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Methodologies for Calculating the Carbon Footprint of Small Organizations

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Abstract

The aim of this paper is to analyze the changes in climate, the carbon footprint and existing assessment methodologies, and based on an author's research to develop a methodology for carbon footprint calculation of small organizations. The major problem of small organizations calculation tools are complexity, time consuming and requires significant resources to implement. The research revealed that the key factors for calculating the carbon footprint for small organizations are misunderstanding of general organization operation from the perspective of environmental, employee engagement, leadership of managers, and public sector key factors (such as education and advertising, lack of information, ecoculture education, green procurement, tax exemption). Based on the results of the research, the authors developed a methodology for calculating the carbon footprint and prepared an algorithm for its application, adapted to small organizations. It can be established that the successful carbon footprint implementation and operating outweighs formed issues in the long term.

Keywords: *carbon footprint, sustainable development, small organization, methodology, E. Deming's continuous improvement cycle.*

1. Introduction

Growing global demand for environmental protection – air, water, human life, animal and plant life, natural resources and ecosystems – will be determined by fundamental changes organizations engaged in areas of activity such as manufacturing, services, marketing, consumption, state governance, management of international economic and political organizations. Solving environmental problems cannot be limited to the management of their environment by only a few countries – combined and coordinated efforts of all countries and international organizations are needed (Ruževičius, 2010, 2012; Šimanskienė & Petrulis, 2014; The Council…, 2016). Currently, carbon footprint is one of the most used environmental and sustainable development indicators (Čiegis & Vijūnas, 2014; Tjandra et al., 2014; Ruževičius, 2012). Various initiatives, calculation methods, international standards provide only guidelines for assessing the carbon footprint of organizations. Most of them are based on the philosophy and classification of the greenhouse gas protocol (GHG) and ISO 14064 standard. However, due to the lack of a clear format and procedure for these standards, it is difficult to apply them to small organizations. In addition, organizations that are just starting to assess their carbon footprint may not have the resources or trained staff to carry out a comprehensive assessment. In order to fill this gap, simple methodology is truly needed providing the main sources of emissions and the emission factors, which are categorized, are quickly identified and calculated.

The aim of this paper: to prepare a methodology for calculating the carbon footprint of small organizations based on scientific literature sources and the results of this research.

Work tasks:

1. Identify the strengths and weaknesses of current carbon footprint calculation methodologies;
2. Carry out a qualitative study to determine the essential requirements and motives, problems and benefits of calculating the CO_2 footprint;
3. Based on the data obtained from the literature analysis and the study, prepare and approve the methodology of carbon footprint calculation.

Research methods:

4. Systematic analysis of scientific literature (studying of Lithuanian and foreign authors' books and scientific articles on the subject of carbon footprint).
5. Matching method (analysis and assessment of current carbon footprint methodologies).
6. Since the target group of this study are environmental specialists and auditors, in addition to the topic – the suitability of carbon footprint assessment methodology in small organizations – therefore, the semi-structured interview method was chosen for the achievement of the empirical research goal and objectives. During the interview with the respondents, we try to get answers to the formulated questions, to reveal the desired topic. In addition, document analysis was used to check the accuracy of respondents' answers.

2. Carbon (CO_2) footprint in the concept of sustainable development

Sustainable development is a better quality of life for current and future generations. The aim of sustainable development is to promote the fight against poverty, promote sustainable consumption, reduce climate change, take care of clean water supply, improve transport and infrastructure, build sustainable cities, accountable and transparent organizations, ensure proper governance of the countries, human rights and gender

equality (agreed for the World Summit on Sustainable Development 2030). Exponential population growth – 1960 – 3.03 billion, 1990 – 5.33 billion, in 2018 – 7.63 billion (Worldometers ..., 2018) causes a lot of problems between human and environmental, since natural resources are no longer enough to withstand the current population. Topical problems – excessive consumption, poverty, pollution, loss of biodiversity, the spread of new diseases, and the decline of essential resources – should be regarded as strategic threats to human civilization (Čiegis & Vijūnas, 2014). One of the indicators of sustainable development and atmospheric pollution is the carbon footprint. It also helps to measure greenhouse gas emissions.

Carbon footprint (CF) is the total amount of greenhouse gas emissions that is directly or indirectly caused by the activities of organizations or accumulated through the stages of the life cycle of products (Harangozo & Szigeti, 2017; Moss et al., 2008). The main greenhouse gases or carbon footprint amounts are carbon dioxide (CO_2), methane (CH_4), nitrogen oxide (N_2O), hydrofluorocarbons (HFCs) – ones of the greenhouse gases that absorb the greenhouse effect when absorbed by the sun. At present, there is no mandatory European Union (EU) legislation for calculating the carbon footprint of public or private sector institutions. In principle organizations can decide on themselves whether to report emissions related to their activities, and if they decide to do so, how to calculate and monitor them.

In total, more than 80 GHG reporting methods and initiatives are counted, which are tailored to specific sectors or complementary to other methods. Basically, in the Europe and worldwide are using about 30 methodologies for assessing carbon footprint. There are currently not enough guidelines for small organizations. Reporting methods or initiatives are considered too complex and take away too much time from small enterprises. Additional time and human resources are needed to make these standards easy to apply without simplified guidance.

3. Calculation methods of carbon footprint

Academic literature provide three main methods for carbon footprint calculating: input-output analysis (IOA), life-cycle analysis (LCA) and hybrid (IO-LCA) (see *Figure 1*). The chosen method is practically dependent on the functional unit being investigated. Consumer goods are most often dealt with in the life-cycle or bottom-up approach. An analysis of input-output or top-down analysis is carried out at national level or for a sector-specific assessment. Hybrid methods combine the strengths of both (LCA and IOA) methods

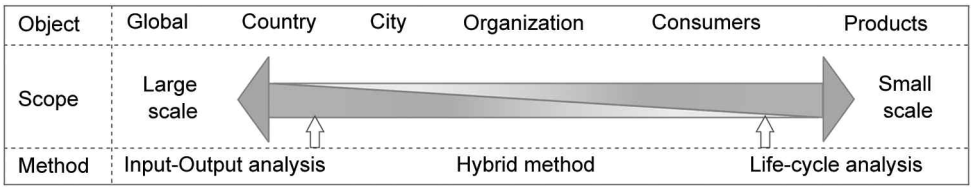

Figure 1.
Different objects and methods of applying carbon footprint
(*Source*: Gao et al., 2013; Peters, 2010)

These methods are very detailed and require a trained specialist in these areas. Such a complexity may be a frightening practice for a person who wants to begin to assess his organization's carbon footprint. Very often, organizations that want to contribute to environmental awareness and, in calculating their carbon footprint, must evaluate their resources and capabilities. This is especially true for small businesses that are looking for the most appropriate method based on the size of the company.

As regards voluntary carbon footprint calculation is concerned, there are many spreadsheets or consultants. All these spreadsheets state that they are based on recommended guidelines, ISO standards or GHG protocols. However, studies have shown that they rarely receive the same results when the initial data are the same (Harangozo et al., 2017). Therefore, the accuracy and reliability of such tools are questionable, which reveals a lack of uniformity (Malakahmad et al., 2015).

The current methodologies for assessing carbon footprint are not ideal for small organizations, so it would be useful to create a tool that meets the specific requirements of small enterprises. Each organization, which has set a priority in combating climate change in its social responsibility principles, is invited to actively cooperate in calculating the carbon footprint. It is important to get a CF, which is really affordable, transparent and comparable. This requires more and better quality information and would help companies to change their production patterns and carbon-use habits and move to a low carbon culture. All of this is accessible to the entire business community, especially for small businesses with limited resources (Villar et al., 2012). The goal of the whole CF system is to reduce emissions (see *Figure 2*).

The purpose of the carbon footprint system is depicted as the roof of the house – the bigger the roof the greater the success of combating climate change. Appropriate support and structure are needed to achieve this. If the support is appropriate then the result will be higher.

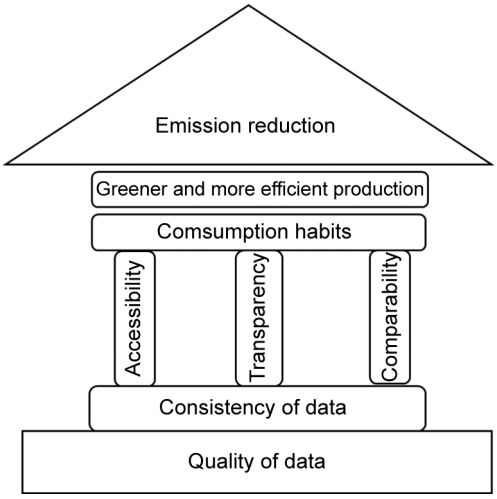

Figure 2. Requirements system for calculating carbon footprint
(*Source*: Villar et al., 2012)

4. Research and results

According to J. Moss et al. (2008), several requirements are set for the development of a new methodology: a simple tool, without complex data requirements; can be assessed and understood by non-professionals; informative about the environmental impact; showing the financial benefits to small organizations that social responsibility is valuable; sufficiently accurate information to make substantiated strategic decisions.

Figure 3. The Assessment phases of Carbon footprint
(*Source*: designed by the authors of this paper)

It can be argued that small organizations give preference to environmental measures that do not require significant investment, and the result is clearer and faster. The overall study on the methodology for calculating carbon footprint is based on six stages of the study (*Figure 3*).

In this work only the first 4 steps are discussed in more detail. A third party performs the results of the verification where the results are for external use (e.g. submitting to the public or calculating the total carbon footprint of the country). The CO_2 reduction action determines the activities of the company and its effects on climate change. The calculated organizational footprint must be clear, reliable and easily verified by the third party. Each methodology assessment step is defined as follows (Gao et al., 2013):

1. The first stage of the assessment of the carbon footprint is important in defining the purpose, methods, expected results and actions of the carbon footprint after reporting. At this stage, it would be necessary to provide options for calculation, to define target groups, purpose (for data comparison or publicity), and verification procedures.

2. The determination of the boundaries is based on an imaginary line around the organization's activity, which will be used to calculate the carbon footprint (*Figure 4*). Below you can find an organization survey model that include compulsory activities (vertical lines) and optional processes (the square dotted is upstream and dash line is downstream). If, in one or another case, the indirect action is excluded, an explanation should be given as to why it is not needed.

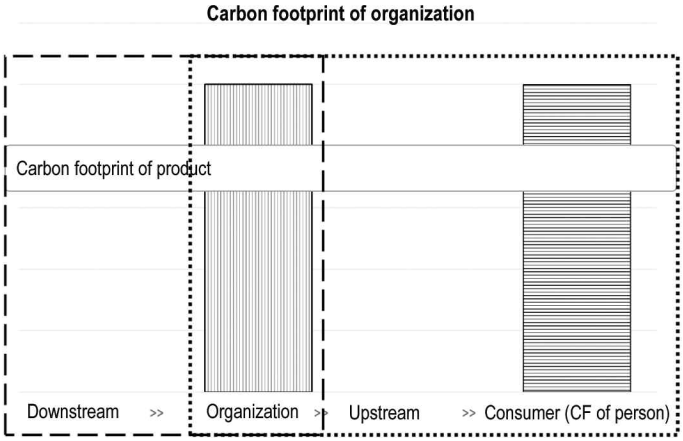

Figure 4.
Establishing boundaries of organizational carbon footprint
(*Source*: Gao et al., 2013; Navarro et al., 2017)

3. In the context of the operation of small organizations, the main activities become sources of emissions (pollution). The most commonly identified activities are small enterprises, which are divided into several areas: water consumption, secondment, transport used by the organization, waste, travel to and from work, energy and IT (*Figure 5*). The main idea behind this developed system is to be easily adapted to small organizations. Companies can adjust – adding new sources of pollution according to the nature of their activities.

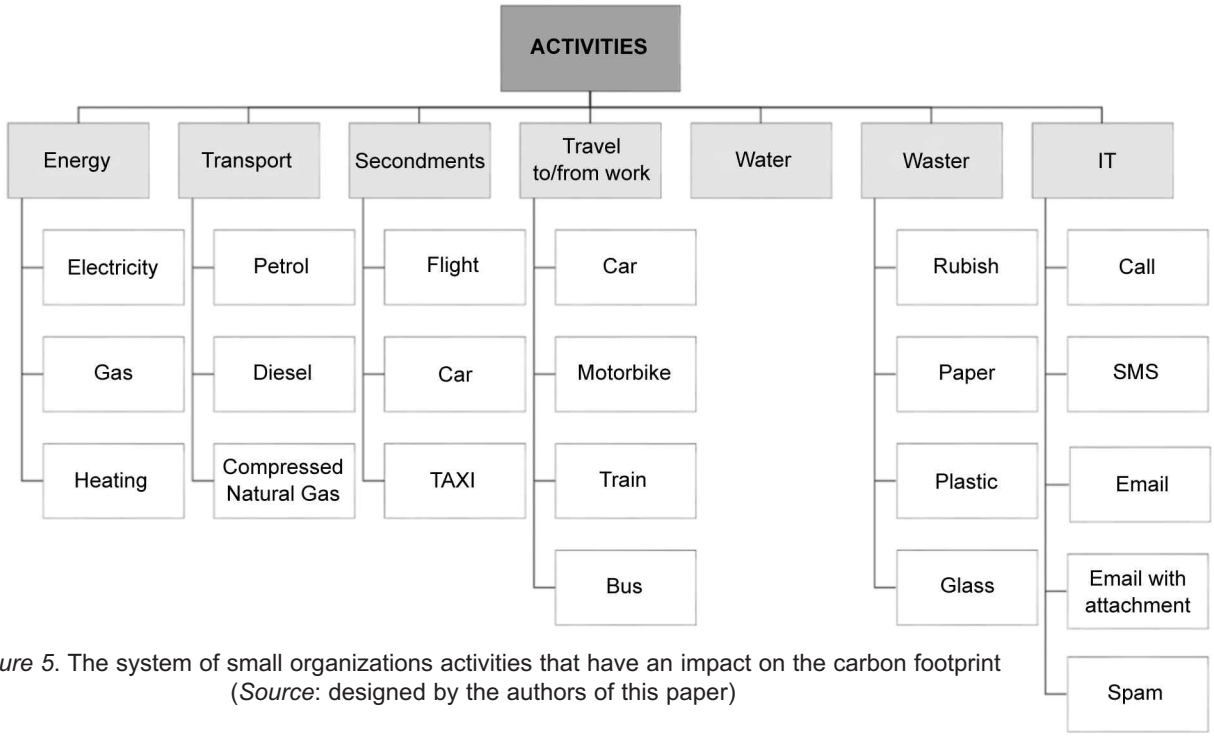

Figure 5. The system of small organizations activities that have an impact on the carbon footprint
(*Source*: designed by the authors of this paper)

It is important for the organization to identify activities and emissions that have an impact on the environment. The accuracy of calculating the CO_2 footprint is based on comparing the data for all emission sources over time.

4. The carbon footprint is measured in CO_2 equivalents (kg CO_2 e) and is calculated using operating data multiplied by standard emission factors.

CFP = Σ (*Adi Adi x*)

CFP - Carbon footprint (kg CO_2 e)

AD - Activity data of the organization (based on units of

measure)

EF (Emission factor) - coefficient (kg CO_2 e / unit of measure)

I – Index (activity source)

One of CF calculation principles of the GHG protocol is the accuracy. In assessing possible sources of pollution, it is necessary to take into account the latest emission factors, measurement units and the frequency of measurement (see *Figure 6*).

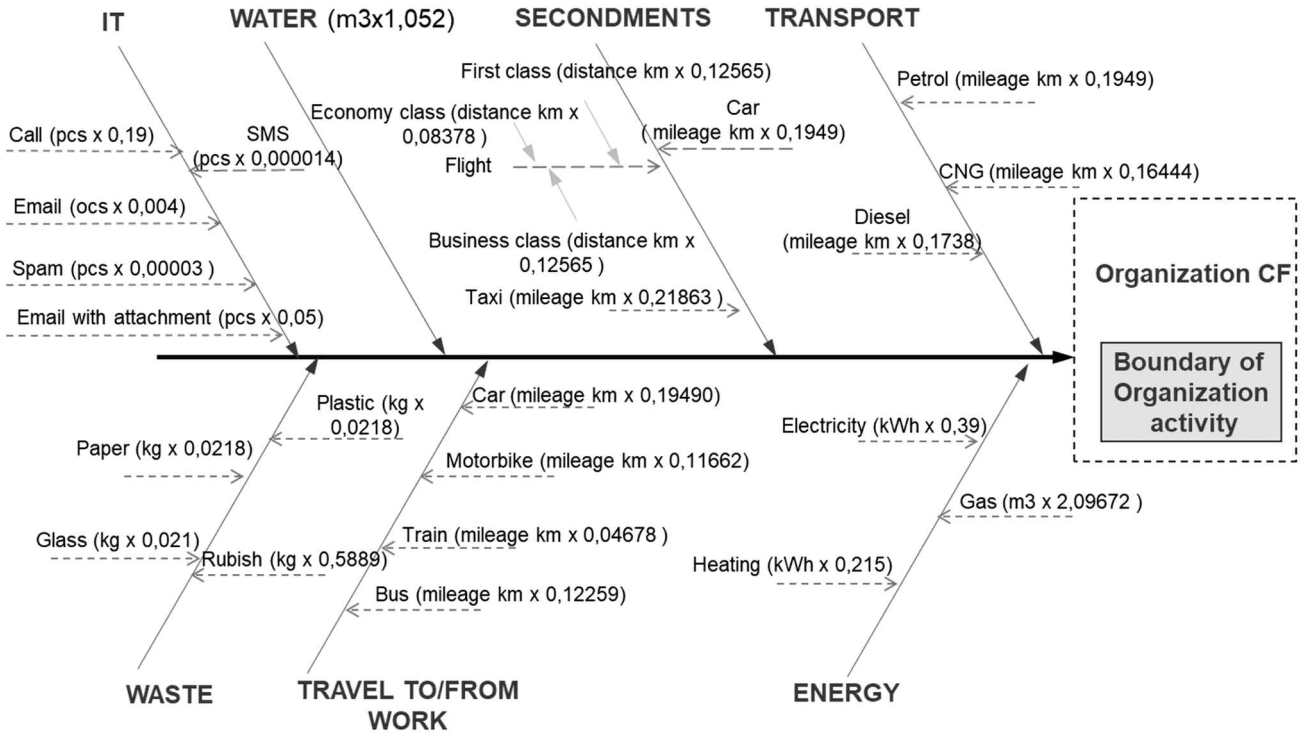

Figure 6. Scheme for calculating the carbon footprint of small organizations (*Source*: designed by the authors of this paper)

The purpose of the second part of this study is to explore the applicability of the methodology for the calculation of the carbon footprint to small organizations operating in Lithuania and to determine the perspective of application of the principles of sustainable development in the context of carbon reduction.

For the study were selected environmental safety experts, environmental advisers, auditors, specialists working in public sector institutions with work experience in the field of climate change, and competent experts in the field of study. During the semi-structured interview with nine respondents, the aim was to find out the requirements and motives for calculating the carbon footprint, the benefits and problems, and the suitability of the methodology developed for small organizations.

Summarizing the analysis of scientific literature and the results obtained during the author's research distinguishes the main steps that a small organization can follow to assess its carbon footprint (*Figure 7*).

The first step of the E. Deming's continuous improvement cycle “Plan-Do-Check-Act” (PDCA) is **"Plan"**. Each organization must start at the planning stage when calculating the carbon footprint from the goal why they are doing it. In order to understand your purpose, you must evaluate the current situation, identify and describe activities. After the study, the authors suggest using the main activities of small organizations (step 2.2), which are presented in *Figure 5*. They may vary depending on the organization's specifics, sources of pollution, or production processes. Understanding and purifying of this situation becomes the starting point for further action.

It is very important to emphasize in the **"Do"** stage that data is collected for a certain period, for example one year. In order to ensure data consistency and quality, they should be collected on a regular basis, for example, every month. With accurate organization data, emission factors are also needed to calculate carbon footprint. The main emission factors presented in this paper (see *Figure 5*), additional factors can be found on the DEFRA (Department for Environment, Food & Rural Affairs) website. Carbon footprint is counted by multiplying the activity data of the organization and the emission factors.

"Check" stage combines the carbon footprint of all activities. Carbon footprint report obtained in CO_2 equivalents (in kilograms or tons). Following the study, the scheme for calculating the CO_2 footprint of small organizations is presented in *Figure 5*. Company executives or consultants to visually see the amount of computation can use this scheme. With the final amount of carbon footprint, you can also count derivatives such as CO2 / employee or CO_2 / m². These relative sizes can be compared with other organizations. If an organization requests that notified bodies verify the CO_2 footprint calculation, an audit can be performed. In many cases, organizations rely on results, and audits are rarely carried out.

"Act" stage aims at reducing the carbon footprint – saving natural resources, reducing the amount of waste entering the landfill, using electricity more efficiently, etc. If sometimes the carbon footprint can no longer be reduced due to the ongoing activities, it can be offset through projects – investing in renewable energy, planting forests, drinking water preparation, etc. This way, organizations can achieve zero carbon footprint.

By following this cycle one or more times and finding out the trend of the CO_2 footprint, the organization's activities can be targeted at reducing this indicator. This cycle reminiscent of the main principles of Deming's continuous improvement management – the organization can each year evaluate its environmental performance and achieve continuous environmental impact reduction.

The developed model for assessing carbon footprint has been practically applied in several Lithuanian organizations. The survey methodology is chosen for data collection, requested to fill in the questionnaire of eight companies according to the type

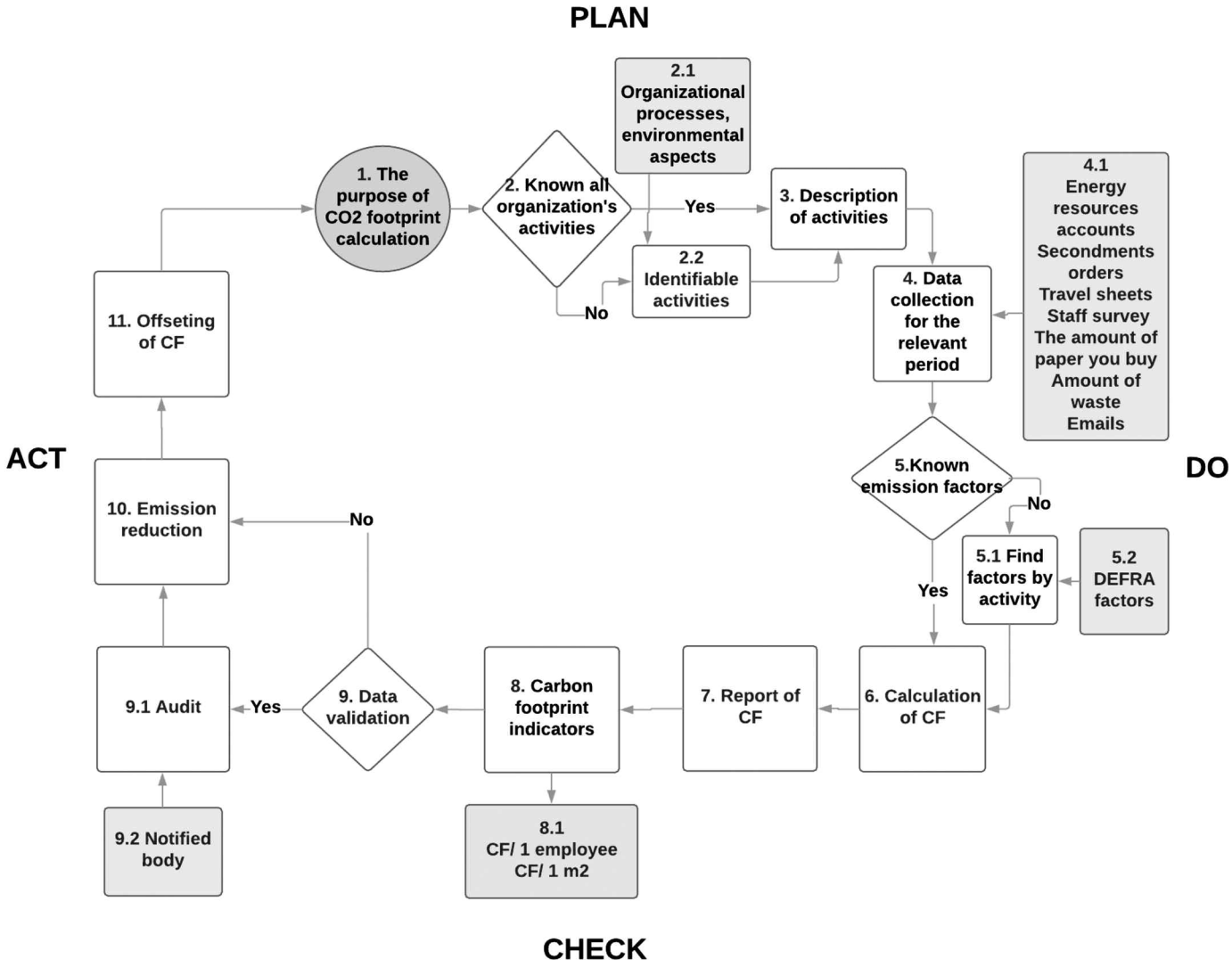

Figure 7. Algorithm for the application of a methodology for calculating carbon footprint of small organizations (*Source*: designed by the authors of this paper)

of activity: production, services and public sector. All companies that have agreed to participate in the survey, regardless of size, have been evaluated to check how the model works. The study found that each organization faces certain computing problems in order to measure its CF. The most common problems are:

- The importance of the CO_2 footprint for the organization of environmental culture, for example, are not interested in calculating and / or reducing carbon emissions;
- Inaccurate data collection, for example. Instead of 12 months, 11 months are taken;
- Incorrect interpretation of the data may distort results, for example. Arrivals to / from work are calculated on both sides and not in one;
- Leaders' involvement in sustainable development and environmental activities. In particular, CO_2 emission calculations are much more effective when the lead person initiated the calculation of that indicator;
- Insufficient perceptions of the general functioning of the organization from an environmental point of view. For example, not all employees know who leaves the carbon footprint in the monitoring and calculation organization;

This research has shown that the methodology developed can only be applied to small organizations, since it is easy to gather and evaluate business data, and it is easier to interview employees. Medium and large organizations are necessary to assess additional factors such as organizational structure, personnel management, company data accounting or business IT systems. Managing large enterprise processes and data is unthinkable without quality management systems. Well-run standards facilitate data collection, employee engagement, leadership, which are important for assessing the CF. From a practical study we see that the methodology for calculating CF is made easier and more adaptable to small organizations in a variety of sectors, due to flexibility and broad applicability.

5. Conclusions

In the context of the increasing global awareness of the anthropogenic climate change, the carbon footprint concept is now widely used both as a marketing tool and to mobilize public sentiment. This paper reveals similarities and differences between the concepts of “ecological footprint” and “carbon footprint” as well as elucidates their importance for the sustainable development and education of “green consumers”.

Both manufacturing and service as well as public sector's small organizations which planning for any of its activities have to assess their impact on the environment, people and society as a whole. First of all, this theoretical concept of a sustainable business and a sustainable organization is analyzed through organizational relationships. As the external environment and organizations are closely interlinked, the long-term success of the organizations depends on how well it is able to converge and integrate into the environment and to feel the social moods of

the concerned parties. Therefore, it is important to understand that if an organization wants to secure long-term public acceptance and trust, it must carry out an environmental survey of its product throughout its production, distribution and use periods and evaluate all possible environmental and technological consequences (Šimanskienė et al., 2014).

Based on the results of the research, the author developed the methodology for calculating the CO_2 footprint and developed an algorithm for its application adapted to small organizations (*Fig. 6*). The developed methodology is based on the principles of sustainable development and the E. Deming's continuous improvement cycle "Plan-Do-Check-Act" (PDCA), which aims to ensure the planning, analysis, improvement and operation of the organization's activities in order to set environmental goals. In order for such a system to function, it is recommended that the organization periodically communicate inside (especially at the beginning of the installation), which would facilitate the implementation and implementation of this system. This would involve employees, suppliers, focusing on the environment and creating sustainable management based management.

Considering the positive benefits of using the carbon footprint, small organizations can be expected to achieve better results in engaging in carbon footprint calculations in Lithuania. In particular, Lithuanian companies should take initiatives and implement the calculation of the carbon footprint. It would help for organization to achieve sustainable development, involving employees in the process, developing their motivation and loyalty. The results would improve the reputation (image) of the organizations, increase confidence, and serve as an example for other organizations. This is especially true for companies operating in the public and service sectors. An integrated assessment of the carbon footprint of small organizations would contribute to the development of eco-culture and the development of a public environmental awareness. At the national level, this will contribute to the achievement of the goals set for the reduction of GHGs.

Summing up the results of all work, it is important to emphasize that for small organizations, the CO_2 footprint report would not be the ultimate goal, but merely a means of achieving the long-term goals of sustainable development. With the methodology and explanations developed is indeed to enable small organizations, without significant investment, to supplement their human resources with their carbon footprint. Of course, this should be done through voluntary incentives and integrated into corporate management.

It could also improve the energy efficiency of businesses. In particular, companies are concerned about the reputation of the brand, even though consumers, at present, show only a limited willingness to pay for low-carbon goods. Although labels by themselves will not completely solve the problem of climate change, but the shrinking of the size of the consumer footprint suggests small changes in the buying behavior of consumers can bring a significant reduction in emissions of CO_2. It is also very important to evaluate and verify the carbon footprint index of products independently. The authors of this article are convinced that product carbon footprint certification will soon become an integral part of the universal quality certification system for goods and services.

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