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Carbon footprint of a news broadcasting organisation

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ABSTRACT

Carbon footprint analysis has been used as a well-known indicator to study the carbon dioxide emissions of organisations and productions. Although various studies and approaches are developed, none focus on news broadcasting organisations. Therefore, the carbon footprint of such organisations and carbon emission reduction strategies are not well understood. This lack of knowledge potentially undermines such organisations' sustainability and blocks their contribution to the higher level sustainability goals. To address this gap, for the first time, this study aims to explore and quantify the carbon footprint of news broadcasting organisations. The current study took Nieuwsuur, a Dutch news broadcasting organisation, as a case study. The results demonstrated that the news broadcasting organisation emits 235.28 t of CO_2eq yearly. The study categorised the CO_2 emissions into five main categories, namely: (i) travel and transport, (ii) office and studio, (iii) accommodation, (iv) materials, and (v) waste, which for each of them sub-categories have been defined and studied. Travel and transport contributed the most to the carbon footprint of such organisations. Within this category, air travel has the most significant share (27 % of total emissions), which cannot be mitigated due to the nature of news broadcasting organisations. In contrast, commuter travel and outsourced travel (together with 37.6 % of total emissions) have considerable potential for reducing carbon emissions. The following categories are office and studio, with 20.7 % of total emissions and materials, with 4.9 % of total emissions. The study recommended that working from home and outsourcing from sustainable companies are the easiest and most effective carbon reduction strategies. Other emissions reduction strategies are discussed for each category, and recommendations are provided.

1. Introduction

Carbon footprint refers to a person, product or organisation's direct or indirect carbon dioxide and other greenhouse gases (GHG) emissions (Wiedmann and Minx, 2007), which is a well-established indicator in sustainability assessments (Laurent et al., 2012). Although carbon footprint is mainly used to analyse products and processes (e.g. Chen et al., 2022, Mwambo et al., 2021), it is also used to provide insights into industry enterprises and organisations (Gao et al., 2014).

Consequently, there are different tools and standards for carbon footprint analysis developed by organisations such as the International Organisation for Standardization (ISO) (Gao et al., 2014), the World Resources Institute (WRI) (Pandey et al., 2011), the World Business Council for Sustainable Development (WBCSD) (Pandey et al., 2011) and the British Standards Institution (BSI) (Franca et al., 2021). Various studies focused on different types of organisations' carbon footprint using these tools and standards (or developing their own analysis).

In this context, knowledge institutes and healthcare organisations are examples of different types of organisations studied in this literature branch. For instance, El Geneidy et al. (2021) studies the carbon footprint of a multinational knowledge organisation (i.e. working in Germany, Spain and Finland) with a particular focus on the influence of the COVID-19 pandemic. Varón-Hoyos et al. (2021) explores the carbon footprint of the Technological University of Pereira in Colombia as a particular knowledge institute. Furthermore, Valls-Val and Bovea (2022) developed a tool for assessing the carbon footprint of universities. Other studies, such as Charlesworth et al. (2018) and Holzmueller (2021), focused on healthcare organisations. In detail, Charlesworth et al. (2018) argues for the large carbon footprint of health organisations and provides recommendations for improving the sustainability of such organisations. An overview of the carbon footprint of Japanese healthcare services is presented by Nansai et al. (2020). Further recommendations on reducing the carbon footprint of healthcare organisations are presented in Holzmueller (2021).

Other examples are studies related to carbon footprint in hospitality organisations. For instance, Masotti et al. (2016) evaluates the carbon

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footprint of a microbrewery in Italy and provides insights into the reduction strategies. The hotels' carbon footprint and different methodologies for their evaluation are presented in De Grosbois and Fennell (2011). Also, strategies for improving the carbon footprint of hotels are discussed by Salehi et al. (2021). The carbon footprint of the business event sector in Japan is presented by Kitamura et al. (2020). Furthermore, studies such as Ruževičius and Dapkus (2018) and Jurić and Ljubas (2020) explore different methodologies for evaluating an organisation's carbon footprint. Specifically, the application of the enhanced Bilan Carbone Model for assessing the carbon footprint of three different organisations is presented in Jurić and Ljubas (2020). However, none of these peer-reviewed studies (and analysis tools) explores and investigates the carbon footprint of a news broadcasting organisation. Only in the none peer-reviewed literature, a few documents, such as Albert.com (2020), focus on the broadcasting and screening industry. Such lack of studies and information potentially undermines such organisations' sustainability, which contrasts with sustainable development goals where there is an emphasis on promoting sustainability measures in different sectors and organisations with determined targets (Terra dos Santos et al., 2022; Adshead et al., 2019).

Therefore, this study aims to investigate the carbon footprint of news broadcasting organisations. To accurately address this aim, the study focuses on Nieuwsuur as a case study. Nieuwsuur is one of the leading daily current affairs shows on Dutch national television. It covers a full spectrum of domestic and foreign topics, including politics, economics, social issues and arts (NOS, 2020). Nieuwsuur is a standard one-hour news programme (similar to programmes on CBS and BBC), which runs seven days a week and makes short-term and long-term choices on what to broadcast. This means that besides the broadcast quality, the time constraints dictate the Nieuwsuur's decisions regarding production, travel choices and material use. The news broadcast is filmed in a studio in Hilversum, which they share with Nederlandse Omroep Stichting (NOS), one of the largest news broadcasts in the Netherlands (NOS, 2021). In this building, Nieuwsuur has an office with >50 employees, and they often travel within the Netherlands or abroad to film content.

Although Nieuwsuur often covers the topic of climate change and sustainability, the organisation has not yet implemented measures to measure and potentially reduce its environmental impact. Considering its scale and standard programme and, in addition, the need to implement sustainable measurements, Nieuwsuur is deemed to be a suitable case for this study. Therefore, the study scientifically contributes to the carbon footprint literature by investigating Nieuwsuur as a case study to explore the carbon footprint of news broadcasting organisations. The study also aims to provide concrete insights and recommendations to relevant stakeholders (mainly the decision-makers in the news broadcasting organisations) to reduce such organisations' carbon footprint. Such insights and recommendations could also potentially contribute to climate change and sustainability agendas at a higher level. The limitations, results' generalisability and recommendations are also discussed in detail in Section 4.

The structure of the paper is as follows: Section 2 elaborates on the research methods, mainly the emission factors and the collected data. Section 3 presents the results. Section 4 demonstrates the discussions, main findings, reduction strategies and limitations. Finally, Section 5 provides conclusions and recommendations.

2. Methods

2.1. Carbon footprint calculations

Following Nederland and Prestatieladder (2022) and Kitamura et al. (2020), the CO_2eq emissions of different categories and sub-categories of an organisation, such as news broadcasting, are calculated, as presented in Table 1.

For each sub-category, the CO_2eq emissions within the system are calculated using Eq. 1.

$$CO_2\text{eq emissions} = \text{activity data*emission factor} \quad (1)$$

Table 1
Categories in the carbon footprint analysis.

Category	Sub-category
Travel and transport	Air travel
	Domestic travel
	Outsourced travel
	Commuter travel
Office and Studio	Production office and studio
	Home office
Accommodation	Hotels
Materials	Catering
	Office supplies
Waste	Office waste

2.2. Data collection

To provide input on the categories presented in Table 1, the needed documents from Nieuwsuur are studied (e.g. outsourced orders and energy-related expenses). Several interviews took place with different roles within the Nieuwsuur organisation (e.g. climate director, secretaries, editors, reporters and building managers) to get the needed data which was not provided in the documents. As discussed in Sections 3 and 4, as this is the first study of its kind and the data is also limited (and following studies such as Kitamura et al., 2020), the primary focus is on the direct carbon footprint of such an organisation. The emission factors for the sub-categories are extracted from the literature and are presented in Table 2.

Table 2
Emission factors.

Sub-category	Description	Emission factors	Units	Reference
Air travel	Short-haul (<700)	0.19	kg CO_2eq/km	(Peeters and Reinecke, 2021)
	Medium-haul (700–2500)	0.14	kg CO_2eq/km	(Peeters and Reinecke, 2021)
	Long-haul (>2500)	0.12	kg CO_2eq/km	(Peeters and Reinecke, 2021)
Domestic travel	Travelling to the location for the broadcasting production by a vehicle	0.145	kg CO_2eq/km	(Goederenvervoer, 2020)
Outsourced travel	United (camera crew services)	0.16	kg CO_2eq/km	(Coemissiefactoren, 2022)
	The ENGcie (camera crew services)	0.11	kg CO_2eq/km	(Coemissiefactoren, 2022)
	HPM (camera crew services)	0.16	kg CO_2eq/km	(Coemissiefactoren, 2022)
	NEP (camera crew services)	0.16	kg CO_2eq/km	(Coemissiefactoren, 2022)
	Taxi Roy	0.15	kg CO_2eq/km	(Coemissiefactoren, 2022)
Commuter travel	Train	0.00	kg CO_2eq/km	(Rijkswaterstaat et al., 2021)
	Bus	0.10	kg CO_2eq/km	(Rijkswaterstaat et al., 2021)
	Bicycle	0.00	kg CO_2eq/km	(Rijkswaterstaat et al., 2021)
	Electric vehicle	0.00	kg CO_2eq/km	(Rijkswaterstaat et al., 2021)
	Plug-in hybrid	0.00	kg CO_2eq/km	(Rijkswaterstaat et al., 2021)

(continued on next page)

Table 2 (*continued*)

Sub-category	Description	Emission factors	Units	Reference
	Personal hybrid car (petrol)	0.11	kg CO_2eq/km	(Coemissiefactoren, 2022)
	Personal small passenger car (petrol)	0.13	kg CO_2eq/km	(Coemissiefactoren, 2022)
	Personal medium passenger car (petrol)	0.16	kg CO_2eq/km	(Coemissiefactoren, 2022)
	Personal large passenger car (petrol)	0.17	kg CO_2eq/km	(Coemissiefactoren, 2022)
	Personal hybrid car (diesel)	0.11	kg CO_2eq/km	(Coemissiefactoren, 2022)
	Personal small passenger car (diesel)	0.13	kg CO_2eq/km	(Coemissiefactoren, 2022)
	Personal medium passenger car (diesel)	0.14	kg CO_2eq/km	(Coemissiefactoren, 2022)
	Personal large passenger car (diesel)	0.15	kg CO_2eq/km	(Coemissiefactoren, 2022)
Production office and studio	Electricity	0.45	kg CO_2eq/kWh	(Status, 2011)
	Green electricity	0.00	kg CO_2eq/kWh	(Status, 2011)
	Natural gas	1.79	kg CO_2eq/m^3	(Status, 2011)
Home office	Without green electricity	3.88	kg CO_2eq/day	(Skillett et al., 2020)
	Without green electricity	3.83	kg CO_2eq/day	(Skillett et al., 2020)
Hotels	A standard hotel room	Between 4.3 and 148.0	kg CO_2eq/night/occupied room	(Ricaurte and Jagarajan, 2020)
Catering	Vegetarian	0.76	kg CO_2eq/meal	(Poore and Nemecek, 2018)
	Vegan	0.53	kg CO_2eq/meal	(Poore and Nemecek, 2018)
	Fish	2.49	kg CO_2eq/meal	(Poore and Nemecek, 2018)
	Meat	5.28	kg CO_2eq/meal	(Poore and Nemecek, 2018)
Office supplies	Papers	0.94	kg CO_2eq/kg	(Tomberlin et al., 2020)
	Pens	0.02	kg CO_2eq/pen	(Industry, 2005)
Waste	General waste	1.31	g CO_2eq/kg waste	(Nederland and Prestatieladder, 2022)
	Paper waste	0.68	g CO_2eq/kg waste	(Nederland and Prestatieladder, 2022)
	Hazardous waste	1.31	g CO_2eq/kg waste	(Nederland and Prestatieladder, 2022)
	PMD waste	0.12	g CO_2eq/kg waste	(Nederland and Prestatieladder, 2022)

3. Results

This section presents the results in two main steps. First, the overall carbon footprint of the organisation is presented. In the second step, the details of the carbon footprint of each sub-category and potential reduction strategies are presented.

3.1. Overview of carbon footprint

The total yearly carbon footprint of Nieuwsuur is 235.28 t of CO_2eq, in which the organisation has produced an average of 353 broadcasts per year over the last three years; therefore, the average carbon footprint for one broadcast is 667.07 kg CO_2eq (235.28 t/353 broadcasts = 667 kg per broadcast). An overview of the contributions of each category and sub-category to the total carbon footprint is given in Fig. 1 and Table 3.

As Fig. 1 and Table 3 present, travel and transport comprise the largest carbon footprint share, namely 72 % of Nieuwsuur's carbon footprint. Air travel and commuter travel sub-categories contribute the most to CO_2eq emissions within this category. With a considerable difference (i.e. more than three times difference), the second category is carbon footprints related to office and studio, with the largest share of the carbon footprint. Details of each category are presented in the next step.

3.2. Details of each category

3.2.1. Travel and transport

The travel and transport category is divided into four sub-categories, namely:

1. Air travel: includes all flights reporters must take for making reports.
2. Domestic travel: includes all regional land travel of reporters for making reports.
3. Outsourced travel; includes all hired travel, such as taxis and external camera crews.
4. Commuter travel: includes the commuter travel of all employees of the organisation.

For each sub-category, the emission factors taken are Tank-to-Wheel (TTW), meaning that only the emissions of the travelling itself are considered instead of including the emissions needed to produce or dispose of the transport device.

3.2.1.1. Air travel. The CO_2eq emissions of air travel are determined based on the total distance travelled by aeroplane combined with corresponding emission factors for air travel. The distance travelled is based on a flight's departure and arrival location; a direct route between the two is used for the distance. Different emission factors are used for different distance classes. It is relevant to differentiate between the emission factors since fuel use is highest during the take-off and landing of aeroplanes (Guo et al., 2018). These are categorised into three different flight distance groups: (i) <700 km short-haul, (ii) 700–2500 km medium-haul and (iii) >2500 long-haul (Coemissiefactoren, 2022).

Due to the COVID-19 pandemic, the air travel behaviour of news broadcast organisations might have changed over the last few years. To consider this, air travel data for the last five years is considered to be able to identify changes in the behaviour, as Table 4 presents. As many meetings and interviews that would first have been done exclusively in person can now be done online (due to the COVID-19 pandemic or

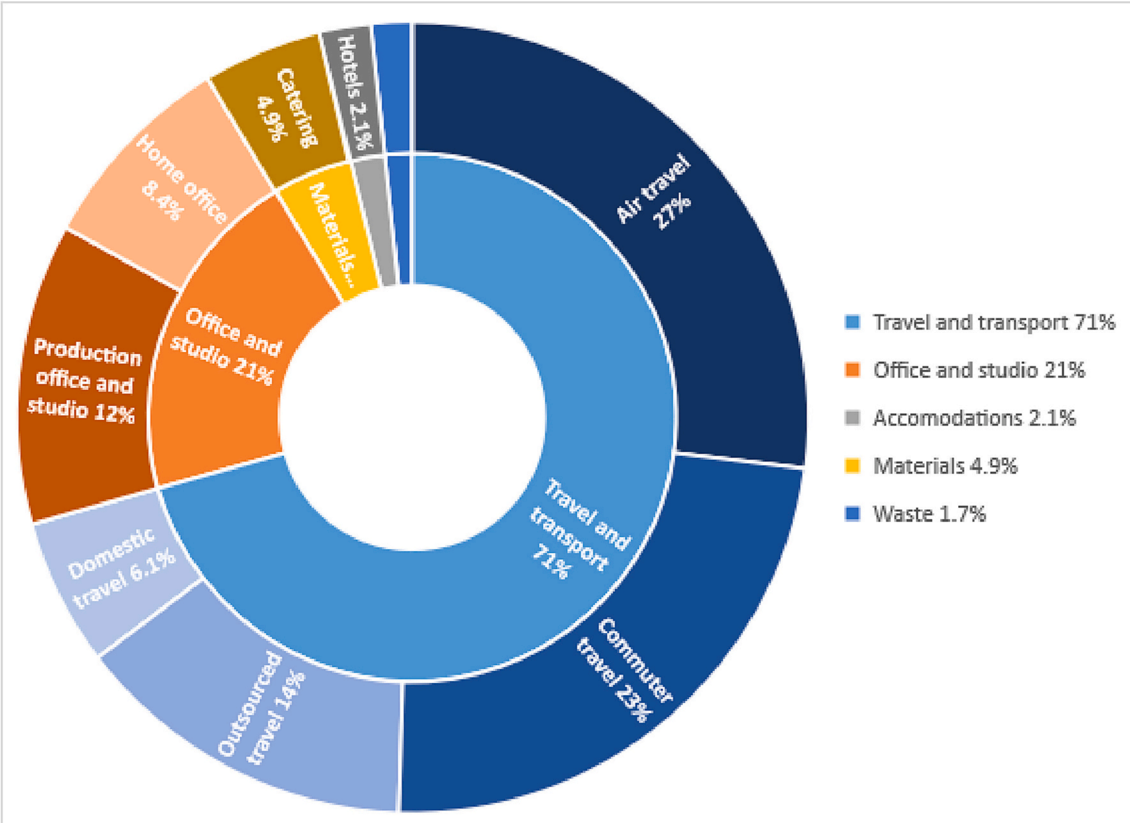

Fig. 1. Overview of the contribution of each category and sub-category to the total carbon footprint.

Table 3
The carbon footprint of each category and sub-category per year and broadcast.

Category	Average per year [tonne CO_2eq]	Per broadcast [kg CO_2eq]	%	Sub-category	Average per year [tonne CO_2eq]	Per broadcast [kg CO_2eq]	%
Travel and transport	166.26	471.39	71.7 %	Air travel	63.72	180.66	27 %
				Domestic travel	14.27	40.45	6.1 %
				Outsourced travel	33.09	93.82	14.1 %
				Commuter travel	55.18	156.46	23.5 %
Office and studio	48.63	137.89	20.7 %	Production office and studio	28.97	82.15	12.3 %
				Home office	19.66	55.74	8.4 %
Accommodations	4.89	13.87	2.1 %	Hotel	4.89	13.87	2.1 %
Materials	11.54	32.71	4.9 %	Catering	11.41	32.36	4.9 %
				Office supplies	0.13	0.36	0.1 %
Waste	3.95	11.20	1.7 %	Waste	3.95	11.20	1.7 %
Total	235.28	667.07	100 %	Total	235.28	667.07	100 %

convenience), the travelling distance decreased significantly in recent years. Depending on the finding of the behavioural change, an estimation of the current yearly air travel is made.

Fig. 2 shows the carbon footprint of air travel in the Nieuwsuur organisation between 2017 and 2021. Long-haul flights make up most of the emissions, averaging 54 %. Consequently, medium-haul flights make up the second-biggest category, averaging 34 %. Finally, short-haul flights contribute 12 % to total emissions. Although the emission factor decreases with distance (as presented in Table 2), the emissions are largest for longer-haul flights due to the distance travelled for long-haul flights being significantly larger than for short- and medium-haul flights. The variation between years can mainly be explained due to the COVID-19 pandemic that significantly impacted Nieuwsuur's ability to travel abroad in 2020 and 2021. Therefore, the average emission between 2017 and 2021 is considered in the overview calculations. The yearly average emissions are 63.72 t of CO_2eq.

Although air travel has the largest share in the total carbon footprint of a news broadcasting organisation such as Nieuwsuur, it cannot be effectively reduced as the nature and goal of such an organisation is to be able to cover news around the world. Carbon offsetting (Becken and

Table 4
Total distance travelled by Nieuwsuur in the last 5 years per distance class in kilometres.

Year	Short-haul (km)	Medium-haul (km)	Long-haul (km)	Total (km)
2017	62,254	209,050	295,866	567,170
2018	71,516	238,810	407,622	717,948
2019	40,802	137,246	300,874	478,923
2020	10,826	88,641	324,596	424,063
2021	14,481	87,709	132,045	234,235

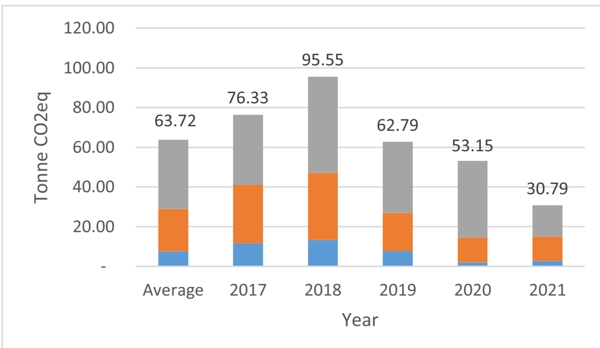

Fig. 2. Tonnes of CO_2eq emissions for each flight distance for air travel.

Table 5
Total distance travelled domestically by car in the last five years in kilometres.

Year	Distance travelled/year (km)
2017	91,425
2018	92,977
2019	88,618
2020	110,195
2021	108,761

Mackey, 2017) is a suitable option for reducing the carbon footprint of this sub-category.

3.2.1.2. Domestic travel. The CO_2eq emissions of domestic travel are determined similarly to air travel. Likewise, the total distance travelled is used to determine the emissions combined with the corresponding emission factor of the transportation method used. Reporters get compensation for their travelled distance for reports. The total distance travelled is thus based on the declarations made by reporters. Also, similar to air travel, the COVID-19 pandemic might have changed domestic travel behaviour. Because of this, domestic travel over the last five years is considered for estimating the current year's domestic travel behaviour, as presented in Table 5.

The carbon emissions related to domestic travel are shown in Fig. 3 in tonnes of CO_2eq between 2017 and 2021. The domestic travelling distance and, therefore, the carbon emission in this category is relatively stable. The slight increase in recent years can be explained by the more frequent domestic travel for making reports due to COVID-19 constraints in recent years. The yearly average emissions are 14.27 t CO_2eq.

Similar to air travel, carbon offsetting is a suitable option for reducing the carbon footprint of this sub-category.

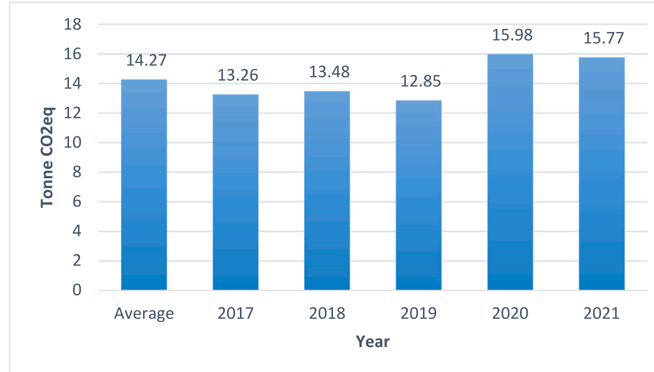

Fig. 3. Tonnes of CO_2eq emissions for domestic travel.

3.2.1.3. Outsourced travel. The outsourced travel sub-category contains all travel behaviour of hired services (e.g. taxis for reporters and guests and external camera crews for footage). The CO_2eq emissions are calculated based on the yearly average distance travelled by these hired services for the news broadcasting organisation and emissions factors corresponding with the means of transport they use. Table 6 presents the data for the different outsourced companies which provided services for Nieuwsuur in 2018 (which is used as a representative for a year).

Fig. 4 shows the yearly CO_2eq emissions for camera crew services and taxis that Nieuwsuur hires. It can be seen that the travel emissions of camera crews are much larger than those of taxis. This is unsurprising, as camera crews are used for nearly every broadcast, whereas not every broadcast requires a taxi. Furthermore, camera crews use larger vehicles to transport their gear and therefore have higher emission factors than taxi vehicles. The yearly average emissions of the camera crews and taxis combined are 33.09 t of CO_2eq.

As electric vehicles have increased range and shorter battery charging times in recent years, such vehicles can more easily be adopted

Table 6
Total distance travelled by each company hired by Nieuwsuur.

	Company	Distance travelled per year (km)
Camera crews	United	33,584
	The ENGcie	112,925
	HPM	19,641
	NEP (estimated)	13,292
Taxi	Taxi Roy	63,750
	Taxi remaining (estimated)	1913

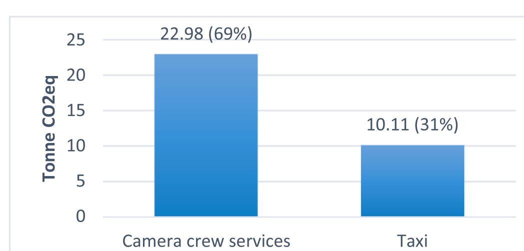

Fig. 4. Tonnes of CO_2eq emissions for transport of camera crews and the taxi company for 2018.

by commercial companies (Aravena and Denny, 2021). Therefore, along with carbon offsetting, Nieuwsuur could potentially consider switching to companies that only use electric vehicles for their services.

3.2.1.4. Commuter travel. The commuter travel's CO_2eq emissions are the combined emissions of all employees' commutes to the office. The commuter travel emissions are calculated based on the type of transportation used, the distance travelled, and the commute frequency during a typical working week for employees. This is subsequently multiplied by the total number of working weeks in a year (i.e. 46 working weeks) to get an overview of the commuter distance travelled per year. Once the commute travel distance is known, the distance is multiplied by a corresponding emission factor to get the CO_2eq emissions. For the commute by car, the distance travelled to work is multiplied by the emission factor of that type of car. Buses are calculated similarly but with an average emission factor for public buses. The CO_2eq emissions of commutes by train or tram, depending on the country, which in the Netherlands runs on green electricity (NS, n.d.), thus will have no CO_2eq emissions. Similarly, bicycle commutes are seen as emission-free. Table 7 presents the relevant data.

As can be seen in Fig. 5, only cars are presented in the CO_2eq emissions. This is because none of the employees took the bus to the office, and the other transport types (trains, trams and bicycles) had an emission factor of zero. Therefore, the emission in Fig. 5 is categorised by the five different types of passenger vehicles that employees use to get to the office (the description and details of these five types are presented in Coemissiefactoren, 2022). Notably, the medium and large petrol vehicles contribute the most to the emissions for the commute to the office. This could be explained by the fact that these vehicle types were most common among the employees as well as having high emission factors. Notably, a relatively large share of the employees used an electric vehicle, namely 30 %. The yearly emissions for commuter travel are 55.18 t of CO_2eq.

Table 7
Total yearly distance travelled by each transport type for commuter travel.

Transport type		Distance travelled/year (km)
Train		113,370
Bus		0
Bicycle		13,974
Electric vehicle		195,834
Plug-in hybrid		13,127
Petrol	Hybrid	0
	Small passenger	139,825
	Medium passenger	159,272
	Large passenger	18,266
Diesel	Hybrid	0
	Small passenger	56,008
	Medium passenger	9801
	Large passenger	0

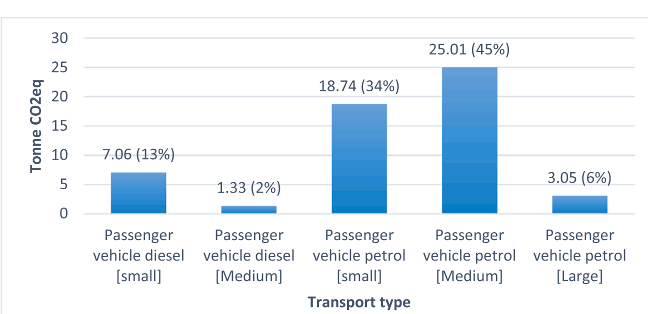

Fig. 5. Yearly tonnes of CO_2eq emissions for the daily commute to the office.

As demonstrated in Fig. 1, after air travel, this sub-category contributes the most to the carbon footprint of news broadcasting organisations such as Nieuwsuur. The possible strategy for carbon emission reduction could be:

- ❖ First, reduce the need to commute to the office as much as possible.
- ❖ Secondly, Nieuwsuur could encourage the employees (and potentially provide incentives) to use public transport, cycling or car sharing as an alternative to cars.
- ❖ Lastly, Nieuwsuur could encourage and facilitate the employees' adoption of electric cars.

3.2.2. Office and studio

To determine the CO_2eq emissions of the office and studio, this category is split into two sub-categories, namely production office and home offices. Since the COVID-19 pandemic, it has become normalised for employees to work partly from home instead of in a production office. As a result, home offices are included as a separate sub-category.

3.2.2.1. Production office and studio. The CO_2eq emissions of the production office as well as the studio are based on the electricity and natural gas consumption of the building(s) where the news organisation is based, combined with corresponding emission factors. The consumption from the last years has been used to estimate the expected consumption for the current year. In case a building is shared with multiple organisations, only a part of the total building energy use will be considered. In case this data is not available, the amount is calculated based on the surface area used by the organisation compared to the overall building size. A standard CO_2eq emission factor is used to determine natural gas emissions. For the emission factor of electricity, an emission factor based on the provider's electricity mix is used if available. Otherwise, the country-specific average emission factor for electricity generation is used. When the office building's electricity and natural gas consumption is unknown, an estimation is made based on consumption data from offices in the same area. As the data is on average for the offices with same characteristics (e.g. function and purpose and working hours), such estimation is considered to be accurate.

Nieuwsuur case has two locations, namely Hilversum and The Hague. The total electricity and natural gas consumption for the Nieuwsuur building in Hilversum was available. Since Nieuwsuur shares the building with other broadcasting organisations, an estimate had to be made to find only the energy use for Nieuwsuur. The data shows approximately 1 % of the total electricity consumption of the building is for Nieuwssur. For natural gas and electricity demand for the heating and cooling of the building, an estimation was made by dividing the square footage that Nieuwsuur rents, 632 m^2, by the total square footage of the NOS building, 24,000 m^2. This results that approximately 2.5 % of the total yearly usage for cooling and heating can be appointed to Nieuwsuur. It must be noted that Nieuwsuur uses 100 % green electricity for the office in Hilversum (also, 20 % of electricity is used for heating and cooling), which means that the emission factor is zero. Therefore, 80 % of the electricity used for cooling will be multiplied by the emission factor for cooling.

For the office in The Hague, the electricity and heating demand was unknown. Therefore, an estimation of this demand was made based on the square footage of the office. The heat demand for offices in The Hague is 80 kWh/m^2 (Aste and Del Pero, 2013), and the electricity demand is 204 kWh/m^2 (Aste and Del Pero, 2013). The total surface area of the Nieuwsuur office in The Hague is 16 m^2. An overview of the electricity and natural gas consumption of the two buildings is given in Table 8.

Fig. 6 shows the resulting emissions for the production office and studio, based on the natural gas and electricity consumption. This figure shows that most emissions are caused by heating and cooling the

Table 8
Yearly energy consumption of the production offices and studios.

Office's location	Unit	Total yearly use
Office Hilversum	Electricity (kWh)	88,000
	Electricity (kWh)	24,220
	Natural gas (m^3)	10,131
Office Den Haag	Electricity (kWh)	3264
	Heating (kWh)	1280

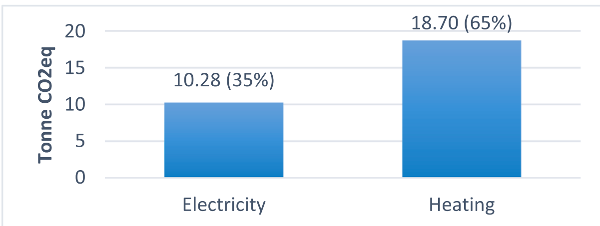

Fig. 6. CO_2eq emissions of the production office and studio sub-category.

building. The total annual CO_2eq emissions are 28.97 t. As this data is about the office and studio's demand (and does not include detailed energy analysis and efficiency analysis), no specific strategy for carbon emission reduction is presented. However, the general recommendations, such as increased thermal insulation, using more efficient devices and adopting energy-saving behaviours, are applicable.

3.2.2.2. Home office. The emissions of the home office are determined based on the time spent working from home combined with an emission factor for home offices. Different emission factors will be used for homes with or without green electricity. The time spent in a home office is determined similarly to commuter travel, based on the employees' typical workweek. Once the average time per week is known, the time is multiplied by a corresponding emission factor for home offices and the number of working weeks per year. Each working day is assumed to be 8 h, and a year contains 46 working weeks. This resulted in 1980 working days from home without renewable electricity and 3128 with renewable electricity. The emission factors combined with the amount of yearly worked days give the overall emissions, as shown in Fig. 7. The total annual emissions are 19.66 t of CO_2eq.

The home office sub-category covers 8.4 % of the total carbon footprint of such an organisation, as presented in Table 3. The main potential strategies for reducing carbon emission in this sub-category are carbon offsetting or facilitating the adoption of green energy technologies (e.g. solar photovoltaic systems and heat pumps).

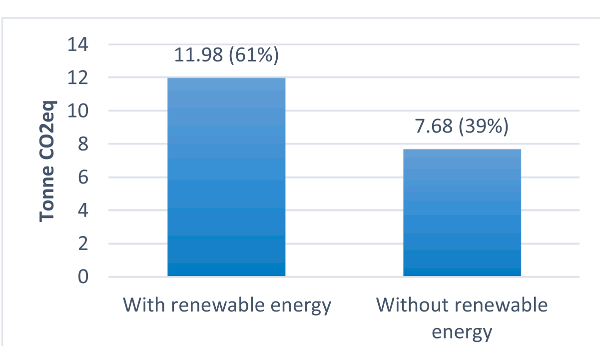

Fig. 7. Yearly CO_2eq emissions of the home office sub-category.

3.2.3. Accommodations

3.2.3.1. Hotels. The calculation of the CO_2eq emissions of the accommodations needed to produce a broadcast is based on the type and location of the hotels used by reporters. For this, the Hotel Sustainability Benchmarking Index 2021: Carbon, Energy, and Water are used (Ricaurte and Jagarajan, 2020). This annual study collects data on hotels' energy and water use in specific cities, regions, countries and climate zones. Based on this, it is calculated what the emission factor in CO_2eq per night per room is. Fig. 8 shows the chosen emission factors for each hotel based on the available data. The carbon footprint is calculated by multiplying the nights stayed by the carbon emission factor of a specific hotel. Similar to air travel and domestic travel, the COVID-19 pandemic might have changed the hotel use of a broadcasting organisation. Because of this, the hotel stays of the last five years are considered. Depending on the finding of the behavioural change, an estimation of the yearly hotel stays is made.

This resulted in the CO_2eq emissions of hotels over the last five years, as shown in Fig. 9. This figure corresponds well to Fig. 2 as it can be seen that in years when the travel emissions by planes were also at a peak, the accommodation emissions were also significant. In 2021, due to the COVID-19 pandemic, there was less travel, which means fewer hotels were used. This led to a decrease in accommodation emissions. The average carbon footprint for accommodation between 2017 and 2021 is 4.89 t of CO_2eq. Similar to air travel, this average was found to be representative of the present-day yearly average. The main strategy for reducing carbon emissions in this sub-category is to choose hotels with sustainability certification in case these alternatives are available. These types of hotels are sometimes net-zero in their emissions (Nižić and Matoš, 2018).

3.2.4. Materials

The materials category is split into two sub-categories: catering and office supplies.

3.2.4.1. Catering. The catering sub-category includes all ordered meals at the production office. The CO_2eq emissions are based on the number of meals and type of meal served. Table 9 shows the different types of meals that are considered. The amount and type of meals are determined using a typical workweek as a reference for the total amount of meals per year ordered for each type. Nieuwsuur orders 80 meals weekly (divided into 50 % vegetarian, 10 % fish and 40 % meat). Based on this, and considering 46 working weeks, Table 9 presents the number of meals for each category per year.

Based on the emission factors presented in Table 1 and the number of meals ordered by the organisation, the total yearly amount of CO_2eq emission from catering is 11.41 t, presented in Fig. 10.

Although the number of meals based on meat is less than vegetarian and fish options, meat meals contribute the most to the carbon emissions of this sub-category. Therefore, the possible strategy could be shifting to entirely vegetarian options.

3.2.4.2. Office materials. The sub-category office supplies contain all materials a news broadcasting organisation regularly uses in large quantities. The CO_2eq emissions of the supplies are calculated based on the weight of the materials or the number of units used and their corresponding emission factors. To get an overview of the number of units of a specific material, orders from previous years are used to estimate the yearly use of materials.

The annual number of supplies used is based on the usage of the first 5 months of 2022. Data from 2021 was also available, but this data was not representative of the present day due to the COVID-19 pandemic. Table 10 shows the estimated yearly amount of used office supplies. Since Nieuwsuur uses notepads from Lyreco, these weight categories are used and shown in Table 10.

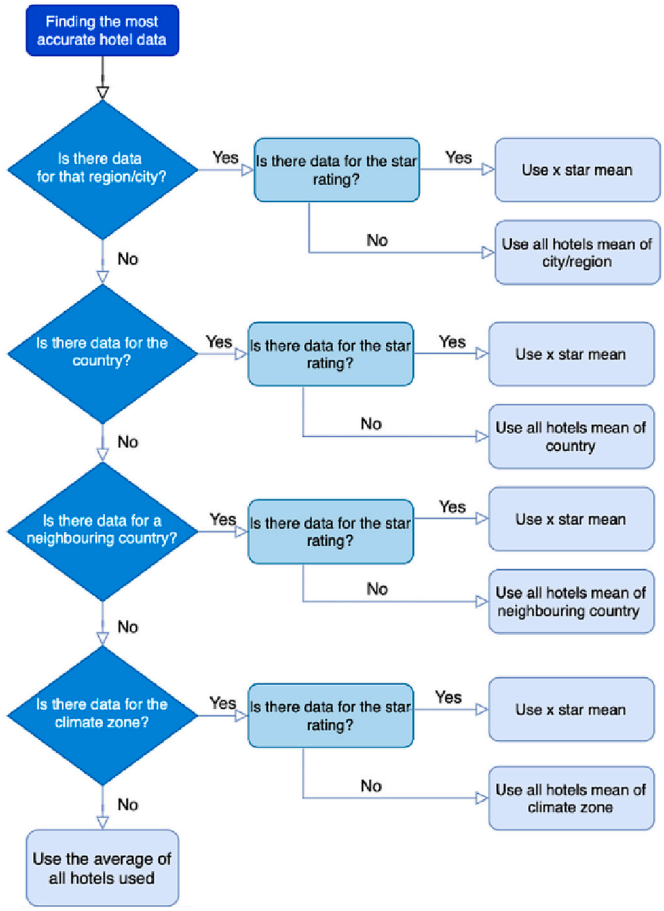

Fig. 8. Flowchart diagram depicting the accommodation emission factors chosen from the Hotel Suitability Index (2021).

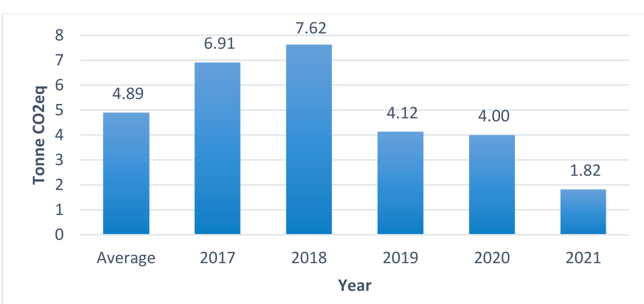

Fig. 9. CO_2eq emissions of the hotels used by Nieuwsuur over the last five years.

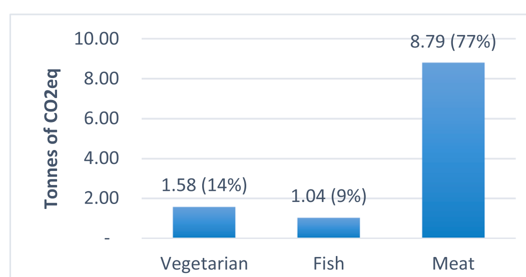

Fig. 10. Yearly CO_2eq emissions from catering.

Table 9
The number of yearly catering meals Nieuwsuur.

	Vegetarian	Fish	Meat
Annual meals per year	2080	416	1664

Table 10
Yearly used office supplies by Nieuwsuur.

Products used/year	Printing paper A4	Notepads A4	Notepads A5	Pens
Number of units used in 2022 (estimated)	6000	144	188	648
Specific weight (kg/unit)	0.005	0.374	0.186	–
The total weight (kg)	29.94	53.89	35.06	–

Fig. 11 shows the annual CO_2eq emissions for the different office supplies. The total yearly amount of CO_2eq of office supplies is 0.13 t. This sub-category has the smallest contribution to the carbon footprint (see Table 3), and consumption reduction could be a suitable reduction strategy to reduce its impact.

3.2.5. Waste

The waste sub-category includes four types of waste produced in an office, namely general waste, hazardous waste, paper waste and plastic, metal and drinks cartons waste (PMD). Using emission factors for the recycled waste (as Nieuwsuur recycles the wastes), the CO_2eq emissions are calculated by multiplying them with the weight of every waste type produced. To get an estimation of the current amount of waste produced each year, data from previous years are analysed to make an estimation.

The amount of waste produced was only known for the entire NOS building for the first five months of 2022, which is used to estimate the yearly produced waste of the building. To estimate the amount of waste produced by Nieuwsuur specifically, the ratio between the number of Nieuwsuur Full Time Equivalent (FTE) employees is compared to NOS FTE employees. This ratio is then applied to the amount of waste Nieuwsuur produces compared to NOS. There are 821 FTE employees for the NOS, while Nieuwsuur has 50.1 FTE employees working in the office. Therefore, approximately 6.1 % of the total waste of the building was appointed to Nieuwsuur. Table 11 shows the waste produced and the assigned part appointed to Nieuwsuur.

Consequently, using the emission factors presented in Table 2, the annual CO_2eq emissions for the different types of waste are shown in Fig. 12, in which the total yearly amount of CO_2eq of waste is 3.95 t. Similar to office materials, the strategy for reducing this sub-category's impact is reducing consumption.

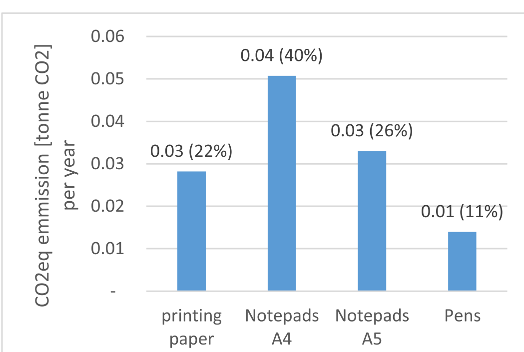

Fig. 11. The carbon footprint of the office supplies, including printing paper, notepads A4 and A5 and pens.

Table 11
Yearly waste that is produced by Nieuwsuur.

Type of waste	Total waste produced	Waste produced by Nieuwsuur (estimated) (kg/year)
General waste	38,712	2365.30
Paper waste	16,358	999.5
Hazardous waste	274	16.7
PMD waste	21,516	1314.60

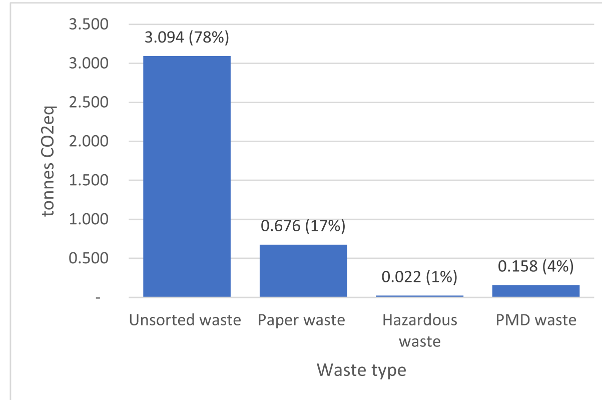

Fig. 12. The carbon footprint of waste.

4. Discussion

Carbon footprint is a well-established indicator for evaluating the carbon dioxide (and other greenhouse gases such as nitrous oxide and methane) caused by a particular product or organisation. There are various research and tools for studying carbon footprint; however, none of them focuses on analysing and evaluating the carbon footprint of a news broadcasting organisation. Consequently, there is no available knowledge on the amount and possible reduction strategies of the carbon footprint of such organisations. Therefore, this study investigates this knowledge gap by focusing on Nieuwsuur as a standard news broadcasting organisation in the Netherlands.

The results demonstrated the total emissions were 235.28 t of CO_2eq/year on average for a news broadcasting organisation. On average, each news broadcast emits 667 CO_2 kg approximately. The travel and transport category contributed the most (71.7 %), followed by office and studio (20.7 %) and materials (4.9 %) to the carbon emissions. Compared with other organisations, such as business events (Kitamura et al., 2020) and the hospitality industry (Oluseyi et al., 2016), news broadcasting organisations have a lower carbon footprint. However, the shares of categories (e.g. share of travel and transport) are almost similar.

Air travel (27 %) and commuter travel (23.5 %) have the most significant shares in the travel and transport category. In order to avoid the emissions from air travel in such an organisation, carbon offsetting seems to be the most suitable option, as explained in Becken and Mackey (2017). For reducing the carbon emission for commuter travel, strategies related to reducing the need to come to the office (e.g. online or hybrid meetings) are necessary and easy to implement, as explored in Porpiglia et al. (2020). Other strategies for reducing Nieuwsuur's carbon footprint are encouraging the adoption of electric cars and renewable energy systems, outsourcing the services from more sustainable companies, and reducing meat consumption within the organisation.

4.1. Carbon emission reduction strategies

Following the results and strategies presented in Section 3.2, the impact of three carbon emission strategies, namely, (i) working from home to reduce commute travel, (ii) switching outsourced travel to only electric transport, and (iii) fully vegetarian catering, is presented in this section. These selected strategies are considered the easiest and fastest strategies for reducing the carbon footprint of such an organisation, as they do not influence the organisation's final product (i.e., news broadcast) and do not require significant changes in its daily operations.

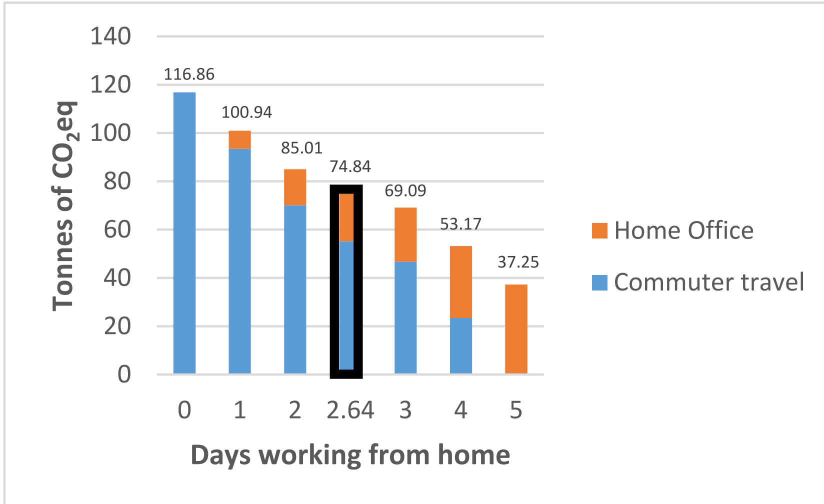

Fig. 13. Carbon emission of working from home and commuter travel.

For instance, changing in the other sub-categories, such as air travel and production office and studio, requires long-term planning by the organisations strategists and significant changes, in order to avoid negative influence on the final production.

4.1.1. Working from home to reduce commute travel

As presented in Fig. 1 and Table 3, commuter travel and working from home together are responsible for 31.4 % of the total CO_2 emission of Nieuwsuur. In the current situation, the emission from working from home and the commute combined (with an average working from home of 2.64 days) is 74.8 t of CO_2eq annually (19.6 from the home office and 55.2 from the commuter travel). If all the employees worked from home 5 days a week, the total emission from working from home would be 37.2 t of CO_2eq and no commute travel emissions. So the overall savings would be 37.6 t CO_2eq annually (approximately 50 % of the two categories accumulated). The total carbon emission increases by decreasing the number of working days from home. Fig. 13 elaborates on the different scenarios based on the distribution of working from home and commuting to work.

4.1.2. Switching outsourced travel to only electric transport

As presented in Table 3 and discussed in detail in Section 3, outsourced travel is responsible for 33.09 t of CO_2eq, which covers 14.1 % of the total CO_2 emission of Nieuwsuur. Although the organisation tries to choose sustainable companies for its outsourcing, such companies do not fully use electric cars for their services. If Nieuwsuur could manage to adjust all its outsourced travel to electric transport only, 100 % of the direct emissions would be reduced.

4.1.3. Fully vegetarian catering

As discussed in detail in Section 3, Nieuwsuur's catering is a mixture, with dominating orders of meat-based meals. Therefore, catering covers

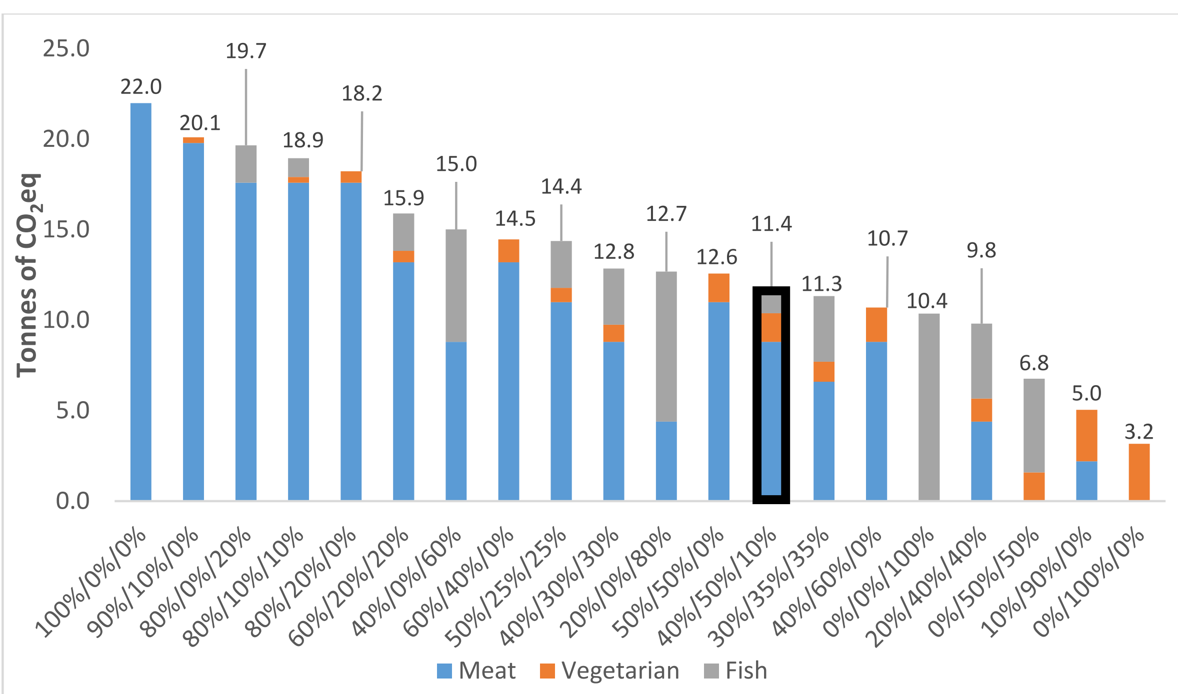

Fig. 14. Mixture of catering and the CO_2eq emissions.

11.4 t of CO_2eq annually (4.9 % of the total CO_2 emission of Nieuwsuur). If such an organisation switch to fully vegetarian catering (100 % vegetarian food), this could result in saving 8.2 t of CO_2eq annually, meaning approximately 72 % reduction of CO_2 emission of this particular category (and 3.5 % of total CO_2 emission of Nieuwsuur). Fig. 14 elaborates in detail on a different mixture of the catering and their representative CO_2 emission.

Considering all three mentioned strategies, the total possible carbon emission saving would be 78.9 t of CO_2eq annually (approximately 34 %). However, the challenges and barriers to implementing such strategies should also be also noted. For instance, always working from home or only using an electric vehicle require planning for a news broadcasting organisation such as Nieuwsuur. However, such calculations delineate the considerable potential in carbon emission reduction of such organisations.

4.2. Limitations and further work

These results provide insights to relevant stakeholders (mainly the decision-makers in the news broadcasting organisations) to reduce such organisations' carbon footprint. However, the study's limitations must be kept in mind to make the results generalisable and the strategies useful. The first limitation relates to the categories and sub-categories studied in this research. Although these categories are in line with the current body of literature (e.g. Kitamura et al., 2020; Nederland and Prestatieladder, 2022), it is important to keep in mind that there might be other potential categories which are needed to be considered when the carbon footprint analysis needs to be more details. This also includes considering indirect carbon footprint categories, which were out of this research's scope. However, this would not jeopardise the findings of this study and only contribute to the further development of this study, as there is no peer-reviewed literature on the carbon footprint of news broadcasting organisations.

The second limitation is particularly related to the available peer-reviewed literature and data dedicated to news broadcasting organisations. The study made few realistic assumptions and estimations for its carbon emission calculations (as elaborated in Section 3); however, the real-world data could lead to more accurate results. Therefore, addressing the lack of real-world data constructively and open-sourced (and over time could considerably contribute to overcoming such limitations).

The third limitation is the case study selection and emission factors. Although the Netherlands, and Nieuwsuur in particular, provides an opportunity to explore the carbon footprint of news broadcasting organisations (as explained in Section 1), this choice is a limitation. The case study influences data collection and emission factors. For instance, Nieuwsuur already recycles its waste, which influences the emission factors, as presented in Table 2. Thus, it is insightful for future research to explore other news broadcasting organisations in other countries which their different characteristics and representative emission factors. This could potentially lead to further developments in this branch of literature and industry.

Lastly, as the study focused on investigating an organisation's carbon footprint and providing insights on strategies for reducing it, the study did not include exploring the impact of different reduction strategies. Also, the study did not investigate implementing such reduction strategies' economic and policy considerations. Therefore, it would be insightful to focus on cost-benefit, cost-effectiveness and scenario planning for implementing such strategies for future studies.

5. Conclusions

This study investigated and quantified the carbon footprint of news broadcasting organisations by focusing on Nieuwsuur as a standard news broadcasting organisation in the Netherlands. The results demonstrated two categories, namely "travel and transport" and "office and studio", with the largest CO_2 emissions. "Commuter travel" showed the largest potential to reduce carbon emissions. In conclusion, the following recommendations are formulated for decision-makers in news broadcasting organisations to reduce their carbon footprint:

- ❖ Encouraging working from home when possible and then incentivising employees to adopt electric vehicles could drastically influence the CO_2 emissions of news broadcasting organisations.
- ❖ Outsourcing services (e.g. taxis and accommodations) from a sustainable company could also contribute to reducing carbon emissions. Also, focusing on vegetarian meals rather than meat-based meals could reduce the carbon footprint.
- ❖ Offsetting is one of the easiest and fastest strategies to reduce the carbon footprint of such an organisation.

As extensively elaborated in Sections 3.1 and 4.1, the carbon footprint of broadcasting organisations such as Nieuwsuur has a considerable reduction potential without significant changes in their strategies. Particularly for Nieuwssur, with current emission of 235.28 t of CO_2eq annually, the 34 % reduction (78.9 t CO_2eq annually) is achievable. Along with environmental and social benefits, such carbon emission reduction could also contribute drastically to the Dutch carbon emission reduction targets.

Although the study systematically approached the carbon footprint of a news broadcasting organisation and provided its results, conclusions and recommendations constructively, it is crucial to keep in mind that it is the first attempt of its kind. This branch of literature, namely the environmental assessment (including the carbon footprint) of news broadcasting organisations and, in general, the screening industry, needs specific attention. Therefore, the insights and limitations of this work could also be seen as avenues for further research. The study highlighted the need for more research and data on news broadcasting organisations, including collecting data on direct and indirect carbon emissions categories and possible carbon emission reduction strategies, as they are largely missing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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