Kuwait Chapter of Arabian Journal of Business and Management Review, 12(2),2023,51-55
ISSN: 2617-3018
Open Access Journal

Arabian Journal of Business and Management Review (Kuwait Chapter)

Research Article | Homepage: www.arabianjbmr.com | AOJP

Social Life Cycle Assessment in Solar Dryer House for Postharvest Loss Management Technology: Application of UNEP / SETAC in Tanzania

Francis Mwaijande [1], Eliaza Mkuna[2], Ashiraf Abeid [3], Felichesmi Lyakurwa[4], Joseph Sungau [5] and Shokri Manouchehr [6]

[1] *Mzumbe University; mwaijandef@gmail.com*
[2] *Mzumbe University; ejmkuna@mzumbe.ac.tz*
[3] *Mzumbe University1; ahabeid@mzumbe.ac.tz*
[4] *Mzumbe University; fslyakurwa@mzumbe.ac.tz*
[5] *Mzumbe University; jsungau@mzumbe.ac.tz*
[6] *Aachen University; manouchehr.shokri@inab.rwth-aachen.de*

ABSTRACT

Social Life Cycle Assessment is inherently an extension of sustainability assessment that is limited to environmental and economic pillars. Social life cycle assessment (S-LCA) on the other hand is a methodology used to cover the social aspects of sustainability. This article integrates three pillars of sustainability; economy, environment and society on Solar Dryer House technology for reduction of post-harvest losses. The purpose of the article is to examine the extent of sustainability of Solar Dryer House technology by exploring the environmental, economic and social pillars. A textual analysis was undertaken on United Nations Environment Program/Society for Environmental Toxicology and Chemistry (UNEP-SETAC) Life Cycle Initiative to examine the social life cycle assessment of SDH manufacturing technology on major categories of producers, workers, distributors, consumers. Analysis of social indicators were developed with the scoring system to describe the potential positive and negative social impacts on related stakeholders within life cycle stages. Lack of clarity in conceptualizing of UNEP-SETAC Life Cycle Initiative to examine the social life cycle assessment of SDH manufacturing technology limit the application of sustainability assessment on manufacturing technologies in Tanzania. Social Life Cycle Assessment supports social and labour policies as well as Sustainable Development Goal 8 which entails that people should have jobs that pay decently to support their livelihoods while other social welfare aspects and labour rights are considered. Manufacturing technologies that adhere to S-LCA principles guarantee sustainability.

Keywords:
Social Life Cycle Assessment, Solar Dryer House, Loss Management Technology, UNEP, SETAC

Article History:
Received: 12 Nov 2023
Accepted: 15 Mar 2024
Available Online: 05 Apr 2024

1. INTRODUCTION

Concept of sustainable development evolved in the commonly known as the Brundtland report following the United Nations Conference on Environment and Development (UNCED) in Río de Janeiro (1992) (Heijungs et al., 2010). This report defines sustainability as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Hajian & Kashani, 2021). Sustainability of has become an important scientific methodological tool for assessment of sustainability of technologies, products and services using methodology such as Environmental Accounting, Environmental Management Accounting (EMA), Life Cycle Sustainability Assessment (LCSA) and Social Life Cycle Assessment (S-LCA) (Cinelli et al. 2013). Sustainability is aligned to impact on three pillars: economic, social, and environmental impacts (Valdivia et al., 2021). These pillars of sustainability are used for products' assessment as well as on systems and services in the sense of understanding impact to "People, Planet, Profit" , where People refers the social pillar, Planet refers the environmental pillar, and Profit refers the economic pillar (Heijungs et al., 2010). Solar Drier House is one of the emerging cleaner energy technologies for reducing postharvest loss responding to climate change challenges. Climate change brought challenges of drying crops to the maximum moisture content requirements. Solar drying technology provides solutions to the challenges of climate change using the cleaner energy. Thus, solar dryer house provides an alternative solution to the world's food and energy crises (Burade et al., 2017). Post-harvest losses (PHL) constitute a global problem because food losses and waste which are estimated at 1.3 billion tons per year (Osabohien, 2022; Akpa et al., 2023). While global population is on the increase and is estimated to rise to 9 billion by 2050 (United Nations, 2021) addressing food post-harvest loss becomes necessary. With the increasing population globally, the looming food crisis may be managed by increasing food production commensurate population growth (FAO et al., 2019; Osabohien, 2022) as well as adopting environmentally sustainable post-harvest loss technologies (Fernandez et al., 2021). Post-harvest food loss poses a threat to the actualisation of the United Nations (UN) Sustainable Development Goals (SDGs) of no poverty (SDG1) and food security (SGD2) (United Nations, 2021). Life cycle Assessment (LCA) methods are adopted to evaluate sustainability. Among these, and of particular significance, is the Social Life Cycle Assessment (S-LCA) (Arcese et al., 2013) to support policy decision making. The manufacturing of Solar Drier House use a selection of variety of raw materials including iron, aluminum, wood, plastics, glass, cement in a combination of various types of energy such as electricity generated from hydropower or gas. The raw materials that are depleted over years and generate emissions thus risking sustainability.

2. DESCRIPTION OF SOLAR DRYER

The construction of solar dryer consumes raw materials such as wood (Lobsiger-Kägi et al., 2018), steel pipes, iron sheets, aluminum, sand, cement, etc which has adverse effects to environment. The construction of SDH in Tanzania takes aluminum, steel pipes, electricity, sand and cement.

Table 1. Materials for Construction of Solar Dryer House

Materials/fuels	Measurement	Quantity	Comment
Aluminum alloy, AlLi {GLO}| market for | APOS, U	7.6	kg	Undefined
Flat glass, coated {GLO}| market for | APOS, U	0.8	kg	Undefined
Agricultural machinery, tillage {GLO}| market for | Conseq, U	0.0006	kg	Undefined

Electricity/heat			
Electricity, medium voltage {TZ}| market for | APOS, U	1	kWh	Undefined
Diesel, burned in agricultural machinery {GLO}| diesel, burned in agricultural machinery | APOS, U	0.7	MJ	Undefined
Waste to treatment			
Waste aluminum {RoW}| treatment of, sanitary landfill | APOS, U	0.6	kg	Undefined
Inert waste, for final disposal {RoW}| treatment of inert waste, inert material landfill | APOS, U	0.1	kg	Undefined

A case study of SDH describes the Social-Life Cycle Assessment of SDH in Tanzania in the contexts of sustainable development. Social Life Cycle Assessment (S-LCA) is a methodology to assess the social impacts of products and services across their life cycle (UNEP, 2009). It has becomes a useful framework for sustainability assessment of products and services (Kalvani et al., 2021). S-LCA include the social dimension to examine the subcategories related to impact on labor conditions, local community conditions, consumers' well-being (Manik et al., 2013; UNEP, 2009). Social life cycle assessment therefore guides social impact evaluation on stakeholders throughout the life cycle of production and consumption. Solar dryer house temperature ranges between 20 – 59.5°C, 21.5 - 68°C, and 25-78°C with average relative humidity of 71.64%, 60.21%, 49.77% capable to dry cereals, chilli pepper, yam, fish, vegetables and spices in a period of 5 days (Ade et al., 2018). The socio-economic value of solar dryer enables farmers to dry food products without degrading contents, enables seasonal products to be sold at any time of the year at a cost that is higher than cost of the original fresh product without any fear of climate change (Bishwash et al., 2017).

Figure 1. Solar Dryer House

Many scholars have examined the Life Cycle Assessment (LCA) of Solar Dryer House and the environmental (Bishwash et al., 2017; Burade et al., 2017; Fudholi et al., 2018) and most scholars (Dreyer et al., 2006; Finkbeiner et al., 2010; Kalvani et al., 2021) have studied the Social Life Cycle Assessment (S-LCA) of products and services other than SDH. Thus, there is inadequate evidence on the Social Life Cycle Assessment of Solar Dryer House Solar Drier House used for postharvest losses management. One of the reasons is a lack of a methodological framework for the analysis of social dimensions in the value chains for estimating the social impacts of technical innovations. S-LCA divides impact on stakeholders to include; impact on workers, local communities, consumers, society, value chain actors, human rights, health and safety, working environment, and governance (Kalvani et al., 2021; UNEP, 2009). The purpose of S-LCA is to evaluate the social aspects associated with the life cycle of goods and services (Corona et al., 2017).

3. METHODS

The United Nations Environment Program/Society for Environmental Toxicology and Chemistry (UNEP-SETAC) Life Cycle Initiative (UNEP-SETAC Life Cycle Initiative 2009) are the protagonist and developer of S-LCA procedures. The S-LCA methodology described in the UNEP-SETAC Guidelines methodology ISO 14040 and 14044 consists of four interconnected phases: goal and scope; inventory analysis; impact assessment; and interpretation (Corona et al., 2017). This study use UNEP-SETAC guidelines (UNEP, 2009) for Social life cycle assessment (S-LCA) in the context of sustainable development which follows key steps of defining the goal and scope, developing and weighting the criteria and assessing the criteria. We adopt ISO 14040 framework for the elaboration of S-LCA thus we consider four phases: Goal and Scope, Life Cycle Inventory, Life Cycle Impact Assessment and Interpretation (UNEP, 2009) (Fig. 2).

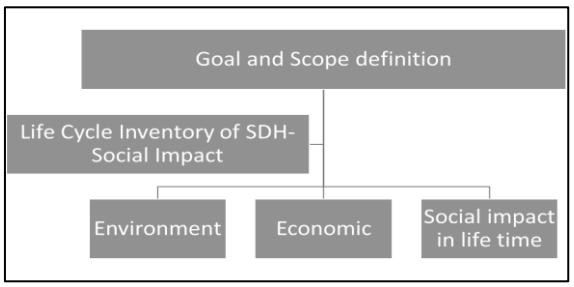

Figure 2. S-LCA Basic Steps

A Boolean search query technique was used that key words "S-LCA" + "Solar" + "Dryer"+ "House" + "postharvest" + "Loss management" conducted in Environmental science database. The search string comprised social life cycle assessment, "Solar"+ "Dryer" AND "posthavest loss"+ "technolog*"

The S-LCA methodology requires an examination of social impact assessment of products and services adopting the Life Cycle Assessment (LCA). (Kloepffer, 2008) suggests a conceptual formula for sustainability assessment that account for a life cycle sustainability assessment (LCSA), a life cycle assessment (LCA), life cycle costing (LCC) and a social life cycle analysis (SLCA) represented as: LCSA= LCA + LCC + S-LCA.

Since a United Nations Environment Programme / Society of Environmental Toxicology and Chemistry (UNEP/SETAC) Life Cycle Initiative guidelines provide a framework to assess social impacts across product life cycles (Benoit-norris et al., 2012; Benoît-Norris et al., 2011; UNEP, 2009), we apply UNEP / SETAC to examine the social life cycle assessment of SDH manufacturing technplogy on categories including producers, workers, distributors, consumers. Different subcategories and social indicators were developed with the scoring system to describe the potential positive and/or negative social impacts on related stakeholders within life cycle stages. Also the framework for the Social Life Cycle Assessment of product value chains follows the research stages to identify the main social issues and indicators for a Life Cycle Assessment (Reinales et al., 2020). The developed subcategories became the base for S-LCA of SDH because they are the items on which justification of inclusion or exclusion needs to be provided and they are assessed by the use of inventory indicators. The relationship among stakeholder group and impact categories is defined by the United Nations Environment Programme classification (UNEP, 2009), whereby stakeholder categories impact subcategories that comprise socially significant attributes. These subcategories are assessed by the use of impact indicators whose inventory indicators link directly with the inventory of the product life cycle (UNEP, 2009; Wu et al., 2014). Studies of (Martucci et al., 2019) developed a similar methodological framework for the Italian wine sector by defining the social impacts and indicators applying the Social Life Cycle Assessment methodology for identification of the social impact in the wine production sector.

3.1 Research questions

1. What social criteria are most relevant to assess sustainability of Solar Dryer House technology?
2. What sustainability pillars rventions in Solar Dryer House technology?
3. What UNEP/SETAC Guidelines address S-LCA in Solar Dryer House technology?

4. RESULTS

Stakeholder analysis involved identification and mapping of stakeholders using solar dryer house (SDH) for reduction of post-harvest loss and enhancing food and nutrition insecurity. A power- influence matrix (Fig.3) maps out stakeholders using SDH as a cleaner energy technology.

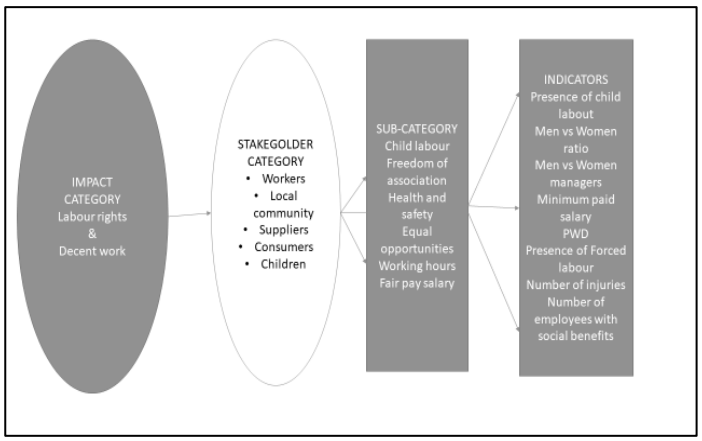

Figure 3. S-LCA of SDH Technology
Source 1: Adopted from Corona, C. et al , 2017

Sustainability assessment of SDH for Post-Harvest Management Technology in Tanzania takes into consideration on its environmental, economic and social impact on stakeholders, who include SMEs owners-investors, traders, farmers, workers, Government (Ministry of health, agriculture), labor (unions, medical associations), private sector for-profit and non-governmental organizations (NGOs). The adoption of UNEP methodology gives us the stakeholder categories with significant social significance results as indicated in Table 2.

Table 2. Social Life Cycle Assessment of Solar Drier House

Stakeholder's category	Impact category	Subcategories	Inventory data source
Local community	Engagement	Local employment	Company website
		Local supplies	
Society	Human rights	Freedom of association	National policy Company regulations
		Right to organize and collective bargaining	
		Abolition of child labour	
		Abolition of forced labour	National policy Company regulations
Workers	Health and safety	Health Insurance	
		Protective gears	
	Equal opportunities	Gender inclusion, diversity	National policy Company regulations
	Decent job		National policy
Consumers	Cultural aspects	Perception on end product quality on performance	National policy Company regulations
		Convenience	
Value chain actors	Governance		National policy Company regulations
Technology adoption	SMEs		
	Farmers (consumers)		National policy Company regulations
	Certified environmental impact assessment	Ecolabelling	National policy Company regulations
	Investment on SDH technology		
End-of- Life Responsibility	Waste management		National policy Company regulations
	Information on product end-of-life		National policy Company regulations

The concept of sustainability was coined and known as the development that is capable to cover today's needs of environment, social justice and economic prosperity without compromising the ability of future generations to meet their needs (Finkbeiner et al., 2010; Jørgensen et al., 2010). The contemporary sustainability research considers the environment, economic and social impact of development such as the SDH technology for the reduction of post-harvest loss. (Toboso-Chavero et al., 2021) argue that the social dimension of sustainability captures the impact of an organization, product or process on society that can be estimated by analyzing the effects of the organization on stakeholders at local, national and global levels. UNEP guidelines for Social Life Cycle Assessment of Products provides the generic methods for conducting S-LCA. However, the guidelines do not sufficiently address the sustainability social context in Africa. The next section presents UNEP guidelines for Social Life Cycle Assessment of Products and its suitability for assessing post-harvest technologies in Africa.

5. PROCESS

Identification: The identification and elaboration of a stakeholders in the SDH industry

Definition: Definition and scope of social impact categories/subcategories and social indicators for the SDH was done covering (i) geographical relevance, (ii) data availability and (iii) bibliography validation. Tanzania labour law and the Sustainable Development Goal (SDG) guided the framework for decent jobs and equal opportunities, child labour protection, and gender inclusion. The social indicators subcategories selection considered social protection and benefits policy related actions. Specific factors for health and safety issues at work place were examined in the SDH technology and manufacturing in accordance to Tanzania labour law.

End –of-Life Assessment: Assessment of the end-of-life performance by means of improving recyclability and recycling.

Goal of the Social Life Cycle Assessment was to assess the social aspects of SDH based on the scoring system on a five-point scale between -2 and +2, where 0 represents the baseline conditions, positive values represent an improvement and negative values represent a deterioration in comparison with the baseline conditions.

6. DISCUSSION

There has been technological development to address postharvest loss including the Solar Dryer House. These technologies are developed in the context of sustainable development whose goal is to achieve and sustain human well-being, while considering the needs of current and future generations (UNEP, 2009). Scientists and scholars have developed methodologies for sustainability assessment for products and services to support policy making and decision making for three pillars of sustainability (i.e. environmental, economic and social). Social Life Cycle Assessment is one of the adopted methodologies that facilitates organizations to be socially responsible when conducting their business and operations by providing information about the potential social

impacts on people caused by the activities in the life cycle of their products or services(Dreyer et al., 2006). Considering SUGECO as an organization producing Solar Dryer House (Product), their business operations have potential social impact to workers, communities, consumers and all other actors in the value chain as S-LCA adds indicators of human wellbeing that are influenced by processes or companies in supply chains, such as worker's rights, community development, consumer protections, and societal benefits (Benoit-norris et al., 2012). The potential social impact of SDH produced by SUGECO to the agriculture value chain begins with workers, all employees are employed under the ILO conventions and the National Employment Policy.

ILO has set minimum standards of basic labour rights in countries including the human rights in a labour market stipulated as Freedom of Association and Protection of the Right to Organize Convention (No. 87) Right to Organize and Collective Bargaining Convention (No. 98) (ILO - International Labour Office, 2015; URT, 2008). Tanzania National Employment Policy 2008 (3.21) guides institutions and employers on labour rights. We examined freedom of association and collective bargaining at SUGECO and found that there is SUASA, an association for employees which organizes for collective bargaining on the social welfare of employees. ILO convention on Forced Labour Convention (No. 29) and Abolition of Forced Labour Convention (No. 105) restricts employment of children (ILO -International Labour Office, 2015). Tanzania National Employment Policy 2008 (3.22) guides institutions and employers on elimination of child labour (URT, 2008). Our assessment at SUGECO found that workers on SDH are graduates of Sokoine University of Agriculture who enters after completing their university programmes at the age of 23 years. S-LCA contributes to informed policy decision making on selecting policy options and decisions that brings optimal value on sustainable development (Kalvani et al., 2021). The UNEP/SETAC provides methodological sheets for subcategories of S-LCA of products like SDH (UNEP/SETAC 2009) that aim to describe the impact on basis of S-LCA. The subcategories are socially significant attributes classified according to stakeholder groups and impact categories. A social life cycle assessment organizes subcategories according to both stakeholders and impact categories (Fig. 3).

7. POLICY RELEVANCE

The policy relevance of this article is on the attainment of Sustainable Development Goal 5 whereby SDH technology observes gender equality in the value chain; it responds to Sustainable Development Goal 8 seeking for decent work and economic growth in the SDH value chain; and Sustainable Development Goal 12 of having responsive consumption and production. This article also describes the subcategory connects to potential positive or negative development outcomes and how management strategies may either encourage or discourage sustainable development through use or misuse of local material resources sustainably. S-LCA practice in SDH manufacturing is confined to the Universal Declaration of Human Rights, the ILO Prevention of Major Industrial Accidents Convention as well as the Tanzania Employment and Labour Relations Act 2004 on prohibition of child labour, Employee's right to freedom of association , Prohibition of discrimination in the workplace , working hours and Occupational Safety and Health.

8. CONCLUSIONS

Solar drying technology is one of the emerging cleaner energy with potential solutions to climate change and post-harvest loss solutions. This paper examines the social aspects in the adoption and use of SDH. It contributes to the understanding and application of the S-LCA methodology in Africa where post-harvest loss technologies are highly needed. The methodology relies the UNEP guidelines to take into consideration of sustainability assessment of products and services. While the environmental and economic impact of Solar Drier House are well known and covered, the social impact are rarely considered. This paper presents the social effect dimensions of SDH covering the effect on employment, health and safety of workers, workers' rights and all that stipulated in the UNEP guidelines. Solar Drier House technology for drying crops uses cleaner energy sources that is abundant in Africa. The UNEP guidelines manufacturing of SDH makes use raw materials that has environmental, economic and social impact. This paper contributes to the understanding and application of the S-LCA methodology in Africa where post-harvest loss technologies are highly needed. The methodology relies the UNEP guidelines to take into consideration of sustainability assessment of products and services. While the environmental and economic impact of Solar Drier House are well known and covered, the social impact are rarely considered. This paper presents the social effect dimensions of SDH covering the effect on employment, health and safety of workers, workers' rights that must be stipulated in the National Postharvest Loss Management Policy in Tanzania.

Funding

Authors are members of the TeTraPHar Africa project funded by the German Federal Ministry of Education and Research in Tanzania in partnership with RWTCH Aachen University. This paper benefited from the TeTraPHar activities. We thank Institute of Sustainability in Civil Engineering, RWTH University for the knowledge and technology transfer that has contributed to the advancement of sustainability assessment methodology.

Conflicts of Interest

Authors declare no conflict of interest of any kind, personal circumstances or interest that may be perceived as inappropriately influencing the representation or interpretation of reported research results.

REFERENCES

Ade, A. R., Olayemi, F. F., Adebiyi, A. O., Zubair, O. M., Adeiza, O. A., & Achime, K. C. (2018). Recent Advances in Solar Drying of Agricultural Produce in Nigeria: Nspri Experience. *Food Sufficiency AZOJETE*, *14*, 86–94. www.azojete.com.ng

Arcese, G., Lucchetti, M. C., & Merli, R. (2013). Social life cycle assessment as a management tool: Methodology for application in tourism. *Sustainability (Switzerland)*, *5*(8), 3275–3287. https://doi.org/10.3390/su5083275

Benoit-norris, C., Cavan, D. A., & Norris, G. (2012). *Identifying Social Impacts in Product Supply Chains: Overview and Application of the Social Hotspot Database*. 1946–1965. https://doi.org/10.3390/su4091946

Benoît-Norris, C., Vickery-Niederman, G., Valdivia, S., Franze, J., Traverso, M., Ciroth, A., & Mazijn, B. (2011). Introducing the UNEP/SETAC methodological sheets for subcategories of social LCA. *International Journal of Life Cycle Assessment*, *16*(7), 682–690. https://doi.org/10.1007/s11367-011-0301-y

Bishwash, H., Bobadi, S., & Nikam, M. (2017). *Design and Material Optimisation of a Solar Dryer - Tray Section*. *137*, 27–34. https://doi.org/10.2991/iccasp-16.2017.5

Burade, P. N., Dongre, R. M., Thomas, S., Tamgadge, S., & Mandavgade, N. K. (2017). Application of Solar In Food Dryer-A Literature Review. *International Journal of Innovations in Engineering and Science*, *441*(11), 2456–3463. www.ijies.net

Corona, B., Bozhilova-Kisheva, K. P., Olsen, S. I., & San Miguel, G. (2017). Social Life Cycle Assessment of a Concentrated Solar Power Plant in Spain: A Methodological Proposal. *Journal of Industrial Ecology*, *21*(6), 1566–1577. https://doi.org/10.1111/jiec.12541

Dreyer, L. C., Hauschild, M. Z., & Schierbeck, J. (2006). A framework for social life cycle impact assessment. *International Journal of Life Cycle Assessment*, *11*(2), 88–97. https://doi.org/10.1065/lca2005.08.223

Fernandez, C. M., Alves, J., Gaspar, P. D., & Lima, T. M. (2021). Fostering awareness on environmentally sustainable technological solutions for the post-harvest food supply chain. *Processes*, *9*(9). https://doi.org/10.3390/pr9091611

Finkbeiner, M., Schau, E. M., Lehmann, A., & Traverso, M. (2010). *Towards Life Cycle Sustainability Assessment*. 3309–3322. https://doi.org/10.3390/su2103309

Fudholi, A., Ridwan, A., Yendra, R., Desvina, A. P., Bin, M. K., & Fudholi, A. (2018). *Solar Drying Technology in Indonesia : an Overview*. *9*(4), 1804–1813. https://doi.org/10.11591/ijpeds.v9.i4.pp1804-1813

Hajian, M., & Kashani, S. J. (2021). Evolution of the concept of sustainability. From Brundtland Report to sustainable development goals. In *Sustainable Resource Management: Modern Approaches and Contexts* (pp. 1–24). Elsevier Inc. https://doi.org/10.1016/B978-0-12-824342-8.00018-3

Heijungs, R., Huppes, G., & Guinée, J. B. (2010). Life cycle assessment and sustainability analysis of products, materials and technologies. Toward a scientific framework for sustainability life cycle analysis. *Polymer Degradation and Stability*, *95*(3), 422–428. https://doi.org/10.1016/j.polymdegradstab.2009.11.010

ILO -International Labour Office. (2015). *Compendium of international labour conventions and recommendations Compilation of international labour Conventions and Recommendations*. http://www.ilo.org/wcmsp5/groups/public/---ed_norm/---

normes/documents/publication/wcms_413175.pdf
Jørgensen, A., Finkbeiner, M., Jørgensen, M. S., & Hauschild, M. Z. (2010). Defining the baseline in social life cycle assessment. *International Journal of Life Cycle Assessment*, *15*(4), 376–384. https://doi.org/10.1007/s11367-010-0176-3
Kalvani, S. R., Sharaai, A. H., & Abdullahi, I. K. (2021). Social consideration in product life cycle for product social sustainability. *Sustainability (Switzerland)*, *13*(20). https://doi.org/10.3390/su132011292
Kloepffer, W. (2008). Life cycle sustainability assessment of products (with Comments by Helias A. Udo de Haes, p. 95). In *International Journal of Life Cycle Assessment* (Vol. 13, Issue 2). https://doi.org/10.1065/lca2008.02.376
Lobsiger-Kägi, E., López, L., Kuehn, T., Roth, R., Carabias, V., & Zipper, C. (2018). Social life cycle assessment: Specific approach and case study for Switzerland. *Sustainability (Switzerland)*, *10*(12). https://doi.org/10.3390/su10124382
Manik, Y., Leahy, J., & Halog, A. (2013). Social life cycle assessment of palm oil biodiesel: A case study in Jambi Province of Indonesia. *International Journal of Life Cycle Assessment*, *18*(7), 1386–1392. https://doi.org/10.1007/s11367-013-0581-5
Martucci, O., Arcese, G., Montauti, C., & Acampora, A. (2019). Social aspects in the wine sector: Comparison between social life cycle assessment and VIVA Sustainable wine project indicators. *Resources*, *8*(2). https://doi.org/10.3390/resources8020069
Reinales, D., Zambrana-Vasquez, D., & Saez-De-Guinoa, A. (2020). Social life cycle assessment of product value chains under a circular economy approach: A case study in the plastic packaging sector. *Sustainability (Switzerland)*, *12*(16). https://doi.org/10.3390/su12166671
Toboso-Chavero, S., Madrid-López, C., Villalba, G., Gabarrell Durany, X., Hückstädt, A. B., Finkbeiner, M., & Lehmann, A. (2021). Environmental and social life cycle assessment of growing media for urban rooftop farming. *International Journal of Life Cycle Assessment*, *26*(10), 2085–2102. https://doi.org/10.1007/s11367-021-01971-5
UNEP. (2009). Guidelines for Social Life Cycle Assessment of Products. *Management*, *15*(2), 104. http://www.unep.fr/shared/publications/pdf/DTIx1164xPA-guidelines_sLCA.pdf
URT. (2008). *National Employment Policy*. Government Printers.
Valdivia, S., Backes, J. G., Traverso, M., Sonnemann, G., Cucurachi, S., Guinée, J. B., Schaubroeck, T., Finkbeiner, M., Leroy-Parmentier, N., Ugaya, C., Peña, C., Zamagni, A., Inaba, A., Amaral, M., Berger, M., Dvarioniene, J., Vakhitova, T., Benoit-Norris, C., Prox, M., … Goedkoop, M. (2021). Principles for the application of life cycle sustainability assessment. *International Journal of Life Cycle Assessment*, *26*(9), 1900–1905. https://doi.org/10.1007/s11367-021-01958-2
Wu, R., Yang, D., & Chen, J. (2014). Social life cycle assessment revisited. *Sustainability (Switzerland)*, *6*(7), 4200–4226. https://doi.org/10.3390/su6074200