

DELIVERABLE 7.3

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1. Executive Summary

In order to provide quantitative and qualitative information on the third pillar of sustainability (i.e. social field) of the proposed products of the NanoPack project, this report aims to complement the sustainability approach by analyzing the potential social impacts (e.g. health and safety, jobs creation, working conditions, well-being). This methodology is aligned with environmental and economic assessments developed in WP7. The information obtained will complement these mentioned analyses.

The positive results of this study will migrate preference to the NanoPack models, aiming to build a fruitful strategy to increase both retailers and consumers' acceptances of NanoPack bioactive packaging (as inputs for WP8). The Health & Safety assessment over this deliverable will be fed into the human and environmental risk assessment analysis (WP6).



2. Introduction

The social impacts are consequences of positive and negative influences on social endpoints (i.e. well-being of stakeholders). These are understood as consequences of social interactions meshed in the context of an activity (e.g. production, consumption or disposal) and/or induced by it and/or by preventive or reinforcing actions taken by stakeholders (for instance, reinforcing safety measures in a manufacturing plant).

In order to evaluate the social impact, the Social Life Cycle Assessment (S-LCA) has been developed in recent years as a methodological approach to assess the positive and negative social aspects in the life cycle, from the extraction of raw materials stage until the final disposal of a product (Benoit et al., 2010). This category of study is still in development and there is a lack of case studies on packaging (Zamagni et al., 2011; Vinyes et al., 2013). In the same line, this method can be used to determine, to understand, to communicate and to demonstrate the social impacts, for supporting the implementation of the improvement strategies. This kind of study might be also used to help the decision-making procedures, such as choice of supplier.

The argument on how to implement the social and socio-economic criteria into the LCA began in the Society of Environmental Toxicology and Chemistry (SETAC) workshop in 1993 (Fava et al., 1993). Right after, several studies and research groups worked to develop the Social LCA (S-LCA), dealing with issues that are still currently being researched (Weidema 2006; Jørgensen et al., 2008; Klöpffer, 2008; Benoit et al., 2010; Macombe et al., 2013).

In this context, the United Nations Environment Programme (UNEP)/SETAC life cycle initiative launched the Guidelines for Social life cycle assessment of products in 2009 (UNEP 2009). The guidelines pave the assessment of the social and socioeconomic aspects, referred straightforwardly as social level into the LCA framework. This framework is in accordance with the ISO 14040 and 14044 standards (ISO 2006a; 2006b) adapted for the social features.

UNEP (2009) defines S-LCA as a social impact (and its potential) assessment technique that aims to assess the social and socio-economic characteristics of products and their potential positive and negative impacts along their life cycle of the products, including extraction and processing of raw materials, manufacturing, distribution, use, reuse, maintenance and final disposal.

The aim of conducting a S-LCA is to promote adjustments and enhancement of social conditions and of the overall socio-economic performance of a product during its life cycle for all its stakeholders (UNEP, 2009). As part of the same scheme, this procedure allows the identification of key issues, assessing and describing the social conditions in the generation, usage, and disposal of products (Benoit-Norris et al., 2011).

In this sense, a structure for the social impact evaluation over the different NanoPack stakeholders/end users will be defined. To maximize the positive social impact and promote the acceptance of NanoPack to target audiences, feedback from stakeholders/users will be taken into important consideration with the objective of defining the most suitable procedures for these assessments (i.e. queries, surveys, etc.). Social Impact Assessment will also aim to estimate, in advance, the planned and unplanned social consequences, either positive or negative, that are likely to follow NanoPack practices, in order to intensify the positive externalities and drop the negative ones.



3. S-LCA Material and methods

As the environmental LCA and LCC studies, the S-LCA must also follow the four phases of Life Cycle Thinking analysis (ISO, 2006b):

1. Definition of the objectives and the field of study;
2. Definition of the life cycle inventory;
3. Life Cycle Assessment impact;
4. Interpretation of the Results.

The difference between the environmental and the social approach is how to calculate the impacts. The characterization factor is defined in more qualitative principles and the impact categories should be established based on the stakeholders, such as local community, employees, consumers, society and all the players in the value chain (UNEP, 2009). This means that to measure a social performance of the study, it is important that indicators related to each stakeholder should be considered (Macombe et al., 2013). Likewise, it is important to note that the S-LCA method is not fully developed yet, so practitioners cannot yet fully measure social impact, but rather describe the social performance. Nevertheless, the results of this analysis should support the decision-making process.

3.1. Definition of goal and scope

The definition of the purpose and boundaries of the system is the first stage. At this level, it is necessary to highlight how the activity variable is defined and, moreover, it is essential to define the impact categories to be considered in the study (UNEP, 2009). According to some S-LCA studies, the authors implement the same objective and boundaries as the environmental LCA (Vinyes et al., 2013).

- *Functional Unit*: S-LCA often works with semi-quantitative or qualitative information, which is not directly and technically expressed per unit of process output. Several authors recommended that aggregation to be carried out using the activity parameter: working time (UNEP, 2009).
- *Stakeholders, subcategories and indicators*: the UNEP (2009) methodology has listed 31 subcategories, according to stakeholders throughout the life cycle of a product (Table 1). A stakeholder category is a group of stakeholders that is expected to have shared and common interest due to their similar relationship to the investigated systems. Further categories of stakeholders or further differentiations and/or subgroups could be also defined and used by the S-LCA users (Benoit et al., 2010).

A methodological sheet was developed for the 31 subcategories of assessment, outlined in the Guidelines. Each sheet includes a subcategory definition tailored to the S-LCA, an explanation of how the subcategory relates to sustainable development, information on data assessment (containing examples of inventory indicators, data sources and units of measurement) along with a reference section that points the user to additional information (UNEP, 2010).



Table 1.

STAKEHOLDER CATEGORIES	SUBCATEGORIES
Worker	Freedom of association and Collective bargaining Child Labor Fair Salary Working Hours Forced Labor Equal opportunities/Discrimination Health and Safety Social benefits/Social security
Consumer	Health & Safety Feedback mechanism Consumer privacy Transparency End of life responsibility
Local community	Access to material resources Access to immaterial resources Respect of indigenous rights Community engagement Local employment Secure living conditions Delocalization and migration Cultural heritage Safe & healthy living conditions
Society	Public commitments to sustainability issues Contribution to economic development Prevention and mitigation of armed conflicts Technology development Corruption
Value chain actors	Fair competition Supplier relationships Respect of intellectual property rights Promoting social responsibility

Stakeholder categories and subcategories for the S-LCA (UNEP, 2009).

Although S-LCA follows the ISO 14040 framework, some features may differ and may be common or amplified at each level of the study. The UNEP Guidelines for Social Life Cycle Assessment of Products proposes a methodology to develop life cycle inventories. A life cycle inventory is elaborated for indicators (e.g. number of jobs created) linked to impact categories (e.g. local employment) which are related to five main stakeholder groups: worker, consumer, local community, society and value chain actors, as shown in Table 1.

Subcategories are the core of a S-LCA assessment because they are the objects upon which justification of addition or subtraction of needs is to be expressed. They are classified according to stakeholder and impact



categories and are assessed by the usage of inventory indicators, measured by a unit of measurement. The latter, as well as inventory indicators vary, depending on the study’s context.

First classification is with regard to stakeholder categories, which classify social/socio-economic subcategories as this might assist with the operationalization. It can also secure the comprehensiveness of the framework.

The purpose of the allocation into impact categories is to help the stakeholders’ identification, to classify subcategory indicators within groups that have the same impacts, and to support further impact assessment and explanation. The impact categories should preferably reflect internationally recognized categorizations/standards (like the UN declaration on economic, social and cultural rights - ECOSOC, standards for multinationals) and/or result from a multi-stakeholder process.

Figure 1 depicts the assessment reference framework (UNED, 2009).

STAKEHOLDER CATEGORIES	IMPACT CATEGORIES	SUBCATEGORIES	INV. INDICATORS	INVENTORY DATA
Workers	Human rights	■	▸	▬
Local Community	Working conditions	■	▸	▬
Society	Health and safety	■	▸	▬
Consumers	Cultural heritage	■	▸	▬
Value chain actors	Governance	■	▸	▬
	Socio-economic repercussions	■	▸	▬

Figure 1. Social Life Cycle Assessment Framework (UNED, 2009).

3.2. Inventory and data

More than 200 indicators are proposed in the methodological sheets and others can be added by the user (UNEP, 2010). It is not strictly necessary to gather primary data at every unit process across a product life cycle. Instead, there is a requirement to mix the approaches of prioritizing data collection and making use of average or assumption data where feasible. First, data on unit process activity variables should be collected to provide a first assortment of information on the relative importance of the unit processes, for example using working time, as previously mentioned.

As a second step, hotspot assessment is undertaken, which provides more information on where the most important potential social impact may be established within the product life cycle (Benoit et al., 2010).



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Social hotspots are unit processes that are within a field and area that owns high negative impact risk or high positive impact opportunities. The Social Hotspot Database, was develop mostly by Benoit and Norris (SHDB, 2011). It is an international meta-analysis assessment of social themes and social categories that affirms the level of risk and/or opportunity that exist at the any specific level.

Concerning S-LCA, not only quantitative data are used, as in the cases of LCA and LCC. Semi-quantitative and qualitative data that matches the ISO 14040 standard should also be integrated, according to the Guidelines (UNEP, 2009).

3.3. Impact Assessment

Social impacts of this analysis have barely any relation to the processes themselves, but rather to the conduct of the companies performing the above-mentioned processes (Jorgensen, 2008). The social impacts of a product are not well undertaken by the existing S-LCA methods and the Guidelines stress the necessity for further research in the field (UNEP, 2009). Some methods have been issued to provide meaningful estimations of social impacts directly at the unit process activities (Hunkeler, 2006); in addition, some others provide estimations about how unit processes can lead to potential human health consequences by socio-economic pathways (Weidema, 2006).

3.4. Interpretation

The following step is the procedure of assessing results to draw conclusions (Baumann and Tillman, 2004). This is related to the goal and scope of the S-LCA and it has several objectives, such as analyze the results, achieve important conclusions, explain the limitations and constraints of the analysis, suggest recommendations and report properly. According to ISO 14044 (2006) there are three main steps:

- Identification of the significant issues;
- Evaluation of the study (including considerations of completeness and consistency);
- Conclusions, recommendations and reporting.

Another subject to include is the level of engagement with stakeholders.

3.5. S-LCA constraints

As pointed out in the previous paragraphs, S-LCA is still in its infancy, and these tool and metrics are constantly evolving over time (Benoit et al., 2010). This methodology presents a main concern related to the criteria for the selection of the social indicators and the evaluation method, as well as the obstacles to engage the social impact results for each indicator of the S-LCA to the functional unit of the product/system. Besides that, the social databases are quite limited, and on-site company data collection for processes along the life



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cycle of a product is extremely time consuming and not always feasible (Swarr, 2009; Citroth and Franze, 2011).

S-LCA does not provide information on the question of whether a product should be produced or not – although information obtained from an S-LCA may offer inputs and can be helpful for decision making.

4. Social acceptance

The second part of this Task concerns the social acceptance of the NanoPack technology and its final products. The social impact and public acceptance is the crucial point of this activity supporting the nanotechnology packaging products and mechanisms to identify these factors are very important.

Social acceptance has been a vital topic of many investigations. For a technical system to be considered socially sustainable, it should boast wider social acceptance than comparable systems. Therefore, the social sustainability aspect is approached from a social acceptance point of view (Assefa and Frostell, 2007).

Many research results show that several indicators can be used to measure social acceptance in a specific situation (Hall et al., 2013; Venkatesh et al., 2008; Devine-Wright, 2008; Bagozzi et al., 1992). Among these, the addressed ones are:

- Participants;
- Socio-economic background;
- Age group;
- Political beliefs, attitudes and behaviour.

Additionally, the intention to use, cost, trust, perceived usefulness, facilitating conditions, place, participant's position in relation to packaging technology all play a key role.

In accordance with Devine-Wright (2008), understanding the dynamics of public acceptance is rarely considered as a simple, single factor, but rather, considering the multiple personal, psychological and contextual parameters which are involved. More systematic research is needed on public acceptance, led by logical theoretical frameworks drawn among social science disciplines, explicit definitions of concepts, the use of avant-garde methodological tools and wider attention paid to symbolic and affective aspects (Dowd et al., 2011; Assefa and Frostell, 2007).

According to Devine-Wright (2008), a set of powerful explanations can be classified at three levels of analysis:

- Personal (age, gender, class, income);
- Social-psychological (knowledge and direct experience, perceived impacts, environmental and political beliefs, place attachment);
- Contextual.

Assefa and Frostell (2007) proposed a meaningful approach for assessing indicators for the social sustainability of technical systems developed. Three indicators: knowledge, perception, and fear were evaluated using a questionnaire. This is the most used process and its results indicated that respondents had



such a low level of knowledge and information about the considered topic, that they were not able to rank them in a discriminating way. This was found to restrict participation in discussions and decision making about technologies for which public funds would be spent.

After participants are categorised and survey results collected, a quantitative analysis is performed. Likewise, a calculation is done regarding choice of answers and percentage of times each answer was selected.

On this topic, it has been argued that the key to achieving local community support with social acceptance user studies, is utilization of financial or other form of compensation to amend imbalances in the distribution of costs and benefits (MORI Scotland for BBC Scotland, 2005).

5. Social analyses implementation to NanoPack project

The application of the Social LCA and social acceptance tools to NanoPack technology are the core activities of this task. In this regard, the following activities will be followed during the project execution in order to achieve the proposed objectives:

First, a literature review regarding the implementation of nanotechnology in the food packaging production sector will be addressed and/or any other studies related to this field and will be used as a data source. Second, as depicted in Figure 2, the methodology to assess the Social LCA will include:

- Data collection: this is a pivotal step where reliability of data is fundamental, performing interviews with packaging producers and organizing and structuring those input data.
- Stakeholder Assessment: identifying groups of stakeholders involved in the project and gather them together, according to interest and influence in NanoPack (e.g. local authorities, customers, R&D institutes, among others).
- Indicators Selection: end-point categories will be defined (e.g. Labour Practices, Human Rights, Society) and, consequently, mid-points will be selected according to their relevance for the NanoPack project (e.g. Employment, Innovation & Competitiveness, Community). As the next step, indicators for each mid-point will be generated, such as number of employees, gender ratio, etc.
- Social Life Cycle Assessment: in this final stage, the results will be analysed and data presented graphically, deriving both final conclusions and mitigation strategies to deal with negative impact.

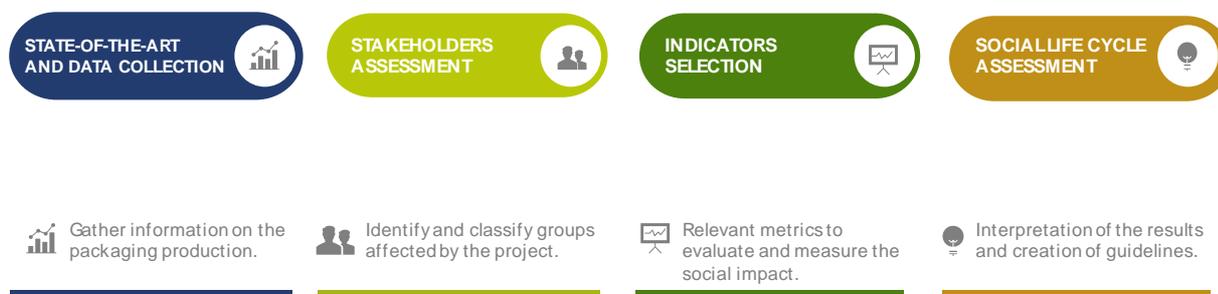


Figure 2. Social Life Cycle Assessment Framework.

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Concerning the Social Acceptance analysis, a survey questionnaire type will be applied for this study. This procedure assists us to include people from various backgrounds to obtain more substantial, reliable and objective research results (Moula, 2012).

To design a social acceptance survey, it is useful to conduct a semi-structured interview in selected communities. Some of the questions and their sequence are determined in advance, while others evolve as the interview proceeds and comprise a mixture of closed and open questions. They are commonly used in B2B market research where there is a need to accommodate a large range of different responses from companies. The use of semi-structured questionnaires enables a mix of qualitative and quantitative information to be gathered. They can be administered over the telephone or face-to-face (Horton et al., 2004).

In a semi-structured interview, interviewers begin with a small set of open-ended questions, but spend considerable time probing participant responses, encouraging them to provide detail and clarification; these data are generally analyzed qualitatively. The cost of this kind of interviews is high, largely due to the amount of preparation involved and the level of analysis, interpretation and presentation of the interview material required.

Semi-structured interviews are often preceded by observation, informal and unstructured interviewing in order to allow the researchers to develop a keen understanding of the topic of interest necessary for developing relevant and meaningful semi-structured questions. The inclusion of open-ended questions and training of interviewers to follow relevant topics that may stray from the interview guide does, however, still provide the opportunity for identifying new ways of seeing and understanding the topic.

The questions that should appear in the questionnaire will be discussed, taking into account the knowledge and understanding of the audience. It is important to balance of the interviewees' knowledge of the topic with the questions in order to avoid meaningless communication and, in turn, meaningless results.



6. Conclusions

Through this report, in accordance with the Guidelines provided by the UNED (2009), the methodology for performing the S-LCA throughout the NanoPack project, has been clearly defined. The main objective is to evaluate the social and socio-economic benefits of the products which enable the extension of food shelf life and enhancement of food safety while maintaining colour, nutrition, taste, etc.

As noted in the previous chapters, the identification of stakeholder categories and indicators selection is the first step of the S-LCA, where the most relevant for this analysis will be identified during the project and with the support of all the partners of this Work Package.

It is important to highlight that this methodology is still emerging, with the aim of playing an important role in assessing the societal pillar of sustainability, quantifying the social impacts on a system. As mentioned in Section 3.5, this analysis includes various constraints which must be considered; to overcome this problem, a deep and thorough study focusing on the correct implementation of the methodology, will be performed in order to limit these obstacles.

Regarding social acceptance, an ongoing set of activities will be dedicated to understanding end user attitudes toward nano-based food packaging which can retain product freshness. Specifically, Task 8.3 Consumer and retailers' behaviour studies and results, will conduct a range of actions including focus groups in multiple geographic locations – in Europe and beyond. Results of these actions will feed into the social acceptance.

It is important to highlight that the present report is considered a living document (same as D7.1 and D7.2). This deliverable will be updated as the project progresses and delivered in M20 and M36. Screening analyses will be presented before the final assessment, in order to provide preliminary recommendations in terms of potential environmental impacts. Preliminary results of the social LCA and social acceptance activities will be presented in the following updates and the full assessment and the final recommendations will be provided at the end of the project.



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