This paper was presented at The 6th ISPIM Innovation Symposium – Innovation in the Asian Century, in Melbourne, Australia on 8-11 December 2013. The publication is available to ISPIM members at www.ispim.org.

Future pathways for radical transformation of an industry sector: the case of South Australian cellulosic fibre value chain

Mikko Dufva*, Toni Ahlqvist, John Kettle, Nafty Vanderhoek, Ville Valovirta, Torsti Loikkanen

VTT Technical Research Centre of Finland, P.O. Box 1000, FI-02044 VTT, Finland.
E-mail: mikko.dufva@vtt.fi

Göran Roos

University of Adelaide, South Australia.

Abstract: Globalisation, rapid technological change, shifts in customer values and other developments create a need for the constant renewal of companies and industry sectors. However, current approaches applied in the study of industrial transformation and renewal do not usually grasp the interactions between the local industrial dynamics and emerging transitions with an adequate clarity or lack a strategic future-orientation. To overcome these challenges, we propose a systematic and integrated approach for creating transformation pathways for a local industry sector in need of renewal. Our approach combines multi-criteria assessment of companies, development of future value networks and strategic roadmapping in a comprehensive framework. Based on a case study we conclude that the approach helped to broaden the horizon and bridge local competences to global developments, but further research is needed in the better integration of the methods.

Keywords: Industry renewal; foresight; roadmapping; value networks; multicriteria assessment; methodological framework

1 Introduction

The operational environment of manufacturing industries is constantly changing: global competition poses new challenges, customers' values and needs change, and developments in technology present new opportunities and threats for existing businesses. This continuous dynamic creates an imperative for companies, and indeed entire industry sectors, to be cognisant of the constant cycle of adaptation and renewal.

However, the renewal requires resources for the exploration of opportunities and the capacities for acting on the basis of the insights gained (March, 1991). The basic problematic of the renewal is that companies may prefer business as usual and disregard emerging signals of threats or opportunities, particularly if the identified challenges are

perceived as too distant, either temporally or cognitively. Why change, when the current business is doing fine?

Operational mode is problematic for companies, especially if the presumed relevance of some factors proves to be incorrect or if a sudden non-identified disruptive phenomenon changes the game radically. The required radical transformation might be hindered by a number of factors; resistance to change due to a fixed habit of doing things the traditional ways (lock in), lack of insight due to misapprehension of future possibilities (myopia) and lack of a culture of cooperation required for direction identification and allocation of resources for renewal (leadership in a silo).

The challenge has become more urgent as a result of globalisation and the increasing pace of technological development. As a generalisation, the main approaches currently applied in the study of industrial transformation and renewal focus on three levels: (1) the level of innovation systems, (2) the level of state-regional nexus, and (3) the level of companies. The innovation systems level includes, for example, national, regional, sectorial and technological innovation systems (e.g. Lundvall, 1992; Cooke et al., 1997; Hekkert et al., 2007). The research approaches usually focus on the structure and dynamics of the systems, for example through lenses of industry, research and government actors. A related approach is transition management (e.g. Geels, 2002), which scrutinises the transformation of socio-technical regimes. The approaches at the level of state-region nexus focus mainly on the initiatives led by the state and implemented in the regions, such as regional foresight (e.g. Uotila et al., 2005), smart specialization strategies and different cluster strategies (e.g. Rosenfeld, 2002). The company level approaches include strategic management and foresight (e.g. Rohrbeck, 2011), vision building and setting, and technology roadmapping (e.g. Phaal et al., 2004).

There are two challenges with the above mentioned approaches; namely a gap between the micro and system levels, and a deficiency in strategic futures perspectives, including actions to bridge this gap. The approaches do not usually grasp the interactions between the micro-level, the local industrial experience and the local specific dynamics of the companies, and the system-level, the meta-level emerging transitions, with an adequate clarity. The second shortcoming is the resulting deficiency to bridge the gap through strategic future-orientation. The suggested approaches may lack a systematic assessment of the current capabilities and be more driven by political hope than strategic vision. Innovation system approaches often focus on analysing the problems of the present and do not explicitly consider future options (for an exception to this rule, see Ahlqvist et al., 2012). Strategic foresight could provide long-term views, but might focus on too narrow a subject (e.g. specific technology), which prohibits thinking "outside the square". In addition, technology roadmapping could be realised in a too normative and narrow a fashion.

This paper reflects on the creation of future pathways for a traditional and regionally embedded industry sector that is in need of radical transformation and the novel methodological solutions that could be developed for this purpose. We propose a systematic and integrated approach for creating transformation pathways for a local industry sector in need of renewal. Our approach combines multi-criteria assessment of companies, development of future value networks and strategic roadmapping in a comprehensive framework. We focus both on the micro-level of the companies and the system level of the sector, analysing the capabilities and interconnections of the companies. We also take into account the external landscape level pressures. Thus by using the framework we are able to analyse the current state and capabilities, create and

analyse different structures for the industry, explore future possibilities from technological, political and market perspectives and create pathways to reach different desirable futures.

2 Theoretical background

Our methodological framework is based on three widely used methods: roadmapping, value network analysis and multi-criteria assessment. While roadmapping provides the backbone of our framework, we supplement it with the other methods. In this section we give the theoretical background of these methods. The overall methodological framework is described in more detail in section 4.

Foresight and roadmapping

Foresight is an ability, a process and a set of tools to anticipate future developments, manage uncertainty and come up with responses to identified future challenges (see e.g. Rohrbeck, 2011; Slaughter, 1997; Miles et al., 2008). It is used in identifying opportunities and challenges, exploring alternative futures, gaining a better understanding of the current situation and its development and creating strategies and plans for coping with changing environment (Martin, 1995; Rohrbeck and Schwarz, 2013; Day and Schoemaker, 2004). In the context of strategic management, foresight contributes to different value creation forms (Rohrbeck, 2012, p. 441) and it has also been deployed to develop new business fields for companies (e.g. Heger and Rohrbeck, 2012; Rohrbeck et al., 2013; Battistella et al., 2012; Kraatz et al., 2012).

A popular method in foresight, used especially in the industry for strategy development, is roadmapping (Kerr et al., 2012). Roadmapping is both the iterative process of crafting a strategy as well as the end result captured in a visual presentation. It combines different modes of knowledge with specific activity layers (Phaal et al., 2004; Kostoff and Schaller, 2001). Roadmaps are tools for the combination of organisational knowledge that may be 'unlinkable' with other strategic methods (see e.g Petrick and Echols, 2004).

It is possible to make a distinction between two roadmapping cultures. First is the culture of technology in which the roadmapping is approached as a normative instrument to identify relevant emerging technologies and to align them with explicit product plans and related action steps (see e.g Phaal et al., 2001). Second is the emerging culture of strategy roadmapping which is perceived as a more dynamic and iterative process that produces weighed crystallisations, usually in a visual form, of an organisation's long-term vision, and short to medium term strategies to realise this vision. This methodology is called process-based or strategic roadmapping. It is based on an idea that roadmaps are like visual narratives describing the most critical paths of future developments (Phaal and Muller, 2009). This visual emphasis enables the use of roadmaps as crystallised strategy charts that open simultaneous perspectives both on macro-level currents and micro-level developments (see Blackwell et al., 2008).

Roadmapping, especially in its strategic form, is an adaptive process-based methodology well suited for systemic contexts (see Ahlqvist et al., 2012): its visual format enables the transparent formulation of visions with explicit linkages across the

temporal spectrum (present, medium term, and long term) and roadmap layers (such as drivers, markets, and enabling technologies).

However, there are challenges when applying roadmapping in the context of a regional industry sector. The first is the tension between the local and the global, which roadmapping does not explicitly address. There is a risk that roadmaps focus too much on the local present situation and therefore are not able to create a compelling picture of a radically different desired future and the path towards it. On the other hand, focusing only on the global developments and available technology may lead to the results being unconnected from the reality of the region. Therefore it might be useful to distinguish explicitly between the local situation and the global state-of-the-art.

The second, related challenge is that roadmaps are seldom able to capture the dynamics of the actors in the region. This is usually postponed to the more detailed action planning phase that is based on the roadmapping. However, understanding the actors, their interactions and the value creation dynamics might be useful already when exploring the strategic pathways or the desired future.

Value networks

Value network analysis is widely used in describing the value creation dynamics and the interactions between the actors in an industry sector. Value networks consist of organisations that cooperate with each other to benefit all network members (Valkokari et al., 2011). Value network describes the competitive environment: the power structures, alliances and conflicts (Heger and Rohrbeck, 2012). Value network analysis aims at generating a comprehensive picture of how value is generated in the network (Peppard and Rylander, 2006). The main focus is on the present situation, although it has been applied in exploring possible future value chains (e.g. Ahokangas et al., 2012; Wessberg et al., 2013). The analysis focuses on the roles or functions of the nodes of the network (e.g. saw mills) and not in specific organisations; therefore it does not explicitly assess the competences of individual companies.

Multi-criteria assessment

In our framework the assessment of companies is based on Multi-Criteria Decision Analysis (e.g. Belton and Stewart, 2002) and especially Multi-Attribute Value Theory (e.g. Keeney, 1993) whilst adhering to the fundamental requirements of measurement theory (Roos and Pike, 2007). The basic idea behind this approach is to include multiple criteria, which are weighted according to their relative importance. Different alternatives, or in our case companies, are evaluated with respect to each criterion. The result is an overall value for each alternative, which reflect both the performance of the company against each criterion as well as the relative importance of the criteria expressed in the weights. Assuming that the attributes are mutually and preferentially independent (Keeney, 1993), the overall values can be calculated by using an additive value function.

There are three main aspects in the assessment: criteria, scores and weights. The criteria give the framing for the assessment and determine what is taken into account. Scores represent the performance of the companies against the criteria. Finally the weights represent the viewpoint taken in the assessment in that they determine what is deemed most important, and how important are other criteria relative to the most important one.

3 Description of the case study and its methodology

The proposed approach and framework is based on the South Australian Cellulosic Value Chain Technology Roadmap project conducted in 2012 and 2013 in the Limestone Coast region, South Australia, which forms part of wider region known as the Green Triangle. The forest and wood products industry and associated value chain, along with many other Australian manufacturing industries, have experienced a very difficult decade, peaking in recent times from the exceptional circumstances created by the global financial crisis and increased globalisation. These developments, coupled with internal factors such as a lack of re-investment, aging equipment and poor management decisions, have resulted in a significant reduction in industry profitability and a loss of employment opportunities that have combined to create an atmosphere of doom and gloom.

The forest and wood products industry in the Green Triangle region was at the start of the project highly challenged and even, according to some, in a state of crisis. Several company closures and the transforming situation in the forest resource have left the region in an uncertain state. The forest sector thus needs actions to boost and renew the industry to a new level (see also Kettle et al., 2012). The objective of the project was to provide the region with the information that would allow such a transition to take place. The project was funded by Department of Manufacturing, Innovation, Trade, Resources and Energy (DMITRE) and led by VTT Technical Research Centre of Finland.

The aim of the project was two-fold; to develop a roadmap describing how to make the practices of the forest-based industry more efficient, both in the short and long-term, and to identify companies interested in locating to the region. The project included 23 interviews with local Australian companies, 6 steering group meetings and 3 workshops, where technology experts in forestry, biotechnology and cellulosic fibre industries crafted strategic technology roadmaps for the region. The interviews were the main data source used in analysing the current local situation. To better understand the global as well as the national and regional context, an extensive literature review of over 600 sources was conducted. The workshops were held to identify the emerging technologies, markets and opportunities. The steering group gave feedback on the results on a monthly basis.

4 Methodological framework for creating transformation pathways

The methodological framework developed in the project is based on two dimensions. The first dimension is the level of analysis, and the second one is the temporal-spatial scale. Together these describe the focus points of the approach and aid in positioning the goals of the methods used. We first describe the two dimensions and then the overall framework with the suggested methods.

Levels of analysis: functional layers

To assess the companies in regional industry system we defined three functional layers (figure 1) based on the layers in roadmapping and the levels in the Multi-Level Perspective (MLP) (Geels, 2002). The functional layers describe the key functions of the company in the context of drivers. These layers were also the basis for our methodological framework. The first layer is the core functions that gather the most elemental issues for a (forest) company. The core functions are divided into raw material and resources, key products and customers, skills and human capital, and cost structure

and finances. This layer is focused specifically to assess the key business processes of the company.

The second layer is the transformation functions. This layer aspires to raise two crucial insights for this project: firstly, it aims at assessing the capacity of the company to transform and renew, and, secondly, it endeavours to identify the core components required for the regional transformation of the forest industry in South Australia. The first component is innovation and renewal that focuses on the potential of the company in innovation-fostering activities and, through these, the renewal. The second component is networking and collaboration that aims at identifying the capacity of the company to form linkages and in finding useful channels for the development of its business. The third component is business management and strategy that aims at recognising the company's capacity in strategy crafting and in constructing and realising feasible targets for the future business development. The fourth component is technological capabilities, which is used for evaluating the company's competencies in adoption of new production technologies and technology sourcing.

The third layer is called context functions. This layer consists of drivers in operational environment at the regional (Green Triangle region), national (Australia) and global levels. The aim of this layer is to understand, on the one hand, how the company is embedded in the regional structure and, on the other, how the company perceives the possibilities to exploit key drivers of change in national and global domains. The drivers were analysed in six categories: industrial, cultural, environmental, financial, regulation, and R&D.

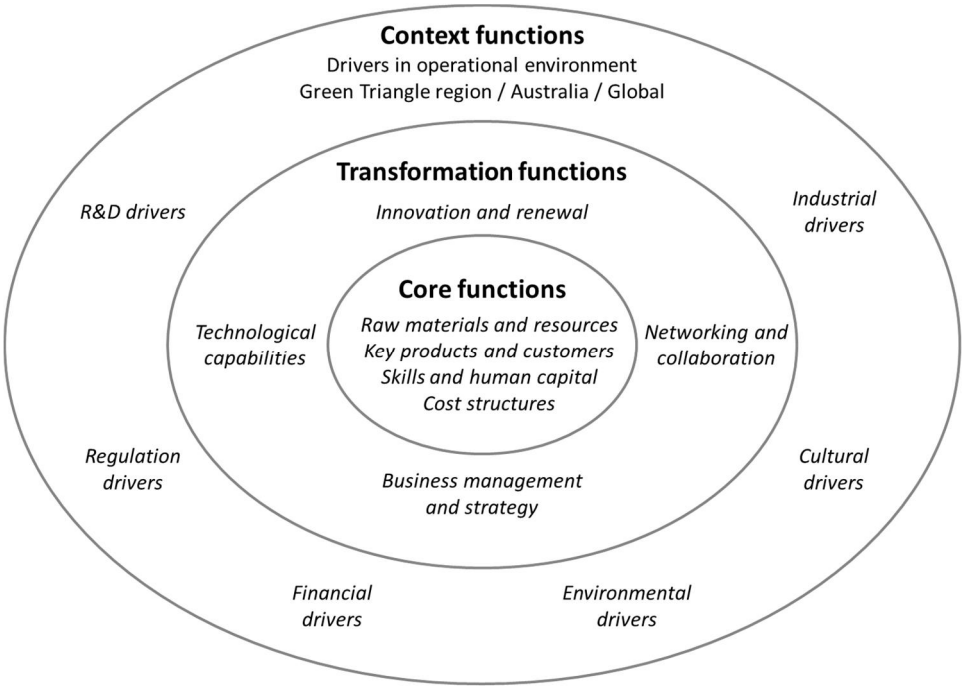

Figure 1. Functional layers used in the assessment of the companies

Since these three layers were based on the layers used in roadmapping and the levels of MLP, there are obvious similarities. The layer of the context functions is analogous to the

landscape level of the MLP and to the layer of drivers in roadmapping. It describes the external changes and pressures that affect the local industry. The second layer of transformation functions differs somewhat from the markets/products level of roadmapping, in that it is more focused on the change capabilities of the system. It is closer to the description of regime change in the MLP. However, the main point is that the focus is on the system in contrast to its components or environment. The layer of core functions is on the other hand more similar to the roadmapping level of technology and knowledge, in that it focuses on the basic elements of the system. The niche level of MLP emphasizes the protected spaces for experimentation and new innovations, which is an important point in our methodological framework also, but not a key focus.

Temporal-spatial scale

In addition to the levels of analysis, there are two important dimensions to consider: time and space. The time dimension is explicitly defined in roadmapping, and the developments in in e.g. technology and markets are put into a time scale. A commonly used time scale ranges from the present to the desired long-term future with one intermediate step. The spatial dimension, on the other hand, is not explicitly considered. However, it becomes especially important in the case of a regional sector behind the global developments, because in that case there is a clear mismatch between the local present situation and the global state-of-the-art. The challenge then becomes to map a path through the state-of-the-art and further into the desired future state.

We thus define a temporal-spatial scale with three ”steps” in our methodological framework: the local present situation, the global state-of-the-art and the local desired future embedded in the global context. The local present situation focuses on the competences, knowledge, technology, markets, networks and interactions in the region at the moment. It represents the starting point with the local historical burdens. The state-of-the-art on the other hand focuses on the leading edge technology, global market situation and opportunities, top knowledge centres and global networks. It represents the “external world” with which the regional industry has to cooperate and compete in order to survive.

Aiming only at the state-of-the-art would lead to an endless catching up, to “skating where the puck is, not where it will be”. It would also disregard the local special characteristics. Therefore the aim should be further in the future, in a vision of the regional industry, specialised and prospering in the global economy. This vision is based on both the local present situation and the global state-of-the-art but goes beyond them.

Positioning methods in the framework

Combining the levels of analysis and the temporal-spatial scale leads to a matrix of the focus points of the framework (figure 2). There are two interdependent narratives in the framework: 1) Finding a path from the present situation through the global state-of-the-art to a locally compelling and desirable future state, and 2) Taking into account the regional competences and resources and the global pressures in the transformation. The first narrative goes from assessing the present situation to creating a vision for the desired future and then mapping ways to get there. The second narrative supplements the first one in each of the steps: exploring the current perception of the global landscape and systematically identifying the local competences, reflecting the local vision against global scenarios, and exploring global drivers as well as emerging technologies.

This paper was presented at The 6th ISPIM Innovation Symposium – Innovation in the Asian Century, in Melbourne, Australia on 8-11 December 2013. The publication is available to ISPIM members at www.ispim.org.

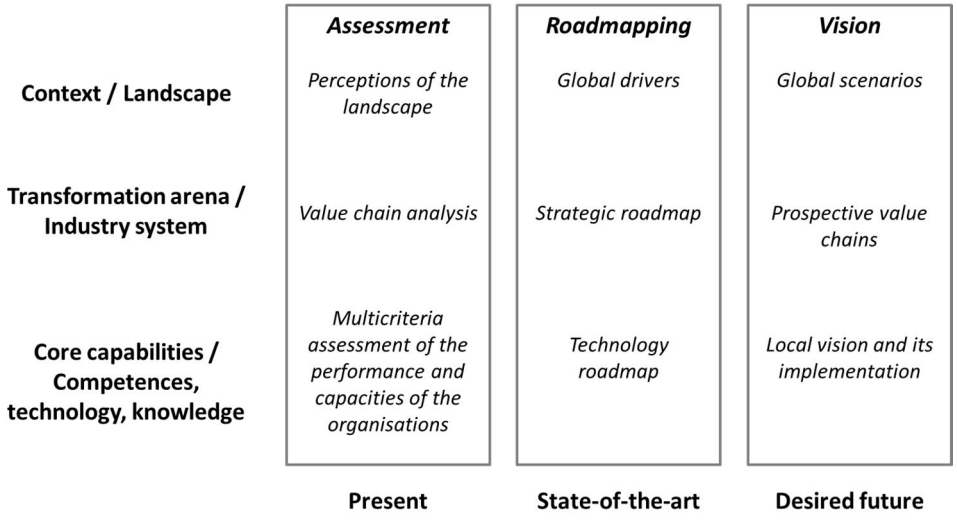

Figure 2. Methodological framework

In line with these narratives, we have roughly divided the methods into three sections: assessment, roadmapping and vision. In practice the boundaries between the methods are of course not as clear as this. The assessment consists of exploring the perceptions about the global landscape and context in the region by e.g. interviews, modelling the current system using value chain analysis and understanding the current competences and performance of the companies using multi-criteria assessment. The roadmapping methods include exploring the relevant global drivers by e.g. doing a literature review, creating a technology roadmap of the state-of-the-art and emerging technologies to see where the technical development is heading and doing a strategic roadmap to integrate these both to a crystallised picture of the current developments in markets, solutions and technologies. The vision methods aim to create a set of compelling images of the possible future directions for the region by reflecting global scenarios to the local context, creating prospective value chain description based on the value chain analysis and enabling the discussions of a common local vision.

Implementation of the methodological framework in the project

The process used in the South Australian Cellulosic Value Chain Technology Roadmap project can be simplified to three main phases: company assessment (steps 1 and 2 in figure 3), value network analysis (steps 3 to 5 in figure 3) and roadmapping (steps 6 to 8 in figure 3). As can be seen from figure 3, the process meanders across both axis, which illustrates the reflection between the global context and the local situation. We present the process as a sequence of methods, although in reality it was far more iterative and overlapping.

The first phase of the project focussed on the assessment of the current companies. To that end extensive interviews were carried out and the performance of the companies was assessed according to the functions presented in figure 1 (Ahlqvist et al., 2013). The next phase was the value network analysis, based also on the interviews. To map prospective

value networks, the current situation was reflected against four scenarios on the future of the forest sector, found in the literature. We called these scenarios “lenses”, since they provide a perspective into four different research frontiers in the industry. The final phase was the roadmapping, which started with an extensive literature review to identify key global drivers. These were used as background material in an expert workshop focused on creating different technology roadmaps based on the four scenario lenses. The technology roadmap and literature review was then used, along with patent analysis and feasibility studies, to create strategic pathways to alternative futures. All these results were then integrated into a recommendation report (Ahlqvist et al., 2013).

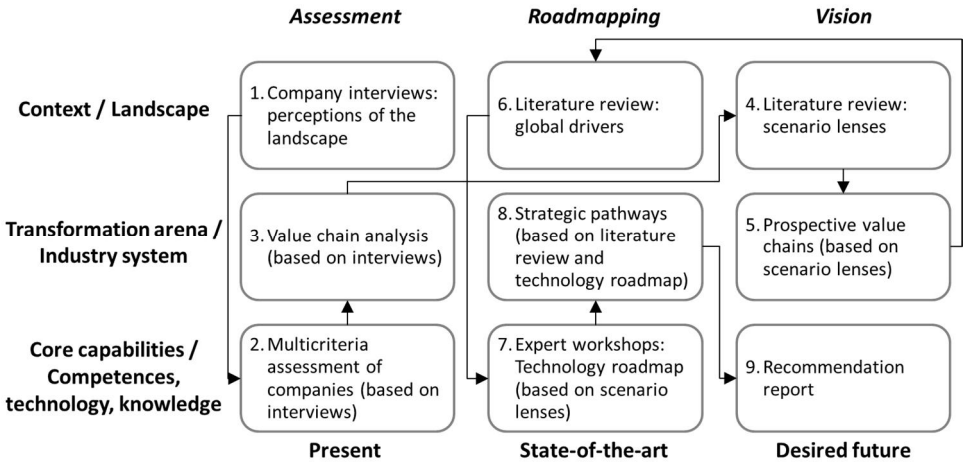

Figure 3. Project process presented in the methodological framework

5 Discussion and conclusions

The methodological framework presented in the section 4 shows one way of combining roadmapping, value network analysis and multi-criteria assessment. These three methods complement each other in the context of creating future pathways for a radical transformation of an industry sector: The roadmapping describes the pathways and the big picture, the present and prospective value networks describe the dynamics between key stakeholder groups in the industry system and the results of the multi-criteria assessment provide a better understanding of the competences of the current actors. Taken separately, these methods would only provide a partial understanding of what is required to renew the sector. For example, the multi-criteria assessment gives an overview of the competences and capabilities the local industry sector has, but does not describe the dynamics and interactions between the actors or provide a future-oriented plan for improving the situation. On the other hand, roadmapping by itself would not give a concise and deep understanding of what is needed in the region to implement the pathways described.

When implementing the methodological framework in the South Australian Cellulosic Value Chain Technology Roadmap project, the main challenge was how to use the prospective value networks in the roadmapping. Both roadmapping and the

prospective value networks had the common starting point of scenario lenses, and illustrated the situation from different angles. However, they ended up being rather separate exercises, and the prospective value networks were not used in the roadmapping. One way to overcome this might have been a workshop, where the technology roadmaps would have been reflected against the dynamics of the value networks by the local stakeholders. However, this was beyond the scope of the project.

Even though the methodological framework is developed to integrate multi-criteria assessment, value network analysis and roadmapping, it is not restricted to only these three methods. The main goal of the framework is to provide a systematic approach to considering both the local situation and the global context both in the present and in the future. The levels or functions described in figure 1 can be used in assessing the renewal capacity of an industry. Likewise the temporal-spatial scale can be used in roadmapping to map pathways from the local situation to a desired future taking into consideration the global state-of-the-art and its development.

The process used in the project differs from conventional strategic planning in that it starts from assessment and ends in visions of alternative futures, not vice versa. The process can be described as an iterative horizon widening approach. The assessment frame used, especially the transformation functions, oriented the perspectives of the current situation towards the capacities to transform. It also positioned the local situation to the global context. The value network analysis, on the other hand, provided an illustration of the local industry system, its dynamics and interactions with the global system, implying the needs and benefits of cooperation between the actors in the region. Thus it widened the boundaries of the system from the region to the global competitive environment. The prospective value networks illustrated possible changes in the interactions and the role of the actors. The scenario lenses, technology roadmap and literature review explored the current research frontiers of the industry sector. As these were reflected back to the regional context, the plurality of futures became more understandable. The decision on which direction to take was left to the regional actors; the recommendations described the pros and cons of different pathways. Each step of the process further widened the horizon, but not with a push from the researchers but in interaction with the local stakeholders.

Since the approach was assessment driven in contrast to vision driven, the discussions on the desired future were to a large extent left to the end of the process, and are still on-going. The outcomes of the process describe possible transformation pathways and the resources needed to implement them. These need to be discussed with the local stakeholders with the aim of building a shared vision and commitment to implementing it. These discussions fell to a large degree outside the scope of the project, but they are an essential part of the methodological framework.

As the project was commissioned by the South Australian government, the methodological framework is linked to supporting state-level and regional decision making. The results of the project are meant to aid policy makers in the creation of a future-oriented strategic agenda for the region to find ways to enhance the competitiveness of the forest sector in the region. In this sense our approach can be seen to “catalyse policymaking”.

During the project there has been a re-organisation of the key actors. This new positioning may lead to a conflict over whose vision is implemented. It can be speculated that this is linked to the regional government issuing a project on the future of the industry; the local actors in the industry do not want to give the decision on the future or

the formulation of the alternatives to the government. A key lesson regarding the methodological frame is that participation in each phase as well as the consideration of the local political culture is important. The project already aimed to build the basis for cooperation via the interviews and local meetings, but the emphasis was perhaps more on consulting and involving than collaborating and empowering (cf. IAP2, International Association for Public Participation, 2007).

The proposed methodological framework provides a first step in finding the linkages between roadmapping, value network analysis and multi-criteria assessment and using them to create transformation pathways for an industry sector. Further research directions include how to use the insights on the dynamics presented in value networks in roadmapping and how to use multi-criteria assessment in the creation and prioritizing of the roadmap paths.

Acknowledgements

The authors would like to thank the State Government of South Australia, Commonwealth Govt DIICCSRTE, the Department for Manufacturing, Innovation, Trade, Resources and Energy (DMITRE), Regional Development Australia Limestone Coast Inc, and PIRSA for their assistance and contributions in The South Australian Cellulosic Value Chain Technology Roadmap project.

Financial support from VTT Graduate School is acknowledged (Mikko Dufva).

References

Ahlqvist, T., Kettle, J., Hytönen, E., Niemelä, K., Kivimaa, A., Vanderhoek, N., Dufva, M., Mäkinen, T., Kurkela, E. & Valovirta, V. 2013, *South Australian cellulosic value chain technology roadmap, stage 2. Future options for the cellulosic fibre value chain in the Green Triangle, South Australia: strategic technology roadmaps, business cases and policy recommendations*, VTT Technical Research Centre of Finland.

Ahlqvist, T., Valovirta, V. & Loikkanen, T. 2012, "Innovation policy roadmapping as a systemic instrument for forward-looking policy design", *Science and Public Policy*, vol. 39, no. 2, pp. 178-190.

Ahlqvist, T., Vanderhoek, N., Dufva, M., Kettle, J., Valovirta, V., Kivimaa, A. & Loikkanen, T. 2013, *South Australian cellulosic value chain technology roadmap, stage 1. Assessment of the present state and future potential of forest industry in Mt Gambier region, South Australia*, VTT Technical Research Centre of Finland.

Ahokangas, P., Matinmikko, M., Myllykoski, J. & Okkonen, H. 2012, "Future scenarios, ecosystems and business models for cognitive radio systems", *Future*, vol. 5, pp. 5.

Battistella, C., Colucci, K., De Toni, A.F. & Nonino, F. 2012, "Methodology of business ecosystems network analysis: A case study in Telecom Italia Future Centre", *Technological Forecasting and Social Change*, .

This paper was presented at The 6th ISPIM Innovation Symposium – Innovation in the Asian Century, in Melbourne, Australia on 8-11 December 2013. The publication is available to ISPIM members at www.ispim.org.

Belton, V. & Stewart, T.J. 2002, *Multiple criteria decision analysis: an integrated approach*, Springer.

Blackwell, A.F., Phaal, R., Eppler, M. & Crilly, N. 2008, "Strategy roadmaps: new forms, new practices" in *Diagrammatic Representation and Inference* Springer, , pp. 127-140.

Cooke, P., Gomez Uranga, M. & Etxebarria, G. 1997, "Regional innovation systems: Institutional and organisational dimensions", *Research policy*, vol. 26, no. 4, pp. 475-491.

Day, G.S. & Schoemaker, P.J. 2004, "Driving through the fog: managing at the edge", *Long range planning*, vol. 37, no. 2, pp. 127-142.

Geels, F.W. 2002, "Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study", *Research policy*, vol. 31, no. 8, pp. 1257-1274.

Heger, T. & Rohrbeck, R. 2012, "Strategic foresight for collaborative exploration of new business fields", *Technological Forecasting and Social Change*, vol. 79, no. 5, pp. 819-831.

Hekkert, M.P., Suurs, R.A., Negro, S.O., Kuhlmann, S. & Smits, R. 2007, "Functions of innovation systems: A new approach for analysing technological change", *Technological Forecasting and Social Change*, vol. 74, no. 4, pp. 413-432.

IAP2, International Association for Public Participation 2007, *IAP2 public participation spectrum.* http://www.iap2.org/associations/4748/files/IAP2%20Spectrum_vertical.pdf [2013, 10/9].

Keeney, R.L. 1993, *Decisions with multiple objectives: preferences and value trade-offs*, Cambridge University Press.

Kerr, C., Phaal, R. & Probert, D. 2012, "Cogitate, articulate, communicate: The psychosocial reality of technology roadmapping and roadmaps", *R&D Management*, vol. 42, no. 1, pp. 1-13.

Kettle, J., Roos, G., Vanderhoek, N., Harlin, A. & Allender, B. 2012, "Is the Australian pulp and paper industry still at the crossroads?", *66th Appita Annual Conference and Exhibition, Melbourne, Australia, April 2012.*Appita, , pp. 222.

Kostoff, R.N. & Schaller, R.R. 2001, "Science and technology roadmaps", *Engineering Management, IEEE Transactions on*, vol. 48, no. 2, pp. 132-143.

Kraatz, J.A., Hampson, K.D., Voros, J., Roos, G., Hayward, P., Parker, R., Bok, B., Campana, J., Chi, S. & Lehtiranta, L. 2012, "*Leveraging R&D Investment for the Australian Built Environment: Industry Report*", Australia's Sustainable Built Environment National Research Centre (SBEnrc), December 2012.

Lundvall, B. 1992, "*National innovation system: towards a theory of innovation and interactive learning*", Pinter, London.

March, J.G. 1991, "Exploration and exploitation in organizational learning", *Organization science*, vol. 2, no. 1, pp. 71-87.

Martin, B.R. 1995, "Foresight in science and technology", *Technology Analysis & Strategic Management*, vol. 7, no. 2, pp. 139-168.

Miles, I., Harper, J.C., Georghiou, L., Keenan, M. & Popper, R. 2008, "The many faces of foresight" in *The handbook of technology foresight*, eds. L. Georghiou, J.C. Harper, M. Keenan, I. Miles & R. Popper, Edward Elgar Publishing Limited, Massachusetts, USA, pp. 3-43.

Peppard, J. & Rylander, A. 2006, "From value chain to value network: Insights for mobile operators", *European Management Journal*, vol. 24, no. 2, pp. 128-141.

Petrick, I.J. & Echols, A.E. 2004, "Technology roadmapping in review: A tool for making sustainable new product development decisions", *Technological Forecasting and Social Change*, vol. 71, no. 1, pp. 81-100.

Phaal, R., Farrukh, C.J. & Probert, D.R. 2004, "Technology roadmapping—a planning framework for evolution and revolution", *Technological forecasting and social change*, vol. 71, no. 1, pp. 5-26.

Phaal, R., Farrukh, C. & Probert, D. 2001, "Technology Roadmapping: linking technology resources to business objectives", *Centre for Technology Management, University of Cambridge*, , pp. 1-18.

Phaal, R. & Muller, G. 2009, "An architectural framework for roadmapping: Towards visual strategy", *Technological Forecasting and Social Change*, vol. 76, no. 1, pp. 39-49.

Rohrbeck, R. 2012, "Exploring value creation from corporate-foresight activities", *Futures*, vol. 44, no. 5, pp. 440-452.

Rohrbeck, R. 2011, *Corporate foresight*, Springer.

Rohrbeck, R., Konnertz, L. & Knab, S. 2013, "Collaborative business modelling for systemic and sustainable innovations", *International Journal of Technology Management, Forthcoming*, .

Rohrbeck, R. & Schwarz, J.O. 2013, "The value contribution of strategic foresight: Insights from an empirical study of large European companies", *Technological Forecasting and Social Change*, .

This paper was presented at The 6th ISPIM Innovation Symposium – Innovation in the Asian Century, in Melbourne, Australia on 8-11 December 2013. The publication is available to ISPIM members at www.ispim.org.

Roos, G. & Pike, S. 2007, "The validity of measurement frameworks: measurement theory" in *Business Performance Measurement; Unifying Theory and Integrating Practice*, ed. A. Neely, 2nd Edition edn, Cambridge University Press, , pp. 218-236.

Rosenfeld, S.A. 2002, "Creating smart systems: A guide to cluster strategies in less favoured regions", *Regional Technology Strategies*, vol. 6.

Slaughter, R.A. 1997, "Developing and applying strategic foresight", *ABN Report*, vol. 5, no. 10, pp. 13-27.

Uotila, T., Melkas, H. & Harmaakorpi, V. 2005, "Incorporating futures research into regional knowledge creation and management", *Futures*, vol. 37, no. 8, pp. 849-866.

Valkokari, K., Kansola, M. & Valjakka, T. 2011, "Towards collaborative smart supply chains? capabilities for business development", *International Journal of Enterprise Network Management*, vol. 4, no. 4, pp. 380-399.

Wessberg, N., Leinonen, A., Tuominen, A., Eerola, A. & Bolwig, S. 2013, "Creating prospective value chains for renewable road transport energy sources up to 2050 in Nordic Countries", *International Foresight Academic Seminar in Switzerland*, 16.-18.9.