Chapter 19
Globalisation and Mainstreaming of LCA

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Abstract The chapter describes how a globalised economy exacerbates the need of a mainstreaming of LCA, in particular the emergence of long, complex and geographically highly dispersed global value chains (GVCs). In documenting the three phases of the UNEP-SETAC Life Cycle Initiative, a conventional roadmap for global mainstreaming of LCA is drawn. However, the questioning by some South governments of the rationale and a North methodological bias of LCA draws attention to the significance of national and local contexts in developing countries. The chapter argues a more elaborate concept for building capacity for LCA in developing countries and suggests how to strategize national LCA agendas.

Learning Objectives
After studying this chapter the reader should have a clear understanding of the importance of the context of globalisation for the development of LCA methodology, its dissemination of and the capacity building for LCA, in particular with regard to the adoption of LCA in developing and industrialising countries.

19.1 Introduction: The Global Challenge for LCA

The greenhouse effect spans the entire globe causing disruption of livelihood for millions of people across continents. The pattern of climate gas emissions mirrors the last century of human civilisation, when mass production and consumption emerged and became internationalised. Thus, mitigating as well as adapting to these environmental impacts constitutes a global challenge.

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M.Z. Hauschild et al. (eds.), *Life Cycle Assessment*,
DOI 10.1007/978-3-319-56475-3_19

The organisational forms of internationalisation of production have changed from exchange of goods across borders by trading companies, to include foreign investment in overseas territories, and to establish subsidiaries of multinational corporations after the Second World War. Supported by improved information and transport technologies, selected segments have been outsourced or offshored to locations offering low tax regimes, low labour cost, same or better quality, delivery on-time and other advantages. More recently, some corporations are transforming from vertically integrated wholly owned companies into sliced up global supply chains organised by lead firms, e.g. branded manufacturers or major retailers. The lead firms cross national borders and combine value-added activities by a range of suppliers into global value chains (GVCs) for the manufacture of a final product.

The growth of emerging economies (first of all in BRIC countries: Brazil, Russia, India and China) is to a significant extent a result of this new form of internationalisation of production, as "GVCs began to concentrate in these giant countries that offered seemingly inexhaustible pools of low-wage workers, capable manufacturers, abundant raw materials and sizeable domestic markets. Thus, China became the 'factory of the world', India the world's 'back office', Brazil had a wealth of agricultural commodities, and Russia possessed enormous reserves of natural resources plus military technologies linked to its role as a Cold War Superpower" (Gereffi 2014).

Looking at trade statistics, the increasing importance of global production chains is reflected in the rising trade in intermediate inputs, which now represent more than half of the goods imported by OECD economies and close to three-fourths of the imports of large developing economies, such as China and Brazil. This phenomenon poses new challenges, because "imported inputs also account for a significant chunk of exports, blurring the line between exports and imports as well as between domestic products and imports. As part of global production chains, products at different stages of value added may be imported and re-exported multiple times, increasing the size of reported exports and imports relative to global and national value added" (World Economic Forum 2012).

The centre of gravity in world trade is shifting from West to East, as the financial and economic crisis in US and EU drags. The crisis has not "reversed globalization, but accelerated two long-term trends in the global economy: the consolidation of GVCs and the growing salience of markets in the South" (Cattaneo et al. 2010). However, inequalities among developing countries may increase.

Conventional trade statistics on gross trade flows between nations reflect the dispersed production process in quite imprecise terms. Thus, recently, an alternative measure, GVC income, which is defined as the income generated in a country by participating in global manufacturing production, has been suggested (Timmer et al. 2015). This will allow a detailed analysis at product level on the distribution of activities in a global value chain among suppliers and the amount of value added with each supplier. The World Input–Output Database (WIOD 2012) enables an analysis of the implications of production fragmented across borders, e.g. for

shifting patterns in demand for skills in labour markets, or for local emissions of pollutants to the environment.

Life cycle assessment of GVCs is confronted with a similar data problem. Making use of generic databases developed in industrialised countries may produce imprecise or invalid results for processes and materials in developing countries, whose different properties and conditions of operation may cause a high degree of uncertainty.

19.2 Global Product Life Cycles

Thus, the length, complexity and geographical location of life cycle segments in GVCs, often in very diverse socio-economic contexts, present challenges for conducting LCA. The following three examples illustrate why an inventory of valid and precise site-specific data is crucial and why this objective may be hard to achieve.

The **farming of pangasius in Vietnam** and its processing into frozen fillets for export to industrialised countries have brought tremendous growth to the national economy. However, aquaculture involves serious environmental problems such as fish feed containing zinc, copper, cadmium and mercury; water pollution due to uneaten feed or faeces and improper discharge of wastewater from the ponds; loss of mangrove forest causing loss of biodiversity and natural barriers against tsunamis; and antibiotics residues in wild fish around farms.

Nonetheless, the strong competition in international markets, first of all from China, motivates a prime concern about compliance with health and food safety standards in Vietnamese aquaculture management. To perform a life cycle assessment of pangasius production is hampered by difficulties in getting site-specific data. A Dutch-Vietnamese research team conducted what they termed as a 'stakeholder-based screening life cycle assessment up to the exit-gate of the fish farm'. The study identified two critical processes: (1) feed ingredient production, transport and milling; and (2) pond effluents in grow-out farming. For the first process, a generic inventory had to be used, as only five out of 30 feed producing companies in the Mekong delta provided data for the team. The team suspected that producers use secret formula, do not meet sanitary standards and are reluctant to provide information out of fear of government authorities (Bosma et al. 2011). Concerning the second critical process, which requires data to be collected from the farmers, the experience of food traceability systems shows that keeping records on inputs and outputs is an extra work task, for which no manpower can be spared during peak production (Yong 2008). Farmers are also concerned about data security, as some may use prohibited drugs in the ponds (own interviews 2009).

While feed producers' secrecy, out of fear of negative sanctions from public authorities and lack of capacity for record-keeping with primary producers, bar the access to local data in Vietnam, an example from Ghana shows that the final segments of the life cycle of some products may be completely hidden.

The **export of second-hand computers to Ghana**, some of which is illegal, extends the use phase of the life cycle of these products to meet needs of cheap computing for consumers in Africa. When the life time of the recycled product comes to a definitive end, final disposal is often performed under hazardous conditions, e.g. by open fire, causing severe problems for the environment and for the occupational health and safety of workers exposed. Only data collection on-site will be able to capture the processes in this and other informal sectors of the national economy.

In Malaysia, emerging capacity for assessing environmental impacts of a product having strategic importance for the national economy illustrates that the validity of foreign LCA studies based on generic data is being contested by local studies based on local data.

Palm oil production in Malaysia is a natural resource sector of strategic importance. The sector has developed over four decades and contributes 5–6% to GDP. In 2011, palm oil and palm oil-based products, ranked as the largest exports revenue earner with a total combined value of RM 80.30 billion, contributed 61.8% to total exports (MPOB 2011). Crude palm oil production accounts for app. 3.5% of the total environmental impacts in Malaysia (Yusoff and Hansen 2007). The country accounts for 39% of world production and 44% of world exports (MPOB 2014). Palm oil is sold on the world market in fierce competition with other vegetable oils and subjected to frequent price fluctuations.

The rationale of the strong R&D efforts is to safeguard the export revenue from this strategic commodity. This includes science-based arguments for the healthier properties—in terms of cholesterol content—of palm oil (MPOC 2016) as compared to soya bean oil. As a contested product, industry-driven research is directed to investigate the environmental concerns about palm oil production. LCA is adopted as a tool to drive back opposition from environmental, non-governmental organisations and from competitors and prove that palm oil has comparatively less environmental impact than other vegetable oils. In the scientific discussion, several Malaysian researchers claim that European databases are not representative for processes in Asia; thus in LCAs, according to them, palm oil appears to be worse than it really is.

These three examples point to the limitations involved when relying on generic databases only. Conditions in developing countries may be very different, when it comes to climate, habitats and natural resources characteristics and also with regard to the socio-economic and regulatory context. In the globalised economy, it is evident that a vibrant, strong and internationally well-connected LCA research community in any country is needed to produce relevant and valid LCAs of products and services. This is part of a general challenge of mainstreaming the use of LCA (Rebitzer and Schäfer 2009).

19.3 The UNEP/SETAC Life Cycle Initiative for Global Mainstreaming of LCA

The origin of capacity support specifically targeting LCA was the framework programme on Sustainable Consumption and Production established by UNEP DTI as part of its follow-up of the World Summit on Sustainable Development 2002. The 10-year framework programme focuses on SMEs as reliable suppliers, regional life cycle networks, and training programmes targeted at National Cleaner Production Centres (NCPCs) (De Leeuw 2006).

Joining with the Society of Environmental Toxicology and Chemistry (SETAC), the UNEP-SETAC Life Cycle Initiative focused on forming a focal point, i.e. a community of practitioners and stakeholders, and defined the following three objectives for its *first phase 2002–2006*:

1. Global representation in the various bodies of the initiative
2. Organisation of activities around the world
3. Organisation of capacity building material and of activities aiming at developing countries as well as small and medium enterprises (SMEs).

Thus, international outreach and capacity building was clearly targeted (Udo de Haes 2003). During this period, three regional networks were formed in Africa (Ramjeawon et al. 2005), Asia and Latin America; also an open forum with more than 1000 members from all over the world has been established. A range of awareness workshops, scientific conferences and outreach activities to cleaner production centres have been conducted. Practical tools in the form of training manuals and guides have been produced and disseminated covering Life Cycle Impact Assessment, Life Cycle Inventories, Social Life Cycle Assessment, Life Cycle Management and a Life Cycle Database Registry (Sonnemann 2003, 2004). The First Edition of the LCA Award 2006–2007 acknowledged pioneering works and individual commitment to Life Cycle Assessments in developing countries, e.g. research to assess the environmental impact of sugar production in South Africa, newsprint paper production in Zimbabwe and new approaches to assess impacts on biodiversity in Brazil (Sonnemann and Valdivia 2007).

The mission for the *second phase 2006–2010* of the Life Cycle Initiative was to bring science-based Life Cycle approaches into practice worldwide, thus explicitly setting capacity development on the agenda. The UNEP/SETAC Life Cycle Initiative served as an umbrella for a number of separate projects with different forms of affiliation to the Initiative. The Life Cycle Awards for projects using Life Cycle approaches in developing countries were being continued (Sonnemann and Valdivia 2007). A number of training and scientific events have been conducted. In the Asia Pacific Region, the National Institute of Advanced Industrial Science and Technology (AIST), Research Centre for Life Cycle Assessment, Tsukuba, Japan, was organising LCA workshops, e.g. focussing on food and waste chains in the region (Inaba et al. 2001, 205–206). Also, a survey has been completed, which compares levels of LCA implementation between nations in using indicators such

as numbers of seminars, workshops, case studies, the establishment of a LCA Forum or Society, LCI Database development, LCIA methodology development, the extent of application by industries and worldwide technology transfer. A regular LCA event in Asia Pacific was reflected in the Seventh International Conference on EcoBalance.

The *third phase 2012–2016* targeted the mainstreaming of the use of life cycle approaches, including better accessibility to cost-effective, robust methodologies and tools based on reliable data, transfer of scientific knowledge to the wider society and improved global communication channels of the UNEP/SETAC Life Cycle Initiative via a number of flagship projects:

- Environmental life cycle impact assessment indicators
- LCA of Organisations
- Data and database management
- Global Principles and Practices for Hotspot Analysis
- Global capability development.

The flagship project on Global capability development (UNEP/SETAC Life Cycle Initiative 2016) had the aim to strengthen and consolidate the life cycle work in the regions, including documentation of local consultants and databases available. Focal points at Governmental offices (including national statistic offices for data management aspects) and chambers of commerce were identified and linked to the national networks. Some deliverables identified for this flagship include the following:

- Establishing a baseline on the level of Life Cycle Thinking worldwide, assessing the current capabilities on Life Cycle issues in non-OECD countries, with updates planned for every 3 years to trace the evolution.
- Life cycle tools (i.e. on life cycle management, life cycle based footprinting indicators and eco-design) spread across the emerging and rapidly growing economies via the Life Cycle Initiative's or local platforms.
- South–south (e.g. in Latin America) cooperation for increased implementation and North–South cooperation for methodologies' enhancement, data generation and exchange.
- Life cycle experts' and practitioners' network established in each region.
- Online tools, if possible, translated into several languages including English, Spanish, Chinese and Portuguese.

In 2001, LCA capacity constraints were documented for Argentina (Arena 2000). In 2006, UNEP DTI took stock of the situation in developing countries (Sonnemann and de Leeuw 2006). In 2007, the need for LCA of globalsupply chains of food products and transboundary movement of waste was highlighted (Inaba et al. 2007). In 2012, an analysis by Toolseeram Ramjeawon of the status of LCA in developing countries and of the need to build LCA capacities (Ramjeawon 2012) pointed to the lack of technical expertise and the absence of awareness as main barriers for improving beyond a very limited or non-existent level of

implementation of LCA. A mapping based upon a six criterion definition, which resulted in a total of one hundred local, regional and global LCA networks around the world, confirms this situation. The survey received a response from only six networks in developing countries, primarily in South America and Southeast Asia, leaving Africa and Central Asia almost unrepresented.

The analysis by Ramjeawon (2012) suggested that joining global value chains provides one avenue for improvement with producers in developing countries, because the foreign lead firms will require LCA-based documentation of environmental performance from their suppliers to facilitate entry to markets in Europe and US (Ramjeawon 2012). Domestically, the key recommendation is for the government to create effective demand for LCA by launching national sustainable consumption and production action plans (Ramjeawon 2012). However, closing the enormous gap between levels of implementation in developing countries and industrialised countries calls for a wide range of capacity building activities to be adopted in developing countries. A roadmap was proposed with the following progressive steps (Ramjeawon 2012):

1. Introduction of life cycle topics in educational programmes and research activities;
2. Networking;
3. Setting up a national inventory database and development of tools to set up, maintain and disseminate data;
4. Development of national life cycle impact assessment methodologies;
5. Capacity development to apply LCA in industry and in public decision-making;
6. Promotion of LCA applications and creating a stock of success stories and dissemination;
7. Policy development.

In 2011, global guidance principles for LCA databases were launched (Sonnemann et al. 2013). In 2015, the status of life cycle management in emerging economies was assessed (Valdivia et al. 2015).

As one of few countries, Malaysia has launched a comprehensive plan for implementation of LCA. In 2006, the *National Initiative to Develop the Lifecycle Inventory Database for the Development of Eco-Friendly Products and Services* (SIRIM 2016) was initiated under the NinthMalaysia Plan. The initiative is hosted at SIRIM Berhad with support from the Japan International Cooperation Agency (JICA) for a number of the activities under the project. The main objective is to develop the National Life Cycle Inventory Database as the basis for LCA studies. This will support the National Eco-labelling Programme and facilitate compliance with environmental standards in international trade. The specific objectives are as follows:

- To develop the national life cycle inventory (LCI) database;
- To develop a critical mass of local LCA practitioners;
- To develop eco-labelling criteria documents for the National Eco-labelling Programme;

To create awareness among industry and consumer groups on the importance of LCA in today's manufacturing and procurement practice. Thus, the national LCA initiative intends to roll out basic resources for LCA practices by sourcing data on relevant processes in Malaysia, by supplying definitions of eco-labelling criteria, by initiating broad-based effort to create awareness the significance of LCA among stakeholders, and by supporting the creation of a pool of LCA resource persons.

In 2008, SIRIM completed a project under the EU Asia Pro Eco Programme *Sustainable Production and Consumption as the Long-term Solution to Reduce Urban Environmental Degradation—Developing a Reference Framework for Electrical and Electronic Products*, establishing a reference framework that links the roles and contribution of all stakeholders in the supply demand chain of electrical and electronic products, i.e. manufacturers, retailers and consumers.

All five major public universities, Universiti Sains Malaysia, Universiti Malaya, Universiti Teknologi Malaysia, Universiti Putra Malaysia and Universiti Kebangsaan Malaysia, have rather limited LCA research activities—currently there is no permanent research group specialising in LCA. Results are not communicated beyond those researchers, who are producing them, except as training modules produced for staff training within the Department of Environment (DOE).

Once completed, the national life cycles inventories (LCIs) will be made available to industry on a subscription basis. SIRIM has conducted an extensive outreach effort, in particular to SMEs; however, attendance to awareness and training workshops has been low. Only the plastic manufacturers have adopted LCA thinking and methods to highlight the environmental impact of the plastic bag product chain as compared to that of products with a similar function.

Environmental non-governmental organisations (NGOs) are not concerned with LCA thinking, except for the Business Council for Sustainable Development—Malaysia (BCSDM 2016). The Environmental Management and Research Association of Malaysia (ENSEARCH 2016), the membership of which is primarily drawn from environmental professionals in industry, is not introducing LCA thinking as such. Some years back, ENSEARCH widely publicised the concept of cleaner production. More recently, ENSEARCH supports the application of green technologies with a focus on energy efficiency and waste minimisation.

As one of the rapid industrialising countries in Asia, Malaysia benefits from transfer of **k**nowledge on environmental management systems by transnational companies as a part of corporate policy in their overseas subsidiaries. However, the small- and medium-scale companies with local ownership, which constitute the majority of enterprises in most sectors, are unable to allocate resources or staff for improving environmental performance. Universities may be in a position to include research on life cycle assessment, possibly triggered by the availability of a foreign research grant, which is specific in scope and has a limited duration. The effort to develop a national LCA knowledge base, also servicing the private sector, may encounter financial and capacity constraints of the national research infrastructure.

19.4 LCA and South Policy Agendas

Global inequalities in resource distribution between the North and a number of developing countries in the South are the cause of serious capacity constraints also in the area of environmental management, in particular with regard to life cycle assessment. This has motivated some governments to assert the position that LCA is part of a 'green protectionism' agenda in trade policies of the North. Such agenda is seen as a push for industrial modernisation denying developing countries a growth potential, which countries in the North have enjoyed during a more than one-century long process of industrialisation.

Thus, stakeholders in developing countries originally adopted an altogether critical stand of confronting the rationale of LCA. In response to the influence of retail buyers, purchasing departments, product development teams, as they present their long 'arm' of environmental audits of suppliers in developing countries, delegates from the Third World claimed a 'one-sided focus on environment' at an LCA workshop during the World Summit on Sustainable Development, Johannesburg, September 2002. They argued that LCA tools are

(1) too complicated for practical use;
(2) too focused on environmental problems as defined by industrialised countries;
(3) one-sided in terms of ignoring costing and social issues such as work environment, human safety and employment. The delegates further observed that life cycle indicators will select against old-fashioned, polluting industries, thus not help to protect employment in developing countries (Udo de Haes 2004, 8).

In response, the need for simplification of LCA tools was recognised; an increased focus on soil erosion, water scarcity, and regional conditions was encouraged. Efforts to include consequences with regard to soil erosion, water scarcity, other regional conditions and land use into life cycle assessments have been recommended and in some cases practiced. Most prominently, land use consequences with regard to biofuel have been extensively analysed and discussed (Dallemand et al. 2010) and the enlargement of the scope of life cycle indicators to cover occupational health and safety, working conditions and other social issues was promoted.

Nonetheless, life cycle approaches aim to stimulate modernisation of industry favouring the development of modern, less-polluting industry. The environmental burdens in developing countries are typically higher than those in industrialised countries per functional unit (Udo de Haes 2004). This line of argument corresponds to the recommendation of *Aid for trade* as needed to effectively dissolve perceptions among developing countries that environmental and social standards are equivalent to green protectionism. Financial support to facilitate trade is considered to pave the way for long-term alliances between developing and developed countries linking trade and sustainable development. Udo de Haes

outlined several options for combining environmental (or social) requirements as calculated by LCA with real financial support: "(1) the costs of such schemes could be funded by industrialised countries, because it is these countries that—justly!—ask for these schemes; (2) technical assistance could be given for the functioning of such schemes, including validation as to whether the respective criteria have been met; (3) funds may be provided for the transition into more modern, efficient technology" (op.cit., 10). A range of intergovernmental programmes to support the diffusion of climate mitigation are now in existence (de Coninck and Puig 2015).

The criticism that LCA methods are quite demanding in terms of time spent, data, software and analytical skills is raised when considering strategies to improve the livelihood of small producers (Riisgaard 2010, 10). Instead of conducting the time-consuming and costly exercise of a full LCA, several types of simplified LCA have been suggested (e.g. Hochschorner and Finnveden 2003; Hur et al. 2005; Xiaoming and Yi 2007). One approach is a stripped down version based on product categories ('product families', cf. Lenau et al. 2002). The effort is to focus on a few essential indicators, while maintaining the substance of environmental aspects. Another approach is to conduct a preliminary assessment in the format of a Life Cycle Check to identify 'hotspots' and the need for more detailed analysis (Wenzel et al. 2001).

An alternative, pragmatic approach combines LCA, risk analysis and scenario analysis into a systematic screening process prompting *go/no go* decisions (Klöpffer et al. 2007).

Basically, the environmental concerns in developing and industrialised countries have a different origin. While non-governmental organisations in industrialised countries have played a major role in alerting the public to the hazards of industrial pollution for human health and nature and pushing for regulation, trade policy conditionalities for entry into export markets currently provide the main motivation for complying with environmental standards in developing countries. This kind of regulation is driven by consumers in industrialised countries giving preference to, e.g. eco-labelled products. Also, many subsidiaries of multinational corporations operating in developing countries are directed to adopt corporate policies on environmental standards. However, for other companies, particularly those which are locally owned, efforts for improving eco-efficiency of products and services are driven as part of optimisation targeting cost savings to be gained. Furthermore, in many developing countries, the scope for civil society is restricted leaving environmental non-governmental organisations (NGOs) with few avenues for addressing policy agendas and public debate at large.

Thus, strategies for the mainstreaming of LCA worldwide need to consider how the LCA agenda of improving eco-efficiency of products and services relate to policy positions of the government, the private sector and public discourse.

19.5 Building Capacity for LCA in Developing Countries

The mere availability of relevant tools and trained professionals does not create transition. For a comprehensive strategy of mainstreaming LCA in developing countries, the concept of capacity development needs to be elaborated. In 2002, the United Nations Development Programme (UNDP) reviewed decades of technology transfer and observed "Donors can ship out four-wheel-drive vehicles, or textbooks, or computers; they can dispatch expatriate experts, whether on long-term secondment or on short-term consultancies. But they have not really appeared to transfer knowledge—or at least not in the catalytic way that might ignite a positive chain reaction throughout developing societies" (Fukuda-Parr et al. 2002, 3). Numerous cases of mismatch between ready-made technology packages and a different socio-economic and political context, into which the package was parachuted, have been documented in the history of technical assistance. On this basis, the UNDP report called for a complete change of paradigm, as "foreign experts … can run multiple seminars and courses that improve the individual skills of thousands of people. However, the capacity of local institutions and of countries as a whole has still not appeared adequate to meet the challenges of development" (ibid). The report identified three levels of capacity development: (1) the training of individuals which is only meaningful when jobs are available in relevant; (2) local institutions operating as well-functioning organisations and interacting with a conducive; and (3) enabling environment of related institutions, regulations and policies.

Accordingly, the new paradigm goes far beyond a simple identification of a relative absence of, e.g. a critical mass of LCA experts in developing countries: "Rather than starting from a mail-order catalogue of standard parts to be forced into likely looking slots, the challenge instead should be fully to understand the local situation and move forward from there—step by step" (op.cit., 13). The concept of capacity can be further elaborated to include five core capabilities:

1. The capability to self-organise and act. Actors are able to mobilise resources (financial, human and organisational); create space and autonomy for independent action; motivate unwilling or unresponsive partners; and plan, decide and engage collectively to exercise their other capabilities.
2. The capability to generate development results. Actors are able to produce substantive outputs and outcomes (e.g. health or education services, employment opportunities, justice and rule of law); sustain production over time; and add value for their clients, beneficiaries, citizens, etc.
3. The capability to establish supportive relationships. Actors can establish and manage linkages, alliances and/or partnerships with others to leverage resources and actions; build legitimacy in the eyes of key stakeholders; and deal effectively with competition, politics and power differentials.
4. The capability to adapt and self-renew. Actors are able to adapt and modify plans and operations based on monitoring of progress and outcomes; proactively anticipate change and new challenges; and cope with shocks and develop resilience.

The capability to achieve coherence. Actors can develop shared short- and long-term strategies and visions; balance control, flexibility and consistency; integrate and harmonise plans and actions in complex, multi-actor settings; and cope with cycles of stability and change (Morgan 2006, 8ff).

Ortiz and Taylor have further suggested assessing whether capacity development is supporting the development of 'standing capacities' that result in an organisational readiness to respond to new and unforeseen challenges. "Standing capacity' requires intangible qualities such as relationship leverage, programme design capabilities, innovative culture, autonomous self-motivation and agile, adaptive management response-ability" (Ortiz and Taylor 2008).

At the level of planning and implementing specific capacity development projects, several approaches have been proposed. One attempt is the *Results-oriented approach to capacity development and change (ROACH*). It was launched at the request of the Danish International Development Agency (DANIDA) following their evaluations of capacity development components in existing projects. ROACH stresses these dimensions when embedding interventions into existing structures, enabling ownership and facilitating organisational learning:

- Both functional–rational and political aspects of change must be addressed. Moreover, they must be addressed inside and outside the organisation. Inside, capacity development in a functional–rational sense must ensure that 'the job is getting done', as this is supplemented by 'political' activities, e.g. to force change in internal power relations. Outside the organisation, the capacity development activities of the functional–rational kind will seek to create an 'enabling environment' for the organisation for getting its job done, while political activities will strive to get power relations right and accommodate the interests of stakeholders involved.
- The context of the target organisation is given full consideration, as both factors within the influence of the project and those beyond are identified and addressed (Boesen and Therkildsen 2005).

19.6 Outlook

Mainstreaming of LCA cannot be assumed to be completed as a straightforward and linear process. A conventional sequence of interventions, Transferring tools, building knowledge bases and training professionals, focusing on inputs (e.g. free software) to make the system work, will produce only limited results. *Handing down the torch* to national stakeholders with an ambition to build consensus and long-term knowledge networking needs to be followed up by local processes to integrate the inputs into the specific national and corporate context of environmental management.

In short, a national agenda must target 'home grown', demand-driven specific opportunities for the implementation of LCA according to existing capacities and enabling environment parameters, as determined by the authorities for civil society and the private sector.

Considering the basic North–South asymmetries, specific tasks include the following:

1. Adapting LCA methodology to conditions of developing economies both in terms of life cycle inventory data that are representative of the conditions of the country and impact assessment for regionally relevant impact categories and resource-based impact categories like land use and water use.
2. Strategizing the adoption of LCA in developing countries—at least these capacity constraints and opportunities must be explored: (1) causes of data insufficiency; (2) current constraints in organisational capacity of key stakeholders; (3) types of relationships between actors within the product chain; (4) gaps in institutional capacity of the enabling environment; and (5) strategy options through extensive dialogues with stakeholders.
3. Reconfiguring the relationship between 'sender' and 'recipient' in international development cooperation on LCA:

    a. In relation to government policy, LCA methodologies need to respond to the specific context of developing countries to fully incorporate socio-economic concerns of the private and public sector, and policy makers in developing countries. Also, programmes of action for LCA in developing countries must be strategized to integrate with the current level and scope of environmental management in a given country.
    b. In relation to company practices, research on simplified tools for small producers must be stepped up, and manuals for application must build upon examples relevant to production and services in developing countries. Data representing regional conditions must be made available for both inventory and impact assessment.
    c. In relation to the actors in domestic and export markets, the application of LCA in developing countries must produce immediate and tangible benefits as a contribution to transition towards national objectives of sustainable production and consumption, and as enabling steps to maintain or access positions in global value chains.

Examples of public and private sector actors pioneering such effort within the context of real economic flows of aid, trade and investment, are as follows:

- Joint capacity building at South partner universities facilitating LCA research, teaching, assessment of local products and contributions to a national life cycle inventory database, e.g. as facilitated by the Danish programme 'Building Stronger Universities' (BSU 2016).

- Transnational companies exploring business options for shared value projects targeting improved environmental performance and socio-economic benefits (Porter and Kramer 2011).

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