Value Chain Planning in Cross-Industry Meta-Cluster Initiatives

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ABSTRACT

Cross-industry meta-cluster initiatives may play a crucial role in speeding up conceptualization and launching of viable innovations. In this context, this paper introduces a methodology for integrated planning of hybrid value chains. Using a roadmap of interrelated planning matrices, appropriate projects, mechanisms and institutional constructions can be formulated and cross-industry meta-cluster initiatives can be built in a structured, systematic and systemic way. Theory is exemplified for planning new generations of innovations at the intersection of ICT and agriculture sectors. The case study shows the potential of the methodology to provide a comprehensive qualitative and quantitative assessment of the current state and to highlight the major challenges for reaching a competitive viability of the emerging innovations within a hybrid innovation eco-system.

Keywords: meta-clustering, cross-industry collaboration, value chain, integrated strategic planning, product-service systems, innovation, emerging industries, agriculture 4.0.

INTRODUCTION

Modern economies are strongly based on science and technology (Chen, Lu, 2016, p. 54). Internet and other communication technologies have facilitated the development of global value chains in almost every economic sector, including financial, industrial and agricultural ones. Also, the value chains of service sectors have evolved in strong dependence with the evolution of mobility and information technologies (Singh, 2016). These evolutions have led to an even higher relevance of economic clusters in relation to economic competitiveness and differentiation of geographic regions (Barbara et al., 2016, p. 226).

Economic clusters are usually related to sectorial economic fields (Resbeut, Gugler, 2016). They agglomerate in geographical proximities a critical mass of companies in particular fields, together with suppliers, service providers, and associated institutions (Porter, 2008). Despite the proved value of suppliers’ proximity for cluster productivity, construction of complete value chains in a small geographical area is not always possible due to different reasons, including availability of all pieces of know-how and human resources (Ketels, Memedovic, 2008, p. 378). Therefore, in many economic sectors, trans-regional meta-clusters are important for regional economic development (Welck, 2012). Due to their demonstrated advantages for developing high-end complex products, services and technologies, meta-clusters have gotten important positions on policy makers’ agenda.

Beyond the need to cover a complex value chain, trans-regional meta-clustering is well-aligned with regional smart specialization (Foray, 2015). Through the extended connection, synchronization and
harmonization between sectorial clusters from different regions, local industries can better adopt and follow strategies for product and service differentiation.

Although sectorial meta-clustering is important for improving economic competitiveness, nowadays breakthrough innovations are happening at the intersection of more economic sectors (Jong et al., 2013). Cross-industry meta-clusters are key elements in setting up new economic sectors, also called emerging economic sectors during their early phase of life-cycle (Monfardini et al., 2012). A simple survey in the scientific literature reveals a lack of knowledge on how to approach integration of sectorial innovation eco-systems in an effective way such as to sustain cross-industry product-service systems. Strategic aligned cross-industry meta-cluster initiatives might significantly contribute to the realization of such desideratum. In line with this goal, a methodology for integrated planning of the value chain for developing new market offers at the intersection of more industrial sectors is introduced in the following sections of the present paper. It also considers the framework of meta-cluster initiatives as a necessary component to build the cross-industry innovation eco-system. From this narrow perspective, this paper is looking for strategic planning of new systems.

Before the description of the methodology, a literature review in the field of strategic planning of value chains is presented. The goal is to highlight transferable know-how from a more general field to a narrow subject. The third section of the paper provides details of the methodology. It is grounded on a roadmap of interrelated matrices, where generic requirements of the markets are deployed into generic product-service systems and further into sectorial value chains, which at their turn are deployed into the integrated innovation eco-system related to emerging cross-industry sector. Current gaps are visualized and quantified in terms of criticality. They are analyzed in three major directions for consolidation of the emerging innovation eco-system: suppliers, policies and smart specialization actions plans. The graphical format of the methodology captures in a condensed manner the whole picture for strategic planning of the cross-industry meta-cluster initiative. This facilitates definition of appropriate projects, mechanisms and institutional constructions. From this point, practitioners can systematically build cross-industry meta-cluster initiatives. This methodology is seen as a practical tool to provide an answer to the following research question: how to construct a meta-cluster initiative in close symbiosis with the needs of building up an emerging economic sector and how to balance distribution, allocation and prioritization of resources to maximize results and minimize time-to-viability of that sector? The proposed framework in this paper is exemplified for the emerging sector of agriculture 4.0; that is, the intersection of information technologies, Internet of Things, robotics and agriculture to develop the cross-sector of smart agriculture. The case study considers in its foundation the specificity of the Balkans meta-region of Europe. Conclusions from this research are extracted and highlighted in the last part of the paper.

BACKGROUND

For the purpose of this research, literature review is focused on issues about value chain strategic planning. Thus, the attention is paid on tools and frameworks that help in defining development strategies, directions of evolution, and resource allocation considering also the inevitable constrains. To this, a particular investigation of current researches to plan value chains for cross-industry sectors is also considered. The basic tool for understanding how value is created in a given economic sector and related organizations is proposed by Porter (Porter, 2008). This model describes the value chain in a way that is common to all businesses. From this angle, Porter’s value chain representation is very useful in the construction of strategic plans for a given economic sector. Value chain is often treated in literature only from the narrower perspective of supply chain or supply network. This is a traditional view on value chains, considering only the external suppliers along the flow of value creation for customers. Also, planning is mostly viewed in terms of quantities to be supplied, and less on planning from the perspective of strategic formation of the network of suppliers. A relevant work in this respect is done by Sahling and Kayser (2016), where stochastic analysis and linear programming formalisms are used in the network planning problem.
The limitation still remains in the identification of the types of vendors and in the conceptualization and construction of supplier network that best fit to an emerging business model and product-service system, in a business environment with various constrains. In the same line, with similar applicability limitations, is the research reported in (Badri et al., 2016).

A multi-objective mixed integer linear programming model is proposed by Mota et al. (2015) to approach the problem of designing and planning sustainable closed loop supply chains from a broader perspective, which includes decisions on facility location, definition of transportation modes, technology selection and allocation, as well as tactical decisions. It lacks the same issues as mentioned with respect to the previous two references in this paragraph, namely before optimizing a network system it is necessary to have that system in place. An indication on mapping value chain network at a strategic level is given in the paper (Kang, 2016). This work introduces an approach for segmenting customers and suppliers and analysing them from a strategic and geographic perspective in the case of an emerging industrial sector (i.e. renewable energy). It is a valuable work on how responsible public authorities must contribute to the creation of large scale innovation ecosystems. Still, the approach proposed in this research does not move further, on investigating innovative paths to construct the clusters and cluster networks to support the materialization of the emerging economic sector.

Park and Lee (2015) highlight the importance of constructing the value network from the very early stage of product and product-service system conceptualization and design. This is a very important message from a strategic point of view. Best value co-creation requires optimization of network suppliers from the very early stages of new product formation. But, for doing this, a preliminary step is about identification of potential participants in the value co-creation effort. For many emerging industrial sectors, it might be possible to occur gaps in the value chain because of lack of suppliers, either locally or globally. In such cases, strategic projects have to be considered for the creation of those suppliers that are necessary to cover the gaps.

A detailed survey on literature databases was conducted to identify research reports on value chain planning for cross-industrial sectors. Till this moment, no paper in this niche of research is reported in international specific databases. The same lack of results is in the area of strategic planning of network partners in the construction of an emerging industry, despite the relevance of this problem for creation of new markets, as well as for revitalizing economies in the periods of extended crises. This gap is fructified in the current paper by conducting researches to set up a systematic construct for planning emerging industries from the perspective of strategic aligned cross-industry meta-cluster initiatives.

**METHODOLOGY**

This section introduces a structured roadmap for planning the development of value chain networks for emerging industrial sectors or sub-sectors, characterized by provision of innovative products and product-service systems at the intersection of two or more traditional industrial sectors. Emerging industries are characterized by a high growth potential, being usually driven by key enabling technologies (Monfardini et al., 2012, p. 10). Considering the key characteristics of emerging industries, a viable methodology for strategic planning requires the presence of the following elements: generic needs and demands of the market such as to enable structural changes, generic components of possible (not yet complete defined) emerging product-service systems in the respective economic sector, primary and support processes of the interlinked economic sectors, players capable to cover the interconnected hybridized value chain, mechanisms to identify the robustness of the innovative ecosystem, as well as areas for differentiation in a global market of the related economic clusters. It was concluded that deploying needs and demands coming from society and environment into the components of value chains is an adequate approach to plan the ecosystem of the emerging industry. In the following part of this section, the proposed methodology is introduced:
• Step 1: identification of the major driving factors (or attractors) that justify the emergence of a cross-industry sector
• Step 2: extraction of the emerging market, of its generic customers, as well as of their generic demands and needs
• Step 3: formulation of the generic product-service systems portfolio, competences and business models required for the emerging cross-industry sector
• Step 4: deployment of step 2 into step 3 in order to see the robustness of solutions formulated in step 3
• Step 5: formulation of primary and support activities in the value chain of all industrial sectors included in the hybrid sector
• Step 6: planning the cross-industry ecosystem
• Step 7: formulation of the smart specialization strategy of the meta-cluster
• Step 8: aligning smart specialization with meta-cluster resources

Figure 1: Graphical representation of the first five steps of the methodology.

A top-level graphical representation of the first five steps of the methodology is illustrated in Figure 1, whereas Figure 2 provides details of the last three steps of the methodology. With reference to Figure 1, the ranks 1.x of the input generic requirements (demands) can be determined via several approaches. A possibility is to ask opinions of an expert group and to allocate the mean values of the individual opinions. Another possibility is to use more sophisticated approaches, such as Analytical Hierarchy Process (AHP) (Angiz et al., 2012). Relationship indexes \( a_{xy} \) in Figure 1 describe the strength between generic requirements and generic elements of the product-service ecosystem. Value weights 2.x in Figure 1 reflect the relative impacts of the product-service ecosystem’s elements to satisfy the generic requirements. They are calculated in absolute values as \( \sum_y (1.x \cdot a_{xy}) \), and then converted into percentages (Cohen, 1995). Value weights for the primary and secondary activities are calculated using the same procedure, but instead of the ranks 1.x and indexes \( a_{xy} \), the value weights 2.x and indexes \( b_{xy} \) are considered.
With reference to Figure 2, the relationship indexes \(c_{xy}, d_{xy}, e_{xy}, f_{xy}\) belong to the set of variables \{0 – no; 1 – weak; 3 – more than weak; 5 – medium; 7 – less than strong; 9 – strong\}. Ranks 7.x for the action plans in the smart specialization strategy can be defined through various approaches, as in the case of ranks 1.x. The value weights 6.s, 6.p, and 6.a reflect the impacts of cross-industry cluster actors from different perspectives: support activities, primary activities, and smart specialization. The value weights 8.x highlight the impacts of public policies towards realisation of smart specialization. Value weights 6.s, 6.p, 6.a, 8.x are calculated with the same procedure as in the case of 2.x. If the cross-industry sector is constituted from more than two traditional industrial sectors, additional matrices will be added both in Figure 1 and Figure 2.

**CASE STUDY**

The next section of this paper illustrates the application of the proposed methodology for the emerging sector called “agriculture 4.0”. Particularities are considered for the meta-region of Balkans, where a cross-national cluster networking initiative exists since 2014. Results are shown in Figure 3 and Figure 4. Deployment of the cross-industry ICT-AGRI product-service ecosystem into the extended ICT-AGRI value chain is not illustrated in this paper because of the size of matrices. This study identified that major challenges in the Balkans region for setting up competitive ICT-AGRI solutions on the ICT side stands in the following areas: integration and installation of ICT-AGRI solutions in farms, market education and training resources of end-users, as well as in after-sale services.
Table 3: Deployment of demands in the value chain.

Problems are also identified in the areas of ICT service integrators and service providers on data analytics. There is a huge gap in the area of ICT hardware resellers and hardware waste management, especially on refurbishing and reusing. On the agricultural side of the cross-industry ecosystem, top issues with missing capabilities in the Balkans region are referring to land irrigation,
fertilising and mostly to crop protection using natural (organic, bio) solutions. For developing a competitive smart agriculture, gaps have been identified with respect to drying, cooling and eco-storage of agriproducts, as well as with respect to regional capacities for international trading. Waste management is another drawback in the Balkans region, with lack of capabilities in place, as well as financing of the sector (e.g. loans, insurance). Also, interdisciplinarity in ICT-AGRI research is close to zero in this region, even if there are very good sectorial capabilities. Still, such research units act independent, with no action plan for integration in order to generate ICT-AGRI innovations with high technical impact and practical relevance. Smart specialization actions are deployed into the key stakeholders for the ICT-AGRI sector and into recommended public policies to be run by the national governments in the Balkans region to support the emerging sector of smart agriculture. Results are introduced in Figure 4.

Figure 4: Deployment of smart specialization action plan.

Figure 4 also shows that materialization of smart specialization for agriculture 4.0 in the Balkans region requires simultaneous application of the whole package of the proposed public policies. Many stakeholders have to operate in a synchronized way, having in front of them a common vision and a unitary understanding of challenges and resolution mechanisms. In this landscape, the highest credit to catalyze constructive energies is given to cluster initiatives. It seems that these cluster initiatives should act in close cooperation with national governments in the region.

CONCLUSIONS

The major contribution of this paper is the idea of deploying demands related to an emerging industry into various layers and elements that describe the related ecosystem, as well as the application of relationship matrices to weight the importance of these elements and to visualize the map of critical intervention points. The systematic deployment process forces experts to approach every issue in a structured way and obliges them to document exhaustively, be creative and bring in the planning map a comprehensive set of innovations, innovative concepts and topics. The resulted picture of mapping permits a fast and clear identification of the crucial areas. The global image provided by the methodological framework proposed in this paper facilitates convergence of various perceptions and higher chances to formulate a unitary perspective of reality by different stakeholders and action agents. Various concerns and criticalities can be listed in a structured manner and alignment to a common plan for resource identification and/or generation, as well as optimal resource distribution and allocation can be better realized.

The methodology has a general applicability, regardless of economic sector. We claim that the effort required to document, collect information, generate ideas, plan the system, and analyze gaps worth it for the effect produced. Nevertheless, the methodology is subject to future refinements and
developments. The primary focus is the calculation of critical mass of qualitative and quantitative capabilities to the level of each stakeholders group such as to pass the tipping point for moving the emerging sector to the level of economic viability. Synchronized movement of all stakeholders, and synchronized movement of stakeholders’ members in a complex environment with many attractors and unexpected influence factors is another open issue that calls for scientific solutions. From this perspective, this work promotes a combination of empirical research for data collection and understanding of causes and behaviors in relation with an expected future goal, with engineering-type research for constructing gap-driven solutions under the constrains of time and other resources.

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