION AND CONCLUSIONS

In this chapter, the results of the study are discussed based on the literature in order to find potential emission reduction actions which the University of Jyväskylä could consider. Also, implications of the study and limitations and further research are discussed. Prior to that, this chapter starts by answering the research question.

6.1 Answering the research question

The purpose of this Master's Thesis was to measure indirect travel impacts: commuting and long-distance leisure travels of students and personnel and unreported business travels of PhD students and Grant researchers of the University of Jyväskylä through consumption-based carbon footprint calculation. The focus was to find out the transport and mobility emissions through transport modes and distances of the students and personnel. The research question of this Master's Thesis was: What is the transport and mobility carbon footprint of personnel and students of the University of Jyväskylä? This was followed by sub-questions: What are the transport modes used to commute, for long-distance leisure travels of personnel and students and for unreported business travels of PhD students and Grant researchers? What are the total emissions of these? What is the total estimated carbon footprint of transport and mobility of personnel and students of the University?

The three most popular commuting transport modes used to the University were bicycle, foot, and car. Bicycle and foot were considered as low-carbon transport whereas cars produced 84.8% of the emissions (357 t CO_2-eq) from the commuting travels. Long-distance leisure travels of students and personnel presented coach, train, and car as the most common transport. However, personnel long-distance leisure travels produced 50% (21.5 t CO_2-eq) of the emissions from car use whereas students' most popular long-distance leisure travel mode was coach, but cars produced 60% of the emissions (134.8 t CO_2-eq). The most popular transport from unreported business travels of PhD students and Grant researchers was airplane as it produced 49% of the emissions (14 t CO_2-eq) while car was the second as it produced 44% of the emissions from this group (12.4 t CO_2-eq).

Based on the consumption-based carbon footprint calculation of the survey, the results showed that students produced 387.2 t CO_2-eq annually with an average of 0.3 t CO_2-eq emissions per student while personnel produced 326.7 t CO_2-eq and 0.5 t CO_2-eq emissions per employee per year. Altogether, this formed a total of 714.03 t CO_2-eq annual emission based on the survey. Personnel commuting travel emissions represented 40% from the total result. The majority of these emissions were derived from car use (59.7%). Students' long-distance travels represented the second largest emitter group as it represents 35% of the total emissions. Cars are the main contributor of these emissions with 60% share of the total students' long-distance travel emissions.

Based on the results from the survey, the total aggregated emissions produced of University students is 3,930.6 t CO_2-eq emissions per year while personnel aggregated emissions is 1,363 t CO_2-eq per year. These result in a total of 5,293 t CO_2-eq emissions of indirect transport and mobility impacts of the University of Jyväskylä.

6.2 Implications of findings and comparisons to existing literature

This study contributes to the existing literature presented to shed light on indirect transport impacts. Carbon footprint of indirect transport has become an important study particularly within higher education institutions. Consumption-based carbon footprint method provided an estimation of the emissions produced in the past and present in order to be aware of the emissions consumed. Scopes 1, 2 and 3 are helpful in classifying and deciding what to include in the carbon footprint calculation. However, the inclusion of scope 3 from indirect transport presented substantial amount of emissions. In this regard, transport impacts have been studied in different parts of the world (Baumeister, 2019; Caponio et al., 2015; Cole-Hunter et al., 2015; van Goeverden et al., 2016; Wiersma, 2020) to identify the emission growth to mitigate them. Several higher education institutions have carried out studies to identify the transport hotspots in universities. The study of the University of Leon in Spain (Pérez-Neira et al., 2020), the study of Ciers et al. (2018) at Swiss Federal Institute of Technology Lausanne and the study of academic and student mobility at Montreal University (Arsenault et al., 2019) are some examples. Hence, this Master's Thesis forms part of the existing research studies to demonstrate the impact of indirect transport at a university in Finland.

The findings of this thesis help discover the impacts of indirect transport emissions at the University of Jyväskylä (JYU) as well as to shed light on other related travels like leisure travels of students and personnel. The literature described the main contributors to the transport emission growth in different studies as it mentioned that airplane and car use produce most of the emissions from transport (Aamaas et al., 2013; Baumeister, 2019; Caponio et al., 2015; H. Wang & Zeng, 2019). The findings of this thesis showed that car users increase 84.8% of the commuting emissions and 57.5% of the long-distance travels even when the share of car use remains 19.1% from commuting travels and 25% from long-distance leisure travels. In contrast to that, the findings show that airplane emissions produce 4% from the long-distance travels. The reason for this was due to the little use of airplanes from long-distance leisure travels and unreported business trips. However, the results of unreported business travels can differ from business travels of the University as air travels tend to be the dominant factor in terms of long-distance travels.

Further, the findings revealed that University personnel produced more emissions despite being a smaller group in comparison to the student group. This was probably because personnel presented a higher propensity for car use as 13% were car users even though their daily average commuting distance was 11.7 km compared to students which was 9.2 km average per day. As a result, 59.7% of the commuting emissions of personnel were produced by car use. In comparison, the findings showed that students produce 48% less emissions from commuting trips compared to personnel due to their propensity to use bicycle (31.7%) and walking (18.4%). In this regard, the share of car use within the student group was 6.1% which generated 25% of the commuting emissions. Yet, the findings showed that personnel produced most of the commuting travel emissions as an employee produced three times more emissions compared to a student.

When analyzing the findings based on the emission production from the University Faculties, the results showed that the emission production does not necessarily relate to the quantity of respondents per faculty, but rather to the transport selection of the respondents which produce emissions. Hence, it could be said that the quantity of people traveling do not impact the emission growth as long as low-carbon transport options are selected.

The literature addressed that infrastructure, and the built environment impacts the emissions from transport (Barros et al., 2018; Cole-Hunter et al., 2015; Minn, 2019). Even though these aspects form part of demographic factors, this thesis did not concentrate on such aspects. Interestingly, socioeconomic factors were not discussed in the literature, however, the findings allowed to discover the emissions of personnel by job tittle and position. Although the study is consumption-based per job position, the findings allowed to differentiate emissions from personnel based on the job title. These results could offer a different insight related to the study of Bekaroo et al. (2019), which state that higher income turns into higher carbon footprint. Wang & Zeng (2019) support Bekaroo's concept as socioeconomic factors are associated with overall emissions. When analyzing the emissions results of personnel and the job position, the average emissions per person per job title showed variations of emissions produced against various job position. Yet, this study lacks data to prove whether socioeconomic factors increase transport emissions of personnel.

The results of the University transport survey (Mobinet, 2015) showed that car users have remained the largest commuting emitting group even though the emissions per employee were two times smaller in 2015 compared to the results of this thesis. Since that time, the emission production per employee has increased in five years. This could be attributed to the creation of jobs, development, and ability to purchase car or travel.

The findings of long-distance leisure travels of this thesis revealed that even though car was not the most popular transport mode, it generated most of the emissions. Car generated 50% of the emissions from long-distance leisure travels of personnel and 60.8% from student long-distance leisure travels. These results and the results from unreported business trips proved that cars and airplanes are the main emission contributors as most of the emissions from this group stem from the use of airplanes and cars. Thus, this study appears to be correct based on the literature reviewed as it is said that air and car travel are among the top emission contributors of long-distance travels (Aamaas et al., 2013; Baumeister, 2019).

The findings from long-distance leisure travels also showed that personnel and students used other transport options like coach and trains. The results showed that coach generated 39.5% of the personnel emissions and 24.8% from the student group. Even though this transport mode still produces emissions, the amount cannot be compared to cars and airplanes which have higher emission rate. Similarly, the findings showed that trains were proven to be a good travel alternative as it shows that train produces low amount of emissions compared to other transport modes. The literature also addressed that such transport modes are alternative modes with the opportunity to reduce emissions due to higher capacity and lower emissions production per passenger (Baumeister, 2019; Liu et al., 2016; Minn, 2019). With these results, coach and train could be used as a substitute to cars and airplanes.

In addition to long-distance travel emissions, studying long-distance leisure travels of personnel and students may not relate entirely to the University carbon footprint. However, long-distance leisure travels still formed an interesting part of this study to evaluate and measure such travel type. The study of Edwards et al. (2016) and Dolf & Teehan (2015) provided examples where other university events, which included transportation, can have a great environmental impact. Therefore, the inclusion of long-distance leisure travels in this thesis can also be used as a study example to other universities to show the impacts of travel.

As part of the impacts, the coronavirus pandemic has caused a strong impact on transportation since 2020. Studies are still needed to evaluate the impacts of the pandemic in relation to the transport emission production. However, this study did not evaluate indirect transport during the pandemic. With that said, the emission production both during and after the pandemic is highly dependent on measures and polices taken to solve the emissions from transport. Governmental and organizational policies and decisions can have a great impact. However, it should be noted that this study lacks literature to support this topic.

The findings of this thesis allow the results to be compared with other universities' results to evaluate the results of this thesis. De Montfort University calculated commuting emissions of students and personnel and represented the largest travel group 18% of which 52% of the emissions originated from the use of car with single occupancy (Ozawa-Meida et al., 2013). However, when evaluating the annual emission per person, De Montfort University produced 0.3 t CO_2-eq emissions per person from commuting travels while the University of Jyväskylä produced 0.2 t CO_2-eq per person. Another similar study at Clemson University, in the United States, studied indirect impacts (Clabeaux et al., 2020).

The study showed that commuting travels produced 19% of the total University's carbon footprint which is equivalent to 0.7 t CO_2-eq emissions per person per year (Clabeaux et al., 2020). The study of the American university showed that a person produced five times more emissions versus a person at JYU. The reason of this is due to the larger number of people using cars to travel to the university.

In contrast, the University of Montreal's (Arsenault et al., 2019) findings allowed the comparison between their students' international and exchange travels with this thesis's long-distance travel figures. International and exchange students generated 3.8 t CO_2-eq per student per year (Arsenault et al., 2019) while JYU students' long-distance travels produced 0.3 t CO_2-eq per student per year. However, the results of the Canadian university (2019) are not comparable with long-distance leisure travels of this thesis in terms of university size, number of international students traveling abroad by airplane and larger scope like the inclusion of exchange students in the calculation.

The study results of Alvarez et al. (2014), Ciers et al. (2018), Gómez et al. (2016) and Larsen et al. (2013) in which indirect transport is studied within universities cannot be compared with the results of this thesis. The studies focused only on business travels and academic travels such as attending conferences. Also, the study of Alvarez et al. (2014) and Gómez et al. (2016) used a different method to evaluate the university carbon footprint. Financial compound methods are said to evaluate emissions from where financial accounts are available (Alvarez et al., 2014). However, there are many emission sources that cannot be accounted with this method as often the cost of an emission source is low, but its carbon density could be high (Kulkarni, 2019) as well as lack of transport data (Gómez et al., 2016). Thus, these drawbacks provide a different emission results which are reflected on the study of Alvarez et al. (2014) and Gómez et al. (2016) forcing certain travel types out of the scope of the study.

The results of the University of Turku (University Properties of Finland, 2020) allow the direct comparison of emissions from personal of which Turku University's personnel produced three times less emissions per person per year than JYU personnel. However, the calculation of the University of Turku differed from the calculation of this thesis such as working days per year were less than the working days from this thesis. More working days equates to an increase in emissions from commuting travels.

The study of Pérez-Neira et al. (2020) showed commuting travel calculations of the University of Leon in Spain. They found transport by car to be important as cars produced 95% of the total travel emissions (Pérez-Neira et al., 2020). In comparison to that study, the findings of this thesis showed that car was among the top three most popular transport modes and produced 84% of the commuting emissions. More importantly, University of Leon produced 0.4 t CO_2-eq per capita per year (Pérez-Neira et al., 2020) double than JYU commuting per capita (0.2 t CO_2-eq). The study of Perez-Neira et al. (2020) showed that car users presented a higher average of kilometers which increase the transport emissions.

Additionally, personnel of the University of Leon represented low use of bicycle and bus unlike personnel from JYU which used bicycle and foot to commute.

Another study from the Autonomous Metropolitan University, in Mexico, studied indirect transport of the Cuajimalpa campus of which commuting produced 1 t CO_2-eq emissions per capita per year (Mendoza-Flores et al., 2019). The Mexican university produced eight times more emissions from commuting compared to JYU commuting per capita (0.2 t CO_2-eq) even though the Mexican university has less people compared to JYU. In another study, the University of Talca, in Chile, compared commuting travels of personnel and students (Yañez et al., 2020). The study of Yañez et al. (2020) showed that personnel produced three times less emission per capita than a JYU employee whereas Talca students produced double emissions per capita than a JYU student. Having a smaller number of people involved, the University of Talca campus produced more emissions per person than the University of Jyväskylä.

The University of Technology – Parana in Brazil (Barros et al., 2018) showed that commuting emissions resulted in 1.4 t CO2-eq of the University. The results of the Brazilian university cannot be compared to this thesis study based on the emission production as emissions are much lower due to the smaller number of students and staff involved in the Brazilian University. However, the study of Barros et al. (2018) showed that most of the emissions originate by car use from the university's personnel whereas students' emission presented a low emission contribution as many traveled by bus. When comparing students and personnel, traveling by bus presents opportunities to decrease the carbon footprint from commuting travels.

Therefore, comparing the results of this thesis with other university studies demonstrate that students form part of the university's carbon footprint as emission are produced while traveling. More importantly, the results of the studies of Pérez-Neira et al. (2020), Barros et al. (2018), Mendoza-Flores et al. (2019) and this thesis show that studying the transport behavior of students could be used as an example for university personnel in order to switch to alternative transport modes such as bus, bicycle, walking and foot in urban areas. Yañez et al. (2020) showed that students can also produce a substantial amount of emissions which should be measured and reduced.

Other studies based on indirect transport in universities overlook the impact of students or certain indirect travels. For instance, the University of Turku (University Properties of Finland, 2020) calculated only personnel commuting and business travel. Similarly, a college in India only included transport impacts of personnel and educational trips within the institution carbon footprint (Kulkarni, 2019). In contrast, an engineering education in India included transport impacts of personnel and students even though these impacts were placed as direct impacts as the fleet is controlled by the institution (Sivaram et al., 2015). Interestingly, the emission per capita of the latter study is 0.2 t CO_2-eq per year similar as the commuting emissions per capita from JYU.

Other universities studies did not include commuting travels as part as the indirect travel impacts (Alvarez et al., 2014; Gómez et al., 2016; Larsen et al., 2013).

These limits depend on what the university includes in its calculation as Alvarez et al. (2014) and Larsen et al. (2013) consider that personnel and students' commuting travels are not part of the university control. However, the level of control could be debatable as universities can be considered to impact the travel emission growth due to their role as job and education providers (Bekaroo et al., 2019; Guerrieri et al., 2019; Robinson et al., 2018) which make people to travel. Universities could be seen as an example to society, therefore, including commuting, and long-distance travels can be seen as an example of commitment to the environment. Additionally, the studies of Ozawa-Meida et al. (2013), Arsenault et al. (2019) and Clabeaux et al. (2020) included indirect transport impacts as part of the university carbon footprint which is similar with the objectives of this thesis. Thus, this thesis supports previous studies and could be used to support future studies with similar objectives.

The literature addressed the use of bicycles, e-bikes and walking modes to support low-carbon alternatives (Astegiano et al., 2019; Cole-Hunter et al., 2015; Okraszewska et al., 2017; Pérez-Neira et al., 2020; Wiersma, 2020). The literature evaluated ways to support commuting travels using such modes for short distances (Giles-Corti et al., 2016; Jiang et al., 2017). The study of Pérez-Neira et al. (2020) proved that bicycle and foot can be used to cover short distances. The findings of this thesis seem to be correct because it is aligned with the literature reviewed as students proved to be a group with active mobility habits by using bicycle and walking to travel short distances. Based on the findings, bicycle and walking are proven modes that can potentially decrease the indirect travel emissions of the University of Jyväskylä. This means that such modes could be leverages as substitutes in urban areas while also enhancing physical activity.

For universities, calculating indirect transport carbon footprint provides a comprehensive understanding of the hotspots from an organizational point of view. Calculating emissions based on consumption from end-users could be considered a useful way to allocate indirect emissions from transport as well as help plan strategies related to carbon management to identify the main emission contributors. Regardless of the difficulty to allocate resources and double counting, the University of Jyväskylä forms part of society, therefore, it shall demonstrate good practices and knowledge. This is why all possible emissions are vital to provide knowledge and solutions. The University could thereby consider future opportunities to compensate for the emissions produced from transport as well as support low-carbon transport modes.

6.3 Mitigation and possible solutions

Throughout this study, it was noted that emissions from individuals grow based on the transport selection and distances. Therefore, the study could be analyzed from an individual or organizational point of view. Responsibility lays on individuals who make decisions and transport selection and on the local government that provides arrangements, services, infrastructure, among other services. Changes should be made from individuals, organizations and government. But because a Finnish university is a public institution, changes at the University of Jyväskylä could have a strong impact on people's behaviors and actions.

In relation to higher education institutions and sustainability, universities could streamline the concept of ''Green University''. The concept could support the idea of responsible behavior to create healthy environmental habits to showcase this to students and personnel of the University. According to Pérez-Neira et al. (2020), universities have the privilege to create knowledge and encourage others for a change. In addition to that, Guerrieri et al. (2019) state that the transition towards a low-carbon future requires a set of policy frameworks to support such development. This concept could enable new behavioral changes and decisions in people.

Green University concept can be spread in the university system in order to reach external community as often universities are interconnected with local community (Gómez et al., 2016). The concept can be aligned with carbon management of the University to show commitment to the environment with responsible behavior (Mendoza-Flores et al., 2019). Sustainability should be incorporated into the university activities such as education, planning, investments, traveling and purchases to educate sustainability leaders (Gómez et al., 2016).

Alongside that, low-carbon initiatives and transport development could support this concept in order to showcase the utilization of low-carbon options. To stimulate this behavioral change, soft policies could be used to show alternative transport modes. Soft policies have been studied in a practical way to stimulate the behavior of people (Dio et al., 2020) which could help reflect on the commuting and long-distance transport selection. For instance, promoting the environmental benefits of using low-carbon transport in media to decrease the use of combustion fuels when commuting and traveling. Promoting the use of bicycle and walk to commute could be connected to people's health as it considered a way to improve physical fitness (Cole-Hunter et al., 2015) and it could make people reflect on their physical activity. Promoting the environmental benefits of trains and buses in media to travel long distances could make people reflect on their decisions as well.

As car is one of the major emission contributors, some solutions could be offered. Capacity could be optimized to decrease the emissions and divide it by the passengers in the car. In this way, the emissions would decrease by passenger travel kilometer. This idea could be implemented within short and long-distance travels. For instance, people who live close to each other could commute together in a single car. The University could support the initiative by providing platforms to exchange and disseminate information as well as offer meeting points in the campuses. To reduce the number of cars within urban areas, the University could also offer rental bikes. The bikes can be given to students, exchange students or visitors for the duration of their stay.

Promoting the use of sustainable mobility is meant to bring major environmental benefits by reducing the use of cars and switching to bicycle, walk or e-bike to commute having produced 0 emissions from combustion fuels. Also, promoting train as long distance travel mode is beneficial as a train produces 95% less emissions than an average gasoline-driven car based on the emission factors. The University could give incentives to personnel using low-carbon options. For instance, the University can organize a lottery or give small prizes to personnel who commute by bicycle and travel by train instead of using car.

Similarly, the use of buses could be leveraged as a substitute mode to cars. Based on its emission factor, a bus produces roughly 65% less emissions than an average gasoline car. The use of buses could be promoted to travel within urban and suburban areas. The University could offer small incentives to those that travel by bus instead of cars. Similarly, the same idea could be applicable to coach used for long-distance travels. However, there may be a need for public incentive to improve the availability and frequency of buses in the Central region of Finland. Overall, the idea to switch to low-carbon alternatives within the urban area can be applicable as University personnel and students can potentially commute within the city of Jyväskylä with right infrastructure.

Another idea to support low-carbon transport options is the use of mobile phones applications for mobility options. Nowadays, transport options are shown in various mobile applications (Guerrieri et al., 2019) but such applications are continuously developed to improve mobility habits (Dio et al., 2020). The idea could be implemented to show the emissions of the transport offered in order to make people improve their mobility habits and switch to a low-carbon transport alternative. However, the ideas of promoting low-carbon transports and the use of mobile applications could only be successful when students and personnel participate in these projects. Thus, both groups can be engaged to communicate and familiarize with the campaigns.

Local government can have the possibility to strengthen these ideas. For that, University of Jyväskylä would need to cooperate with the city of Jyväskylä to receive support and build common targets to solve transport issues. The local government can help with better infrastructure, public transport and/or incentives such as tax reductions.

The lockdown during the Coronavirus pandemic demonstrated that work and study from home could be a solution to reduce emissions from transport. The University could implement remote work and online classes as an alternative to physical participation. This idea has the potential to reduce academic travels as avoiding travelling is a tentative solution to decrease emissions from transport (Achten et al., 2013; Burian, 2018). According to Arsenault et al. (2019), video conferences have the ability to provide networking opportunities. Also, business travels and academic travels are sometimes a necessity to enhance learning and to broaden networks. Technology ought to be used as an opportunity to break boundaries, but not necessarily as a transport replacement. The University could offer this as an alternative solution to decrease the emissions from travels that produce emissions but not to replace traveling entirely.

6.4 Limitations

This Master's Thesis gathered primary data through an online survey and received a response rate of 12%. The results and findings were limited to the response rate of students and personnel. Regardless, the data gathered was sufficient to make an estimation of the transport carbon footprint of the University of Jyväskylä.

Limitations were present when estimations were made such as the number of weeks to be included in a year. The weeks represented the number of weeks that student and employees visited the University in a year. The estimation was based on the official Finnish calendar. However, student depend highly on the frequency of classes and projects which added somewhat level of uncertainty. Similarly, employees may take work leaves during the year. Some thought could be given to the design of the survey. The emissions per passengers could smoothly be calculated using VTT dataset. However, the survey design did not allow to calculate the emissions per passenger in car due to little information which is why the calculation used an average of occupancy.

Business and academic travels were not taken into consideration in this thesis. Data had already been collected but were left out of this study due to a lack of time. Although the calculation was already made, the data required analysis and literature to support the study in this thesis. Similarly, the survey collected open questions to understand the motivations that trigger travelling. However, data was not analyzed due to a lack of time.

6.5 Ideas for further research

It is vital to carry out more research on travel impacts. Transport impacts could be connected to the energy industry. However, it is important to divide it and understand the emission production of end-users like cars, public transports, aviation too. Hence, it is important to understand the drivers that cause the need to travel. This could be analyzed with socioeconomic factors to prove whether emissions increase with higher income and better lifestyle or not. The idea could be realized using quantitative research and acquiring primary data from student and personnel of the University.

To support low-carbon transport modes, a study of the structure of the city of Jyväskylä could be carried out to understand main barriers and obstacles that take place when commuting to the University. The study could analyze the urban environment and built areas of the city in relation to the distance that people are required to travel (from home to University) in order to recognize the strengths of the urban place. The study could leverage ideas to make the travel experience smoother with the right environment to enhance the propensity to low-carbon transports such as bicycles or walking. To develop this idea, geographical information of the city is required followed by the students' and personnel home addresses.

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APPENDIX 1

Jyväskylän yliopiston työ- ja opiskeluliikenteen kysely

Tämän kyselyn tavoitteena on kartoittaa Jyväskylän yliopiston työ- ja opiskeluliikenteen ilmastopäästöjä, osana Jyväskylän yliopiston strategista tavoitetta saavuttaa hiilineutraalius vuoteen 2030 mennessä sekä aiheeseen liittyvää gradu- ja väistökirjatutkimusta. Jyväskylän yliopiston resurssiviisausyhteisön (JYU.Wisdom) toteuttama hanke kartoittaa parhaillaan yliopiston kaikkia ilmasto- ja luontohaittoja ja keinoja niiden vähentämiseen ja kompensointiin.

Tärkeä osa ilmastohaittojen laskentaa on yliopiston henkilökunnan, apurahatutkijoiden, tohtorikoulutettavien sekä opiskelijoiden liikkumistottumusten ja niistä aiheutuvien päästöjen selvittäminen. Työ- ja opiskeluliikenteeseen kuuluvat esimerkiksi matkat asunnolta yliopistolle ja takaisin. Vastatessasi kyselyyn, peilaathan liikkumistottumuksiasi "normaaliin" tilanteeseen, esimerkiksi viime vuoteen, jolloin koronapandemia ei aiheuttanut esteitä liikkuvuudelle.

Vastaamalla kyselyyn edesautat yliopiston kokonaispäästöjen arviointia ja vähentämistä sekä kyselyn pohjalta julkaistavien gradu- ja väitöskirjatutkimusten valmistumista.

Kaikilla kyselyyn vastanneilla opiskelijoilla, jatko-opiskelijoilla sekä apurahatutkijoilla on mahdollisuus voittaa viikon lounaat Semma-ravintoloihin. Viikon lounaat ovat tarjolla yhteensä kymmenelle henkilölle, lounaslippujen muodossa (5 lounaslippua per paketti). Poikkeustilanteesta huolimatta Semma Delivery myy valmiiksi pakattuja take-away annoksia seitsemässä eri pisteessä sekä Kortepohjan ylioppilaskylän ravintola Rentukassa.

Tähdellä merkityt kysymykset (*) ovat pakollisia. Kyselyyn vastaaminen vie noin 10-15 minuuttia.

Tutkimuksen rekisterinpitäjä on Jyväskylän yliopisto. Tietosuojalain mukainen tietosuojatiedote ja tietosuojailmoitus löytyvät linkkien takaa.

Mikäli sinulla on kysyttävää, olethan meihin yhteydessä.

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1.
Sukupuoli

*

- ◯ Mies
- ◯ Nainen
- ◯ Muu
- ◯ En halua sanoa

2. Mihin ikäluokkaan kuulut? *

- ◯ 18-24
- ◯ 25-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55-64
- ◯ 65 tai vanhempi
- ◯ En halua sanoa

3. Ylin suoritettu tutkinto *

- ◯ Perus- tai kansakoulu
- ◯ Ylioppilas
- ◯ Ammattitutkinto
- ◯ Kandidaatti
- ◯ Maisteri
- ◯ Tohtoritutkinto
- ◯ Muu, mikä? ____________

4.
Roolisi Jyväskylän yliopistossa

*

Valitse relevantti

- ◯ Henkilökunta
- ◯ Opiskelija (kandi- tai maisteritaso)
- ◯ Tohtoriopiskelija/koulutettava
- ◯ Apurahatutkija

5. Valitse työnkuvaasi sopiva ryhmä *

- ◯ Sihteerit
- ◯ Suunnittelijat, koordinaattorit ja projektipäälliköt
- ◯ Johtajat, päälliköt, rehtorit
- ◯ Professorit ja apulaisprofessorit
- ◯ Yliopistonopettajat ja -lehtorit
- ◯ Tutkijatohtorit, akatemiatutkijat, projektitutkijat, tutkimusavustajat ja muut tutkijat
- ◯ Teknikot ja insinöörit
- ◯ Vahtimestarit, siivoojat, IT-palvelut ja muut tukipalvelut
- ◯ Peruskoulun ja lukion opettajat sekä koulunkäynninohjaajat
- ◯ Muut asiantuntijat
- ◯ Muu, mikä? ____________________

6. Ensisijainen laitoksesi *

- ◯ Historian ja etnologian laitos
- ◯ Kieli- ja viestintätieteiden laitos
- ◯ Musiikin, taiteen ja kulttuurin tutkimuksen laitos
- ◯ Yhteiskuntatieteiden ja filosofian laitos
- ◯ Soveltavan kielentutkimuksen keskus
- ◯ Informaatioteknologian tiedekunta
- ◯ Jyväskylän yliopisto kauppakorkeakoulu
- ◯ Kasvatustieteiden laitos
- ◯ Opettajankoulutuslaitos
- ◯ Psykologian laitos
- ◯ Jyväskylän normaalikoulu
- ◯ Ihmistieteiden metodikeskus - IHME
- ◯ Monitieteinen aivotutkimuskeskus
- ◯ Liikuntatieteellinen tiedekunta
- ◯ Bio- ja ympäristötieteiden laitos
- ◯ Fysiikan laitos
- ◯ Kemian laitos
- ◯ Matematiikan ja tilastotieteen laitos
- ◯ Kiihdytinlaboratorio
- ◯ Avoimen tiedon keskus
- ◯ Kirjasto
- ◯ Tiedemuseo
- ◯ Avoin yliopisto
- ◯ Kokkolan yliopistokeskus Chydenius
- ◯ Koulutuksen tutkimuslaitos
- ◯ Monikielisen akateemisen viestinnän keskus, Movi (ent. Kielikeskus)
- ◯ Yliopistopalvelut

7. Mikä on työmatkasi pituus yhteen suuntaan? (koti-->JYU) *

Kirjoita arvio työmatkasi pituudesta kilometreinä. Peilaathan liikkumistottumuksiasi "normaaliin" tilanteeseen, esimerkiksi viime vuoteen, jolloin koronapandemia ei aiheuttanut esteitä liikkuvuudelle.

Matkan pituus (km) [ ]

8. Kuinka monta kertaa keskimäärin matkustat Jyväskylän yliopistolle viikossa? *

[ ]

9.
Mikä on ensisijainen kulkuneuvosi kulkiessasi yliopistolle?

*

- ◯ Auto
- ◯ Bussi
- ◯ Juna
- ◯ Pyörä
- ◯ Sähköpyörä
- ◯ Moottoripyörä
- ◯ Skootteri/mopo
- ◯ Kuljen jalan
- ◯ Muu, mikä? [ ]

10. Mitkä ovat merkittävimmät tekijät, joiden takia olet valinnut kyseisen kulkuneuvon?

[ ]

11. Kuinka monta henkilöä yleensä matkustaa autossasi sinun lisäksesi? *

- 0
- 1
- 2
- 3
- 4
- 5 tai enemmän

12. Valitse auton käyttövoima *

- Bensa
- Diesel
- Hybridi
- Biokaasu
- Sähkö
- Muu, mikä? ____________

13. Auton vuosimalli *

- 2000 tai vanhempi
- 2001-2004
- 2005-2008
- 2009-2013
- 2014 tai uudempi

14. Auton koko *

- Pieni
- Keskikokoinen
- Suuri

15. Auton merkki ja malli

____

16. Joudutko asumaan useamassa paikassa töiden vuoksi? *

Tämä kysymys on tarkoitettu henkilöille, jotka asuvat ainoastaan työnsä vuoksi Jyväskylässä (tai muulla paikkakunnalla, jossa on yliopiston toimintaa) ja matkustavat säännöllisesti toiselle kotipaikkakunnalle, esimeriksi perheen tai muun syyn vuoksi.

◯ Kyllä ◯ Ei

17. Kuinka monta kertaa keskimäärin matkustat toiselle kotipaikkakunnallesi viikossa? *

18. Mikä on ensisijainen kulkuneuvosi kulkiessasi toiselle kotipaikkakunnallesi? *

◯ Auto
◯ Bussi
◯ Juna
◯ Lentokone
◯ Kimppakyyti (auto)
◯ Muu, mikä?

19. Mikä on matkasi pituus yhteen suuntaan? (Jyväskylä --> koti 2) *

Kirjoita arvio matkasi pituudesta kilometreinä. Peilaathan liikkumistottumuksiasi "normaaliin" tilanteeseen, esimerkiksi viime vuoteen, jolloin koronapandemia ei aiheuttanut esteitä liikkuvuudelle.

Matkan pituus (km)

20. Matkustatko säännöllisesti toiselle kotipaikkakunnalle nähdäksesi perheesi tai muusta syystä? *

◯ Kyllä ◯ Ei

21. Kuinka monta kertaa keskimäärin vuodessa matkustat kotipaikkakunnallesi? *

22. Millä matkustat useimmiten? *

- ◯ Auto
- ◯ Bussi
- ◯ Juna
- ◯ Lentokone
- ◯ Kimppakyyti (auto)
- ◯ Muu, mikä/mitkä? ________

23. Mikä on matkasi pituus yhteen suuntaan? Jyväskylä --> kotipaikkakunnalle *

Kirjoita arvio matkasi pituudesta kilometreinä. Peilaathan liikkumistottumuksiasi "normaaliin" tilanteeseen, esimerkiksi viime vuoteen, jolloin koronapandemia ei aiheuttanut esteitä liikkuvuudelle.

Matkan pituus (km) ________

24. Raportoitko työtehtäviisi liittyvästä matkustamisesta Jyväskylän yliopistolle? *

Tämä kysymys viittaa työmatkoihin, joita joudut tekemään Jyväskylän yliopiston vuoksi. Esimerkiksi, kun matkustat konferenssiin ulkomaille.

◯ Kyllä ◯ Ei

25. Mitä kulkuvälineitä käytät työmatkoillasi ja kuinka monta kilometriä keskimäärin olet kullakin kulkuvälineellä kulkenut vuodessa?

Voit valita useamman kuin yhden vaihtoehdon. Kirjoita kulkuvälineiden perään arviosi vuotuisesta kilometrimäärästä. Huom! Arvioithan ainoastaan työmatkoihin liittyvät matkat. Lentokone-vaihtoehtoa tarkennetaan seuraavassa kysymyksessä.

- ☐ Auto ________
- ☐ Bussi ________
- ☐ Juna ________
- ☐ Laiva ________
- ☐ Lentokone
- ☐ Muu, mikä/mitkä? ________

26. Kuinka monta kotimaan, Euroopan ja kaukomaiden lentoa teet keskimäärin vuodessa työmatkoihisi liittyen?

Voit valita useamman kuin yhden vaihtoehdon. Kirjoita meno-paluu matkojen määrät numeroina.

- ☐ Kotimaan lennot
- ☐ Euroopan lennot
- ☐ Kaukomaiden lennot

27. Miten Jyväskylän yliopisto voisi tukea sinua työmatkojesi päästöjen vähentämisessä?

28. Miten Jyväskylän yliopisto voisi yleisellä tasolla vähentää työmatkaliikenteen päästöjä?

29. Tähän voit kirjoittaa yleisiä kehitysehdotuksia ja kommentteja yliopiston ilmasto- ja luontohaittojen arviointiprojektiin liittyen

30. Haluatko osallistua Semman lounaskuponkien arvontaan?

○ Kyllä ○ Ei

APPENDIX 2

University of Jyväskylä transport and mobility survey

The aim of this survey is to assess the travel and commuting activities of the students, grantees and employees of the University of Jyväskylä. The project, led by the School of Resource Wisdom - JYU.Wisdom, is currently mapping all the University's climate and biodiversity impacts to find ways to mitigate and compensate them as a part of the University's strategic goal to become carbon neutral by 2030.

Travelling and commuting is likely to be an important part of the University emissions, thus, it is important to assess the mobility habits of the university staff and students. Employee and student commuting include, for example, trips from home to University and back. Therefore, when answering this survey, please reflect on your mobility habits in a "normal" situation, such as last year, when the Coronavirus pandemic did not cause barriers to mobility.

By answering this survey, you contribute to the evaluation of the University's total emissions and to the completion of master's and doctoral theses based on this survey's results.

All students, doctoral students and grant researchers who respond to the survey will have the opportunity to win a week's lunch at Semma University restaurants. The lunch coupons are available for a total of 10 people (5 lunch tickets per package). Despite the exceptional situation, Semma delivery sells pre-packaged takeaway dishes at seven different points and at Rentukka, Kortepohja student village restaurant.

In the survey, the questions with star (*) are compulsory. The survey takes approximately 10-15 minutes to complete.

The survey controlles is the University of Jyväskylä. The research notification and privacy notice can be found through the hyperlinks.

If you have any questions, please do not hesistate to contact us.

Kind regards,

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1. Gender *

- ◯ Male
- ◯ Female
- ◯ Other
- ◯ Prefer not to say

2. Which age group do you belong to? *

- ◯ 18-24
- ◯ 25-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55-64
- ◯ 65 and older
- ◯ Prefer not to say

3. Highest education completed *

- ◯ Primary school
- ◯ High school
- ◯ Vocational school
- ◯ Bachelor's degree
- ◯ Master's degree
- ◯ Doctoral degree
- ◯ Other, please specify ____________________

4. What is your role at the University of Jyväskylä? *

Select the most relevant

- ◯ Staff
- ◯ Student (Bachelor and/or Master level)
- ◯ Doctoral student
- ◯ Grant researcher

5. Choose a group that best fits your job description *

- ◯ Secretary
- ◯ Planner, coordinator, project manager
- ◯ Director, manager, rector
- ◯ Professor, assistant professor
- ◯ University teacher or lecturer
- ◯ Post-doc researcher, academic researcher, project researcher, research assistant, other researcher
- ◯ Technician, engineer
- ◯ Janitor, cleaner, IT-service, other support service
- ◯ Primary and high school teacher, teaching assistant
- ◯ Other specialist
- ◯ Other, please specify ______

6. Select your primary department *

- ◯ Department of history and ethnology
- ◯ Department of language and communication studies
- ◯ Department of music, art and culture studies
- ◯ Centre of applied language studies
- ◯ Department of social sciences and philosophy
- ◯ Department of education
- ◯ Department of teacher education
- ◯ Department of psychology
- ◯ Jyväskylä Centre for Interdisciplinary Brain Research
- ◯ Methodology Centre for Human Sciences
- ◯ Faculty of Information Technology
- ◯ Department of biological and environmental science
- ◯ Department of physics

- ◯ Department of chemistry
- ◯ Department of mathematics and statistics
- ◯ Accelerator laboratory
- ◯ Konnevesi research station
- ◯ Faculty of Sports and Health Sciences
- ◯ Jyväskylä University School of Business and Economics
- ◯ Kokkola University Consortium Chydenius
- ◯ Finnish Institute for Educational Research
- ◯ Open University
- ◯ Centre for Multilingual Academic Communication, Movi (previous Language Centre)
- ◯ Open Science Centre
- ◯ University Library
- ◯ University Museum
- ◯ University Services

7. What is your one-way commuting distance from your home to the University? (home --> JYU) *

Please write the distance in kilometers from your residence to the University. This applies to "normal" situations. For example, from last year when the Coronavirus pandemic did not affect your mobility.

Distance (km) [ ]

8. On an average, how many times per week do you travel to the University from your home? *

[ ]

9. What is your primary transport mode when you go to the University? *

- ◯ Car
- ◯ Bus
- ◯ Train
- ◯ Bicycle
- ◯ Electric bike
- ◯ Motorcycle
- ◯ Scooter/moped
- ◯ On foot
- ◯ Other, please specify ______

10. Please explain the primary reasons for choosing that mode of transportation

______

11. How many people usually travel in your car in addition to yourself? *

- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 or more

12. Please select the fuel type of your car *

- ◯ Gasoline
- ◯ Diesel
- ◯ Hybrid
- ◯ Biogas
- ◯ Electric
- ◯ Other, please specify ______

13. Estimate the manufacturing year of your car *

- ◯ 2000 or older
- ◯ 2001-2004
- ◯ 2005-2008
- ◯ 2009-2013
- ◯ 2014 or newer

14. Select the size of your car *

- ◯ Small
- ◯ Medium
- ◯ Large

15. Please write the brand and model of your car

[ ]

16. Do you have to live in more than one place because of work? *

This questions is meant for those who, due to work and/or family, live in somewhere else than Jyväskylä and its neighboring municipalities. For example, if your family lives in another city.

◯ Yes ◯ No

17. How many times approximately do you travel to your other home weekly? *

[ ]

18. What is the primary transport mode that you use when you travel to your other home? *

- ◯ Car
- ◯ Bus
- ◯ Train
- ◯ Airplane
- ◯ Car pooling
- ◯ Other, please specify [ ]

19. What is the distance from Jyväskylä to your other home? (Jyväskylä-->other home) *

Please write the distance in kilometers. This applies to "normal" situations. For example, from last year when the Corona pandemic did not affect your mobility.

Distance (km) [ ]

20. Do you regularly travel to your home town (other than Jyväskylä) to meet your family or for other reasons? *

- ◯ Yes
- ◯ No

21. How many times approximately do you travel to your home town in a year? *

[ ]

22. What transport mode do you use the most? *

- ◯ Car
- ◯ Bus
- ◯ Train
- ◯ Airplane
- ◯ Car pooling
- ◯ Other, please specify [ ]

23. What is the distance to your hometown? Jyväskylä --> hometown *

Please write distance in kilometers from Jyväskylä to your hometown. This applies to "normal" situations. For example, from last year when the Korona pandemia did not affect your mobility.

Distance (km) [ ]

24. Do you report your business travel to the University of Jyväskylä? *

This questions refers to business travels that you conduct due to your work at the university. For instance, traveling abroad for a conference.

◯ Yes ◯ No

25. What means of transport do you use during your business travel and how many kilometers on average have you traveled with each vehicle in a year?

You can select more than one option. Write estimate in kilometers next to each transport mode. The inputs for airplane is specified in the following question. Please note that this question only applies to business-related trips.

☐ Car ________

☐ Bus ________

☐ Train ________

☐ Boat ________

☐ Airplane

☐ Other, what? ________

26. How many domestic, continental (inside Europe) and intercontinental (outside Europe) flights have you taken approximately in a year as a part of your business travel at the University of Jyväskylä?

☐ Domestic ________

☐ Continental (inside Europe) ________

☐ Intercontinental (outside Europe) ________

27. In your opinion, how could University of Jyväskylä support you to reduce your commuting emissions?

28. In your opinion, how could University of Jyväskylä reduce its emissions from commuting on a general level?

29. Here you can write any comments and ideas you might have, regarding the climate and biodiversity impact assessment project at the University

30. Would you like to participate in the lottery to win Semma lunch coupons?

◯ Yes ◯ No