

Venkatesh Govindarajan

Social Life Cycle Analysis - an Introduction

The Why, the What and the How



VENKATESH GOVINDARAJAN

SOCIAL LIFE CYCLE ANALYSIS - AN INTRODUCTION

THE WHY, THE WHAT
AND THE HOW

Social Life Cycle Analysis - an Introduction: The Why, the What and the How

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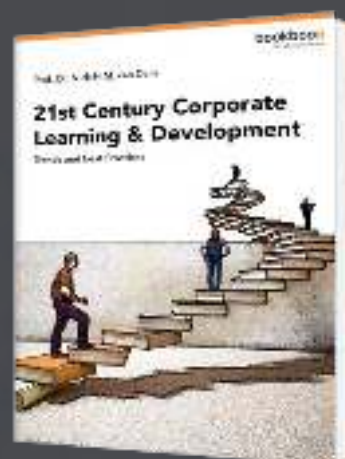
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For my wife, Varshita

‘When shareholders and other outside bodies assess the ‘health’ of a business organisation, they generally do not enquire about the aliveness of its communities, the integrity and well-being of its employees, or the ecological sustainability of its products. They ask about profits, shareholder value and market share and other economic parameters. They will apply any pressure they can to ensure quick returns on their investments, irrespective of the long-term consequences for the organisation, well-being of its employees or the broader social and environmental impacts.....in the longer run, organisations that are truly alive will be able to flourish only when we change our economic system so that it becomes life-enhancing rather than life-destroying.’

Fritjof Capra & Pier Luigi Luisi (2014), in The Systems View of Life, Cambridge University Press

FOREWORD – PROF. DR ARUN KANSAL¹



In *Social life cycle analysis: An introduction*, G Venkatesh creates yet another unique and enjoyable approach to learning Social Life Cycle Assessment. This book is the product of G Venkatesh's many years of teaching and researching on the various aspects of environment and sustainable development. His books, ABC of sustainable development, Environmental LCA, and Life Cycle Costing all are very novel in the way these difficult concepts are presented in a simple manner. Social like cycle analysis once again does not let the reader down as G Venkatesh has been able to recreate his signature style of writing and an uncanny ability to explain complex concepts in an easy-to-understand manner supported by examples from everyday life which helps beginners to grasp, connect and appreciate these concepts.

Social-LCA and Social impact assessment have not received as much importance as other decision-making tools and there is a dearth of books in this topic. This book is perhaps the first book 'for beginners' on Social-LCA. G Venkatesh has wonderfully explained key aspects of social assessment at a conceptual level and at the same time explained methodological steps and has introduced the key terms. Practical and graphical illustrations, probing questions at the end of each chapter and case studies makes it indeed a very interesting book.

It is extremely challenging to make environment decisions as environment and society are interlinked and this complexity increases when the problem is simultaneously looked from the lens of economic considerations and community values. Therefore, decision making today requires understanding of broad range of issues that are at stake. This book helps to provide that foundation.

This book is timely as there is an increasing demand for 'social' appraisal along with environmental and economic assessment. The book is useful not only for students, but will be very useful for mid- career professionals , such as planners, government administrators, engineers, lawyers or environmentalists who have a desire to be better versed in how social assessment is carried out. This book is also for those who want to create tools to operationalise social life cycle assessment while enjoying themselves in the process of learning.

Arun Kansal

PREFACE AND ACKNOWLEDGEMENTS

As with my earlier publications with Bookboon – *ABC of Sustainable Development*, *Environmental LCA: A Primer*, and *Life-cycle Costing: A Primer* – this e-book is also meant for those who wish to start learning about Social Life Cycle Analysis. Needless to add, this may motivate you to start looking for more to read on S-LCA and keep adding on to your knowledge. In other words, the motto of this book could be , ‘ *Try it, get hooked, if you wish to.*’

Formatted almost in a similar way to the aforesaid three books, you would, right at the beginning of the chapter, know what to expect from it, and at the end of each chapter, you get to try some exercises (these, you must attempt, to gain that much-sought-after satisfaction!).

Thanks to my friend and colleague **Prof Dr Arun Kansal** from **TERI School of Advanced Studies** (New Delhi, India) for his constructive review which has helped me to improve the quality of this presentation, and also for the Foreword which he was kind enough to write for this e-book. Thanks to the Department of Engineering and Chemical Sciences of Karlstad University for providing me with the opportunity to design a module – *Tools and Techniques for Sustainable Development*, for fourth-year engineering students. This motivated me to start work on this e-book, as well as the earlier one on Life-Cycle Costing Analysis.

The only source of satisfaction for me would be a high number of downloads of this book from Bookboon.com, and access sought to it through other means; followed by usefulness to the readers.

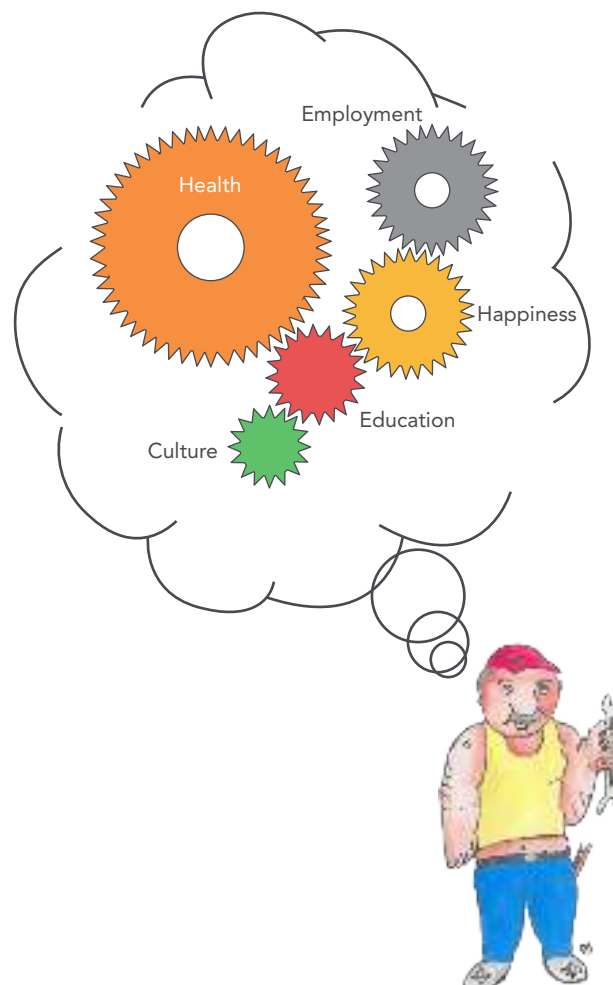
As I would always like to tell my students...
...purposeful reading and good luck

G Venkatesh²

Karlstad, Sweden (2019)

1 THE SOCIAL ASPECT – PEOPLE FIRST?

Learning objectives: *This chapter, which has been extracted from the BookBoon e-book written by this author – ABC of Sustainable Development – will serve as a good introduction. It intends to introduce the reader to the complex aspect of social sustainability and everything that it entails. The reader will at once learn to appreciate that sociology and psychology are as important as economics and ‘financial engineering’ if a meaningful progress towards total sustainability is to be made. The reader will also hopefully be motivated to learn more about Social-LCA, both from the chapters in this e-book and from other books and publications. The exercises towards the end of the chapter will sharpen the learnings from it.*



An economy, ideally, functions for the welfare of the people who comprise it – as producers and consumers. A healthy, happy, well-trained / well-educated populace, engaged in economic activity (in the three sectors), is very vital for economic sustainability. While the former

is necessary for the latter, the latter ought to facilitate the former. There is surely a nexus between social sustainability (depicted in the lead picture of this chapter), as including health, education, culture/heritage/religion, employment which is a socio-economic component, and the more abstract and undefinable ‘happiness’ and economic sustainability, but an over-emphasis on one of these does not guarantee the other. Just as these two could complement each other if one focuses on ensuring such reinforcement, there could be conflicts as well, if one of the two is prioritised consistently over the other.

Imagine a case where you run very fast. You are able to maximize your displacement in a given period of time while running at a given velocity, if you run in a straight line. However, if you run for the same period of time, at the same velocity, around a circular path, the displacement is always less than the distance covered. While the distance keeps increasing as you keep going round, the displacement does not ever exceed the diameter of the circular path. **Just assume for a moment that the distance is economic sustainability and the displacement is social sustainability.** Running around in a circle imposes limits on the latter. Running straight ensures that the nexus is favourable for both. This is just an analogy which has been illustrated in Figure 11. Note that this is for the case of running round along a circular path (diameter considered to be 20 units in this instance). For the straight path, you would get a straight line making an angle of 45° with either axis, both having the same scale. You certainly would not wish to have social sustainability fluctuating in the manner shown with economic sustainability (or economic growth in other words) increasing steadily.

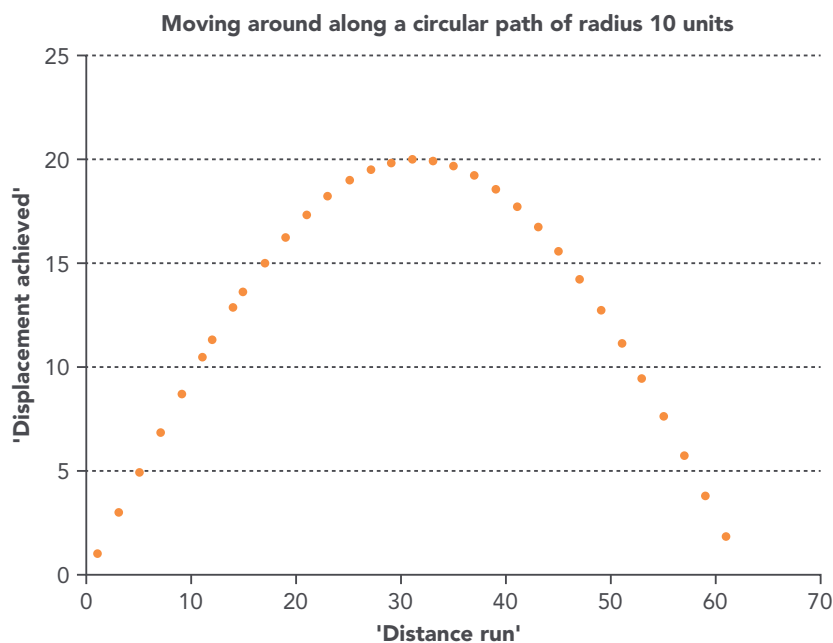


Figure 1-1: The analogy – Economic versus social sustainability

1.1 HEALTH IS WEALTH?

Overworking is unsustainable, simply because such behaviour will take a toll on your health after some time. The efforts will possibly get one economic gains as long as they last, but then, when health takes a beating, the efforts cease and the gains are then channelled back into healthcare. Wouldn't it be wiser to strike a balance, so that efforts do not cease and one does not overexert oneself? Well, this is something which individuals need to think about. Hankering after material gains at the expense of one's good health is quite like pursuing economic sustainability at the expense of all else.

Economic growth adds to government exchequers. Governments then have the prerogative to allocate funds to healthcare. Well-functioning, state-of-the-art public hospitals providing affordable healthcare, are employment generators themselves, even as they need to shoulder the all-important social responsibility of sustaining the health of the populace. Government initiatives apart, there often are enterprises in the private sector which cater to the mental, physical and holistic health needs of the population, while being essential components of the economy.

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YELLOW
SNOW**

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your advice
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It must be remembered here that good health is not something which can be taken for granted. Individuals need to dedicate time, money and resources to ensure that it is sustained. Dedicating money to it, means enabling growth in the tertiary sector, and benefiting in return. Healthy people will be able to work efficiently (without the need to apply for sick-leave). Firms and enterprises, as part of their corporate social responsibility, often invest in healthcare projects. They also take initiatives to enable their employees to stay healthy – providing gym memberships, opportunities to attend yoga classes, facilitating on-campus medical check-ups, etc. Channelling some resources into healthcare, usually produces much greater benefits to the one doing so – individual, enterprise or government. (Here, as you may already have started wondering, a strong link to environmental sustainability also exists, as health is influenced greatly by the state of the external environment – water bodies, atmosphere, soil etc.)

However, a tricky, unsustainable situation may arise if the rate of increase in the working-age population is less than that of the aged. It is possible (though not always true) that sustaining economic growth may then become a wee bit difficult, and with it, sustaining affordable healthcare as well.

Public health is a complex subject and one can think of several indicators to describe it. There may not be one standard way to measure it as a component of social sustainability. Child mortality rate for instance is a good indicator but does not apply to the entire population. The average life expectancy (males and females) may also be another suitable one, but it is here that one may be confronted with the tricky situation referred to above. A seemingly desirable trend in this regard, may turn out to be an unmanageable one in the near future. The focus here though is on the word ‘may’. With this understanding though, one may opt for these two indicators to encompass the entire population. A decrease in child mortality and an increase in life expectancy would augur well for social sustainability.



Figure 1-2: Product innovation by the corporate sector to safeguard health and help combat environmental hurdles (in this case, water-related)³

1.2 EDUCATION IS AN INVESTMENT

You would certainly agree with this. This is true both for individuals as well as for cities and countries. Money spent by parents (on books, fees etc.) to educate their children is an investment, which enables the latter to sustain their livelihoods in the future. By expending on healthcare and availing of the healthcare facilities provided by the government and the private sector for themselves and their children, and also 'investing' in their children's education (this investment is, in sooth, an expenditure, which may pay dividends for the children in the longer-term), responsible adults would contribute to social sustainability. Enterprises/firms, as part of their corporate social responsibility initiatives may channel a portion of the allocated funds to setting up schools in villages, for instance, or providing scholarships to needy and deserving students for higher education.

But as with health, so also with education....there is no free lunch. Both firms and governments need to ensure that economic growth continues so that investments in health and education of the populace become possible. Governments need to focus on education, while not neglecting health, and vice versa. Tax receipts have to be deftly allocated; there is no hard and fast rule on how this is to be done. This is where decision-makers need to show a great deal of sagacity and foresight, and also be willing to learn from hindsight all the time. After all, sustainable development is a non-ending pursuit towards an elusive goal. It pays thereby to know where one has come from, in order to make the progress towards the elusive goal smoother and steadier and surer (Never forget that the progress towards the elusive goal does not mean attainment of the goal; it just means following close on its heels). Governments may decide to set up new schools where they are needed the most, subsidize education wherever and whenever possible, provide scholarships (like firms and enterprises may also do), to needy and deserving students, pay teachers in schools well in order to keep them motivated to continue in their noble profession, sponsor healthy lunches for students, *inter alia*.

However, sustainability of education is not measured or determined by the investments (or expenses) made by governments, individuals and firms, but rather by the outcomes or the effects of such investments/expenditures. There often are instances where money goes down the drain, when it is spent without conditions being imposed. And if this continues, it could then end up becoming truly unsustainable. One may then start feeling that the money could have been put to much better use elsewhere (health, culture, environment etc.)

Talking of outcomes or effects, how are these to be measured? Number or percentage of students passing out of school, number/percentage graduating from university, number/percentage securing PhDs, or simply number of people who learn to read and write (at least the local language), irrespective of whether they go to school or learn to do so in their spare time? If people learn to read and write in their spare time and do not attend school or

university, no investments of money are called for. It would just be an investment of time; perhaps a volunteer (social-worker) may undertake the noble task of teaching the children of poor parents or adults who have never been to school, gratis. There are many who have been doing so...some are written about and some just work in the background. Economic growth may really not be necessary if the literacy rate can be raised in this fashion. But then raising the rate in this fashion may benefit economic growth in the medium-term. However, a thought may linger in the minds of readers – Does a well-diversified economy (all three sectors) really require a very high level of literacy? As people get more and more literate, will not they be dissatisfied with their jobs and start seeking opportunities to move up the ladder? Does not a sound economy need a sufficiently-diverse workforce? Difficult question to answer? Yes and no. You cannot force someone, in a democracy, to be content with where he/she is employed, and continue doing what he/she is doing throughout his/her life, for the supposed good of the economy and society. One also cannot shy away from widening opportunities for education and justify this stance by claiming that one wishes to aid the diversification referred to. Hence, we somehow come to the conclusion that just an increase in the literacy rate should not be the main focus, as it may really not benefit economic growth. ‘Education’ needs to be interpreted differently here – imparting different skills and different types of knowledge to different people to enable them to sustain their livelihoods and also contribute to economic growth in the process.

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Hence, while child mortality rate or life expectancy may after all be useful indicators to measure 'health-related sustainability', deciding upon meaningful indicators to measure 'education-related sustainability' may be tricky. What do you, as a reader think, could serve as a meaningful indicator in this respect?

1.3 CANNOT PLEASE GOD AND MAMMON BOTH

"No one can serve two masters. Either you will hate the one and love the other, or you will be devoted to the one and despise the other. You cannot serve both God and money."⁴ This simply goes to show that if there is an inordinate focus on economic growth, making more money and enjoying the material gains of hard work, one tends to automatically and unavoidably neglect cultural and traditional values, national heritage, spirituality and God. While preserving such values and conserving heritage may call for investments (which would have to be sourced from the economic growth which cannot be overlooked *per se*), economic growth must not in any way necessitate the disappearance of religion and spirituality altogether. Here, the author is not advocating a fanatical pursuit of religion (this has become the bane of civilisation, for that matter), but perfect secularism, respect and tolerance.

A sizable chunk of the human race, at any time in history, has sought/seeks solace in churches, temples, mosques and synagogues – places of worship in general. Traditional forms of art and music, attire and food-habits, provide a great sense of contentment to many of us. Such contentment and satisfaction which is more on the mental, psychological and ultimately spiritual level cannot be sought merely from a high-paying job, a commodious house and a substantial bank balance. Many cultures promote charitable behaviour and generosity towards the underprivileged, which makes an individual play a key role in the larger scheme of things. Such generosity contributes to not just the spiritual well-being of the person who has a charitable intent, but also to social/economic/environmental well-being in general. How can one measure the 'cultural/heritage/religion-based sustainability'? Any suggestions for one appropriate indicator? I would like to leave it you, the reader, to decide what would be the best way to measure this aspect of social sustainability.

1.4 HAPPINESS NOT READY-MADE, STEMS FROM ONE'S OWN ACTIONS

This brings us to the elusive criterion of 'happiness'. The sub-heading is attributed to the Dalai Lama. The lead picture, if you refer back to it, includes happiness as an independent criterion. Happiness is usually defined as a 'state of mind'. There need not necessarily be

a positive correlation between good health and happiness, or between high education and happiness, for that matter. Affluent and highly-educated people are not necessarily the happiest. The adage – *Ignorance is Bliss* – comes to mind. One is also reminded of the advice ‘*Contentment is happiness*’.

An indicator ‘Gross National Happiness’ (GNH), was coined in 1972 by the Bhutanese king Jigme Singye Wangchuck. He also maintained that this was more important than the Gross National Product. GNH was looked upon as overarching and including within its ambit, ‘sustainable development’, ‘preservation of cultural values’, ‘preservation of environment’ etc. By our definition in this book, ‘sustainable development’ is the collective term and it includes all the sub-processes involved in the pursuit of social, economic and environmental sustainability. We define happiness as a component of social sustainability, and consider it to be influenced partly by economic sustainability and environmental sustainability. Seeking happiness is considered to be a part of seeking sustainability and not the other way round.

We must reiterate here that definite correlations if any between happiness on the one hand, and health, education, culture and employment on the other need to be investigated by monitoring all these aspects of social sustainability over time. While health is ‘psychosomatic’, education is ‘intellectual’, happiness is ‘mental’ – a state of mind, culture/religion may be

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looked upon as 'spiritual'. These four thereby can be associated with the four different aspects of human existence, from the grossest to the subtlest. Thereby, it would not be wrong to consider happiness to be an independent criterion of social sustainability, and measure it by interacting directly with the people to find out if they are happy/unhappy, and the reasons for the same. Refer Figure 13, which charts the four dimensions of social sustainability referred to. Also recall that social sustainability here, can also be looked upon as an aggregate of the sustainability which each one of us is able to attain on a holistic level – psychosomatically, mentally (emotionally), intellectually and spiritually. If it exists on a micro-level, it can wonderfully blossom to the macro-level.

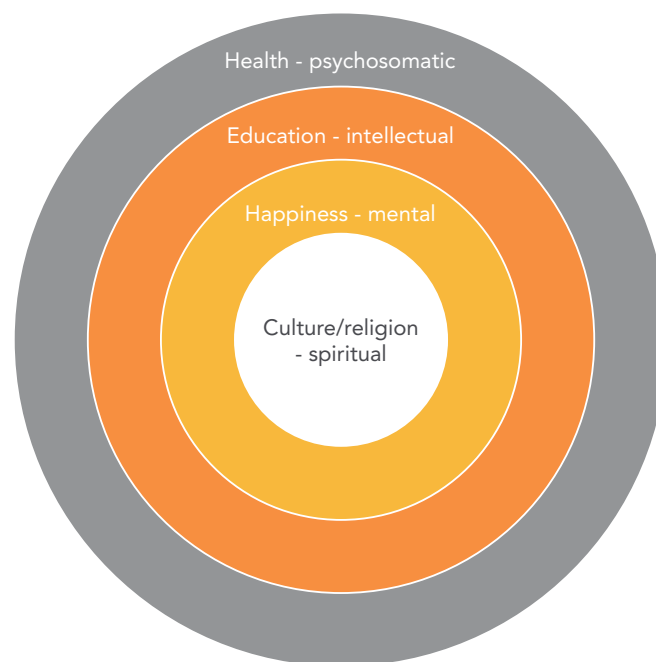


Figure 1-3: The four dimensions of social sustainability – grossest to subtlest

1.5 SOCIAL-LCA – COUNTERPART OF E-LCA AND LCC

What Life-cycle Costing is to economic feasibility⁵, and environmental LCA (E-LCA) is to environmental sustainability (refer *Environmental Life-Cycle Analysis – A primer*⁶, written by this author for BookBoon) a social-Life Cycle Analysis (abbreviated as S-LCA⁷) is to social acceptability. While economic feasibility on a micro-, or meso-level feeds into economic sustainability on a macro-level (by enabling economically-sustainable development), social acceptability on a micro-, or meso-level, feeds into social sustainability on a macro-level (by enabling socially-sustainable development).

Any project undertaken by a municipality for instance, can be subjected to an S-LCA to find out how all the stakeholders view it. S-LCA adopts a survey-approach, where groups

of stakeholders or their representatives are contacted with questionnaires in order to gauge how they think the project would impact their well-being. Depending upon the type of project, questions can be framed to obtain qualitative or quantitative responses which can be translated into averaged indicators. The indicators can then be grouped under the broad criteria – Health, Culture/Heritage/Religion, Happiness, Employment⁸ and Education (Of course, one may define other criteria and have a finer dispersion of the indicators selected). While in an LCC, the Net Present Value is an indicator of the degree of economic feasibility, in an S-LCA, the indicators and the criteria need to be weighted (more about the concept of weighting in a subsequent chapter), in order to obtain an aggregated social acceptability index (say, on a scale of 1 to 10). Benchmarks can be set and decisions taken on the basis of the relation of the index to the benchmark. It follows that what is socially acceptable and implemented, contributes to socially-sustainable development – in other words, the progress towards social sustainability.

1.6 THE SOCIO-ECONOMIC REALM

Employment figures in the lead picture of this chapter, but it may also be considered as a criterion for the dimension – economic sustainability. It belongs to both the social and economic dimensions for that matter; just like the Gini Index. Alternately one may wish to define a new ‘in-between’ dimension – socio-economic sustainability {the goal which economic or (socio-economic) development would pursue} – and assign these two indicators to that dimension.

1.7 EXERCISES

1. Suggest a robust set of indicators to measure social sustainability encompassing all the criteria described in this chapter. Do you agree with the indicators for health suggested in the chapter?
2. Consider a hypothetical case. In a city, there is a very old temple (can perhaps be considered as a heritage site) on a sizable plot of land. You however are not sure how many people value it, or whether it brings in tourist revenue to your city. The city would make do with another school, another hospital, and perhaps even office premises which could be let out to entrepreneurs and perhaps MNCs which intend to locate their offices in your city. This plot of land is very strategically located – close to the railway station, bus depot and a metro station. You are a decision-maker who believes in change, but at the same time, adopts a holistic outlook to development – in other words, you believe in ‘total sustainability’. What would you do? (Hint: No two answers would be the same here).

3. How do the different forms of government – far left to the far right – impact on social sustainability, in general? This is more a political-science question, and goes to show that this discipline is also extremely important in sustainability studies.
4. We talked of a socio-economic realm in this chapter. Employment rate and the Gini Index would fit into one such dimension if it were to be created. Would there be aspects / indicators likewise, fitting into a socio-environmental realm or an enviro-economic realm? Discuss.

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2 STAKEHOLDERS IN AN S-LCA

Learning objectives: *In this short but important chapter, you get to know about the stakeholder groups which need to be taken into consideration in a social life-cycle analysis. You can visualise supply chains and the people from the different groups who are affected/benefited/influenced (or affect/influence) by the processes leading to the final product or service. Visualise global supply chains and understand the disparities which exist when a supply chain extends across over a dozen countries in 5 continents!*

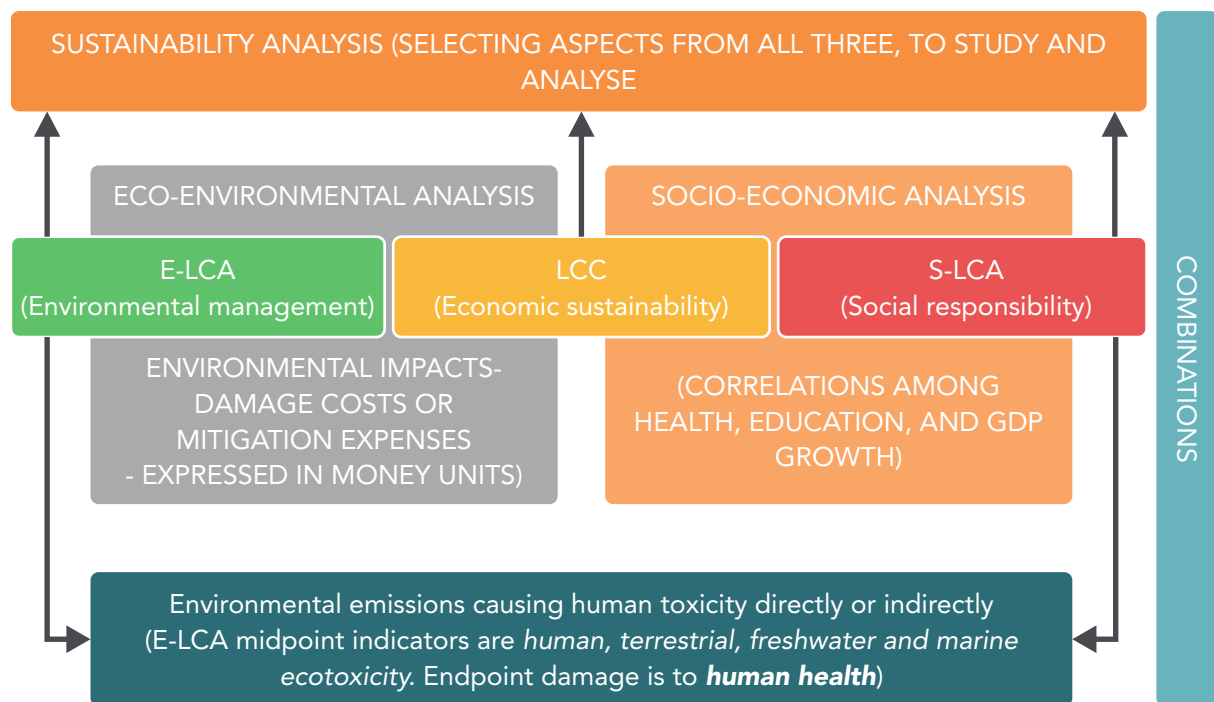


Figure 2-1: S-LCA in the sustainability analysis toolkit^{5,9}

Picking up the thread from where we left off in the previous chapter, the position of S-LCA in the grand scheme of sustainability analysis has been indicated clearly in Figure 2-1. It facilitates a mono-dimensional, two-dimensional (with LCC or E-LCA) and a triple bottom line analysis, as shown. The development of this tool, as observed by Mattioda et al (2015)¹⁰, is still in its infancy. Three years down the line, this observation remains true. Integration between the two types of LCA – environmental and social – as shown in the lowermost block in Figure 2-1, is extremely necessary to avoid the trade-offs between social and environmental impacts, as advocated by Vermeulen (2015)¹¹. As stated in Venkatesh (2018)¹², how clean technologies are cannot be determined without factoring in the socio-economic impacts of the same.

While Figure 2-1 serves as the link between the earlier chapter and this one, the focus of this particular chapter will be on the stakeholders to be considered in an S-LCA. ‘Stakeholders’ in an S-LCA are loosely analogous to ‘shareholders’ in an LCC. If business decisions are made solely to please the shareholders when the economic dimension predominates at the expense of the socio-environmental, they must focus on pleasing all the stakeholders (the shareholders being a subset), when the social dimension is not neglected.

Stakeholders in an S-LCA are the groups of people who affect/influence or are affected/benefited/influenced by the processes in a supply chain which lead eventually to a product or service supplied/provided to the end-consumer. (The end-consumer is also obviously, one of the stakeholder groups!) In an S-LCA, one calculates the ‘social impacts’ of the processes in a supply chain (analogous to the ‘environmental impacts’ one measures in an E-LCA⁶). Note that ‘impacts’ here could be either positive (beneficial) or negative (adverse).

2.1 WHO ARE THEY?

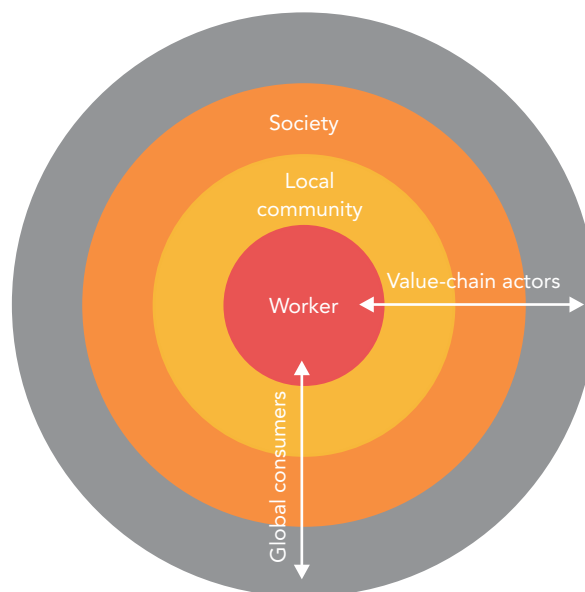


Figure 2-2: Stakeholders – the ins and outs (as defined by the UNEP¹³ unit for Technology and Society)

The workers, needless to say, are at the heart of all supply chains, which essentially are mechanisms operated by the union of capital and labour. This stakeholder category, as shown in Figure 2-3, forms the core of all manufacturing/production units in the supply chain. In Figure 2-3, three such centres have been depicted in China, South America and Africa, the former being ‘fed’ by the other two. The worker is at once a part of the local community (or the society outside the local community if he/she stays further away from his/her place of work), and possibly a consumer of the products /services he/she contributes to putting out on the market. If he is a shareholder, he is also a value-chain actor.

The **local community** (shown in orange) is the area around the site/plant in which some or most of the workers may live and their children may go to school in. It is also the immediate surroundings to which the plant emits its wastes to. These would usually be atmospheric emissions, as wastewater and solid wastes may be transported further out for end-of-life handling. However, it is also possible that solid wastes are dumped carelessly in the near vicinity of the plant and the wastewater is directly discharged to a water body close by. The local community is a part of the larger society and may be a sub-set of the other two categories – value-chain actors and global consumers.

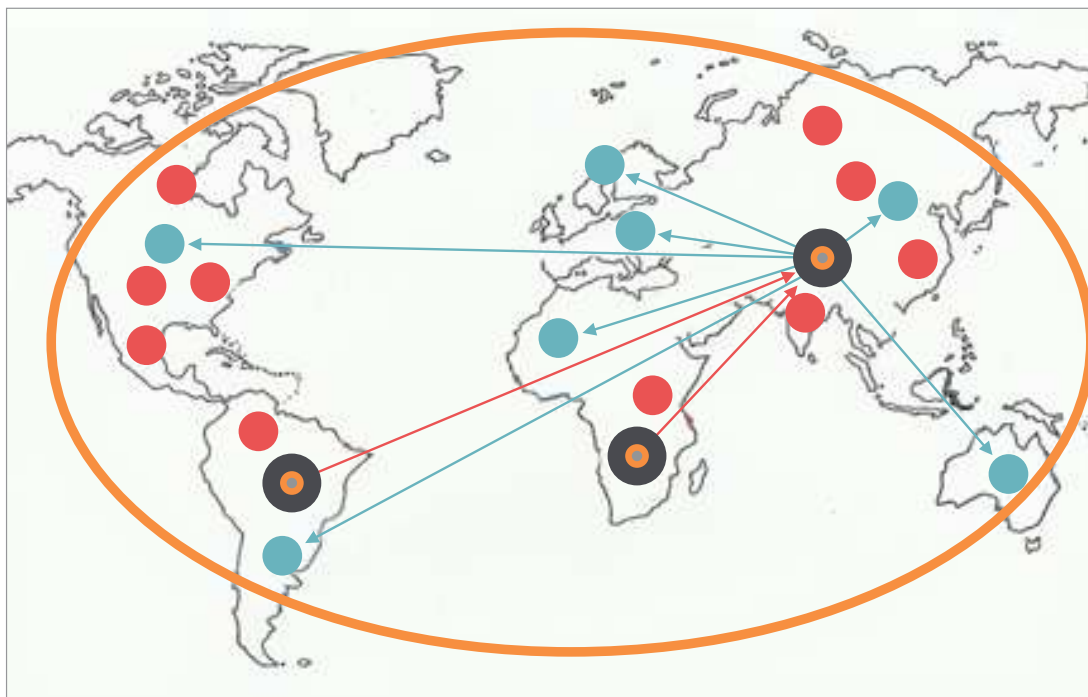


Figure 2-3: Hypothetical supply chain of a final product assembled in China, spanning six continents (the colour codes for the stakeholder groups used in Figure 2-2, apply here as well. The value-chain actors – competitors, collaborators, government agencies etc., are shown in red)

Society, which has been shown in black, is the larger area (city/state) of which the local community is a part of. The plant pays taxes to the government administering this larger area. It is possible that some of the employment for the plant is sourced from the society further away. Resources (processed or otherwise), power and water may also be sourced from outside the local community. The local community and society may be subsets of the consumer-group. However, this is not always true for export-oriented final-producer units or for upstream units like the one in South America and Africa shown in Figure 2-3, which would be exporting all the intermediates or raw materials they produce/manufacture/refine to the main producer in China (depicted by the red China-ward arrows).

Value-chain actors (shown as red circles in Figure 2-3) form a diverse stakeholder group which includes, inter alia, competitors (not just of the final producer, but also of the upstream suppliers), banks for instance, which lend capital to the different units of the supply chain⁵, shareholders who invest and earn dividends⁵, local, provincial, national and regional governments which regulate the operations in the supply chain through a mix of taxation, subsidies, grants, rebates, import and excise duties etc. The outermost ring comprises of **consumers** (shown as blue circles in Figure 2-3), who do not belong to the society or local community or the worker-groups; but as mentioned earlier, the core, and the two rings outside it can also form a small or a big subset of the stakeholder group – consumers.

Figure 2-3, may for example, belong to a product sold by IKEA at its various outlets around the world; the final product being manufactured/assembled somewhere in southern China / Tibet, with suppliers based in Brazil and the Democratic Republic of Congo.

2.2 EXERCISES

1. Consider gold mining in a South African town. Google to identify a suitable region in the country where a lot of gold is mined. Try to understand the three local stakeholder groups – Workers, Local Community and Society – by browsing the Internet for information. Identify upstream suppliers to the gold mining process, the value-chain actors worldwide and also the market (global consumers) for the gold mined. Sketch a diagram like the one shown in Figure 2-3 for this supply chain. Write an essay about these stakeholder groups with valid references to the information you use in the essay.
2. A manufacturing unit pays its workers 10% less than its competitors do, but invests a lot of its profits into corporate socio-environmental responsibility projects in the local community and society around it, and also contributes to charitable causes in other countries in the world in which most of its consumers are based. How would you decide if this is acceptable or not?
3. Repeat exercise (1), but this time, choose a manufacturing unit in your locale, contact personnel therein, and obtain information through direct interaction. What obstacles do you face? Why? How could these be remedied?

3 DIMENSIONS OF THE DIFFERENT STAKEHOLDER GROUPS

Learning objectives: In this chapter, you are introduced to the different dimensions, for each stakeholder category. While you will have understood all the dimensions by the end of the chapter, you are advised to be inquisitive and gather more information online.

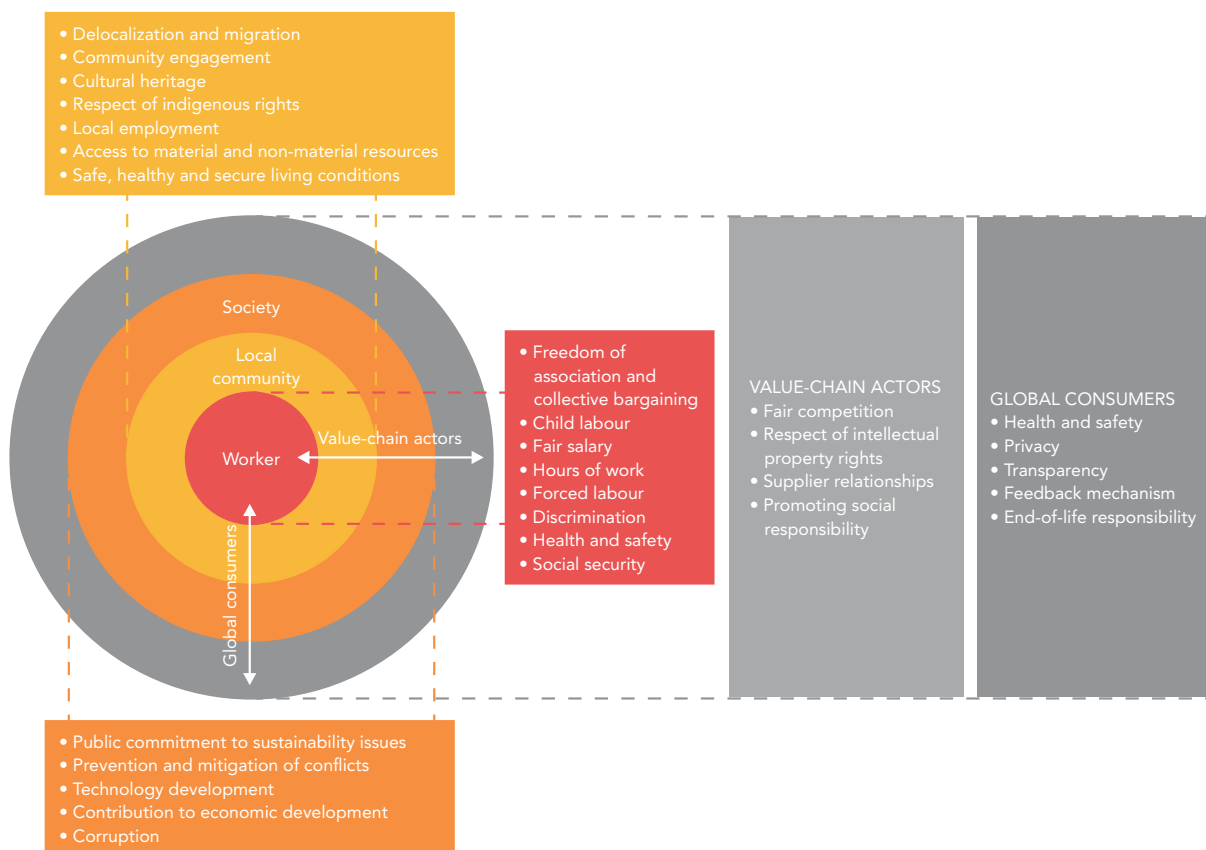


Figure 3-1: Dimensions under each stakeholder category mapped onto the concentric circles diagram

Figure 3-1 above pictorially depicts the different dimensions under the five stakeholder categories, which may need to be taken into consideration (note the use of the word ‘may’; akin to one’s choice of environmental impact categories in an E-LCA⁶, dimensions of relevance and interest may be selected by the analyst) in an S-LCA. It will be apt at this juncture to try to understand what each of these dimensions means, before we move on to the next chapter to discuss the choice of indicators (metrics) to describe the dimensions (or in other words, their status in the nodes of the supply chain being analysed for social impacts). Note that there is a wealth of information about these dimensions on the Internet. Interested readers can avail of it to get to know the specifics.

3.1 STAKEHOLDER CATEGORY DIMENSIONS¹⁴

3.1.1 WORKERS – THE DRIVEN?

Workers, curiously can be looked upon both as the drivers of the economy – generating, producing and manufacturing at the core - and also as being driven by the market (the consumers). Further, they pay for themselves (partly) if they are also consumers of the products or services they themselves churn out. In other words, they drive themselves and assume both the avatars – of the driver and the driven.

- **Freedom of association and collective bargaining:** This, in other words, is the right to form labour unions and elect a representative who can air the grievances of the workers to the top management. It of course includes the right to strike work and demand increments in salaries and better working conditions. Workers are the ‘soul’ of all supply chains after all, analogous to the spiritual aspect depicted in Figure 1-3. When you investigate, you may sometimes find a ‘command and control’ culture, detrimental to worker welfare, which you would identify as an adverse social impact needing correction.



- **Child labour:** In 2014, Kailash Satyarthi¹⁵ of India was awarded the Nobel Peace Prize for his tireless commitment and dedication to eradicating child labour from India. The Global March against Child Labour conceived by him in 1998 is one of the largest social movements ever on behalf of exploited children. As defined by the International Labour Organisation¹⁶, work done by children can be classified as objectionable if:
- It is mentally, physically, socially or morally dangerous and harmful to children
 - It interferes with their schooling by
 - Depriving them of the opportunity to attend school, or
 - Obliging them to leave school prematurely, or
 - Requiring them to attempt to combine school attendance with excessively long and heavy work.

Child labour continues to be a matter of concern in the developing world with lax regulations and/or rampant corruption. In the developing world, further, parents from the economically-disadvantaged strata of society, look upon children as extra pairs of hands to help them to earn more for the household. This author's mother, on a door-to-door student-recruitment drive in one of the largest slums in Asia, on behalf of the Municipal Corporation of Greater Mumbai, was turned away by most of the parents she spoke to. Reason: *'What will he/she do by learning to read or write? Better to learn to do some menial jobs and earn money.'* The governments thus are not to be blamed here. Free primary education (though not compulsory) is guaranteed by municipal corporations in India, but it is the unwillingness of parents to avail of it for their children, that has led to the preponderance of child labour which Satyarthi and colleagues have been waging a war against.

- **Fair salary:** Wages (daily) or salaries (monthly usually) have to be adequate and timely and also regular. In other words, they need to be paid in the right amount at the right time, everytime. As gathered from the ILO website (which this author would like to refer readers to for any and all information pertaining to the worker stakeholder category dimensions), in many countries (developing and underdeveloped, usually), wages are paid in bonds or even alcohol! Employer bankruptcy (at a time when huge arrears have to be paid), have in the past, led to non-payment of salaries. Countries which abide by the ILO standards, must respect the minimum wage levels prescribed, make sure that payments are regular and on-time, and prioritise the settlement of unpaid wages, in the event of insolvency of the employer (in our case, a node in the supply chain). In your analysis, when you investigate, often, the workers themselves are the founts of all the facts you need to collect.

- **Hours of work:** There is of course no single global standard across all the economic sectors, when it comes to 'hours of work'. Intuitively, requiring someone to work for long hours (this may not be slavery or forced labour, for that matter), robs the worker of time which he/she could use for alternate activities – at home with family members, out in society with friends etc. Of course, a worker may willingly work longer hours, if he is paid more, for the overtime he puts in. If there is no extra payment (fair salary for the extra time put in), longer working hours are indeed questionable. What the ILO standards provide can be labelled as a 'framework' for regulated hours of work, daily and weekly rest period and annual holidays. Firms which work within this framework (adhering to the minimums and maximums prescribed), can tick this box in an S-LCA.
- **Forced labour:** One may assume that forced labour may have vanished completely from the surface of the earth in the 21st century and opt to neglect this dimension in an S-LCA. That would be a grave error, especially if the supply chain encompasses regions of the developing world. Forced sexual exploitation and forced labour exploitation – domestic work in the Middle East for instance, agriculture and other economic activities in Asia, Africa and Latin America - are rampant in the developing world. Bonded labour where workers are forced to work for no pay, when they are not able to repay their debts are not uncommon. Some countries with dictatorial regimes extract forced (unpaid) labour as punishment from apostates and dissenters. The mere fact that supply chains these days are complex and mind-bogglingly multi-nodal entails a very careful study of how it is organised, before venturing to study each of the nodes for signs of forced labour.
- **Discrimination:** In radically-conservative enclaves in the world, discrimination is a regular 'cup of tea'. Homosexuals for instance, are not just harassed in society but also find themselves shunted out of the workforce. In the 1980s, when not much was known about AIDS, even in the developed world countries, those infected were sacked at a moment's notice (recall the movie Philadelphia, starring Tom Hanks as the AIDS victim). While in Scandinavia, one sees job advertisements stating that 'Female candidates will be given preference', not with the intention of discriminating against eligible males, but to maintain a healthy gender balance in the workplace, in several countries in the developing world, women find it difficult to find employment. These highly conservative regions of the world, look upon women as child-bearers, cooks and caretakers, and nothing more. Of course, religious and racial discrimination are also not things of the past as yet. Off and on, in the news, one hears about instances where someone or the other is victimized in the job market (discreetly though) on religious grounds. African Americans bore the brunt of this in the USA for a long time, and though things seem to have improved a little in the 21st

century, conservatism threatens to bring it back. The caste system in India was loaded against the 'lower castes' in the past, and in developments similar to the 'reverse apartheid' in South Africa, the upper castes are now being discriminated against in the country to different degrees – subtly though. Of course, the node being investigated may itself not be discriminating on grounds of religion, race, sexual orientation, caste or gender, albeit being situated in a region where such discrimination is otherwise rampant. This node could be a multinational company, while the discriminators in its vicinity may be national players. Hence, a more careful investigation of the node, vis-à-vis its surroundings (the local community or society in which it is embedded) is essential. Generalisations must be avoided at all costs, in an S-LCA, whenever and wherever possible.

- **Health and safety:** Injuries and accidents at workplaces, and work-related diseases disable or kill workers in different economic sectors. The ILO puts the figure of deaths at 2.78 million and injuries and illnesses which decrease the quality of life and leads to absenteeism from work, at over 150 times that number. Ensuring health and safety at workplaces is the responsibility of the employer, while workers also must remember to exercise care and caution as advised and recommended. This author remembers an instance at the ship-breaking yards in Alang in the western-Indian State of Gujarat, where a yard-

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owner brushed aside a question concerning deaths of workers who were not provided gloves, helmets or masks while working at heights above the ground and blow-torching the steel bodies of ships, some of which had been delivered to the yard with inflammable oils inside. He said that if one worker dies, his jobless brother from a faraway state comes over to replace him and thereby the yard does not fall short of labour! If you would be doing an S-LCA of the life-cycles of ships, and visit Alang to investigate, this node will render the entire supply chain questionable from a social perspective.

- **Social security:** Social security is well-entrenched in most of the developed world, and that means that just about one-fourth of the global population enjoys the benefits of adequate coverage. This is necessary to ensure access to health care and income security in cases of old age, unemployment, sickness, invalidity, work injury, maternity or loss of a main income earner¹⁷. A node in a supply chain, in a country where there is no or inadequate social security coverage, represents an adverse social impact on the workers.

3.1.2 LOCAL COMMUNITY

- **Delocalisation and migration**

While economic migrants may relocate to a community in which a node in the supply chain functions in search of employment therein (which may be something which is done voluntarily to further one's economic prospects), there are also instances of families being forcibly (or unfairly, by way of being undercompensated) compelled to relocate from lands which they have occupied for many years, on the pretext of harnessing the land and other resources found on or under it (minerals for instance), for economic growth. This economic growth thereby, cannot be looked upon as 'economic development'. It may contribute to a rise in the GDP and benefits for those who would be associated with the enterprise directly or indirectly, but that rise or growth will have to come at the expense of the well-being of perhaps many families.

In the case of economic migrants, often, one finds a drop in welfare, as they are not able to, or are not allowed to integrate well with the permanent residents of the society they migrate to. This could be a case of xenophobia which may need to be handled dexterously to make the migrants feel at home and avail of their right to contribute diligently to their own and the society's economic development.

- **Community engagement:** Decisions taken by the node in the supply chain need to be bounced off the stakeholders in the local community – all the individuals or their representatives. It is possible that a particular segment in the local community – farmers for instance – are likely to be impacted (temporarily for that matter), by a decision which may entail competition for the water resources available – irrigation versus industrial processes. If the node in question is a pulp mill desirous on increasing its output, forests within the community which

provide ecosystem services highly valued by the community members may need to be harnessed. Proposed policy decisions need to be communicated clearly and transparently (again, a similarity with the Transparency dimension under the stakeholder category – Global Consumers). All voices in the community which seek an audience, must be heard and listened to, before the policies are revisited and modified as required. Community engagement however is not merely about informing the community about policy decisions, but also interacting with the inhabitants on a continuous basis – spreading environment-friendly messages in schools, organising activities in schools, sponsoring welfare-projects (paying for the education of deserving children in the community for instance) and so on. This also has a link to the dimension – Promotion of social responsibility – under the stakeholder category ‘Value-chain actors’. The differentiation here is thus: The local community benefits through Community Engagement; while the ‘Promotion of Social Responsibility’ is what is expected from the value-chain actors. As you read on and try to understand the different dimensions, it at once becomes that there are numerous overlaps; one influencing the other or being an integral part of the other in some way.

➤ **Cultural heritage**

Oftentimes, it is noticed that economic growth and industrialization (mass-production methods) displace and render obsolete several aspects of the cultural heritage which seem to be backward ‘thorns in the flesh’ for those who are keen on ‘growing’ and not ‘progressing’ in the true sense of the term. Sadly, when the word ‘retrogressive’ is used for age-old practices associated with the cultural heritage of the community, not many realise that it is a gross misnomer! Well, cultural heritage includes arts and crafts, language, social and religious practices (which may often come across as superstitious and baseless; ludicrous for the postmodern and too esoteric for those who strive to understand its significance), temples and places of worship in general, cemeteries etc. The supply chain nodes must strive not to hurt the local sentiments associated with heritage spaces and sites, not transgress or trespass, and wherever possible, also try to support conservation projects. Instead of competing with local handicrafts for instance, a modern mass-producer of substitutes can try not to encroach the markets for the former. Alternately, they could devise ways and means of collaborating with the craftsmen and assimilating their skills into their own enterprises. This may not be so relevant in the sparsely-populated developed world countries but most certainly instances of ‘heritage destruction’ are rife in the developing world, where the economic and socio-cultural dimensions of sustainability continue to be at loggerheads with each other.

- **Respect of indigenous rights:** This is not so different from the earlier dimension, as ‘indigenous rights’ are an indispensable part of the cultural heritage of the community. Indigenous peoples may or may not be fully integrated with postmodern society and may not want to jettison their way of life. This dimension can be further divided into sub-dimensions - *right to lands*

they have lived and worked on, right to resources on those lands (both sub-terra and supra-terra), cultural integrity, self-determination and self-government. Your analysis must factor in any conscious efforts being made by the node in question to promote and uphold or to damage and undermine the aforesaid respect of indigenous rights. Indeed, providing employment and training to the indigenous peoples and not discriminating against them in this regard (again, a link to the dimension – Discrimination – under the stakeholder category – Workers; and the next one – local employment), will be a huge plus-point for the social performance of the node and thereby the supply chain. The indigenous peoples live close to Nature and are bonded to it – something which we urbanites must learn from them. Hence, it is often the mining sector, paper and pulp industries, and the offshore oil and gas industry which come into conflict with them when they consciously or unconsciously disrespect their rights.

- **Local employment:** This is an easily-understood dimension. It makes sense to generate employment in the local community (as much as possible, depending on the skillsets which are available, and the training which can be imparted to develop the same). This creates a sense of belonging – of the plant to the community and vice versa. Local employment generation automatically feeds in to contribution to economic development in the larger society of which the local community is a part. From an environmental point of view, reducing the commuting distances for the workers (by way of augmenting the share of local employment), reduces the extended carbon footprint of the operating node.
- **Access to material and non-material resources:** A clear distinction must be made here between material and non-material resources.

Non-material resources	Material resources
<p>Community services: The organisation (or node in the supply chain in other words) can participate in, and support and facilitate community services, the people are entitled to (health, education etc.), and can benefit from. In the least, the organisation must not hinder or obstruct the provision of such services, in cases where they are being provided by other entities.</p>	<p>Water (good quality and adequate quantity): Wise use of water by nodes which need it for their processes is a must to avoid depleting water resources to such an extent that the local community faces water scarcity. If the water used is discharged to the same water body/bodies as wastewater by the organisation, attention must be paid to the degree of treatment prior to discharge.</p>
<p>Intellectual property rights: In general, the organisation must respect the moral and economic rights of the creators of intellectual property. The organisation may or may not be availing of the said creations, and the creators may or may not be residents of the local community.</p>	<p>Land and soil (not overly contaminated): Encroaching on land and displacing people, polluting and contaminating the soils and rendering them infertile, disrespecting heritage spaces (razing down temples which are sacred to people in the community for instance), are condemnable practices.</p>
<p>Access to information: In India, for instance, an Act called the Right to Information act was passed whereby it is legally binding on organisations to share information sought by citizens. This is a constitutional right in many countries in the world which is honoured in letter and spirit by many organisations, though there are many flouting it and several which are not bound by such legislations.</p>	<p>Mineral resources (where applicable): The community may be in need of mineral resources like sand and gravel for construction purposes or for their small businesses, and this availability needs to be ensured by the organisation in question, by not over-exploiting or restricting access by unfair means.</p>
<p>Freedom of expression: Organisations often trample on people's rights to expression (be they community members who rebel against environmental violations) or employees who wish to voice their grievances. A socially-responsible organisation is expected not to act in this manner.</p>	<p>Forests: There are communities or groups of people in local communities depending on the forests for their livelihoods or availing of its ecosystem services (non-economic). Organisations must learn to co-exist with such groups of people, and not be looked upon as threats, capable of endangering the utilities the forests provide to the community.</p>
<p>Technology and skills transfer: Unless something has to be kept confidential to ensure competitiveness (for instance, formulations in the pharmaceutical industry, or some other trade secrets which give a firm an edge in the market), an organisation is bound to get a good name if it educates its community members about the technologies it adopts, and imparts general skills which may stand them in good stead in their careers – either within the organisation or elsewhere (the question is, would a company wish to do this, if the beneficiary uses his/her skills for a competitor in the region – think and discuss among yourselves)</p>	<p>Man-made infrastructure like roadways, waste management systems, water and wastewater systems etc.: Unless such systems are constructed for the sole use of the organisation, the existing ones (meant for use of everyone in the community) must not be appropriated by the organisation by use of force or currying favour with authorities in government.</p>

Table 3-1: Material and non-material resources at the disposal of the local community

➤ **Safe, healthy and secure living conditions**

The dimension – Health and Safety – under the stakeholder category ‘Workers’ pertains to the working environment within the walls of the firm/production unit. This particular dimension is analogous to it, but applies to the space ambient to the production unit, which can be designated as its immediate environment from which it extracts resources – air, water and materials – and to which it discharges its wastes – products of combustion, wastewater and solid wastes. These transfers between the unit and its surroundings must be managed judiciously in order to make sure that the safety, salubriousness and security of the living spaces in the community are not jeopardized.

3.1.3 SOCIETY

- **Public commitment to sustainability issues:** The people in this case need not necessarily be consumers of the products/services which are being studied. Awareness of sustainability issues – social, economic and environmental – prevalent in society, and the thought-to-deed transition of these, can act as spurs to sustainability thinking all across the supply chain. Any node operating within a society which upholds sustainability thinking, must perforce follow suit or face the risk of being ‘unwelcome’ or ‘unacceptable’ in the longer run. If a survey during your S-LCA analysis, gives you sufficient evidence of a strong public commitment to sustainability issues (both among the laypeople and the local governments), that is surely a positive aspect of the social performance of the supply chain. In fact, in such a society, where people’s voices are respected, the manufactory/production unit will be asked to prove before commencing operations that it will abide by the social and environmental regulations which are in vogue. In this context, you may discuss why global corporations relocate to regions of the world, where regulations are lax, administrators are corrupt and unconcerned about enforcing strict standards, and people are powerless and voiceless (even in democracies).
- **Prevention and mitigation of conflicts:** Class-based, caste-based or religion-based conflicts (not directly related to the operating node in the supply chain) are unavoidable in many parts of the world. These may be going on for a long time, with no truce in sight, or may just be short-term acute incidents which can be resolved. Conflicts can be categorised into violent/non-violent, low-intensity/medium-intensity/high-intensity, latent/manifest/crisis/severe crisis/open war. A node functioning in such a clime may either aid and abet such conflicts for its own material gains, may be the very reason for such conflicts (where corrupt politicians and office-bearers ransack the resources for their own private

gains, and park the ill-gotten proceeds in offshore banks; all at the expense of the local population), may be neutral and unconcerned, or active in voicing in opposition to the conflicts and contributing to prevent or mitigate it. Clearly understanding the connections – tenuous or strong – is essential if the analyst wishes to incorporate this dimension meaningfully into his/her S-LCA. The mining sectors in many African countries can be studied for glaring examples of such conflicts and the roles played by the nodes in aiding and abetting them.

- **Technology development:** This is something which benefits society. The development however is triggered in the firms which operate in the region – in other words, the nodes of interest in the supply chain being studied. Benefits of technologies (which may even be different ways of doing things, if one goes back to the etymology of the word ‘technology’) developed and applied at these nodes, permeate through society, and may inspire or spawn new activities and enterprises as positive fallouts, which in turn contribute to further economic development (link here to the next dimension).
- **Contribution to economic development:** If a node functions in a given region defined as ‘Society’, and sources its manpower therefrom (thereby sustaining livelihoods and augmenting their purchasing power), pays taxes to the local and provincial governments, and possibly exports its products/services to generate foreign

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exchange earnings for the country (which is 'expanded society'), it automatically contributes to economic development – rather socio-economic development.

- **Corruption:** Much need not be written about this dimension, as readers are well aware of how corruption entrenches itself into the fabric of society in different degrees at various levels. Bribing to set up a plant, greasing palms to obtain contracts and environmental certificates (without having the necessary qualifications or the eligibility to get them)...the list is endless. In the developing world, corruption is rife. It has become an accepted expense category in many parts of the world, and is a 'way of doing business'. Often, a blemishless supply chain is tarnished beyond repair by corrupt practices uncovered in some of the nodes, which, oftentimes are not substitutable owing to monopolies with respect to materials or technologies. Investigating to uncover corruption is not easy, and at times, not a safe exercise to undertake, lest vested interests resort to intimidation and assault. Ofcourse, an S-LCA analyst may not wish to take the risk, while journalists and NGOs would like to. An analyst would thereby collaborate with the latter to obtain reliable information which is otherwise not available to the public.

3.1.4 VALUE-CHAIN ACTORS

- **Fair competition:** A free marketplace need not necessarily be a fair one. 'Free' here may also imply the freedom to flout the rules and exploit the loopholes. What is sought after is ideally a free and a fair marketplace, where competitors play by the rules on a 'level-playing ground'. It is possible that the supply chain you are investigating may be squeaky clean in this regard, but its competitors may be adopting unfair practices. As long as the node being studied is clean, it would score high on this dimension, though the fact that its interests are harmed by the absence of uniform fairness in the sector must be taken into account. Unfairness includes one or more of the following¹⁴:
- Collude with competitors to fix prices to make it a sellers' marketplace (cartelization which the Oil and Petroleum Exporting Countries resort to, off and on)
 - Adopt predatory pricing to drive away competitors (dumping for instance in foreign markets, which Chinese companies are often accused of)
 - Coordinate bids and avail of corrupt practices (almost run-of-the-mill in dictatorial regimes in Africa)
 - Create market or output restrictions
 - Impose geographic quotas
 - Allocate customers, suppliers, geographic areas, and product lines with the purpose of limiting the effects of market competition.

The unfairness, as readers may already have concluded, is not solely a ‘corporate evil’. Governments levying extremely high import tariffs to keep out competitors support unfair competition and favour the home-grown (possibly crony capitalist) outfits. After all, the governments in which the nodes of the supply chain operate, are also value-chain actors!

- **Respect of intellectual property rights:** Readers can refer to the dimension – Access to non-material resources – under the stakeholder category ‘Local community’. While the local community benefits if respect of intellectual property rights prevails, the value-chain actors are expected to make sure that these rights are respected. Now, there is a direct link between these two – a dimension in the current case, and a sub-dimension for the ‘local community’ stakeholder category. Once you are aware of these overlaps, you will of course be careful to select your indicators (discussed in the next chapter) to avoid any redundancy and ‘double-counting’ of impacts.
- **Supplier relationships:** If you take any node in the supply chain, it has nodes on the upstream providing it with raw materials, intermediates, power, water etc., In other words, every node can define its supplier base (which may be fixed for a period of time, or keep varying continuously). One can think of direct suppliers and indirect suppliers. If a node further downstream ‘D’ receives an intermediate from a supplier ‘S’, which has sourced its raw materials to make the intermediate from ‘A’, ‘B’ and ‘C’, then these three become indirect suppliers to ‘S’. Relationships among suppliers are characterised by mutual agreements, regulations which they all abide by (socio-environmental), contracts drawn up, payment terms and conditions and any memoranda of understanding drawn up among them. Suppliers can further be categorised – if one would like to document the supply chain in very great detail – as subcontractors, agents, manufacturers, distributors and consultants. While an upstream supplier’s consumer is a node on the downstream, all suppliers have a responsibility – direct or indirect – towards the end-consumer, at the far downstream of the supply chain. Think of a tree; rootlets and root-hairs, and trunks and branches... and the end-products flowers and fruits (which ‘receive’ from the upstream network, originating beneath the soil).
- **Promotion of social responsibility:** Social responsibility includes all the dimensions which are included under the stakeholder category ‘Society’. While society benefits when these are in place, it is the value-chain actors – the corporates themselves, banks, entities in the supplier chain and their competitors who may displace them in the said chain, governments (recipients of taxes and awarders of subsidies to entities in the supply chain) and NGOs and the media (the moral police) and also researchers and academicians (in their capacities

as service providers on joint research projects), if one considers the indirect influences on the supply chain – who are responsible for making sure in their diverse capacities that social responsibility is accepted, implemented, sustained and in some cases, enforced legally by the governments.

3.1.5 GLOBAL CONSUMERS – THE DRIVERS?

- **Health and safety:** Just as the health and safety of workers and the inhabitants of the local community must not be imperiled by the production/manufacturing processes at the nodes in the supply chain, that of the end-consumers must also be a criterion of social responsibility. All along the supply chain, attention must be given to minimizing the use of hazardous constituents, designing packaging to avoid contamination or spills which may cause injuries, and providing clear instructions to the consumer about the usage of the product. Readers may recall instances of batteries of Dell laptops catching fire in the USA, or the Volkswagen emissions scandal. The former clearly was a safety concern, while the latter could be termed as a health concern.



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- **Privacy:** The point-of-sale units in a supply chain are the final nodes from which the products / services pass on to the consumers. It is at these units that consumers use their credit cards, and participate in surveys in which they reveal information about themselves. Consumers have a right to privacy and if such information has to be made public or passed on to other parties (most certainly, not sold), permission has to be sought. Often, this privacy requirement is breached. Readers will not have forgotten the online privacy breach Facebook indulged in (though one may argue that social media users are far from being concerned about their privacy when they post and share just about anything about themselves in the first place!); Zuckerberg has to apologise for this *faux pas*. Facebook is a service provider; the registered users are the global consumers. Workers are the programmers and employees of Facebook at different nodes in the world. It essentially has the whole world as the society around it!
- **Transparency:** The consumer demands transparency. It is not the other way round. One could place this dimension for that matter in the stakeholder category 'Value-chain actors' – more specifically the strategic management of corporates which comprise the different nodes in the supply chain (as different from the 'workers' per se). Every consumer has the right to know about the value chain of the product/service he/she is consuming. Where the parts and constituents come from, how the workers upstream are treated, how the profits are used, what are the precautions consumers have to take to benefit from the utility of the product/service without being harmed/imperiled in any way (an overlap here with the 'safety and security' dimension). As a result of this transparency, it is possible that consumers may shift loyalty to competitors with a better socio-environmental profile. That however must be accepted as a possible outcome of honesty, in a free market. '*Caveat emptor*' must fade away to be replaced by powerful and enlightened consumers free to make decisions and choices on the basis of information made easily available to them.
- **Feedback mechanism:** Consumers who pay for products and services have the right to query, complain and demand information about their purchases. This dimension is closely related to the previous one – Transparency. The final seller ought to be able to relay the queries/complaints upstream and there must ideally be a culture of responsibility towards the end-consumers (what we call a good Customer Relationship Management, all along the supply chain; here, readers will realise that there is a link to the Supplier Relationships dimension under the 'Value-chain actors' stakeholder category). Disgruntled consumers are indicators of a supply chain in need of readjustment. Nowadays, with the preponderance of smart phones and apps, it is much easier to have effective feedback mechanisms in place, which link back upstream to the node/s which are required to take corrective action. The feedback mechanism of Amazon and its supply chain is a good example, and a hallmark of a leading global player.

- **End-of-life responsibility:** Here, we are in the realm of the socio-environmental. This responsibility of course belongs to the consumers, but it cannot be shouldered without support from the entire supply chain. Governments as value-chain actors have an enabling role to play here, while all the production / manufacturing nodes need to ‘design for the environment’ so to speak. Instead of passing on the blame to the upstream, consumers can demand environmentally-friendly products and effective mechanisms whereby the end-of-life can be handled in the best way possible. How consumers behave can thus influence the S-LCA results, and augment or truncate the ‘negative’ social footprint.

3.2 EXERCISES

1. After reading the chapter, try to recall the different dimensions under the different stakeholder categories without peeping back into the pages of the chapter. Describe in your own words, based on your understanding after reading the chapter, what each of these represent.
2. You are assigned a task – to carry out a quick S-LCA. You do not have much time on your hands. The supply chain you are asked to investigate is that of catalytic converters. The purpose is to identify the likely hotspots and recommend improvements. Mining takes place in South Africa, the manufacturing happens in Germany, and the use is in Sweden. This is all that you are told. What you need to carry out is a so-called ‘quick and dirty’ S-LCA. Which dimensions would you focus on, for the different stakeholder categories in this supply chain? Which would you leave out? Why? You can base your answer on your own knowledge, or you can refer to the Internet and other sources of information to proceed.
3. Do you see any conflicts among the dimensions described in the chapter? In other words, will betterment of any result in a worsening of some? There is no standard answer to this. It depends on context and your own judgements of likely causes and probable effects. Any complementarities you notice – betterment of one invariably and indisputably resulting in the betterment of some others?
4. The workers have been labelled as the ‘driven’ stakeholders in the supply chain... driven by the global consumers who have been labelled as the ‘drivers’. Discuss. Do you agree? If yes, why? If no, why not?

4 INDICATORS TO DESCRIBE THE DIFFERENT DIMENSIONS

Learning objectives: Having understood the dimensions in the previous chapter, you gain some knowledge in this chapter of how each of these dimensions is described with the aid of indicators, which may be qualitative and/or quantitative and/or semi-quantitative¹⁴. Thus, you are able to construct a grid, the cells of which you will later attempt to fill up. You also understand the difference between a generic hotspots-based analysis (generalized for a country or for a sector within the country) and a specific analysis (focusing on the node in the supply chain being studied, in the sector within the country)

Having elaborated on all the dimensions in the previous chapter, we shall adopt a slightly different approach here. Instead of beginning with the dimensions as the primary categories, we shall attempt a categorisation of the indicators on the basis of their types:

➤ **Pure typologies**

- Purely quantitative
- Purely qualitative
- Purely semi-quantitative (Yes/No or a Likert's scale for instance; 0 to 5 corresponding to 'worst to best')

➤ **Hybrid typologies (either-or)**

- Quantitative/Semi-quantitative
- Qualitative / Semi-quantitative
- Qualitative/Quantitative/Semi-quantitative

Under each of these different types (or combinations of types), we divide the *indicators* (italicized in order to differentiate from the accompanying text) into their respective stakeholder categories (blue font as sub-heading) and *dimensions* (red font and italicized) thereof, while also differentiating between the generic and specific. Readers can refer back to the previous chapter to re-read about the dimensions if needed. The methods adopted to quantify/qualify/semi-quantify these indicators range from field investigations, surveys, interviews with different stakeholders, official statistics accessed through national government websites and global organisations like the International Labour Organisation, World Bank, World Economic Forum, and documents published by NGOs on their websites. In this chapter, the word 'organisation' is synonymous with 'the operating node in the supply chain'

4.1 PURELY QUANTITATIVE INDICATORS

4.1.1 WORKERS

The worker stakeholder category needs to be described carefully and comprehensively, and there are 8 quantitative indicators across five dimensions which capture useful data/information about what we know is the core of supply chains. Table 4-1 lists these indicators. This tabulation approach has been adopted for this stakeholder category for some of the other indicator-typologies which follow.

Dimension	Indicator	Generic / Specific
Fair salary	Minimum wage by country	Generic
	Non-poverty wage by country	Generic
Hours of work	Number of hours effectively worked by employees (at each level of employment)	Specific
Forced labour	Percentage of forced labour by region	Generic
Health and safety	Occupational accident rate by country	Generic
	Hours of injuries by level of employee	Specific
	Number/ percentage of injuries or fatal accidents in the organization by job qualification inside the company	Specific
Social security / social benefits	Benefits provided to full-time employees that are not provided to temporary or part-time employees, by major operations	Generic

Table 4-1: Quantitative indicators for the stakeholder category - Workers

4.1.2 LOCAL COMMUNITY

Under the dimension *‘Delocalization and Migration’*, there are two generic indicators which have quantitative measures – *Forced Evictions as a result of economic development*, and *International Migrants as a percentage of population*. The *Number of Individuals who resettle voluntarily or involuntarily owing to the presence of the node of the supply chain*, is the quantitative specific indicator.

The dimension – *Community Engagement* – has a specific indicator which records the *number of volunteer hours or funds apportioned to community initiatives by the organisation in question*. Time is money, as they say, and this indicator could be measured in time-units or money-units respectively. Likewise, the dimension – *Respect of Indigenous Rights* – is measured by recording the *Number of meetings held with indigenous peoples by the organisation being studied*.

What are of interest quantitatively for the dimension - *Local employment* – are two country-wide generic indicators which measure the *Unemployment rate* and the *Poverty or working poverty*. For the site as such, it would be very much necessary to obtain data on the *Percentage of workers hired locally*, and the *Percentage of spending on suppliers based in the local community*. In both these cases, the organisation pays money to entities in the local community for products, services or direct-labour on-site and contributes to economic development.

When it comes to the dimension – *Access to non-material and material resources* – there is one site-specific indicator which records the *Number of arrests related to protests against the actions of the organisation*. The author is reminded of several such instances from 2017-2018. Mineworkers in South Africa were massacred, when Jacob Zuma was President¹⁸; and protesters in the south-Indian state of Tamil Nadu were gunned down when they protested against the unabated pollution caused by Sterlite's copper smelting plant¹⁹. The mining and metallurgy sector has had blood on its hands for a long time now, and keeps coming under the scanner for violations. There are several important generic indicators which need to be taken on board. They can be listed as under:

1. *Patent filings* (connection to intellectual property rights which are non-material resources, and they need to be honoured by the organisation)
2. *Changes in land ownership*
3. *Levels of industrial water use*
4. *Extraction of material resources (abiotic mineral resources as well as biotic forest-based)*
5. *Percentage of population (urban, rural or total) with access to improved sanitation facilities*

A distinction is made between 'safe and healthy' and 'secure' when one considers the dimension '*Safe, healthy and secure living conditions in the community*'. The former can be described generically by, inter alia, two quantitative indicators – *Burden of disease in the country* and *Pollution levels in the country*. The latter has two site-specific indicators – *Number of legal complaints against the organisation with regard to security concerns* and *Number of casualties and injuries for which the organisation can be blamed*. It is always good to remember that there are rules (generic) and possible exceptions (site-specific).

4.1.3 SOCIETY

The actual *Investments made in technology development/transfer* is a reliable site-specific measure of the organisation's contribution to *Technology development*. The financial damages, in money terms, can be a useful specific indicator, for the dimension *Corruption*. As discussed in the previous chapter, businesses (especially in developing world economies) consider corruption as a 'cost category' which cannot be wished away. This 'cost' eats into their profits.

4.1.4 GLOBAL CONSUMERS

Protection of the *Privacy* of consumers is one of the responsibilities of organisations. The two specific indicators which give the analyst an idea of how well the organisation being studied is fulfilling this responsibility are the Number of consumer complaints related to breach of privacy or data loss in the time period being considered for the analysis, and the Number of complaints registered by regulatory bodies related to the aforesaid breach and loss. As far as the *End-of-life responsibility* dimension is concerned, the *Number of annual incidents of non-compliance with labelling requirements (related to end-of-life handling)* is a quantitative indicator which when recorded and reported puts positive pressure on the organisation to step up their compliance levels.



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4.1.5 VALUE-CHAIN ACTORS

An organisation in the supply chain with links on the upstream (suppliers), must ideally perform audits to ensure that its supplier base is abiding by the social sustainability norms. This is necessary to *Promote social responsibility*, in the first place, and also sustain it over time. The *Percentage of suppliers in the supplier base which have been audited* in this fashion is a useful indicator – the higher its value, the better.

4.2 PURELY QUALITATIVE INDICATORS

4.2.1 WORKERS

In order to understand the *Social security* aspect on-site, the analyst must make a *List of social benefits provided to the workers - health insurance, pension fund, child care support, education subsidies, accommodation assistance etc.* This is the only purely qualitative indicator for this stakeholder category.

4.2.2 LOCAL COMMUNITY

The *Freedom of peaceful assembly and association* is a generic indicator of the *Community Engagement* dimension, which can be described qualitatively. If there exists an *Urgent need for safeguarding cultural heritage* in a country, this is included as a generic indicator under the dimension ‘*Cultural Heritage*’ and a short description of the motivation for the same, is provided. A short description of the *State of security and human rights in the country of operation* can provide useful insights to the analyst, when the dimension *Safe, healthy and secure living conditions* is being analysed.

4.2.3 SOCIETY

The generic indicators for the dimension *Technology development* are sectoral and pertain to *Sector efforts made to develop new technologies* and the *Research and development costs associated with technology development*.

4.2.4 GLOBAL CONSUMERS

Whether there are *management measures in place to assess the health and safety of consumers who buy and use the organisation's products / avail of its services*, needs to be investigated and recorded as a qualitative indicator of *Health and safety*.

4.2.5 VALUE-CHAIN ACTORS

If an organisation in the supply chain *integrates ethical, social and environmental concerns in its purchasing policy, distribution policy and other contractual decisions* (all representing its forward and backward links in the supply chain), provides *support to suppliers by educating, informing and raising consciousness about sustainability issues*, it sets a good example when it concerns *Promoting social responsibility*.

4.3 PURELY SEMI-QUANTITATIVE INDICATORS

4.3.1 WORKERS

Workers are at the core of supply chains, as mentioned earlier. Hence, in an S-LCA, by default, a little more attention is paid to modelling this stakeholder category. That in turn means that the dimensions and indicators are, on average, more in number than the other stakeholder categories. For the first dimension – *Freedom of association and collective bargaining* (which has a Marxist ring to it) – there are ten indicators in all (three generic and seven specific). Of these, six are semi-quantitative. They can be listed as below, beginning with the sole generic one in the clutch:

1. *Evidence of restriction to the aforesaid freedom in the country/sector*
2. *Availability of collective bargaining agreement and meeting minutes*
3. *Freedom of workers to join unions of their choice*
4. *Involvement of workers or their union representatives in major business decisions which will have an impact on their working conditions*
5. *Access for workers to neutral, binding and independent dispute resolution procedures*
6. *Minimum notice period regarding significant operational changes*

All these are semi-quantitative and the measures would be partly-objective – a number on a scale with the extremes representing the worst and the best for each of them. The semi-quantitative indicators for the other dimensions have been tabulated in Table 4-2. There are ten of them across six dimensions – four generic indicators and six specific ones.

Dimension	Indicator	Generic / Specific
Child labour	Operations identified as having significant risk for incidents of child labour, and measures taken to contribute to the elimination of child labour	Generic
	Records on all workers stating names and ages or dates of birth are kept on file	Specific
Equal opportunities/ Discrimination	Country gender index ranking	Generic
Hours of work	Respect of contractual agreements concerning overtime	Specific
	Clear communication of working hours and overtime arrangements	Specific
Forced labour	Percentage of forced labour by region	Generic
	Birth certificate, passport, identity card, work permit or other original documents belonging to the worker are not retained or kept for safety reasons by the organization neither upon hiring nor during employment.	Specific
	Workers are free to terminate their employment within the prevailing limits	Specific
Health and safety	Presence of a formal policy concerning health and safety within the organisation	Specific
Social security/ social benefits	Benefits provided to full-time employees that are not provided to temporary or part-time employees, by major operations	Generic

Table 4-2: Semi-quantitative indicators for the stakeholder category - Workers

4.3.2 LOCAL COMMUNITY

How Transparent the Government policymaking is and how much the people trust the politicians are generic indicators and can both be measured on a Likert's scale, using data published by global organisations like the World Economic Forum for instance. These two describe the dimension – Community Engagement.

Language is a vital aspect of 'Cultural heritage', and a specific indicator which throws light on this aspect is the *Availability of organizational information to the stakeholders in their respective languages*. Just as EU documents are available in English, Spanish, French and German for instance, on a local community level – for instance in India – information must be made available not just in English and Hindi but also in the local language of the State in which the organisation functions.

Whether there are local supply networks can be determined and recorded with a simple Yes or a No, under the dimension – *Local employment*. The dimension *Access to non-material and material resources* can be understood by adding in some information about the *Levels of technology transfer to the community* and the *Existence of a certified environmental management system within the organisation* which ensures that material resources are harnessed responsibly.

The *Strength of public security in the country of operation* is a useful generic indicator to have in the background, for the dimension *Safe, healthy and secure living conditions*.



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4.3.3 SOCIETY

The *Risk of corruption in the country* or more specifically, the *Risk of corruption in the sector* (the latter may be greater or less than the former), can be recorded semi-quantitatively by means of what is known as a Corruption Index (for country or sector). Needless to say, these two are generic indicators for the dimension – *Corruption*.

Public commitment of (the organisation) to sustainability issues should of course be gauged on the organizational level. A semi-quantitative specific indicator is the answer to this question in the affirmative or negative – *Has the organisation committed to complying with the Global Compact and does it communicate its yearly Communication on Progress?* On a generic level, the *Presence of a legal obligation in the country to report on sustainability issues* will possible serve as a strong instrument for desirable behaviour.

4.3.4 GLOBAL CONSUMERS

The NGO Privacy International has its rankings on the following aspects (indicators) of *Privacy*:

1. *Regulations on data-sharing by organisations*
2. *Strength of laws protecting consumer privacy*
3. *Strength of regulatory powers to investigate privacy-related complaints.*

The respective rankings of the country which houses the organisation in question in each of these three indicators are the semi-quantitative measures.

When it comes to *End-of-Life responsibility*, which needs to be shouldered partly by the consumers and partly by the organisations, the *Strength of national legislation covering product disposal and recycling* is a crucial generic indicator. How well this responsibility is shouldered by the stakeholders depends to a great extent on top-down legislation and implementation. As mentioned, the organisations cannot absolve themselves of this responsibility and pass the buck to the consumers. How well the consumers behave depends on *whether and how well and clearly the internal management systems of the organisation communicate information to the end-users about the end-of-life handling options.*

4.3.5 VALUE-CHAIN ACTORS

The lone semi-quantitative indicator describing the *Supplier relationships* dimension in this stakeholder category concerns *Payments on time to the suppliers*. If buyers operate on credit for a long time, trust is destroyed, and it makes it extremely difficult for the suppliers to balance their books without depleting their savings or depending on more bank loans.

Promoting social responsibility all across the supply chain is a 'push-and-pull' exercise, where expectations move up and down the chain, pressure is exerted by consumers' expectations or the strict adherence to sustainability goals, by the final producers/assemblers who realise that how sustainable they are is fortunately (if the upstream is extremely socially responsible) or unfortunately (if the social responsibility of the upstream leaves a lot to be desired), dependent on what the upstream looks like. The upstream, as you can imagine is a maze... not only difficult to visualise for you as an analyst, but also impossible to monitor and control. However, if the threat of losing market share to more-responsible competitors looms large, suppliers will fall in line. The relevant indicators in this typology are:

1. *Industry code of conduct in the sector (generic)*
2. *Presence of explicit code of conduct protecting the human rights of workers among suppliers (specific)*
3. *Membership in an initiative that promotes social responsibility across the supply chain (specific)*



4.4 QUALITATIVE OR SEMI-QUANTITATIVE INDICATORS

4.4.1 WORKERS

Table 4-3 below lists all the indicators belong to this typology, categorised on the basis of the dimensions.

Dimension	Indicator	Generic / Specific
Freedom of association and collective bargaining	Operations in which the right to exercise the freedom of association and collective bargaining may be at significant risk, have been identified and singled out for remedial action	Generic
	Absence of restrictions to freedom of association and collective bargaining	Specific
	Formal recognition of the presence of unions within the organisation.	Specific
Hours of work	Organisation provides flexibility	Specific
Equal opportunities/discrimination	Presence of formal policies on equal opportunities	Specific
	Announcement of open positions happen through national/regional newspapers, public job databases on the internet, employment services or other publicly available media ensuring a broad announcement.	Specific
Health and safety	Are adequate general occupational safety measures taken?	Specific
	Do preventive measures and emergency protocols exist regarding accidents & injuries?	Specific
	Preventive measures and emergency protocols exist regarding pesticide & chemical exposure	Specific
	Appropriate protective gear required in all applicable situations	Specific
	Education, training, counselling, prevention and risk control programs in place to assist workforce members, their families, or community members regarding serious diseases	Specific
Forced labour	Workers voluntarily agree upon employment terms, employment contracts stipulate wage, working time, holidays and terms of resignation, employment contracts are comprehensible to the workers and are kept on file	Specific
Fair salary	Do the lowest-paid workers think that their wages meet their needs?	Specific
	Are there any suspicious deductions on wages?	Specific
	Are payments (wages and salaries) made regularly and are these systematically documented?	Specific

Table 4-3: Qualitative/semi-quantitative indicators for the stakeholder category - Workers

4.4.2 LOCAL COMMUNITY

For the dimension ‘*Delocalization and Migration*’, the *Description of causes for and the treatment of internally-displaced persons*, if well-documented, points to an awareness in the country or the economic sector, of the presence of such persons, whose lot needs to be improved through effective policies. It also indicates a readiness to address and remedy this social impact. While this is a generic indicator, the corresponding site-specific one will look into the *Strength of the policies of the supply-chain-node in question to contribute to resettling the individuals who have been displaced because of its existence*. Also necessary here is another site-specific indicator – *the Strength of the policies for integrating migrant workers into the local community*. Note that generalizations are to be avoided whenever possible. What is true for the country may or may not be true for the sector. What is true for the sector may or may not be true for the site being investigated as the node in the supply chain being analysed.

The dimension ‘*Community Engagement*’ has four specific indicators, two of which fall under this typological category. One of them is the *Strength of the written policies on community engagement on the organizational level*, and the other one is the *Diversity of community stakeholder groups that engage with the organisation*. Different groups in the community have different interests and thereby a single group cannot represent the entire community effectively and faithfully. The different stakeholder groups here could, for instance include, senior citizens, women and children, young men, farmers, fishermen, etc. They could, in a multireligious or multiethnic community, also include groups of indigenous peoples, separate groups of Christians, Muslims, Hindus etc. Assume that there is a mosque, a temple and a church in different parts of the community in need of repair for instance, and each group may be interested in seeking financial support separately for the same, from the organisation through its corporate social responsibility program. The greater the diversity, the greater the possibility that a wide range of issues are addressed by the organisation.

The dimension – *Cultural Heritage* – as described in the previous chapter encompasses language, art, crafts, religious rituals, traditional beliefs, places of worship etc. The degree of *Prevalence of racial discrimination* is a generic indicator (for a country or within a given economic sector) which can be described qualitatively or represented by a number on a Likert’s scale. When it comes to specific indicators under this dimension, the *Strength of policies in place to protect cultural heritage on site* and the *Provisions to include cultural heritage expression in product design* are desirable.

There is a whole clutch of indicators – generic and specific - in this typology under the dimension *Respect of Indigenous Rights*. *Prevalence of racial discrimination* figures here too, just as it does for *Cultural Heritage*. *Human rights issues faced* and *Indigenous land rights conflicts* are the other two generic indicators, presenting an overview of what prevails in the country. As far as the site-specific indicators are concerned, it is necessary to measure the *Strength of*

policies in place to protect the rights of the indigenous peoples (the legislating or proactive aspect) and the *Response to claims of discrimination against the indigenous peoples* (the implantation or enforcing aspect). The *Strength of policies related to local hiring or sourcing of supplies* can be described qualitatively or semi-quantitatively, under the dimension – *Local employment*.

The dimension – *Access to non-material and material resources* – has four site-specific and one generic indicator belonging to this hybrid typology. The generic one describes the *Freedom of expression which people in general have in the country of operation*. The degree, as we know varies across a broad spectrum – with limitless freedom in countries like Norway and Sweden to absolutely no freedom in countries like North Korea. The specific ones are as under:

1. *Existence of active organizational policies respecting economic and moral rights associated with intellectual property rights of the community*
2. *Existence of sound policies promoting community education initiatives undertaken by the organisation (think of the Corporate Social Responsibility of Sustainability reports which companies publish)*
3. *Project-related infrastructure developed with mutual community access and benefit*
4. *Presence of effective organizational risk assessment policies with focus on avoiding material resource conflicts*

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One generic and three site-specific indicators of this hybrid typology can be used to convey more information about the 'safe and healthy' part of the dimension – *Safe, healthy and secure living conditions*. These relate to *Laws on construction safety regulations (generic)*, and *Management oversight of structural integrity*, *Community support provided by the organisation to sustain the health of inhabitants*, and *Efforts undertaken to minimize the use of hazardous substances* (all three site-specific). As far as security is concerned, organisations often hire private security personnel and the robustness and reliability of such services are dependent on the *Management policies* in this regard, which can be assessed qualitatively or semi-quantitatively.

4.4.3 SOCIETY

The organisation's *Involvement in technology transfer programs* and *Partnerships struck with other entities in society in research and development* can be useful measures of the *Technology development* dimension of social sustainability. How the organisation perceives *Corruption* and combats it, can be succinctly captured by means of four specific indicators:

1. *Formalized commitment to combat corruption (as laid down in policy documents)*
2. *The actual implementation of an anti-corruption programme*
3. *Cooperation with internal and external controls to prevent corruption*
4. *Written documentation on actual involvement of the organisation in corruption and bribery and convictions related to the same (if there is a history, and it is documented, and the organisation has rectified its ways, it can be considered as a positive. If there have been convictions and the anti-corruption programme seems to be only nominal, that will tarnish its reputation)*

Under *Prevention and mitigation of conflicts*, there are three moot questions, answers to which comprise the category of generic indicators. The analyst would like to know if *the organisation is doing business in a region with ongoing conflicts, in a sector with linkages to conflicts associated with depletion of resources leading to significant profits which are not being used for the development of society, in a sector otherwise linked to the escalation or de-escalation of conflicts*. Note that efforts made by the organisation to de-escalate conflicts is a well-deserved feather in its cap – a positive contribution to social development! From a more specific point of view, one can include two indicators – *the organisation's role per se in conflict resolution or conflict escalation (note that this may be different from what the sector on the whole is doing)*, and the presence of any *Disputed products. The mineral resources (precious metals and otherwise) exported from countries*.

Most of the indicators under the dimension '*Public commitment to sustainability issues*', fall under this typology. The generic one focuses on *Sectoral engagement in sustainability*, while the specific ones answers questions related to *Presence of publicly available sustainability documents*, *Presence of clearly-outlined mechanisms for pursuing sustainability goals*, *Complaints filed by stakeholders in society about non-fulfilment or violation of sustainability norms*,

4.4.4 GLOBAL CONSUMERS

The *Quality of labels of health and safety requirements* is an indicator under the *Health and safety* dimension, which can be assigned a score (say out of maximum of 5 for instance – a semi-quantitative measure) or can be described in brief in words. For the dimension – *Privacy* - information about the *Strength of the internal management system to protect consumer data privacy* can be gathered and presented qualitatively, or ranked relative to set standards.

4.4.5 VALUE-CHAIN ACTORS

The dimension '*Fair competition*' is mostly described by indicators belonging to this typology. The generic ones include *National law and regulation*, *Sectoral regulation*, *Sectoral agreement* and the *Presence of the sector in consumer unions*. The specific ones which are to be determined on-site (documents, or interviews with employees), include *Membership in alliances that behave in an anti-competitive way*, *Documented statements to prevent engaging in anti-competitive behaviour* and *Employee awareness of the necessity of complying with competition legislation*.

General intellectual property rights and related issues in the country or sector (generic) and the *Organisation's policy and practice in this respect (specific)*, are reliable measures of the *Respect of intellectual property rights*

Supplier relationships can be comprehensively described with the aid of four specific indicators, three of which fall under this hybrid typology. They encompass *Presence/absence of coercive communication with suppliers*, *Sufficient lead time for suppliers* and *Reasonable supply volume fluctuations*. The fourth is a semi-quantitative indicator, referred to in the respective sub-section in the chapter.

4.5 QUANTITATIVE OR SEMI-QUANTITATIVE INDICATORS

4.5.1 WORKERS

There is one indicator under the *Health and safety* dimension which can have a quantitative or semi-quantitative measure - *Number of (serious/non-serious) Occupational Safety and Health Administration (OSHA) violations reported within the past 3 years and status of violations*. In this case, the status of violations can be given a score on a scale from 'no violation' to 'extremely serious'. In the dimension – *Social Security* – there are two indicators belonging to this group. The generic one provides information about *Social security expenditure by country and branches of social security – healthcare, sickness, maternity etc*, while the specific one measures the *Percentage of permanent workers in the organisation receiving paid time-off*. For the dimension – *Equal opportunities / Discrimination*, there is the *Ratio of basic salary of men to women by employee category* and also the *Composition of governance bodies and breakdown of employees per category according to gender, age group, minority, group membership, and other indicators of diversity*, which the analyst can record using suitable quantitative or semi-quantitative measures.



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Bondage of workers to the employer by debts exceeding legal limits & the Risk of forced labour used for production of commodities in the sector or country, are respectively generic and specific indicators under the dimension *Forced labour*. While the extent of bondage and risk can be specified by a score which posits the sector or country vis-à-vis others in the world (semi-quantitative measures), the actual value of the debts and the observed instances of forced labour in the sector/country in terms of percentage of total labour, could be absolute quantitative measures.

It is also useful to determine *where the lowest paid-worker in the organisation stands with regard to the prescribed minimum wage (specific indicator for the organisation for the dimension Fair salary)*. If he/she receives exactly the minimum wage, it can be considered as just, a par score. If less, it is surely questionable. If higher than the minimum, the organisation will have a high score for this indicator. While the quantitative measure in this case, could be the ratio between the wage of the lowest-paid employee and the minimum wage; the semi-quantitative one could be a score on a grading scale.

4.5.2 GLOBAL CONSUMERS

This is the only stakeholder category which has dimensions which can be described by indicators which belong to this typology. Within this category, it is only the *Health and Safety* dimension which accounts for them – two generic and one site-specific. The generic ones include:

1. *Quality of or the number of information / signs related to product health and safety* (semi-quantitative or quantitative in that order)
2. *Presence of consumer complaints (related to health and safety issues associated with the product or service) at the national, sectoral or international level*. Evidently, absence of any complaints indicates a 'squeaky clean' record.

If point (2) above is only for the organisation, it becomes a specific indicator (information stored can be Yes/No, or the actual number of complaints, as required)

4.6 QUALITATIVE OR QUANTITATIVE INDICATORS

4.6.1 WORKERS

The *Equal opportunities/discrimination* dimension has an indicator which can be partly described quantitatively and partly qualitatively. In other words, for this indicator, it is not qualitative or quantitative, but rather quantitative and qualitative. This is the *Total numbers of incidents of discrimination and actions taken*; the former being a number and the latter a short description of the responses to the incidents.

4.6.2 SOCIETY

All the three indicators belonging to the dimension – *Contribution to economic development* – fall under this hybrid typology. The generic ones measure the *Economic situation of the country in which the organisation is based* (which includes one or more of the following: GDP, economic growth, unemployment, wage levels etc.) and the *Relevance of the sector considered for the economy* (shares or percentage of the total GDP, employment generation etc.). The specific ones delves down from country and sector to the organisation per se and tries to find out its *Contribution (in percentage terms) to the sector and to the entire country' economy*.

4.7 QUALITATIVE, QUANTITATIVE OR SEMI-QUANTITATIVE INDICATORS

There are relatively few indicators which fall into this special typology, providing the analyst with the flexibility to measure and report them in any of the three ways. Of all the stakeholder categories, the dimension *Feedback mechanism* under Global Consumers accounts for the greatest share of these.

4.7.1 WORKERS

The *Evidence of absence of respect for the freedom of association and collective bargaining at country or sector level*, and the *Evidence of violations of obligations to workers under labour or social security laws and employment regulations*, can be recorded using quantitative or semi-quantitative measures or for that matter a short description of what is observed and verified. Information about *Women in the labour force participation rate by country* (a generic indicator under *Equal opportunities/discrimination*, can be gathered and expressed as a number and/or a score (on a scale, relative to other countries) and/or as a short note about the status quo and its reasons.

Understanding of the dimension *Forced labour* can be improved by studying the *Operations identified as having significant risk for incidents of forced or compulsory labour, and measures taken on a sectoral / national level to contribute to the elimination of forced or compulsory labour*, while *Child labour* can be comprehended generically by an overview of the *Percentage of children working by sector and country*, and more specifically by investigating the *Presence/absence of working children under the legal age or 15 years old (14 years old for developing economies) within the organisation*, *Existence or otherwise of instance of children working at night* and the *Attendance in school of working children younger than 15 (or 14 for developing economies)*. On a generic level, for *Hours of Work, Excessive Hours of work in a sector or country in general* can be measured and reported as the total number of hours (categorised on a sectoral basis for the country). It could be scored on the basis of the 'degree of excessiveness'.

4.7.2 LOCAL COMMUNITY

In 'Community Engagement', the *Number and quality of meetings held with the stakeholders* can be measured quantitatively (the number part, that is), qualitatively (descriptive account of the agenda and the follow-up and the degree of satisfaction of the community stakeholders) and semi-quantitatively (averaging responses from a survey in which respondents rank quality on a Likert's scale).

4.7.3 GLOBAL CONSUMERS

The *Health and Safety* dimension has an indicator - *Total number of incidents of non-compliance with regulations and voluntary codes concerning health and safety impacts of products and services and type of outcomes*. While this can have a numerical measure, there can also be a short description of these incidents (qualitative) and a relative measure (an index for instance) which could be a semi-quantitative measure.

All five indicators (two generic and three specific) belonging to the *Feedback mechanism* dimension are of the same typology and are as under:

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1. *Presence of feedback mechanisms (after sale, etc.) within the sector or country (generic)*
2. *Number of consumer complaints at sector level (generic)*. This is not very different from the indicator which records consumer complaints related to health and safety. However in this case, one may consider all types of complaints (for instance, complaints about absence of prompt responses to queries)
3. *Presence of a mechanism for consumers to provide feedback (specific)*
4. *Management measures undertaken to improve feedback mechanisms continuously (specific)*
5. *Practices related to customer satisfaction, for instance, surveys, follow-ups and changes planned or implemented on the basis of the survey responses (specific)*

4.7.4 VALUE-CHAIN ACTORS

If Competition legislations have been violated by the organisation in question, legal actions may be pending, in progress, or completed. A record of these is a useful indicator in an S-LCA, under the dimension ‘Fair competition’. Absence of any lawsuits against the organisation is necessary good, while the presence of any taints it. One may think thus: No brownie points for doing what one is obliged to do by law, but surely a minus points for violating legislation. *Use of local intellectual property* is described by an organisation-specific indicator under the dimension – *Respect of intellectual property rights*.

4.8 EN PASSANT – USEFUL TO REMEMBER

Remember that what has been presented in this chapter is the entire swathe of indicators under all the dimensions defined for the stakeholder categories – Workers, Local community, Society, Value-chain actors and Global consumers. However, when you take up a case – a supply chain of a product you choose to analyze – you will not be able to consider all stakeholder categories for all dimensions and all indicators. The choice would have to be made on the basis of:

1. The goal you have in mind or the goal which has been assigned to you. The scope you choose for the analysis, or have been asked to choose. Relevance to the goal and scope you set for your analysis
2. Data availability (organisations may not be very forthcoming with sharing information; data may not be properly documented even if they are keen to share; in some cases, there may also be threats to the safety of the analyst, if vested interests want to interfere)
3. Time and cost for carrying out the analysis (site visits may be expensive)

4.9 EXERCISES

1. For the country you hail from, look for values (quantitative, semi-quantitative) or descriptions (qualitative) for the generic indicators of the different dimensions we have discussed in the previous two chapters. You would first need to make a structured list of all the generic indicators culled from this chapter.
2. Choose a manufacturing unit (any economic sector) from the town or city you belong to. Make a table of the different site-specific indicators for the different dimensions, in well-structured worksheets in MS-Excel. Contact the personnel of this manufacturing unit and with the help of site visits, interviews and access to available documents in the archives of the company, try to describe all the dimensions in your table as comprehensively as you can.
3. Now, try to compare the values for some of the site-specific indicators, with the corresponding generic values for your country, wherever applicable, and discuss the reasons for any striking differences you may come across.

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5 ANALYSIS STEP-BY-STEP: SOCIAL THEMES TABLE, SOCIAL HOTSPOTS DATABASE AND WORKER HOURS TABLE

***Learning objectives:** Now, you know the framework of stakeholder categories, dimensions and indicators. That presents you with the possibility of analysing in very great detail – comprehensive and all-encompassing – the social footprint of supply chains of chosen products or services. However, after reading Chapters 4 and 5, you would have sensed the daunting nature of this exercise. In this chapter, you get introduced to a more manageable way of analysing, albeit at the expense of some comprehensiveness and by resorting to generalisations. You get introduced to the Social Hotspots Database (SHDB)²⁰ and the Social Themes table and the Worker Hours Table, it resorts to, in a step-by-step social life-cycle analysis of supply chains. Note that this database is not freely available online, but if you are at university, it is possible that there are licenses which have been purchased, for the use of researchers and students, which may give you access to the SHDB.*

5.1 SOCIAL THEMES TABLE

The Social Hotspots Database²¹ is an overarching global database which is availed of, to identify social impacts in product supply chains, which as we know, are very complex and can encompass hundreds of entities – tiny, small, medium and large – across countries and continents. Before we move on to understand what the dimensions, social themes, indicators and values in the database are, it is worth always remembering that this is an ever-evolving database, which needs to be updated periodically, as ‘change is the only constant in this world’.

While the UNEP framework identified both generic and site-specific indicators for all the dimensions, while using the SHDB, one resorts to the usage of only generic indicators – country-specific or sector-specific. One can intuitively agree that while the use of site-specific indicators would be the most-preferred option when accuracy and reliability are of paramount importance, the next-best alternative would be sector-specific equivalents; and in the absence of either of these, in a ‘something is better than nothing’ situation, the countrywide indicators can pass muster. Table 5-1 presents the dimensions, social themes, and the numbers of generic indicators in each of the four dimensions.

Category/Dimension	Social themes	#indicators
Labour rights and decent work	Labour laws Wage assessment Population living in poverty Child labour Forced labour Excessive working time Unemployment Freedom of collective bargaining and right to strike	25
Governance	Legal system	7
Human rights	Indigenous rights Gender equity Conflict zones Human health	38
Community infrastructure	Children out of school Access to drinking water Access to sanitation Access to hospital beds	10

Table 51: Dimensions, social themes and indicators, used with the SHDB

You will, after a little thought, realise that the UNEP framework has inspired the contents of Table 5-1 which are applied with the SHDB, with dimensions being redefined (overlaps will at once become evident). Workers become ‘Labour rights and decent work’, Value-chain actors become ‘Governance’, Society and Global Consumers merge and morph into ‘Human rights’, while Local community becomes ‘Community Infrastructure’. Of course, there is one common opinion among many Social LCA researchers, that this tool is still in its infancy, and consensus regarding the choice of dimensions and indicators may be reached in the near future.

Now, what the SHDB has is a score on a scale of 0 to 3 for each of the 80 indicators (25 + 7 + 38 + 10, from Table 5-1). The score indicates the level of risk that global standards set for each of these indicators are not being met. Such risk-level scores are available on sectoral levels within countries. It goes without saying that the data are not necessarily comprehensive, and over time, more sectors from more and more countries of the world will be represented in the SHDB. As mentioned earlier, this is an evolving and ever-changing database.

5.2 HOTSPOT INDEX

Let us take a hypothetical example to understand what the Hotspot Index means. Consider a bauxite miner in Guinea in West Africa as a node on the upstream of a supply chain for say aluminium castings. We would wish to work with all the 80 generic indicators for this node and access the appropriate economic sector in Guinea – in this case, perhaps ‘Mining of metal ores’. Here, this author would like to state at the outset that he does not have access to the SHDB and this hypothetical case does not use real data from the database.

Let us say we consider all four dimensions listed in Table 5-1, but choose to work with 7 social themes only (see Table 5-2), and also narrow down the scope to say, a total of 12 indicators only (denoted simply as I_n in the Table). Note that the analyst can, depending on the goal and the scope he/she selects, choose the dimensions, themes and indicators he/she wishes to restrict the analysis to.

Category	Theme	Indicator	Risk rating	Maximum
Labour rights and decent work	Labour laws	I_1	2	3
		I_2	2	3
	Unemployment	I_3	2	3
		I_4	3	3
Governance		I_5	3	3
Human rights	Conflict zones	I_6	2	3
		I_7	2	3
	Human health	I_8	2	3
		I_9	2	3
		I_{10}	2	3
Community infrastructure	Access to sanitation	I_{11}	3	3
	Access to drinking water	I_{12}	2	3
Total	Seven themes	12 indicators	27	36

Table 5-2: Hypothetical case – Hotspot Index for bauxite mining in Guinea

In Figure 5-2, if all the indicators had registered ‘maximum risk’ values – an utterly hopeless case, indicating a grave situation – the aggregated score would have been 36. If we arrive at an aggregated score of 27, the Hotspot Index for this sector in Guinea, would be simply the ratio of 27 to 36, expressed as a percentage – 75. A similar approach can be undertaken for the different nodes in a supply chain one chooses to study (of course, it cannot be studied in its entirety, and some nodes may fall out of the analysis for a host of reasons), and the Hotspot Indices can be calculated.

5.3 WORKER HOURS IN A SUPPLY CHAIN

We now move on to the Worker Hours table, and it will be useful here to understand what it means and how it is constructed. We begin with Figure 5-1 below.

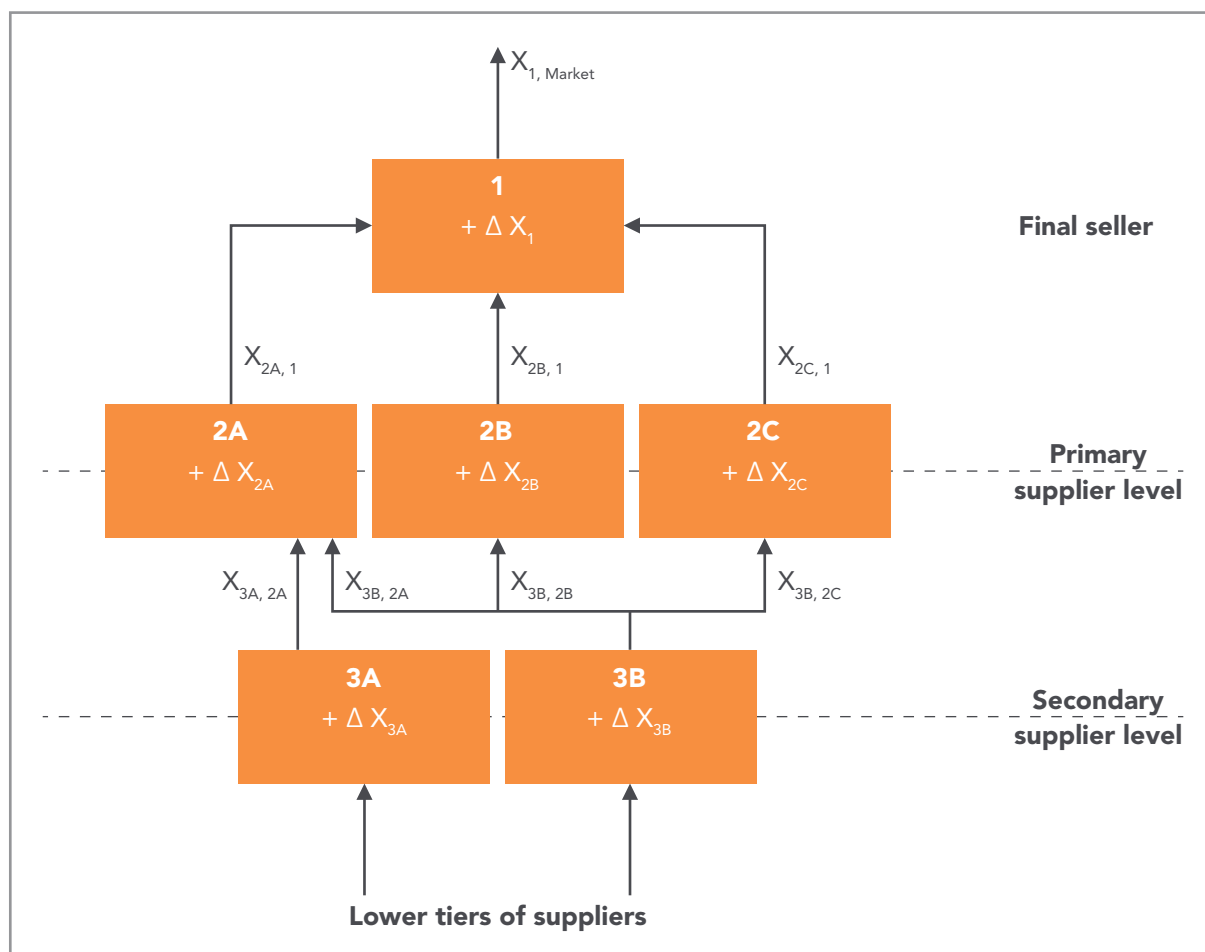


Figure 51: Suppliers and contribution to the final output

Figure 5-1 depicts the top three tiers of a supply chain which ends in the final-seller (1) selling goods worth $X_{1, \text{Market}}$ in the global marketplace. Let us assume that the final seller (1) has three primary suppliers (otherwise known as first-tier suppliers) – 2A, 2B and 2C. They account for $X_{2A,1}$, $X_{2B,1}$ and $X_{2C,1}$ respectively of the final output of $X_{1, \text{Market}}$. Now, evidently, there is value addition within the final-seller's unit, and ΔX_1 can be added on to the expenses incurred on purchases from the first tier of suppliers. This value - ΔX_1 - will include all expenditure incurred in the value-addition process (inclusive of the profit margin sought by the seller).

We can thus construct a series of equations as below:

- $X_{2A,1} + X_{2B,1} + X_{2C,1} + \Delta X_1 = X_{1, \text{Market}}$
- $X_{3A,2A} + X_{3B,2A} + \Delta X_{2A} = X_{2A, 1}$
- $X_{3B,2B} + \Delta X_{2B} = X_{2B,1}$
- $X_{3B,2C} + \Delta X_{2C} = X_{2C,1}$

If you branch out further into the lower tiers, you could think of several equations like the ones above. You at once realise, every supplier in the supply chain contributes a small or big portion to the final value of the goods put out on the marketplace by the final seller.

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This contribution is also directly related to the labour put in at each of the supply-nodes; which can be measured in terms of the number of hours worked.

For industry 'I', if the labour rate is ' L_I ' USD/hour, the total wages paid (in a year, say) equal ' W_I ' USD, then the number of hours of labour put in, in industry 'I' equal ' W_I/L_I '. If this is divided by the output from the industry in a year – say X_I , then we get ' $W_I/(L_I * X_I)$ '. This gives us the labour intensity (B_I), which is the number of hours worked per unit output from the industry. We thus have a relation as below:

- $B_I = W_I / (L_I * X_I)$

The labour intensity calculated above, would be different among different players in the same economic sector. One can think of the generic value as an average for a given sector within a country. Now, focus on Table 5-3. For a moment, assume that there are just two tiers of suppliers (that though is a very erroneous simplification). This simplification was done so that we could assume that all the fractions in the last column would add up to unity. Of course, if you keep on moving down to lower tiers and try to include as many as you can, the sum of the fractions in the last column will tend to unity.

Supply chain node	Labour intensity (hours/output) – hours/USD	Output from the node for the supply chain (USD/year)	Total labour hours for the supply chain (hours/year)	Fraction of the total for the supply chain
1	B_1	$X_{1,Market}$	$B_1 * X_{1,Market}$	δ_1
2A	B_{2A}	$X_{2A,1}$	$B_{2A} * X_{2A,1}$	δ_{2A}
2B	B_{2B}	$X_{2B,1}$	$B_{2B} * X_{2B,1}$	δ_{2B}
2C	B_{2C}	$X_{2C,1}$	$B_{2C} * X_{2C,1}$	δ_{2C}
3A	B_{3A}	$X_{3A,2A}$	$B_{3A} * X_{3A,2A}$	δ_{3A}
3B	B_{3B}	$X_{3B,2A} + X_{3B,2B} + X_{3B,2C}$	$B_{3B} * (X_{3B,2A} + X_{3B,2B} + X_{3B,2C})$	δ_{3B}
Grand total (hours/year)			$\sum B_n X_{n,m}$	1

Table 53: Labour intensity, annual output, labour hours and shares in total labour

5.3.1 SHARE IN WORKER-HOURS AND MODIFICATION OF HOTSPOTS INDEX

As shown in Table 5-3, the share of a given supply node in the total worker hours for the supply chain can be determined. Some thumb rules which may be used (these are not hard-and-fast rules though) are worth mentioning at this juncture. These rules pertain to modifying the values of the Hotspots Indices upwards (Refer Figure 5-2). As shown in the Figure, the index for the node (which is considered to be the same as the index for the sector it belongs to), is increased by 30% of the share of the node in the total labour hours in the supply chain is greater than or equal to 1%; by 20% if it is between 0.2% and 1%, and by 10% if it is between 0.1% and 0.2%. If less than 0.1%, the Hotspots Index is retained as it is.

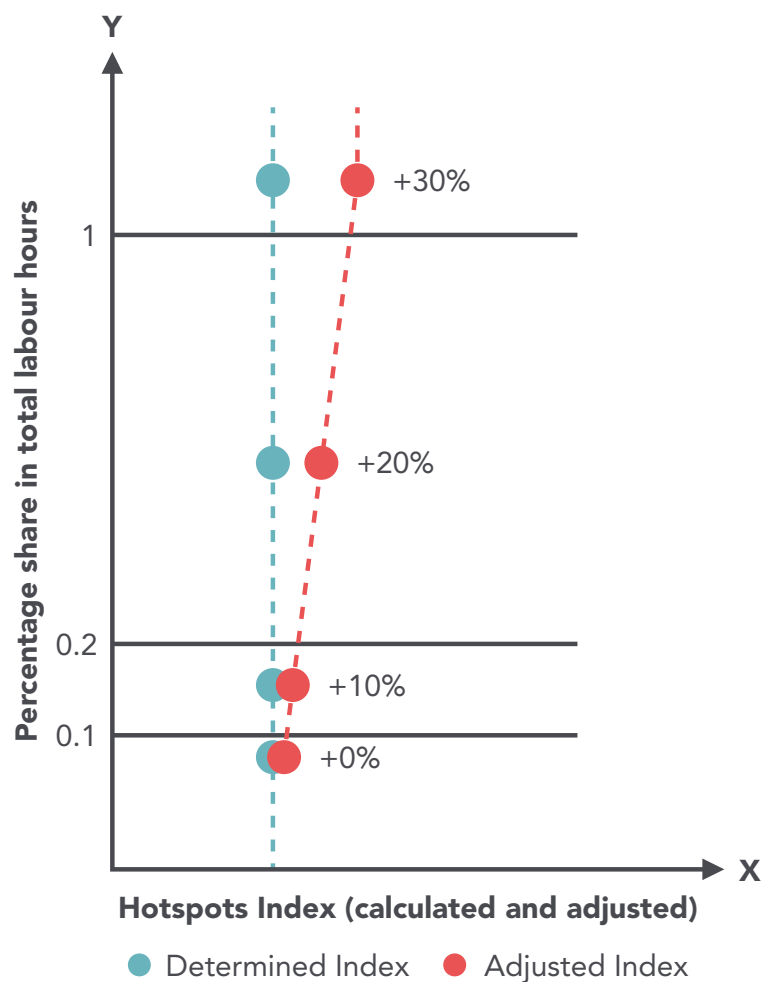


Figure 52: Modifying the Hotspots Index based on nodal contribution to the labour hours

This can be looked upon as a process of weighting. Consider the product of the Hotspots Index and the share of labour hours for each node. If all such products are added together, one gets a Hotspots Index to describe the entire supply chain, taken as a grand whole.

Greater the share in the total number of labour hours, greater is the exposure of workers to the risks that may prevail. If the risk level for an indicator is zero (absolutely risk-free), then that is not a concern in any way. But a risk level of 1, 2 or 3, when exposed to, for a longer time, deserves more attention. This is not applicable merely to the Labour rights and decent work dimension, but to all the four. Every hour of labour accounted for by a node in a supply chain which scores poorly in the Governance and/or Human rights and/or Community Infrastructure dimensions for instance (some of the indicators in which may not be related to Labour conditions and decent work and thereby to Worker hours), must also be prioritised; as it represents social externalities which are not being compensated for. It must however be mentioned here that the adjustment rates and the cut-offs for the shares shown in Figure 5-2 – 10% (0.1%-0-2%), 20% (0.2%-1%) and 30% (> 1%) - may well be changed by the analyst. S-LCA is characterised by subjectivity understandably but that does not undermine its basic purpose: to identify hotspots and suggest changes the value-chain actors must think about to improve the conditions in the local communities and/or societies and/or workplaces, and be trustworthy to the global consumers.



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5.4 SUPPLY-CHAIN ANALYSIS, UNDERSTOOD WITH AN EXAMPLE

On the basis of the understanding gained from the earlier sub-sections, let us take a case study conducted by Benoit and colleagues in 2012²². Figure 5-3 depicts the supply chain which has the dairy farms, milk and yoghurt processing units, distribution and retailing operations and end-consumers in the USA.

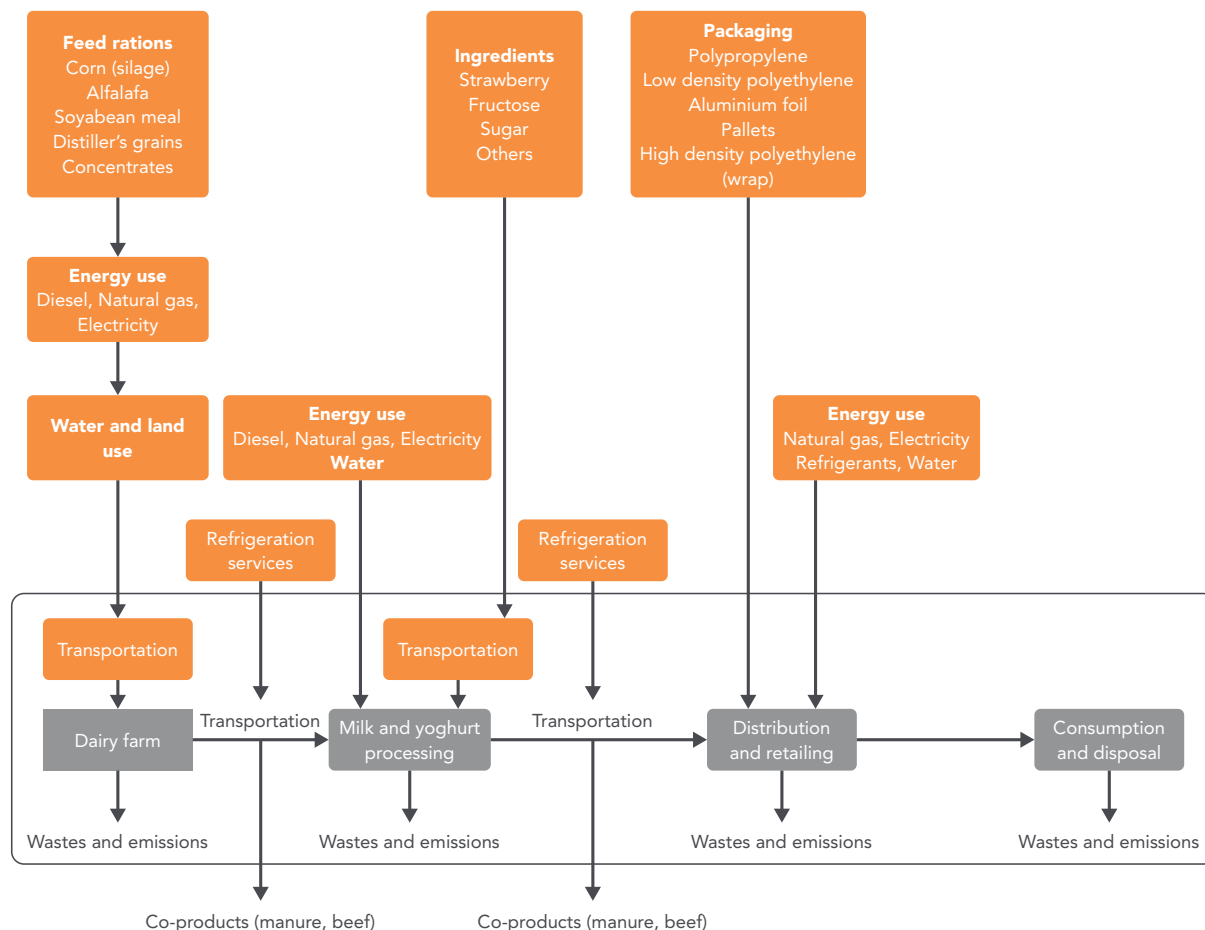


Figure 53: Strawberry yoghurt supply chain²² (Adapted for the e-book from the original)

As seen in the Figure above, which is quite self-explanatory, the supply chain for a simple run-of-the-mill product like strawberry yoghurt can be complex indeed...encompassing many countries in the world. Further, there may be multiple nodes in the same sector (competitors) in the same country, supplying similar inputs (rations, ingredients, packaging materials etc.) to the same node or competing nodes in the same sector (dairy farms for instance), downstream. In this case study, the nodes have been characterised by their shares in the total labour hours (data from the Worker Hours Model from the SHDB, an economic input-output database called the Global Trade Analysis Project (GTAP) that provides total wages paid out by country and sector per dollar of output and also categorisation on the basis of unskilled, skilled and total average wages per hour for those country-specific sectors). The hotspot indices for the nodes were modified as discussed in the previous sub-section,

and the nodes were arranged in the descending order of their respective modified Hotspot Indices (values exceeding 100 after modification, were reported as 100). Table 5-4 lists the nodes (countries and sectors they belong to), with values of modified Hotspot Indices greater than 45, alongwith their ranks in the listing on the basis of their shares in the total labour hours.

Country	Sector (CSS)	Worker Hours rank	Modified Hotspots Index
Angola	Oil extraction	48	100
India	Chemical products, plastics	15	75.1
China	Live animal products, gelatin	92	73.3
Indonesia	Chemical products, plastics	96	72.1
India	Sugarcane, beet sugar	135	66.7
India	Mining of metal ores	166	66.7
China	Coal mining, refining	61	63.8
Venezuela	Oil extraction	17	63.8
China	Other food products and starches	99	62.3
China	Vegetables and fruits	50	61.5
India	Chemical products and plastics	215	60.4
Turkmenistan	Gas extraction	203	58.6
China	Petroleum products	367	57.8
China	Live animal products, gelatin	183	55.9
Philippines	Vegetables and fruits	356	54.6
Venezuela	Chemical products and plastics	63	53.9
Mexico	Vegetables and fruits	56	45.6

Table 54: Strawberry yoghurt supply chain – the ‘bad’ guys²²

The question to you, readers, after you have gone through the table is this : If the Hotspots Index is less than 45, do you agree that we can safely overlook it? Considering that the aggregated level of risk is low? Of course, there may be some indicators which may be at high-risk (3) while the others may be risk-free in totality (zero). In Table 5-4, what has been shown in the third column are the ranks and not the shares in the total labour hours. Knowing the shares in the total labour hours for all the nodes one takes into consideration (not just the ones above which have been prioritised on the basis of their modified Hotspot Indices). For each node, if you multiply the modified Hotspots Index by its share (the fraction) in the total labour-hours, you get a product²³. If you add all such products, you will arrive at what can be looked upon as the Supply-chain's Hotspot Index. This can be used to compare the social footprints of different supply chains for competing products in the global marketplace. Just as you would compare a laptop assembled in Taiwan with one assembled somewhere in Europe for their environmental footprints. Two competing products can thus be compared with each other for their social and environmental footprints. It may turn out one of these scores better on both counts; or the one with a smaller social footprint may have a higher environmental footprint or vice versa.

5.5 EXERCISES

1. Look for the Strawberry Yoghurt report by Benoit et al (2012), online, download and read it carefully. Try to understand it very well, to be able to follow a similar approach to study the social footprint of any other product of your choice, which is sold.

6 UNDERSTANDING SOME CASE STUDIES FROM AROUND THE WORLD

Learning objectives: It is always advisable to read published case studies – from journal papers you can access in your university libraries, for instance. In this chapter, you are taken through two such publications. The intention of the author is to stimulate interest in accessing and reading more such studies and enhancing your understanding of how S-LCA has been/can be used to understand the social impacts of economic activities which we often just take for granted.

6.1 E-WASTE IN PAKISTAN²⁴



Figure 6-1: Onion diagram representing the stakeholders in the electronic waste recycling sector in Pakistan²⁴

In a paper published in 2013, Umair and colleagues had written that of the 20-50 million used computers that are disposed annually, close to 80% are shipped to the developing world, where they are handled manually in hazardous working conditions. Of course, readers will appreciate the fact that when one talks of electronic wastes, it is not just computers one is referring to. These wastes are what we may look upon resources in ‘urban mines’ – ‘orebodies’ which have much higher concentrations of some metals in them. Reportedly, the average concentration of gold in the electronic wastes is 17 times greater than that in the richest orebody yielding gold, and that of copper is over 40 times greater than that in the richest copper-bearing rocks in Chile.

It goes without saying that increasing the degree of recycling of metals is a sine qua non in the 21st century, to combat abiotic depletion and prolong the lifetimes of metal-bearing ores, and providing avenues for the informal recyclers to earn some money and sustain the livelihoods of their families is a positive for the economy. Umair and colleagues have focused on Pakistan, as one of the ‘graves’ to which the used computers are sent for dismantling and recycling (in a related context, the author would like to encourage readers to acquire knowledge about the ship-breaking industry in South Asia and China). The authors zoom into seven big cities in the country – Peshawar, Islamabad, Rawalpindi, Gujranwala, Lahore, Faisalabad and Karachi – and a small town Shahdara, for their investigation and subsequent social life-cycle analysis. Evidently, the focus is not on the entire supply chains of electronic equipment whose life-cycles end in Pakistan, but just on the last node to which the different supply chains converge. The stakeholders interviewed for this S-LCA have been depicted in the onion diagram of Figure 6-1. As shown, the ‘global consumers of the recycled metals have not been included in the analysis.

In Table 6-1, the highlights for each of the dimensions considered in the analysis, have been presented in three columns. There are indeed some positives which are uncovered in the analysis, though indisputably, the negatives outweigh them. Freedom of association and collective bargaining (shown in the central column) is extant only in the southern port city of Karachi through which the wastes enter Pakistan.

Dimension: Positive/s	Dimension: Grey zone	Dimension: Negative/s
<p>Equal opportunity: No discrimination. Christians and Muslims work shoulder to shoulder in the sector</p>	<p>Freedom of association and collective bargaining: No labour unions (except in the southern business hub of Karachi)</p>	<p>Child labour: It is commonly seen that children in the age group of 6 – 18 work in this sector; they do not attend school</p> <p>Work hours: Workers work for over 12 hours daily</p> <p>Health and safety: No protective gear, breathing problems, skin disease, improper ventilation in the recycling shops. Blood lead levels are high in children as lead leaks into soil and water</p> <p>Social security: No such benefits in Pakistan</p> <p>Wages and benefits: Wages are low (USD 2 – 3 per day)</p> <p>Community engagement: The local community seems to be unaware of the problems associated with this business</p> <p>Public commitment to sustainability issues: The government has to enforce periodic testing of soil and water, and also make it mandatory that working conditions are safe enough. The value-chain actors must be fined or imprisoned if they flout norms.</p> <p>Promoting sustainability issues: Importers and business owners are more concerned about making profits and not about the safety of the poor people being exploited.</p> <p>Fair competition: Mafia controls the business in Karachi</p>
<p>Forced labour: Everyone working willingly to earn money</p>		
<p>Local employment: This business has generated employment for otherwise-unemployed people. That seems to be a partly-positive thing (if child labour can be eradicated)</p>		
<p>Contribution to economic development: As many poor people find extra income to support their families, it is good for the economy</p>		

Table 6-1: Positives and negatives of the informal electronic wastes recycling sector in Pakistan

The authors defined four major impact categories – **Health and safety, Socio-economic repercussions, Human rights, Development of the country** – and related the status of the dimensions (highlighted in Table 6-1) to the effects on these categories. The statuses of some dimensions do not have any effect on one or more of these impact categories, while in general, the effect could be positive (worth sustaining) or negative (needing correction). In Figure 6-2 below, for the effects, dimensions have on the impact categories - while the colour red denotes a negative effect, the colour white denotes the absence of any effect and the colour green denotes a positive effect. An overall ('intuitively weighted') rating can then be determined for each indicator (as seen in the last column in Figure 6-2), in which red stands for 'highly negative', yellow for 'negative', green for 'positive' and white for 'no net overall effect'. All the impact categories are accorded equal priority (25% each), though the analyst may decide otherwise, and adopt a semi-quantitative approach to derive numerical scores. Four dimensions in the Worker stakeholder category, two in the Local community category, and one each in the Society and Value-chain actors categories deserve immediate attention. Nothing needs to be maximized or minimized. What is needed is a clever optimisation – sustaining the economic benefits, while controlling the negative social and environmental impacts. The dimensions 'Wages' and 'Contribution to economic development', as seen from Figure 6-2, have a positive overall rating.

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Dimension	Status	Four impact categories defined by the authors				
		Health and safety	Socio-economic effects	Human rights	Development of country	Overall rating
Working hours	74 hours +	Red	Red	Red	Green	Yellow
Child labour	Extant	Red	Red	Red	Red	Red
Health and safety (workers)	Extensive negative impacts	Red	Red	Red	Red	Red
Social security	Absent	Red	Red	Red	White	Red
Forced labour	Not seen	White	White	Red	Red	Green
Wages	More than 2.7 USD per day	White	Green	White	Green	Green
Equal opportunities/discrimination	No discrimination	Red	Green	Green	Green	Green
Freedom of association	No	Red	Red	Red	Red	Red
Safety and health (local community)	No	Red	Red	Red	Red	Red
Community engagement	No	Red	Red	Red	Red	Red
Local employment	Yes	Red	Green	White	Green	White
Public contribution to sustainability issues	No	Red	Red	Red	Red	Red
Contribution to economic development	Yes	Green	Green	White	Green	Green
Promotion of social responsibility	No	Red	Red	Red	Red	Red
Fair competition	No	White	Red	White	Red	Yellow

Figure 6-2: Summary of the results based on the investigations done and observations made in the e-waste informal recycling sector in Pakistan²⁴

In this study, the analysts have adopted the UNEP framework, but working within it, have taken the liberty to improvise a bit, in the ‘journey’ from stakeholder categories to dimensions to status summaries to effects on impact categories defined by them for this analysis. Once you know the goal/s, you can set your scope and resort to improvisations, in order to arrive at end-results tailor-made for the audience/readership you have in mind.

6.2 COMPARATIVE ANALYSIS WITH FOCUS ON HEALTH IMPACTS²⁵

In the e-waste recycling case study in Pakistan discussed in the previous section, Health and Safety appeared as a dimension twice – of Workers and of the Local Community – and also as an impact category. Both the dimensions had a poor overall rating and the effects of 80% of the dimensions (11 out of 14) on the Health and Safety impact category was ‘very negative’, as seen in Figure 6-2. In the paper we shall discuss in brief in this section, the focus is restricted to health impacts – on workers and local community members, as well as global consumers.

Arvidsson and colleagues studied the supply chains of catalytic converters used in automobiles, gold jewellery and airbags (safety ancillaries in cars), and focused on the health/safety impacts on workers (a subset of S-LCA they have labelled as Work Environment LCA or WELCA), the impacts of emissions from the nodes in the supply chain on the members of the local community and society, as well as the benefits to health and safety of consumers

in the use-phase of these products. The unit used by the authors to measure the impacts is Disability-Adjusted Life Years (DALY), which in turn is calculated as a sum of the Years-of-Life Lost (YLL)²⁶ and Years-of-Life Disabled (YLD)²⁷. Human health as one of the three end-point indicators of an E-LCA (ReCiPe method)⁶, measured in DALY, can be looked upon as a socio-environmental indicator. In an E-LCA, it is only the impacts of the emissions/pollutants from the life-cycle stages – extraction, production, use, disposal and inter-stage transport – on human beings that is of interest. However, in WELCA, it is not just the ‘material or chemical impacts’ but also the human factor which is of importance. The human factor includes the following:

- Workers not being provided with adequate safety gear – the fault of the employer
- Workers not being given enough knowledge about safe operating practices – the fault of the employer
- Workers being negligent and thereby injuring themselves – the fault of the workers

The human health impacts in the supply chain are thus both the E-LCA-, and the S-LCA-related ones. In WELCA, the stakeholders are the workers and the value-chain actors. The latter category includes the employers and the government officials responsible for the health, safety and environmental audits. In the wider S-LCA, the society, local community and consumers also come into the picture as victims or beneficiaries of the processes in the supply chain.

Product	Workplaces or life-cycle stages	Impacts to be considered
Airbags	Mines	Work environment impacts Toxic emissions
	Pyrotechnic materials (for the inflators in the airbags) production	Work environment impacts Toxic emissions
	Oil rigs	Work environment impacts Toxic emissions
	Other supplier nodes in the chain (power plants etc.)	Work environment impacts Toxic emissions
	Use-phase	Deaths and injuries prevented for the 'global consumers' – in this case, the ones actually using the airbags in their vehicles.
	Incineration plants for end-of-life handling	Work environment impacts Toxic emissions of dioxins, lead and PAH, from the electronic unit
Catalytic converters	Raw materials extraction (Platinum group metals etc.)	Work environment impacts Toxic emissions
	Component production units (honeycomb, insulation, wash coat, heat shield, steel housing etc.)	Work environment impacts Toxic emissions
	Use phase in automobiles	Reduces emissions of carbon monoxide, nitrogen oxides and unburnt hydrocarbons and reduces DALY (in local community and society in the use-phase regions).
	End-of-life handling (dismantling and recycling)	Work environment impacts Toxic emissions
	Other supplier nodes in the chain (power plants etc.)	Work environment impacts Toxic emissions
Gold jewellery	Mining of gold-bearing ores	Work environment impacts Toxic emissions of especially mercury Conflicts (minor skirmishes or major crises or war)
	Refining and processing	Work environment impacts Toxic emissions of especially mercury
	Jewellery fabrication	Work environment impacts Toxic emissions
	Shops and outlets	Work-place related incidents (related to thefts)
	Use phase	Risk of thefts from households and injuries/deaths related to the same Positive effect could be the elevation in status which comes from the ownership of jewellery

Table 62: Workplaces, life-cycle stages and impacts to look out for in the supply chains of the three products studied

Table 6-2 presents the different nodes/life-cycle stages in the supply chains of the three products and the possible causes of health impacts. In the sub-sections below, the results obtained for the products, in terms of DALY, have been discussed in brief.

6.2.1 AIRBAGS – HEALTH-SAVERS

The DALY for the airbag system is calculated as under:

$$\text{DALY}_{\text{airbags emissions}} = \text{DALY}_{\text{mines and rigs}} + \text{DALY}_{\text{pyrotechnics}} + \text{DALY}_{\text{power plants}} + \text{DALY}_{\text{toxic}} - \text{DALY}_{\text{use phase}}$$

While the first three terms on the right are calculated from workplace records, the fourth is determined from primary emissions data and suitable LCA software. The DALY avoided in the use phase is related to deaths and injuries avoided in the instances of accidents involving vehicles equipped with the airbags being studied (in this particular case, the airbags manufactured by the company Autoliv). A question of course arises here – how much credit is to be given to the airbags and how much to the seatbelts, both of which are instrumental in saving lives and avoiding (or lessening the severity of; thereby reducing the value of the ‘w’ in the YLD equation) injuries.

Arvidsson and colleagues determined the DALY caused by mines, rigs, pyrotechnics, power plants and toxic emissions to be 42 minutes per airbag system. However, the DALY avoided during the use phase was much greater – 87 hours per airbag system. This means that the net DALY is negative, indicating significant life-cycle health and safety benefits. However, a point to be noted here is that the incineration plant to which the airbags wend their way at the end of their lives, was not considered in this analysis. It turns out that even 10 mg of dioxins or lead emitted during incineration, can neutralise the benefits which occur in the use phase. A recommendation from this analysis then is to make sure that the exhaust cleaning systems at the incineration units are efficient enough to keep dioxin and lead emissions well below this limit.

6.2.2 CATALYTIC CONVERTERS – HEALTH-SAVERS OR HEALTH-TAKERS

The DALY for the catalytic converters is calculated as under:

$$\text{DALY}_{\text{catalytic converter}} = \text{DALY}_{\text{mines}} + \text{DALY}_{\text{processing units}} + \text{DALY}_{\text{power plants}} + \text{DALY}_{\text{recycling units}} + \text{DALY}_{\text{toxic emissions}} - \text{DALY}_{\text{use phase}}$$

The results showed that the net DALY could vary between -5 (beneficial) and 7 (undesirable), depending on the functional lifetime of the catalytic converter (higher the functional lifetime, greater the amount of emissions which can be reduced and thereby greater the DALYs which can be avoided), and also on the degree of recycling of the materials used to fabricate the converter (higher the degree of recycling, lower would be the DALYs caused upstream in the mining and production processes). Both these happening in tandem, will result in the net DALY being pushed closer to -5. Neither of these happening (negligible recycling and low functional lifetimes), will push it the other way, closer to 7.

6.2.3 GOLD JEWELLERY – HEALTH-TAKER

The DALY for gold jewellery can be calculated as under:

$$\begin{aligned} \text{DALY}_{\text{gold jewellery}} = & \text{DALY}_{\text{mines}} + \text{DALY}_{\text{processing units}} + \text{DALY}_{\text{power plants}} + \text{DALY}_{\text{conflicts,}} \\ & \text{gold} + \text{DALY}_{\text{toxic emissions}} + \text{DALY}_{\text{shops and homes}} \end{aligned}$$

"I studied
English for 16
years but...
...I finally
learned to
speak it in just
six lessons"

Jane, Chinese architect

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While the first three DALY components are related to work-related impacts (human factor), DALY_{toxic emissions} encompasses the entire supply chain (emissions of pollutants at all stages to the environment). DALY_{shops and homes} has not been factored in by the authors of the said paper, but can well be included in the equation if deaths and injuries related to thefts and robberies of jewellery shops and homes must be factored in. DALY_{conflicts, gold} is a special addition for this product and relates to deaths and disabilities caused in conflicts which are financed by mining bounties. This has been happening in many African mining countries from time to time, and continues to happen in the Democratic Republic of Congo (DRC), which is the site of the gold mining activity that starts off the supply chain of the gold jewellery in this paper. The mine output of the DRC include metals other than gold too – cobalt, tantalum, copper, tin and diamonds. The contribution of gold to the DALY associated with conflicts is determined by an allocation factor of 0.07 (7% being the approximate average share of gold in the economic value of the mine output). The total DALY is expressed ‘per gold ring with 4 grams of gold in it’. For gold mined in the DRC (severe conflict bordering on war), this equals 4.8 months. If the gold had been sourced from South Africa (negligible conflict and even if there is, relatively minor), the total DALY would have equalled 4.38 hours. If the source of the gold had been Sweden (peaceful country with no conflict at all), it would have been less than 1 hour (and all the contribution would have come from the work-place related impacts and toxic emissions).

6.2.4 SUMMING UP

In the case of airbags and catalytic converters, health benefits can be said to be exported to the consumer markets, at the expense of the upstream which endures the adverse health impacts. In the case of gold jewellery, no discernible health benefits exist for the importers, but significant adverse health impacts are indeed borne by the nodes on the upstream in the supply chain (and at times also by the sellers and end-consumers who face the threat of armed robberies).

6.3 EXERCISE

1. Read the paper which has been appended as a PDF. Try to look through the List of References and locate papers which you find interesting. Work in teams of 2 or 3. Each one of you choose one paper, make a short presentation (ppt) and clearly explain it to the others in the group. Finally, sit down and discuss similarities and differences, complementarities and conflicts which you would have come across, based on your reading and understanding, and listening to the presentations made.

2. Refer Figure 6-2. Adopt a semi-quantitative approach (a Likert's scale) and different sets of weighting factors and derive numerical scores for the overall rating.
3. Look up sources on the Internet and get to know about the social impacts of the ship-breaking sector in Bangladesh, China and India. From the information you gather, try to analyze this end-of-life handling sector, using the method adopted by Umair and colleagues²⁴. A good idea for a project – comparison of the ship-breaking sectors in Alang (India), Chittagong (Bangladesh) and Shanghai (China), using S-LCA.
4. You read about the DALY of the gold jewellery available in shops in the developed world in this chapter. If you come to know that all the gold jewellery available for sale in your city in Europe comes from the DRC, would you choose not to buy at all? Discuss the efficacy of S-LCA studies like these, when it comes to actually putting pressure on the upstream, and bringing about change.

Appendix A: Review paper from Cleaner Technologies and Environmental Policy (Open Access article included after informing Springer Science + Business Media)



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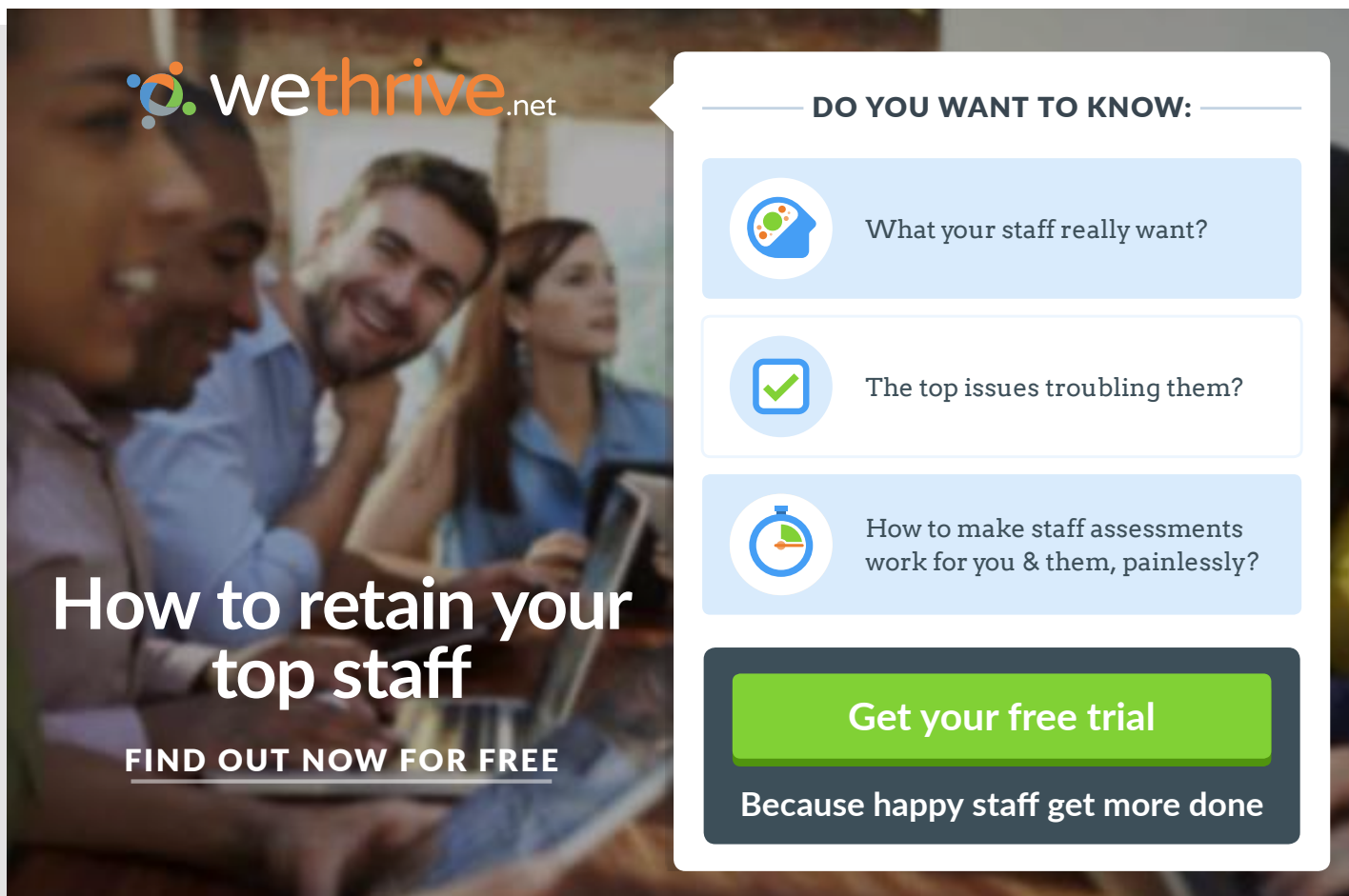
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ENDNOTES

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- ³ The product being used by the little girl in the photograph taken in Ghana is the LifeStraw water filter, which has found a market in Africa. It has been designed, manufactured and marketed by the Danish company **Vestergaard Frandsen**, and is a very good example of selling a product at a very affordable price, and sustaining health thereby.
- ⁴ This is from the Bible, Matthew 6.24.
- ⁵ G Venkatesh (2019). LCC – A primer. Published by Bookboon, Copenhagen, Denmark.
- ⁶ G Venkatesh (2016). Environmental Life-Cycle Analysis – A primer. Published by Bookboon, Copenhagen, Denmark. <http://bookboon.com/en/environmental-life-cycle-analysis-a-primer-ebook>. ISBN 978-87-403-1553-0.
- ⁷ Source on the Internet: <http://www.lifecycleinitiative.org/starting-life-cycle-thinking/life-cycle-approaches/social-lca>
- ⁸ Employment, as you will read in the next section, is a socio-economic aspect, and could be included under either the social dimension or the economic dimension, if a separate socio-economic dimension is not created. It has been considered as a part of S-LCA here, though in the next section, the author maintains that it is closer to the economic dimension, and can be included therein. This is of course, very subjective.
- ⁹ G Venkatesh (2018). Critique of selected peer-reviewed publications on applied social life cycle assessment: Focus on cases from developing countries. *Clean Technologies and Environmental Policy*. DOI: 10.1007/s10098-018-1644-x (Appended at the end of this e-book)
- ¹⁰ Mattioda et al (2015). Determining the principal references of the social life-cycle assessment of products. *International Journal of Life-Cycle Assessment*, 20(8): 1155-1165.
- ¹¹ Vermeulen (2015). Self-governance for sustainable global supply chains: can it deliver the impacts needed. *Bus. Strateg. Environ.* 24:73-85
- ¹² G Venkatesh (2018). Critique of selected peer-reviewed publications on applied social life cycle assessment: Focus on cases from developing countries. *Clean Technologies and Environmental Policy*. DOI: 10.1007/s10098-018-1644-x
- ¹³ United Nations Environment Programme
- ¹⁴ United Nations Environment Programme & SETAC (2013). The methodological sheets for sub-categories in an S-LCA.
- ¹⁵ <http://satyarthi.org.in/>
- ¹⁶ <https://www.ilo.org/global/topics/child-labour/lang--en/index.htm> - Note that the ILO is a treasurehouse of data, news and information about the stakeholder category – Workers. Details of all ILO conventions and instruments can be accessed through the website
- ¹⁷ <https://www.ilo.org/global/topics/social-security/lang--en/index.htm>
- ¹⁸ <https://www.theguardian.com/world/2017/mar/16/marikana-massacre-victims-damages-compensation-south-africa>
- ¹⁹ <https://www.dnaindia.com/india/report-at-least-11-protesters-dead-in-tamil-nadu-why-villagers-want-to-shut-down-sterlite-plant-in-thoothukudi-2617845>

- ²⁰ Benoit Norris, C. (2014). Data for Social LCA. *International Journal of Life Cycle Assessment*, 19(2): 261-265.
- ²¹ <https://www.socialhotspot.org/>
- ²² Benoit, C., Aulisio, D., Hallisey-Kepka, C., Tamblyn, N. and Norris, G.A. (2012). Social Scoping Prototype Report- Product Category 7: Strawberry Yoghurt. The Sustainability Consortium and New Earth; for Arizona State University and University of Arkansas.
- ²³ Consider a node X, adjusted Hotspot Index of 70; share in total worker hours of 0.7%. Consider another in the supply chain Y, adjusted Hotspot Index of 100; share in total worker hours of 0.3%. The product for X equals 0.49 and the product for Y equals 0.3. Thus, even though the adjusted Hotspot Index of X is 70 (much less than 100), its product is 63% greater than that of Y – it contributes more to the Supply Chain's Hotspot Index.
- ²⁴ Umair, S., Björklund, A. and Petersen, E.E. (2015). Social impact assessment of informal recycling of electronic ICT waste in Pakistan using UNEP SETAC guidelines. *Resources, Conservation and Recycling*, 95: 46-57.
- ²⁵ Arvidsson, R., Hildenbrand, J., Baumann, H., Islam, K.M.N., Parsmo, R. (2018). A method for human health impact assessment in social LCA: lessons from three case studies. *International Journal of Life Cycle Assessment*, 23(3): 690-699.
- ²⁶ $YLL = \text{Life expectancy} - \text{Average age at death}$
- ²⁷ $YLD = w * D$, where w is the severity of the injury and D is the duration of the injury. For minor sprains, w is 0.05 and D is 2 days, resulting in a YLD value of about 0.00027 years (2.3 hours); while for major accidents, w is 0.7 and D is 20 days (recuperation time) resulting in a YLD value of 0.038 year (13.8 days)



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APPENDIX A

Critique of selected peer-reviewed publications on applied social life cycle assessment: focus on cases from developing countries

G. Venkatesh

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Focusing on Technology Research,
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ORIGINAL PAPER



Critique of selected peer-reviewed publications on applied social life cycle assessment: focus on cases from developing countries

G. Venkatesh¹

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Abstract

The social aspect of sustainable and ‘clean’ production/manufacturing technologies is researched and understood by means of social life cycle assessment (S-LCA), a life cycle sustainability assessment (LCSA) tool, which is still in its infancy. In this paper, a search for all peer-reviewed publications on applied Social LCA, which have appeared in scientific journals, between O’Brien et al. (*Int J Life Cycle Assess* 1(4):231–237, 1996) and the latest one at the time of writing (April 2018), was carried out, using Scopus as the repository and using ‘S-LCA’ or ‘SLCA’ or ‘Social LCA’ or ‘social life cycle assessment’ as search phrases in title, abstract and keywords of publications, separately. Overall, 213 publications were unearthed, and the trend shows that there has been a near-exponential increase over time. A little over 55% of these publications—121 to be precise—were applications of S-LCA—often in combination with environmental LCA and life cycle costing analysis, in an LCSA. This paper discusses the contributions of a selected subset of these 121 publications to the body of S-LCA knowledge, with the focus being restricted to applications in developing and transition economies of the world, on the premise that there is a more urgent need to understand social aspects of production and manufacturing in these parts of the world. A SWOT analysis of S-LCA has been carried out towards the end. There is a consensus among many researchers that while LCC and E-LCA have matured a lot over time, S-LCA, the newest of the trio, is evolving slowly to become a harmonised tool which can serve as an effective complement to the aforesaid two, in LCSAs of products and processes in industry.

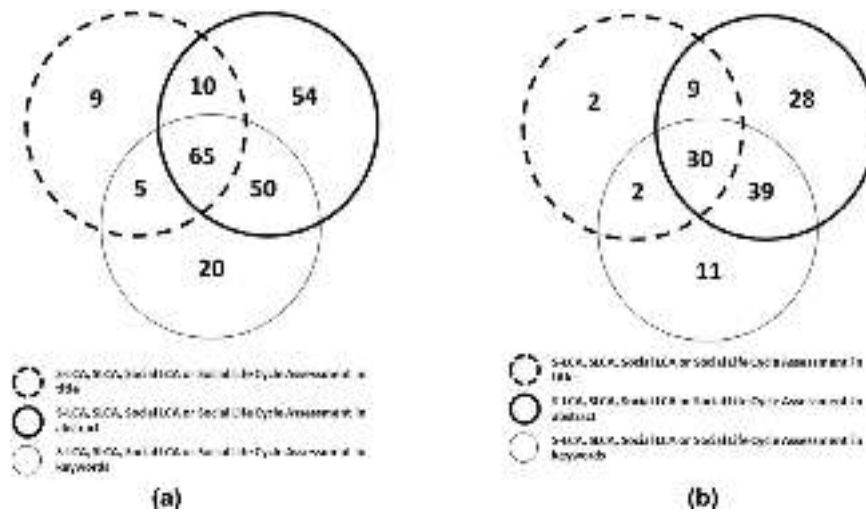
Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s10098-018-1644-x>) contains supplementary material, which is available to authorized users.

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Graphical abstract



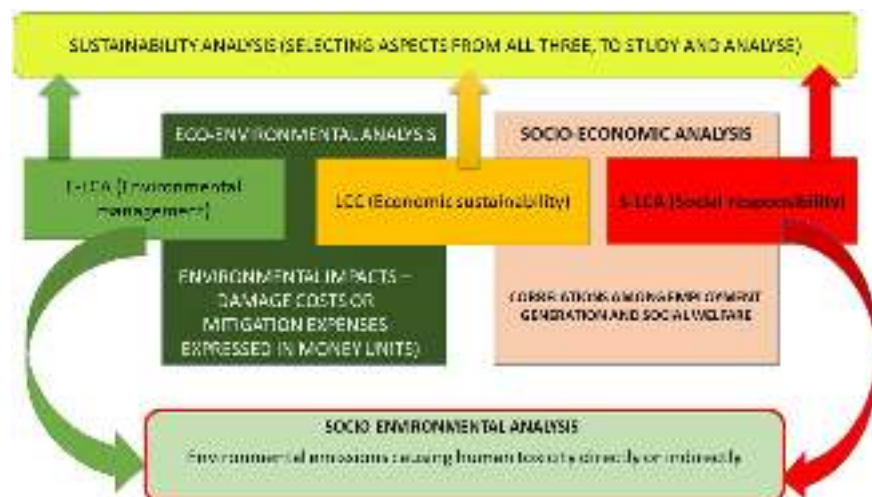
Keywords Life cycle sustainability assessment · Social life cycle assessment · S-LCA · S-LCA · Social LCA

Introduction

The aspect of ‘cleanness’ in production is twofold—social (moral, ethical) and environmental (techno-physical). This is restricted not merely to the production/manufacturing stage of a product’s life cycle but also to the upstream (supply of raw materials and components) and the downstream (use and end-of-life handling). The social aspect is researched and understood by means of social life cycle assessment (S-LCA), a life cycle sustainability assessment (LCSA) tool, which is still in its infancy (Mattiotta et al. 2015). As

observed by Bocoum et al. (2015), researchers are yet to arrive at a consensus regarding the selection of the right indicators. Along with the better-entrenched environmental life cycle assessment (E-LCA, its environmental counterpart) and life cycle costing (LCC), S-LCA makes a triple-bottom-line approach to LCSA of products, processes and projects, possible (Alanne and Mälkki 2016). The focus of this article is not on the operational combination of the three tools referred to, to analyse the sustainability of production processes. Readers may refer to Alanne and Mälkki (2016) for a clearer understanding of the same. Figure 1 depicts the

Fig. 1 E-LCA, LCC and S-LCA and the combinations in which they can be used in sustainability studies



combinations of tools used to carry out uni-dimensional, double-bottom-line and holistic sustainability analysis of systems. E-LCA traces its origin to the late 1960s as far as the ideation is concerned and to 1991 as far as the christening as LCA is concerned (Baumann and Tillman 2004). LCC also established itself as a decision-making tool in the 1970s, while S-LCA is the newest of the trio, which made its first appearance in the literature in the second half of the 1990s.

In the two decades after the very first paper on S-LCA was published (O'Brien et al. 1996), a few reviews have appeared in peer-reviewed journals (Petti et al. 2018; Arcese et al. 2018, for example). Russo Garrido et al. (2018) critically reviewed 32 selected publications from the period 2006–2015 and analysed the plethora of approaches adopted by researchers performing type I S-LCA. Three years before that, Chhipi-Shrestha et al. (2015) had concluded *inter alia* that the diversity of S-LCA methods/approaches may be misleading, as they would lead to different results that would confuse decision-makers. In that very year, Bocoum et al. (2015) had recommended consensus among S-LCA researchers as regards the standardisation of indicators, a point which was taken up later again by Kühnen and Hahn (2017) who believed that such standardisation was indispensable for what they termed as the 'maturation and establishment' of S-LCA. There have also been some reviews focusing on the need for application of S-LCA to specific sectors and product groups—like the information, communication and technology sector (Arushanyan et al. 2014); automotive sector (Tarne et al. 2017; Zanchi et al. 2018); waste-to-energy sector (Zhou et al. 2018); road infrastructure sector (Hamdar et al. 2016); bio-based value chains or the bioeconomy (Macombe et al. 2013; Martin et al. 2018; the latter reviewing indicators from a Swedish perspective alone); and the agribusiness sector (Delcour et al. 2015; De Luca et al. 2017). Mancini and Sala (2018) reviewed the published literature to identify and discuss about relevant S-LCA indicators for the mining sector.

For this paper, the author first read peer-reviewed publications on applied Social LCA, in scientific journals, between O'Brien et al. (1996) and the latest one at the time of writing (April 2018), before selecting a subset of the papers read, for a more detailed review. The methodology adopted is first described briefly, and then, it is followed by a structured and systematic presentation of the results and findings. The novelty of this review process is the classification of the papers on the basis of the sectors to which S-LCA has been applied, selection of a subset on a well-defined premise and a discussion centred around some 'talking points' raised in the publications relevant to future developments in the theoretical, methodological and application-related aspects of this sustainability analysis tool. In addition, the paper also provides a good overview of the temporal (historical trend) and geographical spread of S-LCA publications till date,

their distribution among different scientific journal publications and a SWOT analysis of S-LCA in "Discussions" section, based on the observations made by researchers in their publications.

Methodology

Source

Scopus was the only repository the author availed of, to obtain a list of, and access therefrom, to publications focusing on S-LCA in general. The search was conducted in the second week of April 2018. The basic premise for selecting Scopus was the well-known fact that Scopus is the largest database in vogue, and therefore, there is a likelihood of most (if not all) publications related to known fields of research like S-LCA, being accessible using it. Of course, there may be some journals and therefore publications which may tend to get left out, but this may be small fraction and therefore negligible. A claim of comprehensiveness is therefore not being made here. The range is certainly limited by the choice of the source and the rationale behind it. Scopus, however, accounts for 14,000 journal titles from 4000 publishers, and hence, it was considered safe to rely on it for this review paper.

Search

The search phrase used was 'S-LCA' or 'SLCA' or 'Social LCA' or 'social life cycle assessment' in title, abstract and keywords separately. Only peer-reviewed scientific journal publications were considered; conference proceedings, editorials, letters, notes and books/book chapters were excluded from the analysis. There were of course some papers which figured in any two or all three of these lists. To a great extent, it can be assumed that all papers which have any of the above terms—full acronyms, partial acronyms or the entire expansion—in their respective titles restrict their focus to social life cycle assessment, or that social life cycle assessment is one of the many foci of the publications (in which a double-bottom-line or a complete life cycle sustainability assessment has been carried out). 'Social life cycle assessment' was also used as a part of the search phrase, bearing in mind that the acronym might not have been as popular, as it is today, in the past.

Screening and elimination

(It was observed that s-LCA (with a lower-case 's') has also been used as an acronym for *simplified* life cycle analysis, *screening* life cycle analysis, *static* life cycle analysis and *streamlined* life cycle analysis in some publications, where

the analysis referred to is environmental and not social; it is also an acronym used in medicine to abbreviate lymphotoxicity screening assay and is commonly used in informatics and computing to denote smallest lowest common ancestor, or in cellular manufacturing for single-linkage cluster analysis.) All the matches were therefore carefully screened. The Venn diagram in Fig. 2a is a useful illustration which categorises the 213 publications—applied S-LCA and otherwise—into seven different categories, with respect to the search terms and the title, keywords and abstract. The focus was subsequently narrowed down to the applied S-LCA publications, and Fig. 2b categorises them in vein similar to Fig. 2a.

Scoping and subset for review

In order to narrow down the scope further, for the sake of brevity, the spotlight was cast on S-LCA application papers

originating from (and focusing on products and systems in) the developing and transition economies (identified by excluding the 39 developed economies defined by the International Monetary Fund in IMF (2016)). The rationale behind this choice is intuitive—there is a more pressing need for understanding social aspects of production chains in these parts of the world, vis-à-vis the developed countries, relatively speaking. A limitation here would be the exclusion of most papers published by researchers based in the developed countries and focusing on geographically spread-out supply chains extending to the developing and transitional countries as well. However, some papers of this nature have been included in the analysis.

Among the list of 213 publications, the following countries belong to one of the two categories mentioned above, either as countries of origin of the publications (Table 1) or as case study locations for papers originating in the developed world—Algeria, Bangladesh, Brazil, Cameroon,

Fig. 2 A summary of the search results, with the intersection sets. **a** All publications on Social LCA. **b** Only applied Social LCA publications

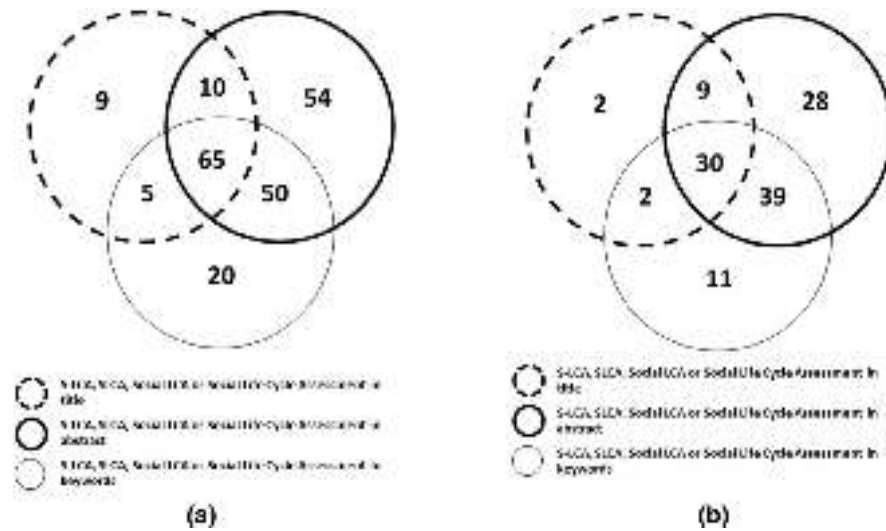


Table 1 Geographical distribution of all the S-LCA publications

Region/continent	Countries which figure in the list as <i>places of origin</i>	# countries	# publications
North America	Canada, USA	2	24
South and Central America	Brazil, Peru	2	7
West, East, Central and Southern Africa	Ghana, Mauritius, South Africa, Uganda	4	5
Middle East and North Africa (MENA)	Algeria, Kuwait, Lebanon, Iran, Israel, Turkey	6	12
South Asia	Bangladesh, India, Pakistan	3	3
Western and North Europe	Austria, Belgium, Denmark, Finland, France, Germany, Ireland, the Netherlands, Norway, Sweden, UK	11	92
East and Southern Europe	Greece, Italy, Poland, Portugal, Spain, Switzerland	6	45
East Asia	China, Japan, Taiwan	3	16
ASEAN and Australasia	Australia, Indonesia, Malaysia, New Zealand, Philippines, Thailand	6	9
Total		43	213

China, (Democratic Republic of) Congo, Ecuador, Ghana, India, Indonesia, Iran, Kenya, Kuwait, Lebanon, Malaysia, Mauritius, Mongolia, Pakistan, Peru, the Philippines, Sierra Leone, South Africa, Thailand, Turkey, Uganda and Western Sahara which is now a disputed territory governed by Morocco. This subset was whittled down in the last step to include only the application-related publications (Table 2).

Literature review and analysis

Trend over the years: all publications and journals

This section presents information about all the 213 publications first, before delving deeper into the whittled down subset for a more detailed analysis and discussion. O'Brien et al. (1996) coined a new acronym, which perhaps has not been used so often over the last 22 years. SELCA, which is present in the title of O'Brien et al. (1996), stands for social and environmental life cycle assessment. On date, there are 89 publications (of the 213, as shown in Fig. 2a) which have one of the search terms referred to in "Methodology" section, in their respective titles. 'Social LCA', 'SLCA', 'S-LCA' and 'social life cycle assessment' were used for the first time in paper titles by Yamaguchi et al. (2002), de Haes (2008), Ying and Yang (2014) and Jørgensen et al. (2009), respectively.

Only 14 publications appeared in the first 14 years—1996–2009, before a conspicuous increase in the annual output was noticed. In Fig. 3, the time period 2006–2018

has been considered, with 2006 being designated as year zero ($x=0$, in the best-fit curve equation shown in the figure). A very clear exponential increase is seen over this period of time. In 2017, there were 39, and in 2018, fifty-six papers have already been accepted/published. Figure 4 which includes all the 213 publications also gives one the impression that S-LCA is slowly but surely gaining popularity as more and more journals seem to be accepting publications related to the development of this tool or its application. From just two journals in 2011, the number of journals with S-LCA papers rose to 14 in 2017. Only four of the 45 odd journals have published 10 or more S-LCA papers thus far, the International Journal of Life Cycle Assessment accounting for nearly 50% of the total of 213, followed by the Journal of Cleaner Production (22), Sustainability (21) and the Journal of Industrial Ecology (10)—refer Fig. 5 which depicts the spread of these 157 publications over time.

Geographical distribution

All the 213 publications were first sorted based on where the case study was conducted (where applicable), otherwise based on the country in which the first author's university/institute/organisation is located. (For the source data, please refer to Supplementary Material.) Table 1 shows the region-wise distribution of all the 213 publications.

Eleven countries in Western and North Europe—dominated by Germany—account for 92 of the 213 publications (43.2%), while Eastern and Southern Europe (led by Italy, which equals Germany in the total number of publications,

Table 2 Sectors focused on, in the selected applied S-LCA publications originating from (and/or focusing on) the developing and transition economies of the world

Sector	Publication/s with full or partial focus—review and applications
Agriculture, forestry and dairy farming	Bouزيد and Padilla (2014), Cardoso et al. (2018), Cortez et al. (2015), Feschet et al. (2013), Franze and Ciroth (2011), Prasara-A and Gheewala (2018), Zortea et al. (2018)
Building and construction	Hosseiniyou et al. (2014), Babashamsi et al. (2016), Dong and Ng (2016), Hossain et al. (2017)
Chemicals, cosmetics and pharmaceuticals	Brent and Labuschagne (2007), Xu et al. (2017)
Energy and fuels	Ren et al. (2015), Ghaderi et al. (2018), Ekener-Petersen et al. (2014), Ekener et al. (2018)
Equipment, machinery, automobiles and white goods	Arvidsson et al. (2018), Dreyer et al. (2010), Islam et al. (2018), Pastor et al. (2018), Reuter (2016), van Kempen et al. (2017)
Fashion and jewellery	Arvidsson et al. (2018)
Food and beverages	Bouزيد and Padilla (2014), Prasara-A and Gheewala (2018)
Mining and metalworking	Singh and Gupta (2018)
Society and households	Fan et al. (2018)
Textiles and related consumer goods	Lenzo et al. (2017), Musaazi et al. (2015), van der Velden and Vogtländer (2017)
Transportation	Agyekum et al. (2017), Arvidsson et al. (2018), Ekener-Petersen et al. (2014), Ekener et al. (2018)
Waste management/recycling	Foolmaun and Ramjeawon (2013a, b, c), Aparcana and Salhofer (2013b), Hu et al. (2013), Umair et al. (2015), Teah and Onuki (2017), Aleisa and Al-Jarallah (2017), Mirdar Harijani et al. (2017)

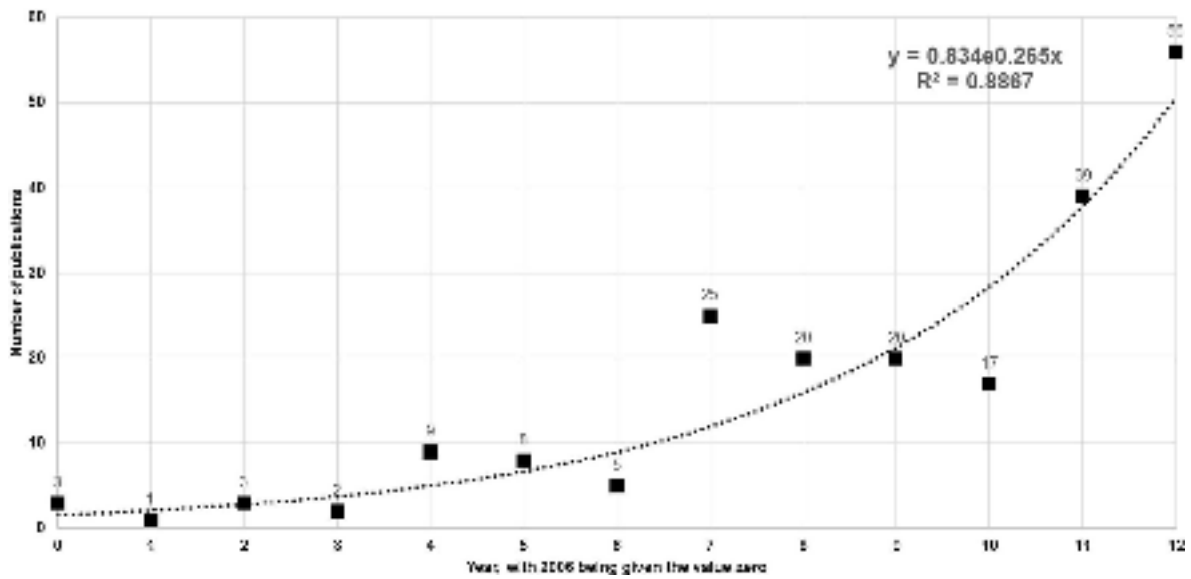


Fig. 3 Increase in the number of Social LCA publications over time follows depicts a clearly exponential trend (years 2006–2018 shown; refer Supplementary Material for source data)

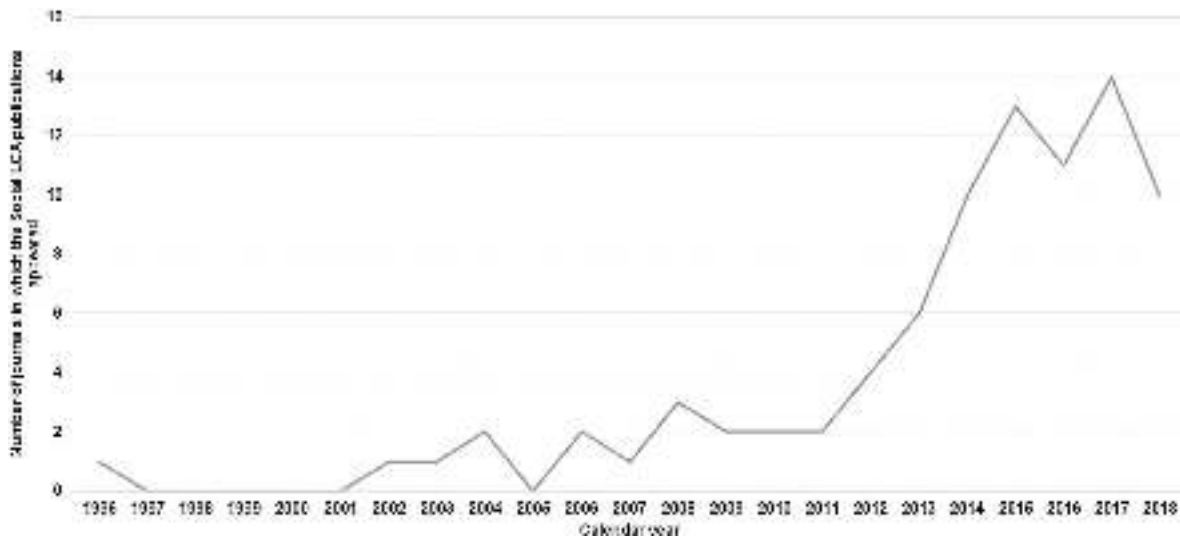


Fig. 4 Number of journals in which the Social LCA publications were published increased over time, indicating the growing popularity of this nascent field of research (refer Supplementary Material for source data)

with 32) contribute 21%. Mauritius leads the African quartet (Algeria being counted among the MENA countries) pack with two publications, and Brazil the South and Central American duo with 6 publications. The top ten countries (as shown in Fig. 6) account for 70% of the total.

Applications to sectors: in developing and transitional economies

Table 2 summarises the foci adopted by the selected applied S-LCA publications (originating in the developing and

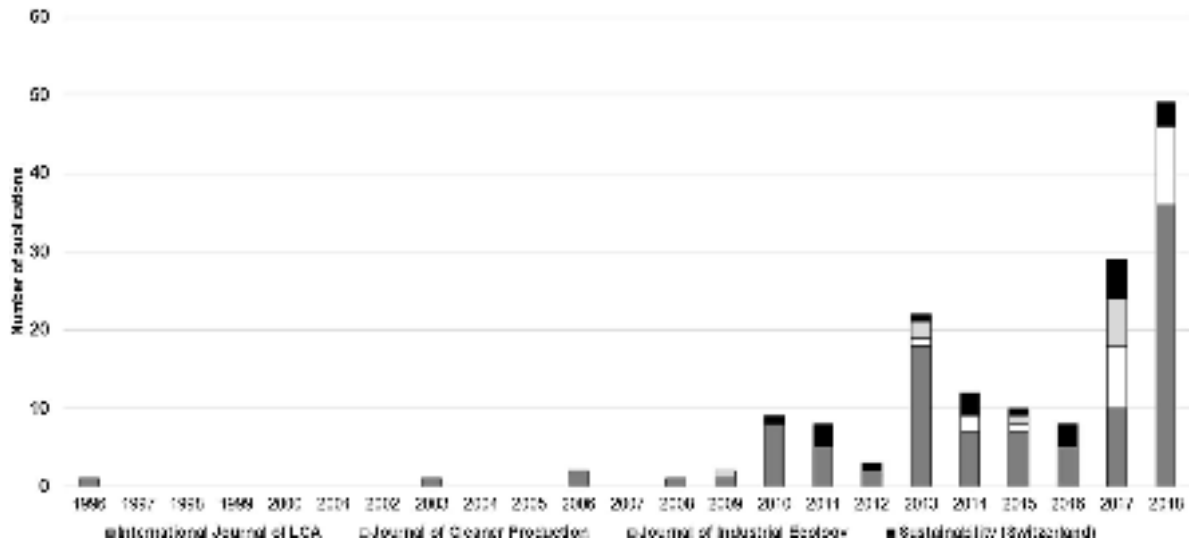


Fig. 5 Four journals with 10 publications or more each, over the period 1996–2018, accounted for over 73% of the total number of all the Social LCA publications

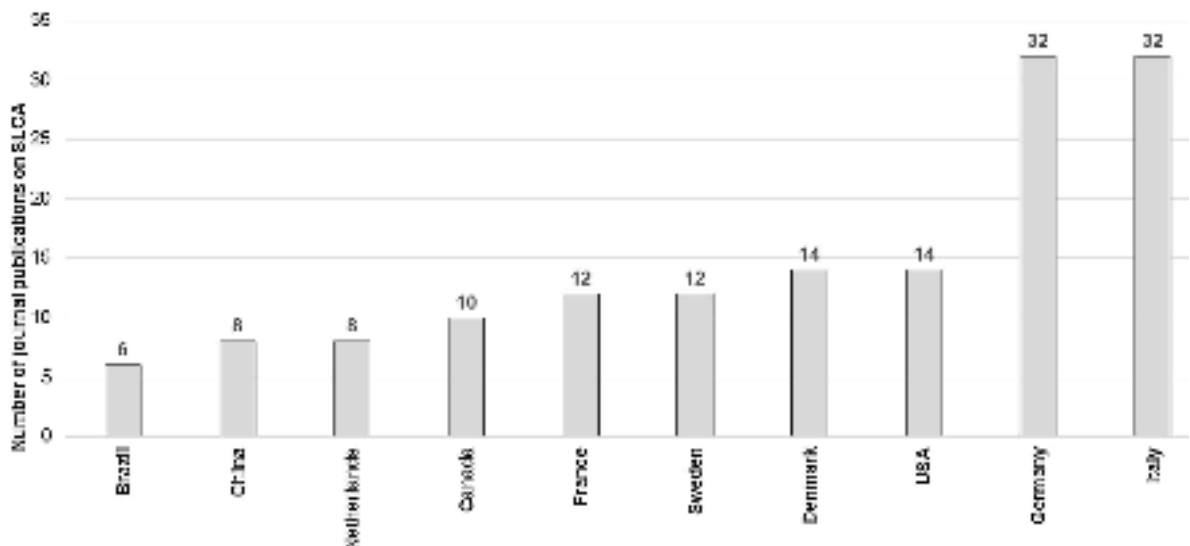


Fig. 6 Top ten countries in the list of 43, led by Italy and Germany

transition economies). Some papers may have multiple foci—for instance, the Algerian study by Bouzid and Padilla (2014), which focuses on not just tomato cultivation but also the food processing sector. It is seen that this is a tiny subset of the larger set of 121 applied S-LCA publications from the period 1998 to 2018 (April), consisting of only 41 publications (about 34%). The subsections below present an analysis of the important findings and recommendations from these publications, followed by a discussion of some important

‘talking points’ culled from these as well as the other papers read, in the form of a SWOT analysis of S-LCA.

Society and households

In a very recent Chinese case study, Fan et al. (2018), focusing on green buildings (or green residential areas), interviewed stakeholders identified as ‘real estate developers’, ‘construction companies’ and ‘local government’ (all three

comprising value chain actors), and the residents (consumers in this case). They then used the analytic hierarchy process (AHP) method to obtain weighting factors for the social themes defined. All the stakeholders accounted for were in favour of improving the living conditions in green residential districts—in other words, they deciphered a willingness to spend (among the residents) and a willingness to invest (among the construction companies and the real estate developers). The top-down support—from the local government—was also strong enough, indicating no conflicts of any kind in going ahead with such improvements. Housing retrofits generate some employment in the building and construction sector and depending on what is/are being retrofitted may have a slightly negative impact on the disposable income of the households. This may be more than offset by the positive impact on indoor air quality and the health of the inhabitants. Of course, it would be necessary to perform an LCSA to verify the assumed offset and determine the environmental impacts (avoided and caused) by the retrofitting operations, and that brings weighting factors for the three dimensions into the picture. The AHP method used by the authors for weighting the different social themes can be extended to the other two dimensions of sustainability and the criteria thereof.

Process and manufacturing sectors

Chemicals In a relatively older publication—vis-à-vis the others in the subset being reviewed—the South African process industry was advised by Brent and Labuschagne (2007) to proactively include social sustainability thinking in the initial phases of their projects. This paper was more of a demonstration of the usefulness of S-LCA as a tool, rather than a full-fledged application.

Dreyer et al. (2010) considered the four ‘worker’ impact categories—forced labour, child labour, discrimination and freedom of association—and chose six different companies from six different countries. Two of these were from the developing world—Malaysia and Brazil. The authors derived a cumulative so-called company risk score—between zero and one—and ended up with the result that the Brazilian firm with 0.46 had the highest risk, followed by the Malaysian (0.42), while the other four which were based in the developed world scored between 0.14 and 0.34. Dreyer et al. (2010), of course, narrowed the scope of their paper to include only the Worker category, but this, rather than being considered as a limitation, ought to be looked upon as a well-intended focus on the lot of workers in developing and developed countries. It clearly communicates the differences between them, using aggregated single scores.

A method similar to the one developed by Schmidt et al. (2004) for the German chemicals major BASF (*Badische Anilin und Soda Fabrik*)—SEEBalance[®]—was

used by Xu et al. (2017) in China, to compare and rank three different ammonia production routes—coal–syn-gas–ammonia, nuclear energy–hydrogen–ammonia and hydropower–hydrogen–ammonia.

Food and beverages The paper by Bouzid and Padilla (2014) encompasses both the agricultural and the food processing sectors, as it studies the supply chain of canned tomatoes in Algeria. On the downstream, at the cannery and nursery stages of the chain, the working conditions are favourable. This is in stark contrast to what prevails at the farm-level upstream. The farm work environment is marked by hard labour with negative impacts on worker health, the absence of the freedom to form trade unions and the presence of child labour. Having identified the impact categories here on the upstream, the recommendations for improvement must be fairly straightforward. However, S-LCA here is merely a tool which can be used to communicate the status quo to decision-makers and advise them on the measures which could be taken to truncate the social footprint of the products/services in question. LCSA carried out to optimise social welfare, economic development and the health of the environment will lead to desirable changes, only if it is subsequently supported by effective policy-making and good governance.

Textiles and related products Lenzo et al. (2017) have used the subcategory assessment method (SAM) developed by Ramirez et al. (2014) and availed of the social hot spots database (SHDB) (Benoit Norris 2014), to study the social impacts of garment production in Italy which imports cashmere from Mongolia. (This method–database combo is analogous to how E-LCA is conducted and the choice of one or the other is motivated by the suitability to the case study.) The risk values for the Mongolian end of the chain for almost all the social themes are quite high (child labour in particular). The question, however, is whether the Italian garment manufacturer can exert pressure on the Mongolian supplier/s and promote social responsibility. Here, one can recall the decision-maker analysis which is a part of the interpretation step of an E-LCA, where the ability of the final producer in the chain to influence the environmental sustainability of the players in the supply chain is analysed. The authors have not availed of the worker hours table in the SHDB to weight the cumulative risk values for each player in the supply chain and determine the ‘hot spots’ with regard to the product of the risk value and the percentage contribution to the total labour hours per unit output. This, in the opinion of this author, may be looked upon as a drawback of this paper, as following through till the end and expressing the contribution of all the players to the total social impact, and also relative to the Mongolian supplier, could

have provided additional useful and easily communicable information.

Just as there are eco-costs or ecological costs which are externalities that need to be internalised into the life cycle costs of a product, van der Velden and Vogtländer (2017) have developed a methodology for determining socio-economic costs and applied the same to compare three supply chains for T-shirts and jeans. This is an ingenious approach which at once provides a monetary value to the social damages caused by the supply chain, and informs any top-down (taxes) or bottom-up (voluntary contributions by the consumers) efforts which could be made to allay the damages upstream. One of these is entirely in the Western world (USA–Belgium), and the other two are based in Asia (China, India and Bangladesh). By factoring five subindicators encompassing child labour, fair wages, working hours and poverty, the authors determined the socio-economic externalities for the chosen products. They ranged between € 0.05 and € 1.46 for T-shirts, and between € 0.38 and € 12.56 for a pair of jeans, with the all-Western supply chain performing the best in both cases (in other words, having the least socio-economic costs). The supply chains in this paper have been assiduously chosen to drive home the differences among the developed and developing countries on the one hand, and the effect of improvement in standards in the developing world courtesy consumer demands and top-down regulations.

In an extremely enlightening and practical analysis, Musaazi et al. (2015) have compared indigenously manufactured sanitary pads with imported ones in a Ugandan case study. Making sure that it is both available and affordable to everyone in Uganda is a social (health-related) imperative. Additionally, manufacturing within the country for the domestic market contributes to employment generation and therefore socio-economic well-being and economic development. The authors also showed that it is not just the improvement in the socio-economic aspect but also the decrease in the environmental impacts, which make the locally produced MakaPads more holistically sustainable than the imported Libresse alternative. In this study, the results of the S-LCA happen to complement those of the E-LCA, each playing the role of being a sustainability (or suitability) ‘verifying tool’, in a ‘confirmatory test’, so to say.

Mining and metallurgy In the first-ever elaborate S-LCA publication originating in India, Singh and Gupta (2018) have chosen a case study from the steel sector. This analysis is characterised by its comprehensiveness with regard to the selection of stakeholders, impact categories and indicators to be measured. Singh and Gupta (2018) have stressed on the need to collect data at a more granular local level and use it in concert with regional-level data from government reports. The geographical spread of

the stakeholders even within India implies great diversity, and that necessitates the use of site-specific data to reduce uncertainties which arise due to generalisations using proxies. The authors believe that S-LCA results when clearly communicated to companies can aid them in designing and initiating social projects and awareness drives. The uncertainties associated with the subjectivity of the weighting factors which are needed for the aggregation of the impacts are a ‘necessary evil’, which can at best be handled by performing an uncertainty analysis to inform the end-user accordingly. Singh and Gupta (2018) hopefully will set a trend for S-LCA research in India, a developing country which needs to make concerted efforts to balance social welfare with economic development and environmental upkeep in this century.

Equipment, components and jewellery Arvidsson et al. (2018) have, *inter alia*, studied the supply chain of gold jewellery—to estimate the human health impacts (both environmental and social) in terms of net DALY or disability-adjusted life years. The methodology for estimating the DALY related to environmental emissions during the product life cycles, accidents, injuries and deaths in workplaces, and also the presence of conflicts (minor skirmishes to civil wars) in the regions where the players in the supply chain are located, has been clearly explained. The authors have concluded that the net DALY for the gold jewellery is positive, making it a health-taker, while the catalytic converter studied in both Arvidsson et al. (2018) and Islam et al. (2018) could be either a health-taker or a health-giver depending on the degree of recycling and the duration of the use phase. However, the focus in Arvidsson et al. (2018) has been only on health impacts on stakeholders, and not on other social themes like contribution to economic development, fair wages and child labour. This may seem to be a limitation, as the negatives with respect to health, tend to get unduly magnified, if one does not consider any possible positive trend in any of the other social themes. However, in this particular case, when the Democratic Republic of Congo is one of the sources of gold in Arvidsson et al. (2018) and also the supplier of cobalt in the comparative analysis of lithium–nickel–manganese–cobalt (Li-NMC) and lithium–iron–phosphorus (LiFeP) automotive batteries, done by Reuter (2016), one may safely assume that apart from the absence of fair wages and the persistence of child labour, there is no contribution as such to meaningful economic development in that country. The mining of both gold and cobalt is associated with a host of social ills in this conflict-ridden, war-torn country where human rights abuses have been rampant. Just as the gold jewellery (with gold being mined in the DRC) was a health-taker in Arvidsson et al. (2018), the Li-NMC battery scores poorly vis-à-vis the LiFeP alternative in Reuter (2016).

In Schau et al. (2011), the remanufacturing of alternators in Germany, India and Sierra Leone was studied. The S-LCA results showed that the social risks associated with siting the plant in India and Sierra Leone were considerable, and if these countries wished to compete with Germany, they would need to truncate their social footprint considerably. Supply chains converging to automotive manufacturing firms have their own water (and carbon) footprints. Even though the total consumption of water (or energy) during the life cycle may be more or less the same for supply chains of similar automotive parts, the geographical locations of the players in the chains determine the relative degrees of criticality of water (or energy) usage. Here is where Pastor et al. (2018) have applied the Social Water Scarcity Index to assess instrument panel suppliers based in South Africa, Germany and China to the German automotive industry. The index relates to the risk of exposure of the local community and society to deteriorating water supply and sanitation facilities, for which the industrial water user may be partially responsible. This risk is the highest when the component is sourced from China, and tapers down appreciably if the assembler decides to source from the German supplier. The narrowing down of the scope in Pastor et al. (2018) to calculate what they have termed as a Social Water Scarcity Index is something quite novel, and seems to be driven by an interest in understanding the competing uses of water and its uneven distribution in the world.

van Kempen et al. (2017) applied LCSA to compare the supply chains of kitchen sets from India and Kenya, distributed in two refugee camps in Kenya. Socially and environmentally, the results favoured local sourcing, quite similar to what Pastor et al. (2018) found out in their case study of instrument panel supplies to the automotive sector in Germany. The complementary nature of the socio-economic and environmental aspects in this Kenyan case study is similar to that uncovered by Musaaazi et al. (2015) for a case study in a neighbouring country—Uganda. In general, local enterprises are favoured for the lower-end developing countries in Africa, Asia and Latin America, from a sustainability point of view.

Agriculture, forestry and dairy farming

Cut roses have a burgeoning market worldwide and play an important part in the socio-economic development of many countries. Franze and Citroth (2011) have chosen Ecuador and the Netherlands and performed a double-bottom-line (socio-environmental) comparative analysis, following the UNEP/SETAC guidelines. The social issues in Ecuador raise red flags. While employment generation is highly desirable, efforts ought to be made, according to the authors, to ensure that child labour is discouraged and international conventions and codes of conduct are not violated in this South

American country. This paper again brings out the stark differences between the developing and the developed world, when it comes to the social aspects of production of similar products for the global market. Even if the environmental footprints of similar products originating from two different parts of the world may be more or less the same, there could be conspicuous differences in their social footprints.

An interesting observation from Cardoso et al. (2018) in their holistic, triple-bottom-line analysis of sugarcane cultivation in Brazil is the two-faced nature of automation—low employment rate on the one hand and a negligible accident/injury rate on the other. Quite like sugarcane, soybeans are also raw materials for both the food and fuel sectors in Brazil. Brazilian soybean cultivation is the focus of Zortea et al. (2018). In a very insightful LCSA, the authors have concluded that while the environmental sustainability can be regarded as good, the social and economic aspects need to be improved. In the S-LCA, they have tried converting qualitative measures to semi-quantitative ones and have identified that as a limitation which needs to be overcome. While fertiliser and pesticide use, quite intuitively, is the environmental hot spots demanding attention, Zortea et al. (2018) have identified the lack of adequate education and training of value chain actors and workers as a concern which needs to be overcome. Among all the stakeholders considered, the local community and society fares the poorest.

Sugarcane has a history associated with slave labour all over the world, and it is a known fact that the populations of many countries that were colonised in the past are comprised of a significant proportion of descendants of slave labourers on fields and farms. Slave labour or otherwise sugarcane cultivation is a labour-intensive process. Prasara-A and Gheewala (2018), working against the challenges imposed by difficulty in data collection and poor data quality for the Thai sugar industry, have concluded that sugarcane trash burning, which affects local health and safety, low wages and violation of land and water rights are aspects which deserve immediate attention. Farmers are the focus of the study carried out by Cortez et al. (2015), in the manila hemp farming sector of the Philippines, in which the authors have recommended the provision of earplugs to the farmers to counter the risk of loss of hearing and have observed that the farmers do not receive their fair share of the proceeds from the sales of the farm outputs.

Energy, infrastructure, transport and service sectors

A double-bottom-line approach was adopted by Hosseinijou et al. (2014)—a paper which has been cited prominently by Singh and Gupta (2018) in their steel sector case study—to compare the life cycles of steel and concrete as inputs to the building and construction sector in Iran, from raw material acquisition to disposal, from environmental and social

perspectives, using material flow analysis (MFA), E-LCA and S-LCA as tools. Steel emerged as the better overall alternative, with a lower social footprint, though the authors identified that human rights and working conditions (accidents, low wages and absence of job security) need to be redressed in the future, in the Iranian steel sector. Concrete production on the other hand was seen to have a more adverse impact on living conditions (noise pollution, destruction of natural habitats, etc.), for people in the local community, vis-à-vis steel production. How the different social themes or for that matter environmental impact categories are prioritised for the analysis plays a key role in determining which of the two alternatives is socially/environmentally more sustainable.

Dong and Ng (2016) have reiterated what Arcese et al. (2013) wrote about the strength of quantitative and semi-quantitative indicators over the qualitative ones when it comes to the effectiveness of communicating the results to stakeholders, in their paper which presents a social impact model for construction (SMoC) (also discussed in Dong and Ng (2016) as a tool in LCSA for buildings), and applies it to a construction project in Hong Kong. Irrespective of whether indicators are quantitative, qualitative or semi-quantitative, the difficulty in precisely defining what a social impact is and how to estimate it is according to Babashamsi et al. (2016), a major weakness of S-LCA which needs to be overcome, if it could serve its purpose effectively as an appraisal tool in pavement project management.

The bicycle is rightly touted as an environment-friendlier and health-positive means of transport. While that is true in the use phase of the bicycle, it is important to study its life cycle from cradle to cradle (including the recycling of its component parts at the end of life). Agyekum et al. (2017) have compared the use of steel, aluminium and bamboo as possible materials for the bicycle frame, and concluded that environmentally, bamboo is well and truly the best alternative. They, however, have observed that safety gear is not provided to workers during harvesting operations and this has a detrimental impact on 'safe and healthy working conditions'. However, the authors have set the system boundary for the S-LCA around the life cycle of the bamboo components of the bicycle and excluded the supply chains of the China-centred aluminium and steel alternatives, which may very well have larger social footprints. A more holistic LCSA would provide more information about the relative benefits of the alternatives over each other. Nevertheless, the main purpose of this paper was to provide practical advice to the value chain actors (business owners) in Ghana, who could contribute to truncating the social footprint of the bamboo bicycle frames, as much as possible.

Brazil has been in the forefront in sugarcane-based bioethanol production, just as it also has a fair share in cultivating the raw material for soybean-based biodiesel. Souza et al. (2018) differentiate between the original

first-generation bioethanol production and the prospective second-generation technology in which both sugarcane and straw recovered from the fields are inputs to the biorefinery, and conclude that the former contributes more to employment generation in the agricultural sector, while the latter has the added advantage of generating employment in the secondary and tertiary sectors of the Brazilian economy as well. In these sectors, according to the authors, wages and working conditions are likely to be better and work-related health impacts lesser. While the focus of Souza et al. (2018) was only on the social dimension of sustainability, analysis of the other two dimensions—environmental and economic—will provide a more holistic outlook of sustainability. Biogas is a renewable form of 'carbon-neutral' energy and finds favour with decision-makers keen on truncating the carbon footprint of a country's energy sector.

Environmental analyses of fossil fuels (gasoline and diesel) vis-à-vis biodiesel and bioethanol are more common than a comparative S-LCA between these two families of automotive fuels. Ekener-Petersen et al. (2014) in the first-ever such comparative study used the SHDB (Benoit Norris 2014) to study eight different supply chains originating in crude oil (Norway, Russia, Nigeria) and biofuel crops (France—maize and wheat, USA—maize, Brazil—sugarcane, and Lithuania—oil seeds) and involving domestic or international transport after or before the refining processes. The findings were extremely insightful and showed that biofuels too display high risks of adverse social impacts. The country of origin of the crude oil or the biofuel crop played an important part in the severity of these impacts. Four years later, in Ekener et al. (2018), which can be looked upon as a development over Ekener-Petersen et al. (2014), the authors narrowed down the focus to gasoline from Nigerian and Russian oil, and bioethanol from Brazilian sugarcane and US corn. An LCSA was carried out using multi-criteria decision analysis which studied the effect of four different weighting schemes—egalitarian, hierarchist, individualist and equal weighting—on a sustainability index incorporating the three dimensions of sustainability. Bioethanol from Brazilian sugarcane emerged as the most sustainable option, holistically, while bioethanol from US corn ended up being the least sustainable in all but one weighting scheme. This just goes to show that one cannot generalise that biofuels are more sustainable than fossil-based transportation fuels. A holistic sustainability assessment needs to be carried out on a case-by-case basis. Arvidsson et al. (2018) in their study of the life cycles of catalytic converters, airbags and gold jewellery (the last named has been discussed earlier in this article) make an observation with respect to 'positive social impacts' being exported by the developing world to the developed world, while the negative impacts are borne by the upstream of the product's life cycle which happens to be concentrated in the developing world—this is true for

biofuels consumed in the developed world, but originating from fuel crops cultivated in the developing world.

It is clichéd that data uncertainty plagues life cycle assessments, be they E-LCA or S-LCA. The reliability of the final results and the recommendations made therewith, are highly dependent on the quality of data—its consistency, relevance with regard to time and geography, reproducibility, completeness, representativeness and precision (Baumann and Tillman 2004). Ghaderi et al. (2018) have found a way around data uncertainty issues in LCSA (of which S-LCA is a part), by applying multi-objective robust possibilistic programming to holistically analyse a switchgrass-based bioethanol supply chain in Iran. In Ren et al. (2015), wheat, corn and cassava were compared as potential sources for bioethanol production in China. A multi-criteria decision-making method, in combination with AHP and VIKOR (*ViseKriterijumska Optimizacija I Kompromisno Resenje*, which in Serbian means multi-criteria optimization and compromise solution), with a weighting factor of close to 60% to the environmental dimension and about 16% to the social, put bioethanol from cassava right on top. Cassava, most notably, unlike wheat, is not a common food crop in China, and hence, food security is not hampered in any way by utilising more of it for other purposes. For wheat, food security was accorded the highest weighting factor among the three social criteria considered—contribution to economic development, employment benefits and food security.

Waste management and recycling

The informal recycling sector in the developing world is a source of employment and income to many poor families. This is the main reason why governments of developing countries are wary of dismantling it. Any disruption of the informal sector which may result from efforts made by the government or the private sector to ‘formalise’ it can be disastrous for several families. However, there often are social issues in this sector, which raise red flags. Umair et al. (2015) have studied the social impacts of informal recycling of electronic wastes (a good proportion of which is imported) in selected big cities in Pakistan, on four stakeholder categories (the consumer phase was excluded) and 15 social themes among them. They have qualitatively determined (exactly like Franze and Citroth 2011 did for cut roses) that the final rating is ‘very negative’ for eight of the social themes, while positives to salvage from this sector include a contribution to economic development, absence of forced labour, decent wages which enable sustenance to some degree and also the fact that there is no discrimination of any kind when it comes to employment in the sector. It is interesting to note that these positives do not exist in the gold mining sector in the Democratic Republic of Congo, studied in Arvidsson et al. (2018). Aparcana and Salhofer

(2013b) applied the methodology developed and presented by them elaborately in Aparcana and Salhofer (2013a)—which incidentally appeared in the same issue as the sequel mentioned—for three recycling systems in Peru, considering 3 impact categories, 9 subcategories and 26 indicators. The recommendations, which the authors have given, to truncate the negative social footprint of the informal recycling sector in this South American country include the improvement in anti-discrimination policies (note the contrast to the Pakistan case study in Umair et al. (2015), where there is no discrimination), employment terms, occupational health and safety training and adult education.

Foolmaun and Ramjeawon (2013a, b, c) had focused on the end-of-life handling of another polymer—polyethylene terephthalate (PET)—in Mauritius from a double-bottom-line perspective—environmental and social. In the S-LCA conducted for four different scenarios—landfilling, incineration + landfilling, recycling + landfilling (two different splits)—for three stakeholder categories (consumers and value chain actors were excluded) and eight social themes, the scenario in which 75% of the PET waste was recycled and 25% landfilled emerged as the best alternative, socially and environmentally. Including the economic dimension to convert this to a holistic sustainability analysis, by also factoring in possible top-down interventions like taxes and subsidies, would have made a substantial addition to the significance of this paper for waste management researchers and also for decision-makers in Mauritius.

One of the strengths of S-LCA, despite the lack of consensus among researchers as far as the impact assessment methods and the choice of indicators are concerned, is its ability to communicate results qualitatively or semi-quantitatively to decision-makers. (Of course, this may not be as effective as communicating results quantitatively, with the aid of well-defined indicators and measurement techniques.) This is what Teah and Onuki (2017) have done to stress on the indispensability of increasing the degree of phosphorus recycling from sludge and manure in Japan. While abiotic depletion of the phosphate ores and the environmental impacts associated with the mining and processing of the same can be analysed using E-LCA as a tool, and the concept of scarcity rent can be used to inform the unavoidable rise in the cost of extraction and refining and therefore in the prices farmers have to pay for synthetic fertilisers, the human rights violation in the Western Sahara region (one of the major exporters of phosphate rock to the world), which is the highlight of Teah and Onuki (2017), makes the dependence on phosphate ores undeniably and indisputably unsustainable on all counts. However, as a sequel to this publication, one must also analyse the sustainability of different methods of phosphorus recovery in Japan from different waste streams—from a triple-bottom-line point of view. Highlighting the possible net socio-economic benefits, the

Japanese farmers may enjoy and hereby will present phosphorus recovery from waste streams to reduce the dependence on imports of mineral phosphates from Western Sahara, in a very positive light. This may also inspire governments of other countries like India for instance, which is highly dependent on phosphate imports to sustain its agricultural sector and feed its ever-increasing population.

In an LCSA conducted in Kuwait, Aleisa and Al-Jarallah (2017) found out that among six different solid waste management (SWM) alternatives—different combinations of incineration, landfilling, recycling and composting—100% incineration turned out to be the most socially acceptable (although economically unfavourable), contrary to 100% landfilling which was ranked lowest in this regard. The authors conclude with the caveat that the uncertainties associated with S-LCA results of SWM vary widely across cultures, ideologies and degrees of socio-economic development. This is not unusual as it is often the choice of the system boundaries which determines the final results of a life cycle analysis, be that environmental or social. After all, cultures and ideologies form an integral part of the social aspect of sustainability.

Mirdar Harijani et al. (2017) carried out an analysis similar to the Kuwaiti one in Aleisa and Al-Jarallah (2017), for Iran. They compared different combinations of material recycling, anaerobic digestion, composting, landfill with methane gas recovery and advanced thermal treatment, and showed that an improvement in the social sustainability comes at a cost—profits decrease and the environmental impacts tend to increase. This is in stark contrast to the complementary nature of the socio-economic and environmental benefits in the Ugandan case study of Musaazi et al. (2015), as discussed earlier. However, when one of the aspects of sustainability improves at the cost of the other two, prioritising and weighting are often needed in order to determine whether the measures undertaken to improve social sustainability are holistically sustainable. For a developing country like Iran, which also needs to guard against environmental degradation to sustain its socio-economic development, one can assign equal importance to the three aspects and proceed to determine whether the measures analysed are holistically sustainable.

Discussions

A SWOT analysis of S-LCA can be conducted on the basis of affirmations made by researchers in S-LCA publications read (213) and reviewed (41) in this particular paper. The **SWOT** here includes **Strengths** of S-LCA which are being utilised currently, **Weaknesses** which are known and need to be overcome, **Opportunities** which can be availed of once the weaknesses are overcome, and **Threats** to the entrenchment

of S-LCA as a sustainability analysis tool along with E-LCA and LCC, if the **Opportunities** which can be availed of, are not, owing to persistent **Weaknesses**. Here, it is apt to note that **Strengths** and **Weaknesses** are inherent to the tool, and the development of the tool over time will serve to magnify the former and diminish the latter. However, **Opportunities** and **Threats** are external factors—**Strengths** enabling S-LCA to avail of the former, and **Weaknesses** undermining it, in the wake of the latter. This section therefore clubs together strengths and opportunities on the one hand, and weaknesses and threats on the other.

Strengths and opportunities

As Aleisa and Al-Jarallah (2017) and Cardoso et al. (2018) have observed, E-LCA needs to be compounded with S-LCA and LCC as the financial and social aspects of any system cannot be overlooked if an analyst wishes to prove feasibility and credibility at a strategic level to decision-makers. In other words, S-LCA helps to set up what could be labelled as an 'inclusive business model' (Thomas et al. 2014) which would assume responsibility for the health, safety and well-being of workers, the local community, society, the environment and economic development. In Lenzo et al. (2017), for instance, the Mongolian player in the supply chain accounted for the largest share in the social footprint of the product sold by the Italian firm. When such facts are uncovered courtesy an S-LCA, the final producer can assume the responsibility to induce its suppliers to enforce corporate social responsibility and contribute to truncating the social footprint of the product/s sold eventually in the global marketplace (Dewulf et al. 2015).

A detailed evaluation of all the risk levels—from low to very high—is necessary to get a complete picture of the hot spots in the supply chain of a product. S-LCA is a tool which is capable of such an evaluation, given the availability of reliable and comprehensive data. Often, one would like to focus on the high-risk nodes of the supply chain only, at the expense of the low-risk ones. But an understanding of the dynamic nature of the social impacts needs to be imbibed, so that any possibility of a low-risk node deteriorating to a high-risk one is not overlooked. This is where the periodically updated SHDB (Benoit Norris 2014) serves as a pillar supporting S-LCA analyses.

S-LCA uncovers not just the adverse social impacts a process may cause, but also credits it for the positive ones (analogous to the avoided impacts for which a process is given credit for, by expanding the system boundaries in an E-LCA). If an S-LCA includes positive social impacts, the contexts in which they materialise are very important when it comes to interpreting the results. In other words, the starting point with respect to which the changes (or positive impacts) are measured determines the context. In order to

elucidate this, we may think of ‘not so good’ to ‘good’ being a significant change, vis-à-vis ‘good’ to a ‘little better’.

As depicted in Fig. 4 earlier, S-LCA is slowly and surely gaining in popularity as more and more journals are accepting methodological and application papers for publication. This is also an indication of a gradual mushrooming of the S-LCA community and if the history of E-LCA (Baumann and Tillman 2004) is anything to go by, maturation of the tool and its firm entrenchment in LCSA as a harmonised tool is not very far away in the future.

If S-LCA can also be used to study the use phase in life cycles in greater detail than it has been done in analyses thus far, the effectiveness and comprehensiveness of the tool can be demonstrated and this would work in its favour. Just as one finds eco-labels on products in the supermarket for instance, the emergence of socio-labels (Nikolaou and Tsalis 2018) is not far away if concerted efforts are made to refine the methodologies and facilitate a globally standard interpretation of the data on the socio-labels. Products which are able to acquire both the labels can be sold at a premium, the reason being transparently communicated to the prospective buyer—the labels, by virtue of their credibility, representing all the data and analyses.

Weaknesses and threats

Researchers are yet to arrive at a consensus regarding the choice of impact indicators, as Bocoum et al. (2015) have observed. Brent and Labuschagne (2007) had pointed out that quantitative approaches to S-LCA were impaired by the absence of global standards in this field of research, and recommended that the use of indicators must be introduced in the analysis of any project in the chemical industry, only when information would be readily available. It must be mentioned that this impasse still exists a decade down the line. However, one must note at this juncture that even E-LCA which is better entrenched now in the field of sustainability research can be carried out using different methods and different sets of indicators (Baumann and Tillman 2004). That begs the question—cannot one likewise think of different methods and therefore different sets of indicators in S-LCA? If E-LCA analysts can use CML, EcoIndicator99, ReCiPe, EPS or EDIP without creating any confusion in the minds of readers and end-users of such results, why must the diversity of S-LCA methods be confusing for S-LCA researchers, as Chhipi-Shrestha et al. (2015) for instance, has stated? Jørgensen et al. (2009) have, however, advocated that as long as one learns to differentiate among usable S-LCA methods, valid S-LCA methods and methods that are likely to yield beneficial results, any element of confusion that may exist can be thwarted easily.

Results in the form of quantitative and semi-quantitative indicators are more effectively communicated vis-à-vis

qualitative ones, as stated in Arcese et al. (2013), though an inability to define quantitative or semi-quantitative indicators for the analysis must not be a reason for not carrying out an S-LCA. This is one of the observations made in Zortea et al. (2018), who found it challenging to integrate qualitative results from an S-LCA with quantitative ones from the E-LCA and LCC in an LCSA done for soybean cultivation in Brazil. Of course, if one would perform just a uni-dimensional analysis, like Teah and Onuki (2017), then qualitative S-LCA indicators will still enable the analyst to communicate the end results effectively. It is not just about whether an indicator is quantitative or qualitative, but also about what exactly is a social impact indicator, how it must be defined and measured, as Babashamsi et al. (2016) have stated in their paper. Even if there would be a large family of indicators to select from, it is essential to know precisely what each one stands for, in the larger scheme of things and standardise the methods of measurement to a certain extent.

Singh and Gupta (2018) encountered challenges with non-availability of site-specific data when they performed an S-LCA of the Indian steel sector. This is a hurdle which needs to be overcome, and it is necessary to differentiate among company-level, sector-level and national-level SAM, as Hannouf and Assefa (2018) have done and recommended, to highlight the errors that may creep in if one resorts to generalisation. Data availability (in order to eliminate the need for proxies) has been and will continue to be the cornerstone of both environmental and Social LCA.

The tediousness which the iterative nature of S-LCA introduces into the analysis often (Smith and Barling 2014) is a perceptible drawback which may temper the advancement of this field of research and application. This can be overcome if one can accept the fact that the complexity is simply a mirror of the reality around us, which the tool it helps us to measure and understand.

Aggregating results to a single social impact score will make communication of the results to non-specialists clearer and easier, but many researchers have advocated caution here, especially when there are conspicuous data gaps and uncertainties (or subjectivity regarding the weighting factors) to be accounted for. It is here that do Carmo et al. (2017) recommend an uncertainty analysis before proceeding with the aggregation based on the weighting factors. The ‘story behind the aggregated score’ tends to become suspect, if there is no clear communication about the possible uncertainties. The weighting factors needed for the aggregation have to be derived through the entire gamut of focus groups—workers, local community, society and value chain actors—for a set of chosen social impact categories. This diversity will confer greater legitimacy on S-LCA as a decision-making tool.

It is also necessary to be aware of the fact that the uncertainties associated with S-LCA results vary widely across

ideologies, cultures and degrees of socio-economic development (Aleisa and Al-Jarallah 2017), and this is quite obvious, as just like E-LCA, the results obtained are dependent on the system boundaries one chooses for oneself. This is not a threat as such, but failure to appreciate this may distort one's understanding of comparative S-LCA results.

Conclusions

In this paper, a literature search was carried out on Scopus for peer-reviewed journal publications with 'S-LCA' or 'SLCA' or 'Social LCA' or 'social life cycle assessment' in title and/or abstract and/or keywords. Overall, 213 publications, over a 22-year period, were unearthed. Well over 50% of the publications were applications of S-LCA to a variety of sectors of the global economy—primary (mining, agriculture, forestry, etc.), secondary (processing and manufacturing) and tertiary (a range of service sectors).

A detailed review and analysis of applied S-LCA publications originating in the developing and transitional economies in the world (41 of the 121) were subsequently done. These 41 papers encompassed 12 industry sectors as defined in Table 2. Some 'talking points' centred around the present and the future of S-LCA were raised. Emergent knowledge was discussed using a SWOT analysis. There are still challenges to be overcome, en route to a consensus regarding standardisation of methodologies and indicator sets, which many researchers have recommended over the last 4–5 years, as indispensable for the maturation and establishment of S-LCA as a reliable tool. It must be noted, however, that applications of S-LCA can lead to different types of deliverables like the Social Water Scarcity Index introduced and calculated by Pastor et al. (2018), for instance, or the offshoot Work Environment LCA (WELCA) developed and applied by Arvidsson et al. (2018), or the opportunity to use companion methods like VIKOR (Ren et al. 2015), or set up new models which could be used by researchers in the future, like the social impact model for construction (Arcese et al. 2013). In this article, the segmentation of the studies on the basis of the economic sectors throws light on the drawbacks associated with generalising the challenges associated with the social aspect of sustainable production and manufacturing. Decision-makers ought to devise tailor-made policies for different sectors of the economy, based on more nuanced knowledge of conditions.

In conclusion, one may state that there is a consensus among many researchers that while LCC and E-LCA have matured a lot over time, S-LCA is evolving slowly to become a harmonised tool which can serve as an effective complement to the aforesaid two, in LCSAs of products and processes in industry. Talking of consensus, however, researchers are yet to arrive at one regarding the choice of indicators,

and the difficulty in defining what a social impact actually is, and how it must be measured, tends to persist. While the use phase figures prominently in an LCC and an E-LCA, it needs to be studied in much greater detail than it has been till date, in an S-LCA, and further development of this methodology must take this into account. From a developing world perspective, a detailed evaluation of all the risk levels—from low to very high—is necessary to get a complete picture of all the hot spots in the supply chain of a product. This article narrowed down its focus to the developing world. Unlike the developed world where ideologies, cultures and levels of socio-economic development are fairly similar (though there are nuances for those who wish to investigate), one finds a veritable palette of ideologies, cultures and levels of socio-economic development in the developing countries and transition economies that understanding the uncertainties associated with the results of S-LCA studies in different regions of the world is an interesting area of research in itself.

S-LCA as a standalone tool is effective in itself, but in combination with E-LCA and LCC, it provides richer insights from the point of view of sustainability, as some publications based on LCSA have shown.

Harking back to the name of this journal, the adjective 'clean' which appears in front of technologies when one talks of 'clean technologies' needs to be interpreted holistically. Environmental policy-making cannot isolate itself from the socio-economic aspects of production and manufacturing systems in the world.

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