

LIFE CYCLE ASSESSMENT AS TOOL FOR REALIZATION OF SUSTAINABLE DEVELOPMENT GOALS - TOWARDS SUSTAINABLE FUTURE OF THE WORLD: MINI REVIEW

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Abstract

“One planet, one main goal: good life for all”: it could be a motto of sustainable world. Sustainability is global mega trend in all fields of life to promote prosperity protecting our planet. Sustainable development is a requirement and a priority for all people all over the world. It is defined as development of the current world with a view to the future generations. In 2015, the UN Member States established Agenda 2030, including seventeen “Sustainable Development Goals”, SDG, which should be realized by 2030. Objectives scope all areas of life, namely quality of human life, ecosystem, world peace or partnerships. Each goal has an environmental context. According to the “United Nations Environment Program” (UNEP), Life Cycle Assessment (LCA) is a perfect method in the context of the environmental dimensions of the SDGs. The concept not only concerns the effects of the process/production system or the product/service but also all stages of its life (from cradle to grave), considering the carbon, environmental, consumer or biodiversity footprints. LCA is the only comprehensive eco-innovation indicator and policy implementation technique of sustainable development in companies in terms of eco-efficiency and eco-products. This mini review provides a survey of the current state of knowledge on sustainability and sustainable development as well as the relevance of new holistic methodology bridging SDGs with LCA, on the base of the newest scientific worldwide literature.

Keywords

Sustainability, sustainable development, methodology: Life Cycle Sustainable Assessment (LCSA), Sustainable Development Goals (SDGs)

Introduction

Our age is called *Anthropocene* defining by climate change, fast loss of biodiversity and natural resources. Nowadays, civilization, massive consumption, continuous development of industry and economy leads to very bad condition of our planet. Consequently, not only environmental but also economic and social dysfunctions cannot be overlooked [1,2]. Therefore, sustainability in all aspects of our life is necessary. Sustainable Development Goals (SDGs), established by all United Nations Member States, are a priority for sustainable development of the world, to improve quality of our planet, human life in all countries worldwide now and in the future [3]. This mini review is focusing on the state-of-the-art of diverse aspects of sustainability and sustainable development as well as its challenges and methodological approaches for the assessment of the sustainability. In this context, Life Cycle Sustainability Assessment (LCSA), should be highlighted as the most suitable tool helpful in the achievement of ambitious sustainability targets, considering potential applications of bridging this holistic method with SDGs. Briefly speaking, the concept of LCSA is based on the Life Cycle Thinking (LCT), directing thinking towards protection of ecosystem and shaping pro-ecological citizenships. LCSA is combining of environmental (Life Cycle Assessment - LCA), economic (Life Cycle Costs – LCC) and social (Social-Life Cycle Analysis - S-LCA) models of life cycle analysis.

LCA is standardized analytical method in the terms of combination and assessment of the inputs, outputs and potential impacts of products on environment in their life cycle, LCC takes into account all costs during the life cycle, while S-LCA includes social features related with entire life cycle. All of them are described in detail in the section entitled Results.

Our aim was directed into answering the main question - if this method is helpful and sufficient to realization of SDGs and identification other eventual useful tools and gaps in the scientific studies. More specifically, this mini-review provides an overview of the definition, evolution, scope, importance of sustainability for protection our planet and improving quality of life in relation to current and future generations, as well as development of methodologies used to realise sustainable targets. The main objectives of this paper are thorough survey of the scientific literature fulfilling the following certain criteria:

- clarifying definitions of sustainability, sustainable development and description of their evolution over the years,
- understanding the most important issues in the aspect of sustainable development,
- characterization of sustainable goals including identification of their main common context,
- -recognition among available tools useful in either qualitative or quantitative interpretation of results concerning environmental impacts of products/processes/organisations in the context of their life cycle,
- evaluation of the state of knowledge on the particular topics related to methodological concepts, identification their advantages and disadvantages, and gaps in the scientific literature, to formulate future research possibilities towards technical improvements.

Overall, the findings revealed that concept of Life Cycle Sustainable Assessment (LCSA) is the best complex strategy capable of integrating essential aspects leading to assessment of impacts on ecosystem during the entire life cycle and combining LCA with sustainable assumptions. Nevertheless, current method does not include sufficient data integrating all dimensions of sustainable goals. Therefore, future technical development into proposed novel LCA -SDGs methodology should put more emphasis on introduction into databases and calculations as many factors as possible providing holistic evaluation in terms of all sustainable goals. This mini-review is the first, on the best of our knowledge, on this range of main topic, consequently providing novelty into the LCSA state-of-the-art knowledge. More specifically, only materials of PRÉ-Sustainability company, which is working on new methodology, are available. In the scientific literature, suitable articles are lacking. Papers concerning LCSA aspects and selected issues of possible linking LCA with SDGs can only be found. We tried to examine the validity and accuracy of new proposed LCA-SDG technique on the base of collected all published information. Broadly speaking, this work may serve as background for further studies suggesting future directions.

The rest of the paper is organised as follows: methodological approach to literature overview, discussion of results of literature survey, including important issues in the range of topic, summary, impact and conclusions.

Methods

This article has character of usual mini-review focusing on the newest scientific articles scattered across the world literature. More specifically, the review process has been performed in the below described manner:

The first step towards planning the paper was directed to basic research questions. The overview is concerned about the relevance of global sustainability development in protection our planet, and innovative methods helpful in realization of sustainable goals. In this context, the three main research questions, are as follow:

- what is the reason, the characteristic landscape and result of sustainable development in a wider perspective?
- what are sustainable goals?
- what are the main techniques helpful in realisation of the global targets?

As regards the subsequent stages of review strategy, the expressions used to survey of suitable articles were: sustainability, sustainable development, Life Cycle Sustainable Assessment (LCSA), Sustainable Development Goals (SDGs).

We searched scientific articles, especially from the five last years since Sustainable Goals were reported. Next, for wider perspective and collection all available data, we included conference papers and other materials as well, published either in English, German or Polish. The actual data were the most interesting and important. Nevertheless, for deeper background and evolution of sustainability, we included papers published over the previous centuries as well.

The next step was collection of all information on new promising methodology combining LCA with SDGs. In this case, we extended literature survey to additional materials published mainly by PRé-Sustainability company, The Netherlands (but also OnePlanet and LCA Consultant), which is working on new methodology. Unfortunately, non-scientific key articles are visible. Therefore, we did not limit scope of literature survey. All kind of information (presentations, reports, bulletins etc.) published on the websites of this company were very valuable for preparing appropriate review. However, it should be highlighted that even such information is very rare.

To sum up, we used different web browsers. Nevertheless, mainly the Scopus database was helpful in the context of collection of scientific articles.

Results and discussion

Sustainability

The term “sustainability” (*sustinere* in Latin) means “to hold” (sub, under) in relation to improving quality of life with care for environment. The roots of this expression can be tracked back to the antiquity and the world of hunting [4,5]. Originally, sustainability was defined only in the context of effective use of natural resources by people in the long term. Its concept (*Nachhaltigkeit* in German) was applied to German forestry industry, in the 18th century [6,7]. In the book of Hans Carl von Carlowitz from Freiberg (in Saxony), entitled “*Sylvicultura Oeconomica* (or the *Economic News and Instructions for the Natural Growing of Wild Trees*), published in 1713, is described sustainability in the context of management and use of forests [8]. Furthermore, in another publication, *Instructions for the Taxation of Forests*, written by Georg Ludwig Hartig (from Gladenbach) in 1804, is also pointed that forest industry is based on the sustainability [7]. Nowadays, sustainability has more complex meaning in the context of climate, environment, economic and human development focusing on progress, responsibility, freedom and culture in sense of respect for nature [9]. Maxim of sustainability is “*living off the interest rather than the capital*”. Interestingly, Switzerland was the first country which introduced the expression “sustainability” to its constitution. In the article 2 we can read “*the Swiss Confederation supports the common welfare, the sustainable development, the internal cohesion and the cultural diversity of the country*” [6]. Sustainability can be considered in different aspects: welfare either people or other living organisms, in terms of relationship between current and future generations [10]. Sustainability is very popular trend all over the world in all fields of life. Therefore, sustainability science has been developed [11]. The problems of sustainability and identification of solutions helpful in achievement of sustainable development are the main challenge in this field. Sustainability is “life principle” in terms of responsibility for either people currently living or future generations [7,12]. It is either a mission or a survival strategy.

Sustainable development

The 21st century is the century of sustainable development [13]. Sustainability should be considered in the terms of synergy of human life and ecosystem quality, while sustainable development is the holistic approach, covering economic welfare, social equity and environmental quality, leading to resulting points of sustainability [14]. Sustainable development consists of two essential issues: development and sustainability. According to the dictionary, development is “*the process in which someone or something grows or changes and becomes more advanced*”, while sustainability is “*the quality of being able to continue over a period of time*”. The latter, in the environmental context is defined as “*the quality of causing little or no damage to the environment and therefore able to continue for a long time*”. Sustainability development can be expressed as economic development, while caring for the environment in relation to present and future generations [15–18]. In other words, it is sustainable improvement of living standards of people all over the world with care for natural resources, state of our planet, in the context of responsibility for future generations [19]. Notably, concept of sustainable development comes from economics [20]. Interestingly, the first consideration on limited natural resources for increasing population of people, started in the 1800s (Malthusian population theory) [21–24]. The need to sustainable development appeared together with the Industrial Revolution. Nevertheless, the first official declarations in the relation to sustainable development were in 1973, on the Congress entitled “*Growth and Its Implication for the Future*” [25]. In 1980, term “sustainable development” was officially introduced, and described as a global priority [26,27]. Sustainable development focuses on the balance among economic prosperity, protection of biosphere and quality life of people [28,29]. We should remember that either our survival or life of the future generation depends on responsible behaviour of all of us. Sustainable development is the key to a future better world [23,30]. The main principle is “*predict and prevent*”.

Interestingly, in the Polish legal system, in the article 5 of The Constitution of the Republic of Poland we can read: *“Poland ... ensures freedom, human rights and the security of citizens ... it ensures environmental protection on the basis of sustainable development”.... “In order to achieve sustainable development, states should: reduce or eliminate patterns of production and consumption that disrupt these developments, develop scientific knowledge in this area, and effectively ensure that everyone has adequate access to it information on environment and raise public awareness in this area” [31].*

Sustainable Development Goals

In 2000, the eight Millennium Development Goals (MDGs) were established. The headline target was the improvement of health, poverty, gender and social aspects. Nevertheless, the focus was on the environmental sustainability [32]. It was discussed at the Conference on Sustainable Development (Rio Earth Summit 2012). In consequence, it led to improved and extended Sustainable Development Goals (SDGs) [3,33,34]. In 2015, Agenda 2030 for sustainable development has been established, leading to better human life and ecosystem quality. The seventeen SDGs (including 169 targets and 230 indicators [35]) should be realized to 2030. The goals, listed in the Figure 1, are a roadmap and a call for all countries all over the world to the sustainable decisions and actions [35,36]. Notably, each aim has an environmental context.



Fig.1.Sustainable Development Goals [36]

Source: <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

Life Cycle Sustainability Assessment

Everything in nature has its own life cycle, from birth to death, namely man, animal or plant. Businesses, policies, technologies as well as products also have a life cycle in diverse meanings. In the latter case, life cycle consists of the following levels: introduction, growth, maturity, decline. According to the ISO, life cycle includes the corresponding stages of the production, from introduction of raw materials into processes to the final disposal/recycling of the product [37,38]. The concept of Life Cycle Thinking (LCT) focuses on the thinking about impact of everyday life to the environment in a holistic sense. We should be mindful of the fact that our behaviour, especially consuming products affects our planet. LCT is helpful in sensible decisions and actions leading to the reduction or elimination of negative impacts on the ecosystem and increase of the economic benefits within the entire life cycle [3]. Based on LCT, Life Cycle Management (LCM) and Life Cycle Sustainability Analysis (LCSA) were built to introduction of sustainable development-based knowledge useful in products' decision-making processes [39–42]. LCM is a management approach improving products/services within their life cycle. It is a manner of operationalizing sustainability in organizations (industrial and service sectors),

concentrating on internal operations, costs or risk management. From the holistic point of view, we can say about Life Cycle Sustainability Management (LCSM) [43]. Three main aspects of LCM are following strategies: environmental – known as Life Cycle Analysis, or as Life Cycle Assessment (LCA), economic – Life Cycle Costs (LCC) and social – Social-Life Cycle Analysis (S-LCA). Bridging all of them leads to Life Cycle Sustainability Assessment (LCSA) [44–47]. LCSA is a balance among environmental, social and economic dimensions of sustainability. All these methodologies are based on the ISO 14040 standards [38]. LCC is resulted to quantification of all costs during the life cycle (development, service, utility and recycling costs) [48], while S-LCA focuses on the social impacts over life cycle [49]. The latter is a method used for collecting and analysing data concerning real and potential socio-economic features related to products, processes and services within their life cycle [50]. LCA is analytical technique focusing on the identification, quantification and evaluation of the environmental impacts of a product/process/organization/man/service/activity in its all life cycle, from cradle to grave. Additionally, more circular aspect is considered, from cradle to cradle – in the case of product recycling (and its “new life”) [41]. Therefore, all life phases are included into analysis. In the case of product, it is extraction of raw materials, production, transportation, storage, use stages, recovery, reuse and disposal. Comparison of real and potential impacts of diverse products are also possible [51,52]. The concept of LCA has its roots in the 1960s in relation to packaging studies and energy use in the US and Northern Europe, in cooperation of universities and industry. The first results, related to energy requirements to produce chemicals, were presented on the World Energy Conference in 1963 [53]. Next, in 1969, Coca Cola company used LCA method to compare beverage containers. The methodology was evolved over the years, and standardised, namely ISO 14040, describing the principles and framework, namely the goal and scope definition as the first step of analytical procedure (ISO 14041), life cycle inventory, the life cycle impact assessment as the next two stages of analysis (ISO 14042) and the life cycle interpretation – final stage of analysis (ISO 14043). The compilation of the latter three was included into the ISO 14044 standard, which have additional aspects of analysis such as multi-functionality issues or allocation [23]. The method is very sensitive. The key, for appropriate results, is collection of all suitable data and precise definition of functional unit. The latter defines the qualitative features and quantitative aspects of the main function. It should answer basic questions such as “what?”, “how much?”, “how long”, “where” etc. More specifically, the functional unit is reference point for scope of analysis (which unit processes should be included/excluded) [10]. LCA identifies and quantifies environmental impacts of product/processes *via* impact categories. The environmental impact categories, grouping diverse emissions into the environment, are as follows: global warming, reduction of abiotic resources, eutrophication, acidification, eco-toxicity, human toxicity, ozone layer depletion, land use, photochemical oxidant formation, suspended dust and its effects on the respiratory system, ionizing radiation. These mid-points are further classified into three main damage (endpoints) categories such as eco-system quality, human health and natural resources [38,53,54]. Moreover, this method enables description of “footprint”. This term derives from literature: “*I was exceedingly surprised with the print of a man’s naked foot on the shore, which was very plain to be seen in the sand.*” [55]. It was adopted in the environmental science as “ecological footprint” by William Rees in 1992 [56]. It is an indicator helpful in monitoring human activities on natural environment. It was developed to water- [57], carbon- [58] or consumer footprint [59]. We can consider either product (PCF/PEF) – or organization carbon/environmental footprints (OCF/OEF) [60–64]. Footprints measure negative environmental (and social) impacts, while new indicators known as “handprints” define positive aspects in relation to sustainable development [65].

Additional aim is preventing footprints [66–69]. Besides, the product biodiversity footprint (PBF) is a novel approach linking the LCA and ecology to support *inter alia* eco-design. Comparative assessment of the environmental impacts of products/organizations on biodiversity is considered [70].

Furthermore, Life Cycle Engineering (LCE) should be mentioned. It focuses on the development of products and processes in a life cycle perspective towards more sustainable solutions in relations to either manufacturing or consumption [71].

Bridging SDGs and LCA: a new tool helpful in realization of sustainable goals

Realization of all 17 SDGs with 169 targets, and more than 200 indicators by the 2030, is a challenge. Therefore, proper strategy and methodology which could be helpful in sustainable decisions leading to realization of ambitious sustainable goals by the end of this decade is essential and prioritised. Different tools and innovative environmental technologies are tested thanks to the initiatives of the European Commission. However, only the life cycle approach is well-suited to addressing sustainability issues/problems [39].

- The *status quo* of relations between sustainable development (and SDGs) and LCA

LCSA is the best investigated, the most important, the most suitable and complex methodology, which includes sustainability aspects from a life cycle perspective. More specifically, LCA evaluates diverse environmental impacts within entire life cycle of product, process or organization, namely from cradle to grave, or at the corresponding stages of life cycle, in various system boundaries, such as from cradle to gate, from gate to gate or from gate to grave. In the case of life cycle of products we have the following stages: extraction of raw materials, processes/production, use of the product, recycling etc. In the case of life cycle of organization, stages from building, through its performance to liquidation, are analysed. Notably, sustainability assessment should be related to the three-bottom line framework: people, ecosystem and economy. It could be linked to Life Cycle Management (LCM), including social (S-LCA), environmental (LCA) and economic (LCC) aspects of life cycle-based methodology [72]. Therefore, LCSA is the best strategy for holistic quantification and evaluation of sustainability [42]. Furthermore, other concepts related to LCA are helpful for bridging product/processes/organization-based data and the targets of SDGs. As an example, LCT, concerning eco-thinking during life cycle, is central core concept for sustainability assessment towards ambitious targets [43,73–81]. Moreover, eco-efficiency is practical dimension of sustainability. It promotes transformation of unsustainable to sustainable development. It is based on the formation of more goods/services with less environment pollution [82]. It includes economic and environmental aspects into the product improvements. This concept is helpful in the measurement of the sustainable productions and selection of best-quality eco-solutions in organisations [82]. Footprints and handprints are additional issues in the scope of LCA. Footprint approach considers the negative, while handprints [65–67] - the positive contributions of products to sustainable development. Their practicability and flexibility are helpful in solving the social (and environmental) problems included in the plan of SDGs.

- Novel LCA-SDG methodology

In view of the above, philosophy of LCSA is a base of SDGs essence. LCSA can be useful tool to measure the progress of diverse activities and products into the SDGs. Relationship between SDGs and impact category groups (health, climate etc.) is obvious. In consequence, a life cycle SDG analysis could provide data for general impact either on sustainable well-being or on each of the SDGs. Linking the SDGs with LCA indicators is promising methodology useful in analysis of companies' contributions to the SDGs ("*SDGs + LCA = impact*"). The realization of SDGs will provide additional business value (increase sustainable development of organisations resulting in additional jobs, better quality of life etc.).

The project has been started by the UN Life Cycle Initiative. It is under administration of OnePlanet, LCA Consultants and PRé-Sustainability [83]. Currently, novel proposing methodology is still tested and developed [78,84], particularly in the context of data sources, and social features, and collection as well as proper combining the impact pathways with all 17 SDGs. It should be mentioned that LCA focuses *per se* on the business and individual products, while the SDGs – on governments at global (country) level [65]. Moreover, SDGs are rather qualitative, may overlap, interact or conflict with each other [65,83,85]. On the other hand, a new methodology it seems to be flexible in relation to corresponding goals. Specific practical tests are still performed. Method should provide framework for diverse kinds of impacts evaluation in diverse contexts of applications.

At the beginning, three major stages such as development of methodology, public consultation and businesses cases were considered.

More specifically, there are two possible variants of linking LCA with SDGs: A Life Cycle SDG screening (LCSS) and methodology LCA-SDGs. The first option qualitatively combines results of LCA with SDGs. In other words, LCSS is useful in identification of potential contributions (positive and negative impacts of organisations) to the SDGs. However, the second approach considers more comprehensive holistic integration of indicators related to all SDGs. The aim is more complete and consistent qualitative analysis of corresponding impacts. It is crucial for sustainable organizations.

Basically, analytical procedure of new methodology is similar to LCA, consisting of four main steps:

- 1-definition of goal & scope,
- 2-inventory analysis,
- 3-impact assessment,
- 4-interpretation of results.

Strictly speaking, in the first step, similar to traditional LCA, key elements, such as aim of analysis, analysed product, inputs, detailed definition of functional unit and the system boundaries, should be determined. The major questions are which SDGs, if/how/how much contribution of product to SDGs change during life cycle etc. The main sustainable aim is increasing/improving positive contribution of products to SDGs.

In the second step, collection of all suitable social and environmental data on the product system in the context of defined goal, and conversion data to a 5-point-scale of calculations are needed. The impacts (flows, inputs, outputs) on sustainable development are related with activities of people in the environmental (inputs from nature, emission to air, water, soil), economic and social dimensions (inputs from work, monetary flows, flows of unpaid goods/services). These human activities are quantified *via* indicators based on the SDGs (measured in the context of individual activity/organisation) [41].

The LCSA indicators can be divided into all (economic, emission and occupational indicator categories) or only specific organisations (supplying basic services, located in urban core regions, related with foods/beverages or bio-materials). In particular, these business-based inventory impact categories are as follow: economic, such as salaries, social costs, tax payments, rents etc., emission: harmful substances, radiation, noise, occupational: premature return to work, education in infective disease prevention etc. It is in progress and diverse cases are tested in practice in diverse conditions. On the other hand, majority but not all 17 SDGs can be well characterized by LCA indicators. Precise optimization of the diverse flows is still required.

In the next step of analysis, indicators as starting points and collected data of human activities are translated to impact scores related to midpoints and endpoints, which will be helpful in decision-making. The pathways of impacts as well as linking impact categories with SDGs are still ongoing.

In the final step, the results should answer the defined aim. Determination of results validity and uncertainty and data quality are needed. Life cycle SDG assessment provides quantitative results for the general impact on sustainable well-being, impact on all SDGs, their targets and indicators and for the contribution from all impact categories to mentioned earlier impacts [83].

The intention of Life Cycle-SDG-Assessment is to avoid gaps and overlaps, impact results in comparable units related to sustainable wellbeing (potential expression in monetary values) [83,85–91].

Due to multidimensional social systems, S-LCA, numerous and complex tests are necessary. Until quite recently, for the S-LCA significant differences had been observed, despite of only two indicator sets had shown only slight differences [41]. However, it gradually changes from year to year through introduction of high-quality indicators of social impacts in the context of products/processes as well as specialist databases [3,49,75,83,84]. Currently, in a capitalistic society, cities, communities, personal consumption, lifestyle of people, private households have a huge relevance in global gas emissions etc. [84]. SDGs include a more sustainable consumption. Therefore, the newest bottom-up concept – life-LCA is relevant for evaluation of whole human life and lifestyle, diverse impacts in all stages of their life, from birth to death [92]. On the other hand, it should be mentioned that Organizational Life Cycle Assessment method (O-LCA), including also social parameters, also is compiled [93,94].

Furthermore, another interesting issue is sustainability price as a new measure in relation to either social or environmental Life Cycle Costs towards a sustainable economy. It communicates the costs in relation to poverty and climate change in global supply chains. Sustainability price is the sum of the market price, additional price in terms of minimum social and environmental sustainability values [95].

To conclude, linking the impact categories with all sustainable targets and corresponding sub-targets, and selection of suitable indicators helpful in the holistic assessment of life cycle is key for new methodology. Notable progress on the development of new methodology by PRé Sustainability and 2.-0 LCA Consultants is reported [96–99]. A case studies on applicability new methodology are gradually presented, but only in selected aspects and initial insight into the results [84].

- Strengths of the LCA-SDG

The main strengths are as follow:

- it provides information on the real and potential (positive and negative) sustainability impacts, throughout entire life cycle,
- quantifies impacts in all dimensions of sustainability,

- is applicable to realization of sustainable goals, is holistic,
- integrated analytical approach in relation to corresponding sustainable targets and sub-targets,
- results support sustainable decisions via different ways,
- results can be reported in a comprehensible manner.

- Limitations

On the other hand, method also has shortcomings such as:

- huge diverse, multidimensional precise data needs,
- still relatively low maturity of S-LCA,
- uncertainties and sensitivity [42].

Impact

We summarized state-of-the art and importance of sustainable development. As pointed out at the beginning of this mini-review, sustainable development is a global priority in order to protect our planet and improvement quality of life, in relation to either current or future generations. Therefore, the establishment of the SDGs is crucial for all people all over the world. More explicitly, the paper reveals diverse methodological approaches to realization of these goals. Firstly, Life Cycle Assessment (LCA) as typical analytical tool provides information on potential impacts of products/processes/organizations on environment in either entire life cycle (from cradle to grave) or at the corresponding stages of the life cycle (e.g. from cradle to gate, from gate to gate, from gate to grave). The impacts are evaluated in three main damage categories such as human health, ecosystem quality and natural resources. More specifically, impacts can be categorized in diverse midpoint groups such as human toxicity, respiratory effects, ionizing radiation, ozone layer depletion, photochemical oxidation, aquatic ecotoxicity, terrestrial ecotoxicity, aquatic acidification, aquatic eutrophication, terrestrial acid, land occupation, global warming, non-renewable energy, mineral extraction. The next - social aspect is related with Social-Life Cycle Analysis (S-LCA), while economic - with Life Cycle Costs (LCC), including all social features and all costs during all life cycle of product, process or organization. These three concepts are described by Life Cycle Management (LCM). In addition, Life Cycle Thinking (LCT) as ecological thinking, helps to understand that all human activities have environmental impacts. It should be holistic thinking during entire life cycle and clear connection of all mentioned strategies with sustainability philosophy has been identified leading to Life Cycle Sustainable Assessment (LCSA). More analytically, every methodology has relevance and is rather complementary than competitive. In consequence, LCSA is perfect tool for realization of sustainable goals. Nevertheless, introduction of specific algorithms and parameters helpful in proper assigning potential impacts to all seventeen sustainable goals leading to correct results and interpretation, is required. In consequence, innovative methodology, called LCA-SDGs has been proposed. Added value will be not only qualitative but also quantitative holistic assessment within the entire life cycle of product or organization. The newest forms of LCA such as *inter alia* Life-LCA (LLCA), providing advanced diverse social parameters, either at the regional or at the global level, will complement studies. The results obtained from the innovative method will be valuable in making reasonable sustainable decisions. Nevertheless, it is under development. A lot of data is needed to build specialistic databases, which are compiled with the program. None of key aspects should be neglected. This work will have additional impact in popularization of new methodology, and consequently acquisition of valuable information in advanced further studies. This first, to our best knowledge, attempt to gather and analyse the knowledge in this topic is helpful, particularly as realization of SDGs is in the global priority list by the end of this decade. Moreover, we emphasize that behaviour of each of us, in daily life, has impact on quality of our planet and sustainable future of the world.

The willingness to change life, acceptance of an appropriate hierarchy of values that will shape pro-ecological attitudes in the context of life cycle thinking are key for the common good. A lifestyle changes in the context of reduction of consumption, saving, could have global benefit. To sum up, sustainable behaviour of people and the use of LCA-based concepts, and new methodology combining SDGs with LCA in a holistic way will have a great environmental, social and economic impact in effective progress to reach the global targets. Future research efforts should be directed towards incorporating as many diverse descriptors as possible, which will result in establishing quantitative criteria and construction multidisciplinary results.

This kind of review focusing on the innovative methodology, which is still under development, but extremely required in realization of sustainable goals by 2030 towards sustainable future of the world, is lacking, thus providing novelty.

Conclusions

Bad condition of our planet calls all of us to pro-ecological actions towards sustainable development of the world. Sustainable Development Global Goals should be realized to 2030, for this purpose. All seventeen goals have environmental context. Core concept could be described as *“one planet, one main goal: good life for all”*. Hence, effective assessment tools helpful in sustainability concrete decisions to reach ambitious targets and sub-targets is needed. LCSA, the best known and investigated analytical complex method in relation to entire life cycle, which supports environment, economic and social dimensions of sustainable development, can be helpful in suitable identification and assessment of diverse impacts in relation to the corresponding SDGs. On the other hand, SDGs and LCA seems to be in conflict because the SDGs focuses on a macro-level (improvement of world), while LCSA - on micro level (evaluation of potential environmental impacts of particular products or organisations). SDGs were not related with business, and consequently difficult to effective measurement and results control. Nevertheless, common points were found, and linking the LCA indicators with corresponding SDGs by specialist data conversion were possible. Universal and flexible character of LCA-SDGs enables its applicability in diverse branches. Results obtained by novel LCA-SDG methodology will be helpful in sustainable decision-making, and consequently realization of ambitious global goals, including improvement quality of eco-system (and care about renewable energy), fight against unsustainable aspects in society (e.g. poverty or hunger) as well as better human well-being. The innovative LCA-SDGs methodology useful for measuring and reporting on companies' contributions to the SDGs is nearly ready, but still under development. The main disadvantage (except uncertainties as an integral part of each analysis) is the fact that a huge diverse data is required. Proposed method combines all aspects (environmental, social, economic) of sustainable development with actions of organisations. In the nearest future, continuous improvement and expansion of impact channels among indicators and SDGs are needed. Moreover, methodology focuses mainly on reduction of negative impacts of organisations. Therefore, analytical side should be expanded to additional solutions leading to obtainment of positive impacts as well. Deadline of realisation of SDGs towards sustainable global future is getting closer and closer. This mini-review as recommendation of new methodology possessing high innovation's potential to reach SDGs can leads to increase its popularity and consequently more advanced study on inventory indicators essential for proper holistic evaluation before its implementation.

Conflict of interest

There are no conflicts to declare.

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