The extended role of life cycle networks

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Abstract

This paper elaborates on the role of life cycle centers and networks. It shows that networks and centers on life cycle thinking serves many roles in boosting industrial application of life cycle thinking as well as scientific advances, for example as ways of sharing and developing knowledge and resources. However, they also serve as arenas for empowerment, reduction of uncertainties and the building up of trust within and between organizations and institutions. By adding these benefits to the merits of the centers another role for networks emerge: not only as the function of efficient knowledge sharing, but also as catalysts for system innovation. The paper concludes by recommending life cycle networks to discuss their role in system innovation, and experiment with ways of identifying and communicating their impact as system builders.

1 Targeting the main barrier

Collaboration is often argued to be of particular importance in the area of sustainable development, given its multi-dimensional and multi-stakeholder nature, (e.g. Perez-Vico et al. 2014; Camarinha-Matos et al. 2010). Similarly, lack of collaboration between actors is emphasized as a major barrier to further systemic change in many areas related to sustainable development (e.g. Energimyndigheten 2014).

There are many forms of collaboration. Common approaches in the area of life cycle thinking are life cycle networks, centers, roundtables, national and international research programs, standardization committees, industry associations, industry clusters etc. In this paper we will explore the role of formally organized networks and centers with the aim of supporting a life cycle approach and includes, but are not restricted to, members from both the academy and industry, (c.f. Bjørn et al. 2013).

2 Different roles of networks and collaboration

Research on networks and collaboration has different starting points regarding the network's primary role; as an efficient way of using resources to achieve specific results or as a process that leads to empowerment, trust and common understanding.

In a review of literature on sustainability collaborations, Fadeeva (2004) summarizes the most common motivations for collaborative ventures as:

- The provision of mutually accepted solutions (due to the opportunities of creating forums for discussion)
- The delivery of results in a more cost and time efficient way (due to reduced risks and uncertainties and avoidance of potential conflicts)
- The achievement of more innovative results (as a result of the mix of actors with complementing expertise and approaches).

Fadeeva (2004) examine these "beliefs" and conclude that it is most uncertain if collaborative ventures have these effects in general. Lack of incentives, unclear goals and neglected interests are but some reasons for failures. Other drawbacks of collaborations emphasized in the literature includes e.g. that the cost of time and commitment needed for development of trust, common understanding and formal agreements not always meets the benefits of the collaboration. This is especially a risk in complex center organizations and less so in more informal networks. Conflicting goals and time-frames, and the risk of jeopardizing ones role as independent actor may be other shortcomings of formal collaborations, especially for research actors (Perez-Vico et al. 2014.) Another line of research recognizes that "the collaborative process" can have a value in itself, not so much for the concrete results as for the role it fulfils on e.g. empowerment of members (Fadeeva 2004). Benefits following this line of reasoning include common understanding, sense of community and trust (Perez-Vico et al. 2014).

Frankl and Rubik (1998) argues that for successful and effective diffusion of the life cycle approach, collaboration needs to take place both within the single company, upstream and downstream in the life cycle and through collaborations with researchers and practitioners outside companies' value chains. In life cycle networks industry often work together with academia in this respect (Bjørn et al. 2013 even has inclusion of academic institutions as a prerequisite for being an "LCA network"). Such collaborations can have several benefits for both sides.

Musiolik et al. (2012) describes formal networks as "visible organizational structures where firms and other actors come together to achieve common aims". When asked about their motivations for engaging in formal networks and centers, industry see the ability for improving their products and make them better as essential for being part of industry-university collaborations (Stern et al. 2013). However, effect-studies of collaborative research show a higher impact in industry regards strategic guidance than transfer of specific technologies and innovations (Perez-Vico et al. 2014).

Academic bodies benefit on their behalf from industry collaboration. Life cycle networks can facilitate collaborations between researchers among different research organizations (e.g. de Sousa and Barbastefano 2011) and provide an open meeting place to facilitate high quality discussions (e.g. Neu Morén and Hård af Segerstad 2011). Increased understandings of the reality and priorities of industrial and other partners enhance knowledge and inspiration among researchers (Perez-Vico et al. 2014), and the access to industrial environment ease for researchers make case studies (e.g. Bjørn et al. 2013; Baras et al. 2000).

3 LCA and LCM networks and centers

It can be argued that networks and centers are particularly important in life cycle management (LCM), as the concept per se induces changes that involve actors throughout the entire life cycle. Collaborative arrangements are often seen as a suitable approach for sustainable development (Fadeeva 2004), and formal arenas for networks are particularly common in areas involving a range of different actors (Perez-Vico et al. 2014). Collaboration around data is further one of the most essential part to enable implementation of life cycle thinking (Sonnemann and Valdivia 2014), and life cycle centers can facilitate the knowledge and trust needed for this exchange between involved partners (Jacobsson et al. 2014). Many practitioners are also quite alone in their respective organization, and life cycle networks and centers allow for meeting peers from other companies and researchers (Jacobsson et al. 2014), which can strengthen their role and provide opportunities for more aware and apt uses of life cycle assessments (LCA) (Rex and Baumann 2008).

There exists a number of life cycle related networks and centers worldwide and observations show an increasing trend in the formation of LCA networks over time. Bjørn et al. (2013) made a study, which aimed to map and characterize LCA networks, and identified 100 networks, mainly located in Europe and in the USA. In addition, the Life Cycle Initiative shows that networks are also present and established in regions such as Latin America and

Asia (UNEP/SETAC 2015). The common ambition for all studied LCA networks by Bjørn et al (2013) was to act as a platform for facilitating multi-stakeholder cooperation. According to this study, main activities for life cycle networks are knowledge sharing and communication, support of case studies and development of life cycle inventories and impact assessment methods.

Life cycle networks exist in different forms with varying roles and functions. Some exist as National LCI Databases, such as the German Network on Life Cycle Inventory Data and the Australian Life Cycle Inventory Database Initiative (LC Data 2015; AusLCI 2015). One center is identified specific on LCM, New Zealand Life Cycle Management Centre (NZLCM Centre 2015). Most common are the networks working on a LCA scope, such as the Peruvian LCA network and the American Center for LCA (RPCV 2015; ACLCA 2015). The constellation is varying, some are built between research organizations, such as the Central and Southeast Europe LCA Network, and others are built on membership from both research organizations and industry, Columbia University Center for LCA (CASE-LCA Network 2015; CLCA 2015). Networks also exist with involvement also from the society (governmental), such as the Swedish Life Cycle Center (Swedish Life Cycle Center 2015) although involvement of governmental agencies, standardization organizations and environmental NGOs are less common among life cycle networks according to Bjørn et al. (2013).

4 Networks as catalysts in emerging innovation systems

Life cycle networks can be seen as support to practitioners in industry and academy, but they may also have a wider role for society and extend their impact beyond the scope of already engaged actors (e.g. Valdivia et al 2009). In the academic field of transition studies, networks and collaboration has long been recognized as components for societal change (e.g. Markard et al. 2012; Grin et al. 2010). The literature on technological innovation systems, for example, identifies "networks" as one of four structural components of an innovation system, along with technology, institutions and actors (Bergek et al. 2008).

Technological innovation systems can be described as "socio-technical systems focused on the development, diffusion and use of a particular technology" (Bergek et al. 2008 p 408). Technological innovation system analyses are often used to describe the prospects of emerging products or technologies (e.g. Energimyndigheten 2014), but could also be centered on a knowledge field such as LCA (Jacobsson et al. 2014). Sub-processes of an innovation system can be described through a set of functions, as illustrated in Fig. 1.

Jacobsson et al. (2014) shows how actions related to the development of life cycle assessment in Sweden, including those by centers and networks, has had an impact on these functions. Inspired by this study, we have looked for examples globally on how existing life cycle networks may contribute to innovation in terms of these functions.

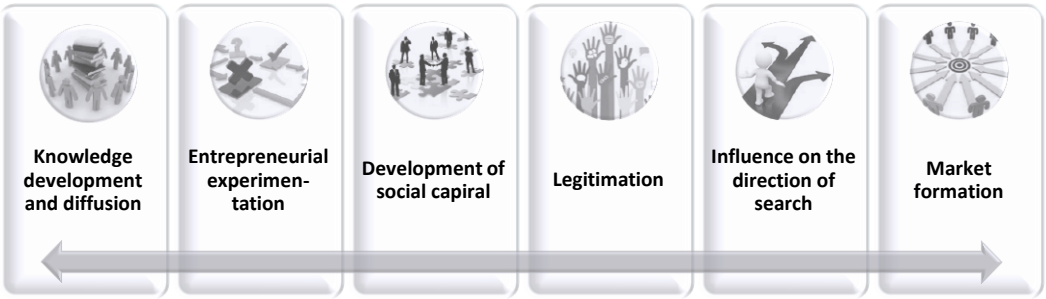

Fig.1: Functions in a technological innovation system. From Bergek in Energimyndigheten, 2014. Authors' translation.

Knowledge development and diffusion is a traditional arena for action among life cycle networks, with the development of methods, tools and database formats, for example. Many centers act as catalysts for industry-academy collaborations with the aim of developing and disseminating new knowledge, one example being CIRAIG that "…aims to develop, interpret and integrate relevant knowledge to operationalize life cycle thinking…" (CIRAIG 2015). Many networks also engage in the hosting of conferences as a means of disseminating results and creating areas for discussion, e.g. Indian Conference on Life Cycle Management, hosted by India LCA Alliance (ILCAA 2015) and The International Conference on Life Cycle Assessment, CILCA, organized every second year by LCA centers in Latin America (Trinidad et al. 2014). Another important way for disseminating knowledge is through the International Journal of Life Cycle Assessment. According to Heinrich (2014), life cycle networks (for example the LCA Society of Japan, Indian Society for LCA, Australian LCA Society) were of high value for the establishment of the journal, both as a body for financial support and as a source for knowledge sharing.

Entrepreneurial experimentation is another major reason for collaborating in the life cycle area expressed for example by UNEP/SETAC Life Cycle Initiative launched in 2002 "…to enable users around the world to put life cycle thinking into effective practice…" (UNEP/SETAC 2015). To act as catalysts for case studies is one action supporting this process, which gives possibilities for pilots and tests (e.g. Bjørn et al. 2013). The provision of data and databases has been another common approach by life cycle networks. Data availability is considered an important prerequisite for industries and other actors to test and use the life cycle concept, and for engaging also people outside of the life cycle community in these activities (Valdivia et al. 2009).

Resource mobilization relates to both financial and human capital. Life cycle networks and centers may attract national and international funding for both research and center activities, including in-kind from participating industries. Collaboration within formal networks also seems to make it easier for participating industries to motivate engagement in associated projects. Mobilization of human capital is another emphasized part of life cycle networks with capacity building identified as a key area for promotion of life cycle thinking in industry and other parts of the society (e.g. Sonnemann and Valdivia 2014; Budak 2015). This mobilization of human and financial capital sometimes also goes hand in hand. The CASE-LCA Network uses co-financing between different universities and government to mobilize human resources

and knowledge sharing (Budak 2015). SKF-Chalmers University Technology Centre for Sustainability is another example, where SKF is funding PhD students in the area of life cycle management, for example (Chalmers 2015).

Examples of actions related to *market formation* could for example include center and network involvement in standardization development. This area is identified by the Swedish Life Cycle Center and by the New Zealand Life Cycle Management Centre (Palander and Hedlund-Åström (2014). both with involvement in International Organization for Standardization and in Environmental Product Declaration.

Legitimation is needed to get acceptance for life cycle thinking and is one core aspect expressed by industry partners for collaborating around life cycle issues. The main benefits of formal network collaboration in this sense seems to be the creation of scientifically based methods and tools, and that tools and practices are developed in broad collaborations across actors to legitimize their use for single industries. These aspects have been particularly highlighted by industry partners of the Swedish Life Cycle centers where for example Hallberg (2014) and Swanström (2014) expressed the value of having a close academic corporation and standing on a scientific base for supporting their companies' environmental work. Since 2011, the Swedish Life Cycle Center also changed their vision to "Credible and applied life cycle thinking globally" as a result of partners identifying credibility as one of the main premises for further spread of the life cycle approach.

Influence on the direction of search and *development of social capital* are functions rarely expressed officially as goals in itself for life cycle networks. Yet these are functions where industry representatives often express their gratitude for the work of life cycle networks in more qualitative evaluations of center activities. The culture of "openness and trust" has been identified as one of the successors of the Swedish Life Cycle Center, for example (Swedish Life Cycle Center 2015). Similarly Budak (2015) note that although agreement, rights and obligations is a prerequisite for networks, the importance of organizing meetings at different locations among partners has been a key in the CASE-LCA Network. Hallberg (2014) and Ström (2014) identifies the ability to benchmark among and together with other companies within the networks as a very important feature providing support in their own decision making processes. This is used both to motivate joint research projects and to raise issues on each companies' own agenda. A similar benchmark may also be of value for governmental organizations, one example being the Swedish Environmental Protection Agency finding collaboration within the Swedish Life Cycle Center as an important pool of competence to draw on in policy processes (Jacobsson et al. 2014).

The presentation above provide just a few examples and should not be regarded a comprehensive overview. Yet it shows how the act of life cycle networks may impact all identified sub-processes of innovation systems. Knowledge development and diffusion and entrepreneurial experimentation seems to be at the center of many life cycle network activities, with lot of focus on developing methods and tools, and supporting the range of practitioners worldwide. Although the focus on knowledge diffusion seems to be strong within the life cycle community, examples of such activities outside of the community has been harder to find. Resource mobilization and market formation are other areas commonly addressed by life cycle networks, yet with more unclear outcomes. Closer involvement and

collaboration with NGOs, governmental organizations and standardization organizations may further strengthen the impact in these areas.

Contribution to legitimation, development of social capital and influence on the direction of search are less tangible but not least important outcomes of life cycle networks. These effects are seldom explicitly stated in goals and visions, and they are harder to measure and follow up. Yet, they tend to be emphasized by industry representatives in more ad hoc and qualitative surveys of why they engage in life cycle centers. Given the social and institutional nature of these functions, closer collaborations with societal institutions, NGOs and governmental organizations would probably increase the ability of life cycle networks to further strengthen these sub-processes of innovation.

5 Life cycle networks as platforms for innovations

Networks can be seen not only as a resource efficient way to achieve results, but also as having "a crucial role in the formation of technological innovation systems" (Musiolik et al. 2012 p 1032). In the area of life cycle thinking, life cycle networks has been argued to not only support but even be an essential part in the transition towards more sustainable consumption and production patterns, not least in developing economies (Valdivia et al. 2009; Bjørn et al. 2013).

Musiolik et al. (2012) conclude that the role of networks primarily has been considered as facilitators of knowledge exchange and, possibly, as means to expand the resource base of individual firms. However, formal networks could also be seen as a source of agency per se, capable of accumulating resources, pursuing strategies and contributing to building innovation systems. Aspects of an innovation system that formal networks particularly can contribute with are trust, common understanding, joint knowledge, power and reputation (Musiolik et al. 2012).

Our list of examples from existing life cycle networks show that many centers already take action to strengthen important sub-processes of innovation systems. Following the above, we suggest that life cycle networks are not only means to boost industrial applications and scientific advances, but also (could) act as broader platforms for innovation.

6 Conclusions and recommendations

This paper shows that networks and centers on life cycle thinking serves many roles, as ways of sharing and developing knowledge and resources, as well as arenas for exchange of experiences and the building up of commitment and trust. It also shows that life cycle networks potentially could develop in their role as system builders more broadly. A more deliberate focus on strengthening system functions might widen the scope and impact of life cycle networks, for example through joint and strategic actions to enhance legitimacy, develop social capital and guide the direction of search of related stakeholders.

The role of life cycle networks in building capacity, competence and joint understandings contribute for example to reduce uncertainty and ambiguity among the practitioners in industry as well as in academy and governmental organizations. This is an important contribution to the development of innovation systems in general and of life cycle management in particular. It is often recognized as a benefit by the network members, but its direct value is often hard to measure or expose to funding bodies.

It is our experience that tangible and measurable results are requested from direct and indirect funding bodies such as funding agencies and top managers of participating industry. Measuring the wide scope of effects of collaboration is however not an easy task. Perez-Vico et al. (2014) points to a range of challenges, including that they are subtle, interconnected, context-, actor- and time dependent. We welcome further research on the role and effects of life cycle networks on society at large, as well as how these effects can be made more explicit for stakeholders within existing life cycle networks and beyond. We would also like to encourage life cycle networks to discuss their role as system builders over and above the ambition to assist direct stakeholders, and to experiment with ways of identifying and communicating their impact on society as large.

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