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Identification of Critical Factor Indexes from Triple Helix Perspective: Case of Slovenian Forest Based Industry

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Abstract. Slovenia's forest-wood product chain has been struggling due to low value-added products and decreasing export competitiveness. In such situation, the necessity of a sustainable forest-based product development effort has to be taken into consideration. Effective interactions between and within the triple helix institutional actors which are the university, industry and public are fundamental as these actors have to explicitly agree on the same issues, share their respective motives and together develop innovative solutions for the issue. The triple helix framework supports knowledge creation by fine-tuning communications regardless of the different value systems used in the background. Continuous evaluation towards organizational competencies and resources guides organizations in striving for sustainable competitive advantage. This study demonstrates the application of Sense and Respond (S&R) analytical models in the analysis of interactions between and within triple helix institutional actors; university-industry-public in the forest-based industry of Slovenia. The model evaluates the distribution of organizational resources based on four competitive priorities; quality, cost, time and flexibility into their operations strategy. It assists in identifying critical attributes in a worse trend development in order to enhance operational competitiveness as well as innovation capabilities of the industry by making strategic adjustments accordingly. The result of the analysis reveals that most of the interactions emphasize on quality in resource allocations. Critical attributes found using the worse trend development with potential drawbacks in the effort to transform operation capabilities into competitive advantage were found in all interactions. The attributes are further compressed into five main categories based on the similarities found within them. The current turbulent business environment demands organizations that are not only competing through their own capabilities but together with other members of the network to generate a value chain synergetic impact to gain competitive advantage. This study is supporting this effort by highlighting the areas for improvement in business processes and organizational routines among the forest-based industry of the triple helix institutional actors in Slovenia to enhance their operational competitiveness.

Keywords: competitive advantage, operations strategy, competitive priorities, sense and respond, triple helix, interactions

1 Introduction

Sustainability has long been an area studied by scholars and investigated by professionals. Despite having various definitions in different contexts, the common meaning of the term meets today's needs with a sense of life quality without consuming the future. Recently, sustainability has become a global mission rather than a term. While it is concerned with the environment and the society, in the business world it means development, economic growth and success in general. The idea of continuous development and success has been attractive for businesses. This encourages organizations and companies to develop strategies to achieve sustainability. However, as the competition gets more aggressive, it becomes a struggle for survival. Having an advantage over competitors within the market is not sufficient for a company to succeed, as the competitive advantage can be duplicated and may change hands. Therefore, it becomes a question of whether a company is able to sustain its competitive advantage. Additionally, sustainability is about managing the resources of a company with an efficient configuration in response to the changing environment. This particular configuration is ensured by a set of strategic decisions called operations strategy (Barnes, 2008; Davis, Aquilano & Chase, 2003).

Smart specialisation, on the other hand, is a strategic approach to sustain economic development through research and innovation in particular areas. The foundation of the smart specialisation concept can be traced back to the work of Etzkowitz (2002) where he discusses the roles of knowledge in society and university towards the economy with the triple helix thesis of relations among university, industry and government (Stanovnik, 2014). According to the model developed by Etzkowitz and Leydesdorff (1995), via cooperation between the actors of the triple helix, the private sector adopts new technologies and competitive advantage in the market, while universities develop academic knowledge and analytical skills, gain academic competitive advantage, image, reputation, and funding for academic activities. The public sector also benefits from the cooperation by gaining strategic advantages such as economic development, resources, new jobs, higher tax revenues, and regional development. Therefore, the triple helix approach is a model aiming at realizing mutual benefits for universities, industries, and the government, despite having different interests.

Cooperation provides a source of competitive advantage through a synergistic effect among partners within a network (Wong, Tjosvold & Zhang, 2005; Tsai, 2009; Choi & Hwang, 2015). It is becoming harder for companies to innovate sufficiently using only their own resources and capabilities. In a turbulent environment, cooperative innovation efforts are most likely to succeed (Peng & Luo, 2000). Innovative partnership between public and non-public agencies creates collective capabilities and points of interest that will contribute to unique and inimitable advantages to a specific region (Martin, Smith & Philips, 2005). Zeng, Xie, Xie and Chi Ming Tam (2010) found that inter-firm cooperation, cooperation with intermediary institutions and cooperation with research organizations revealed high innovation performance. Researchers and managers increasingly recognize that cooperation agreements through external linkages promote knowledge acquisition among participants (Kraatz, 1998; Goes and Park, 1997; Becheikh et al. 2006; Tsai, 2009).

However, it is particularly challenging to maintain an effective cooperation when the complexity of the relationship increases. Approximately 30 to 50 percent of cooperation always ended up in failure associated with unclear roles and responsibilities distribution as well as the shortfall of strategic focus (Anderson and Jap, 2005; Wong et al., 2005; Babiak and Thibault, 2009).

In order to attain a highly innovative and synergistic performance, organizational resources and capabilities should be well managed and fit accordingly to the needs of the cooperation (Weiss, 2002; Lahiri and Kedia, 2009). The role of expectations among the partners of the cooperation should not be taken lightly as it determines the successful execution of all activities at different stages and phases

within the relationship (Wong et al, 2005; Teng and Liao, 2011). Participants should recognize the overall context of each cooperation rather being excessively concerned about their own values. Lasker et al. (2001) highlighted the importance of measuring the functioning level of a relationship in order to forge an efficient cooperation. Sustainability of competitive advantage through cooperation is possibly achieved when inefficiencies can be recognized and responded accordingly to improve and strengthen the functioning of a network. Diaz (2015) emphasized the importance of evaluating cooperation at the early or progressing stages instead of towards the end to allocate plenty of duration for corrective actions.

Slovenia is one of the most forested countries in Europe, with forests covering more than a half of its territory. However, the country's forest management had failed in planning the successful use of wood or creating well-developed wood technology. Wood is the only abundant natural renewable resource in Slovenia. However, is not sufficiently used or sustained (Humar & Kraigher, 2009). Although the Slovenian wood-processing and furniture industries have had a good reputation, they have been limited in terms of value-added products as well as other forest-based sectors. Especially after the sleet disaster in 2014 which damaged half of the country's forest reserves, the need for sustainable forest management for both the recovery process and for the future has become a matter of priority.

Hence, this study proposes an evaluation of organizational resource allocation towards an overall innovative cooperation relationship among the spheres in a triple helix framework. This research work was conducted to find answers to the following research question brought forward by the issues discussed above:
How well is the level of cooperation between the actors involved in the Slovenian forest industry in terms of competitive priorities and operation strategies?

2 Background

2.1 Forests and the Wood-Processing Sector in Slovenia

According to the World Fact Book (2015), Slovenia is one of the most forested countries in Europe with 1,186,104 ha of forests (in 2010) covering more than a half of its territory. 76 percent of the Slovenian forests are private property, while the remaining 24 percent is owned by the state or communes. The forest reserves in Slovenia are an important source of wood biomass for energy. The sustainable potential of wood biomass for energy supply amounts to 1.4 million m3 per year. In 2013, over 1 million m3 of fuelwood was produced in the country. As a consequence of an increase in tree felling, the quantity of removed wood which can be used for energy also increases. Moreover, in the last five years, the share of wood waste used for energy purposes had raised by 50 percent compared to all wood waste. In 2013, 190,000 tons of wood waste were used for energy purposes (Gale, 2015). The use of renewable energy is increasing in Slovenia. The country aims to reach at least 25 percent share of renewable sources in gross final consumption within the EU objective framework for 2020. As the most important renewable source of energy, the use of wood has also been encouraged by the government. The country has been promoting and hastening the use of wood for producing electricity and therefore had adopted regulations to support this attitude (Kremer, 2011).

The Slovenian forest-wood product chain is the most important economic product chain that has a sufficient quantity of raw material which is geographically dispersed and is technologically well-equipped with manufacturing facilities (Humar, Kropivšek, Piškur, Krajnc, Kutnar, Tavzes, Milavec and Likar, 2011). Despite past socio-economic turbulences, Slovenia has been successful in conserving its forests in a healthy, sustainable and predominantly natural state. However, despite the abundant source of wood, the result of successful use of wood or well-developed wood technology is still lacking (Humar & Kraigher 2009). Around 887 companies are actively operating in the wood-

processing sector in Slovenia, with approximately 11,800 employees generating 951 million Euros. The key export markets are Algeria, Austria, Bosnia and Herzegovina, Croatia, Italy, Germany, Libya, Saudi Arabia, Tunisia, Serbia, and Switzerland (SPIRIT Slovenia, 2014).

Additionally, the Slovenian furniture and furnishing industry has been facing problems due to the low number of value-added products and decreasing export competitiveness. Hence, the latest Slovenian competitiveness policy supports activities that focus on promoting research and development (R&D), the usefulness of wood and wood products, efficient and innovative marketing, new jobs and the growth of added-value per employee in forestry and the wood-processing industry. In an adequately arranged value chain, the value of a cubic meter of wood from the forest to a sold finished wood product or a building on the market can increase substantially, even more when the wood is used in a high-tech product (SPS, 2014).

Unfortunately in February 2014, an ice storm had hit Slovenia, leaving severe damages behind (Hudohmet, 2015). Consequently, Slovenia has an enormous quantity of wood waiting to be utilized, or the bark beetle outbreak will ruin an additional part of the country's forests (Strovs, 2014). Due to the disaster, there have been movements of wood prices in the market as a consequence of the increased supply of wood (Gale, 2015).

2.2 The Smart Specialisation Strategy of Slovenia

Gagnon, O'Sullivan, Lane, and Paré (2016) highlighted the importance of cooperative efforts in managing disasters in order to increase the resiliency of a locality. In areas where Slovenia has the critical mass of knowledge, capacities and competencies, as well as innovation potential for development recovery, there is a need to establish a synergistic cooperation to aid the current situation of the industry. Therefore, smart specialisation is the process to ensure a balanced and developed priority-oriented functioning of policies. However, it requires an in-depth analysis of strengths and weaknesses of the state or region, with good governance and a shared vision of stakeholders (SPS 2014).

The triple helix approach is one of the models aiming at realizing mutual benefits for universities, industries, and the government, despite having different interests. Etzkowitz and Leydesdorff (1995) proposed a triple helix model as a formula so that these three spheres could benefit from a cooperation, although they are different in terms of organizational structure, mission, vision, targets, and success factors. According to the model, while the private sector adopts new technologies and competitive advantage in the market, universities develop academic knowledge and analytical skills, gain academic competitive advantage, image, reputation, and funding for academic activities. The public sector also benefits from the cooperation by gaining strategic advantages such as economic development, resources, new jobs, higher tax revenues and thus regional development. In a Triple Helix, in order to improve the conditions for innovation in a knowledge-based society, the industry operates as the locus of production; the government as the source of contractual relations guaranteeing stable interactions and exchange; and the universities as a source of new knowledge and technology (Etzkowitz, 2003). According to Carlsson (2003), the innovation system perspective is used to better understand how institutional arrangements facilitate interactions among economic actors in the market. The common goal is exploring how to build upon existing resources to create innovation (Etzkowitz, 2008).

2.3 The Resource-Based View of the Firm

The resourced-based view of a firm provides a theoretical foundation for understanding the role that operations strategy play in creating and sustaining a competitive advantage (Boyer, Swink, Rosenweig, 2005). The resource-based view (RBV) approach was started by Penrose (1959) who

investigated how the management of internal processes can influence the behaviour of a company. According to Penrose's theory, a company can create economic value by having the special ability in managing its resources (Anwar, Subroto, Alhabsji & Djumahir 2014). The idea that firms are heterogeneous in terms of resources and internal capabilities has been at the centre of the strategic management field. It is suggested that the RBV model be practically used by managers who seek to understand, preserve, or extend their competitive advantage.

According to Barney (1991; 2001), a firm's resources include assets, management skills, capabilities, organizational processes and routines, firm attributes, information, knowledge, etc. These resources can be classified into three categories: physical capital resources, human capital resources, and organizational capital resources. According to this classification, physical capital resources include physical technology, plant, equipment, geographic location of a firm, and its access to raw materials. Human capital resources include the qualities of individual managers and workers in a firm such as training, experience, judgement, intelligence, relationships, and insight. Lastly, organizational capital resources include the company's formal reporting structure, formal and informal planning, controlling, system coordination, as well as informal relations within a firm and with other firms in its environment (Barney 1991).

Barney (1986) discusses that it is possible for a firm to gain exceptional advantages by evaluating information on assets it already possesses. By analysing the resource position, a manager would have a clearer understanding of his situation for a sustainable advantage and improve the strategic direction of a company. Moreover, recognition of strengths and weaknesses of a company's resources allows the company to make priorities and select resources that can be optimized to enhance productivity and efficiency (Anwar et al., 2014).

2.4 Competitive Priorities

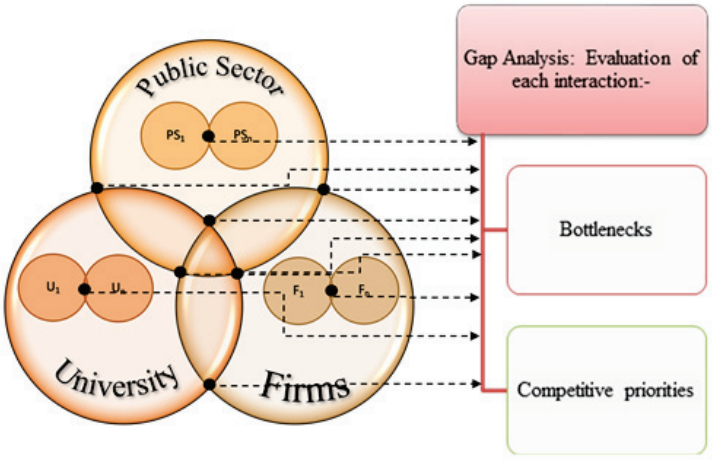
Cooperation accelerates the development and commercialization of innovative processes, products and services, which demand mutual willingness to understand each other's capabilities in achieving the goal of the cooperation (Vachon & Klasson, 2006). A cooperative approach in a network linkage strives to achieve a capacity to react according to the changes of demand from their operating environment (Vachon, Halley & Beaulieu, 2009). Moreover, Vachon et al. (2009) indicated that a sequence of actions derived from cooperation efforts which exploit each partner's capability are associated with the competitive priorities they are focusing on. The selection of competitive priorities determines the organization's operational strategy structure through resources allocation and investment decisions which include low cost, high quality, fast delivery, and flexibility, which enable organizations achieve competitive advantage (Hayes & Wheelwright, 1984; Ward, McCreery, Ritzman and Sharma, 1998; Sanders & Premus, 2002). Lasker et al. (2001) highlighted the importance of measuring the functioning of a relationship in order to forge an efficient cooperation. Hence, the alignment of competitive priorities into cooperation activities should be evaluated to verify that the capital spending is traded off. The following are the dimensions of competitive priorities according to Ward et al. (1998), and they are measured by the importance of each towards organizational strategy.

2.5 Evaluating the Functioning of Cooperation among the Triple Helix Framework

Findings from previous Slovenian based smart specialization studies broadly generalized the country as a whole. Kotnik and Petrin (2015) indicated the need to focus on certain industries in Slovenia to be able to grasp their actual needs. This study specifically chose the Slovenian forest-based industry which is one of the key industries to be developed within their smart specialization strategy (SPS, 2014). In order to strengthen the support of the S3 policy implementation as well as to avoid wasteful subsidies, it is particularly important to evaluate and assess the effectiveness of the execution (David,

Foray & Hall, 2009). The primary goal of this study is to identify the competitive priorities as well as inefficiencies between and within the triple helix institutional actors; university-industry-public in the forest-based industry of Slovenia. This is to address the necessity of connectivity among the actors as recommended by Kotnik and Petrin (2015). To achieve this goal, this study demonstrates the application of Sense and Respond (S&R) analytical models in the analysis of interactions between and within the triple helix institutional actors. The model evaluates the past and future distribution of organizational resources based on four competitive priorities; quality, cost, time and flexibility into their innovation activities. It assists in identifying critical attributes using a worse trend development in order to enhance operational competitiveness as well as innovation capabilities of the industry by making strategic adjustments accordingly. Based on the background of this study, the authors propose the following framework presented in the diagram.

Figure 1: Framework of the study



3 Method

3.1 Sense and Respond

Sense and Respond (S&R) first appeared in Haeckel's Management Review as a business concept in 1992. Bradley and Nolan were the developers of the S&R thinking which was further analysed by Markides as a dynamic business strategy (Liu, Qian, Zhao and Takala, 2011). According to Takala and Uusitalo (2012), S&R is the philosophy of executing best practices in a constantly changing environment by the detection of changes (sensing) and reacting to these changes properly (responding). The S&R model is utilized as a tool to assist organizations in dynamic decision-making to describe, evaluate, benchmark and optimize resource allocations at different levels in an organisation in order to meet performance requirements of all interest groups inside and outside the organization, thus improving to higher level strategies (Liu, 2010). The result generated by the model enhances the ability to quickly adjust processes which has the potential to be a decisive factor in obtaining sustainable competitive advantage (Liu et al, 2011).

In order to make the right decisions, it is necessary to have a profound overview of both the current situation and future development possibilities. The Critical Factor Index (CFI) was developed to offer different supporting decision-making models. The CFI is also a fast and reliable method for management purposes (Nadler & Takala, 2010). The CFI methodology and questionnaire are used as tools for the application of these methods, and are further presented in the following sections.

3.2 Critical Factor Index Method

CFI was first introduced by Ranta and Takala (2010) as a tool that measures the experiences (past) and expectations (future). It has been developed as a method which enables the finding of critical factors by utilizing experts' views (Liu, Takala, Siltamäki, Wu, Heikkilä and Gauriloff, 2011). Based on former models, Liu proposed a further improvement with a new one called NSCFI (Normalized Scale Critical Factor Index) which adds the trend research to the method. It is also discussed that the NSCFI gives higher-accuracy managerial implications compared to former ones (Vuoti, Takala, Mäntylä, Liu, Yang, Malek, Kronman, Kreuzer and Zafar, 2014; Liu & Liang, 2015; Abdul Malek, Shahzad, Takala, Bojnec, Papler & Liu, 2015).

The S&R model proposed by Ranta and Takala (2007) is used for the empirical analyses in this study. According to this model, gap index, direction of development index, importance index, standard deviation of experience and expectations are calculated using the NSCFI calculations (Liu, 2010). Gap index is calculated to understand the gap between experience and expectations of a specific attribute. The development index provides information about the direction of an organization's development. The importance level of an attribute is calculated by actual expectations for that attribute, whereas performance index represents the actual performance of an attribute based on the experience indicated by respondents in the S&R questionnaire (see Table 2). Furthermore, the standard deviation of experience and expectation calculations reflects whether there is a similar or contradictory evaluation for the attributes (Takala, Shylina and Tilabi, 2014).

The final equations for these indexes are as follows (Liu & Liang, 2015):

$$Gap\ index = \frac{Average\ of\ expectation - Average\ of\ experience}{10} - 1$$

$$Development\ index = \left|\left(\frac{Better\% - Worse\%}{100}\right) - 1\right|$$

$$Importance\ index = \frac{Avarage\ of\ expectation}{10}$$

$$Performance\ index = \frac{Average\ of\ experience}{10}$$

$$SD\ experience\ index = \frac{Std\{experience\}}{10} + 1$$

$$SD\ expextation\ index = \frac{Std\{expextation\}}{10} + 1$$

$$NSCFI = \frac{\sqrt{\frac{1}{n}\sum_1^n [experience(i)]^2} \cdot \sqrt{\frac{1}{n}\sum_1^n [expectation(i) - 11]^2} \cdot Performance\ index}{Importance\ index \cdot Gap\ index \cdot Development\ index}$$

The equations also present the development of CFI models over time. In this paper, NSCFI is used for calculations since it is accepted as a more accurate and up-to-date model. In addition to this traditional method, a new of version (CFI) is also used for the analysis. It has been developed by Takala and Kamdee (2015) in order to reduce the complexity of the equation and scale down a distortion of the independent variable, thus preserve the natural form of variables. As shown below, in the new model, CFI′ is obtained by firstly calculating balance index (IBal) and gap index (IGap) with mean of expectations and experiences (xEp, xEr). After finding the development index (ID) based on direction of development (grows, remains the same, lowers), finally the new normalized critical factor index (CFI′) can be calculated.

$$I_{Bal} = \frac{\bar{x}_{Er}}{\bar{x}_{Ep}}$$

$$I_{Gap} = 2^{\frac{\bar{x}_{Ep} - \bar{x}_{Er}}{10}}$$

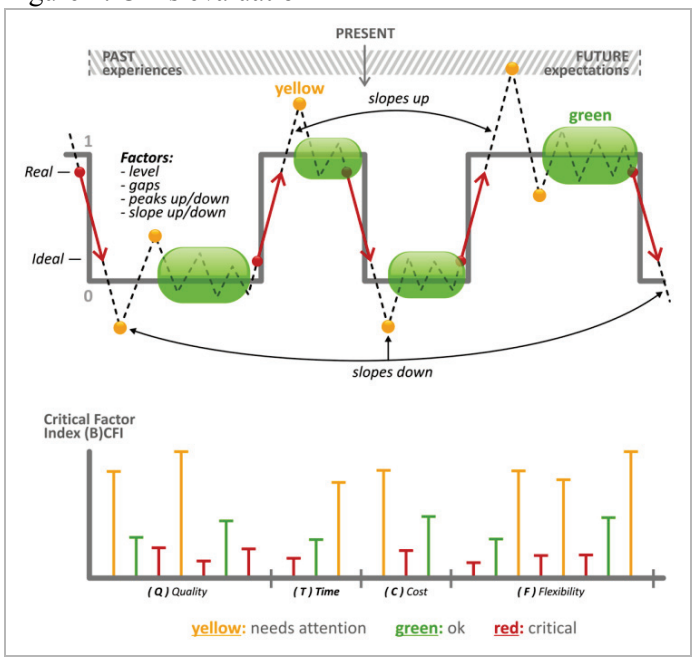
$$I_D = 2^{(\frac{Lowers}{Grows + Remains\ \ the\ same + Lowers}) - (\frac{Grows}{Grows + Remains\ \ the\ same + Lowers})}$$

$$I_D = 2^{D_W - D_B}$$

$$CFI = \frac{\left|\bar{x}_{Ep} - 11\right| \times \bar{x}_{Er} \times I_{Bal}}{I_{Gap} \times I_D}$$

$$CFI' = \frac{CFI}{\sum CFI}$$

Figure 2: CFI's evaluation



For increased practicality and better interpretation, the CFI results are grouped into three categories based on the traffic light colors. According to this, red represents criticalness of under-resourced attributes. If the CFI value of an attribute is over-resourced, it is also accepted as critical but marked with yellow. The attributes which are non-critical are marked with green, representing the safe area where all the attributes should be. In order to identify which color an attribute will be marked with, the level of criticalness is calculated for each relation and thus for each version of the S&R questionnaire. The total value of resources is considered as 100% in each questionnaire. Dividing this total value by the number of attributes, the average resource level can be determined. If the value of an attribute falls between the range of 1/3 and 2/3 of the average level, it is then considered as balanced or non-critical and is marked with green. If the value of an attribute is found to be lower than 1/3 of the average level, it is then defined as an under-resourced critical attribute. Lastly, any attribute which has a value higher than 2/3 of the average level is considered to be over-resourced.

3.3 Data collection

Primary data of this study is collected through the S&R questionnaire which was developed by Rautiainen and Takala (2003) to obtain the required information from each representative of the spheres. In the questionnaire, respondents are asked to evaluate each attribute based on their

experience and expectations in the area by rating the performance in a scale of 1 to 10. Next, the direction of development is indicated as worse, same or better for both past and future. The triple helix formed by the academy, industry, and government spheres consists of 9 different relations when these are considered as unilateral. In order to get accurate information on how these spheres view each other in their cooperation, 9 different questionnaires which are different in terms of either topic area of cooperation, attributes or competitive priority distribution were prepared for the study. Table 1 lists the area of cooperation for each interaction within the triple helix framework. Under each of these areas, there are a number of items which represent the attributes understudied. Table 2 shows the format of a basic form of the questionnaire used in this study.

Table 1: Area of Cooperation

	Firms	**Universities**	**Public Sectors**
Firms	• Cooperation with suppliers • Cooperation with customers • Competitors • Knowledge sharing • Innovation projects • Specific Resources • Department cooperation • Area of cooperation • Research region and patenting activities	• Cooperation concerning educational systems • Cooperation in research • Cooperation in process development • Cooperation in organizational development • Cooperation in marketing development • Cooperation in technological development • Research subject • Research region and patenting activities	• Cooperation in infrastructure • Cooperation in spatial planning • Cooperation in environmental planning • Labor market agencies co-operations • Cooperation with actors in environmental regulation and planning
Universities	• Cooperation concerning educational systems • Cooperation in research • Cooperation in process development • Cooperation in organizational development • Cooperation in marketing development • Cooperation in technological development • Research subject • Research region and patenting activities	• Cooperation concerning educational systems • Cooperation in research • Cooperation in process development • Cooperation in organizational development • Cooperation in regional development • Cooperation in marketing development • Cooperation in technological development • Research region and patenting activities	• Cooperation concerning educational systems • Cooperation in research • Cooperation in process development • Cooperation in organizational development • Cooperation in regional development • Labor market agencies cooperation • Cooperation with actors in environmental regulation and planning
Public Sectors	• Cooperation in infrastructure • Cooperation in spatial planning • Cooperation in environmental planning • Labor market agencies co-operations • Cooperation with actors in environmental regulation and planning	• Cooperation concerning educational systems • Cooperation in research • Cooperation in process development • Cooperation in organizational development • Cooperation in regional development • Labor market agencies co-operations • Cooperation with actors in environmental regulation and planning	• Cooperation in infrastructure • Cooperation in spatial planning • Cooperation in environmental planning • Labor market agencies co-operations • Cooperation with actors in environmental regulation and planning

Table 2: Sample of questionnaire

Attributes	Experiences	Expectations	Direction of development, experiences (past) X			Direction of development, expectations (future) X		
	(1 - 10)	(1 - 10)	Worse	Same	Better	Worse	Same	Better
Area of Cooperation								
Cooperation attribute 1								
Cooperation attribute 2								
Cooperation attribute 3								

4 Results

4.1 Respondents' Background

The questionnaires were sent respectively to respondents from universities, companies, and public organizations which interact actively with the Slovenian forest industry. In addition to responses obtained from municipalities, local bodies and other public organizations in or around Ljubljana, Slovenj Gradec, and Maribor, the public sector included responses from the Slovenian Forest Institute in Ljubljana and Race Kogo. The company sector respondents include Gozdno Gospodarstvo (Maribor), Electro Gorenjska, and Port of Koper. Lastly, for the academy sphere of the triple helix, responses were obtained from University of Maribor, the Faculty of Forestry at University of Ljubljana, and University of Primorska. These are in total 12 respondents who provided 19 responses. The distribution of responses is shown in Table 3 below.

Table 3: Number of responses

Cooperation group		**Number of responses**
Universities – Other universities	(U → U)	1
Universities – Companies	(U → C)	2
Universities – Public organisations	(U → P)	1
Companies – Other companies	(C → C)	5
Companies – Universities	(C → U)	4
Companies – Public organisations	(C → P)	1
Public organisations – Other public organisations	(P → P)	3
Public organisations – Companies	(P → C)	1
Public organisations – Universities	(P → U)	1
		19

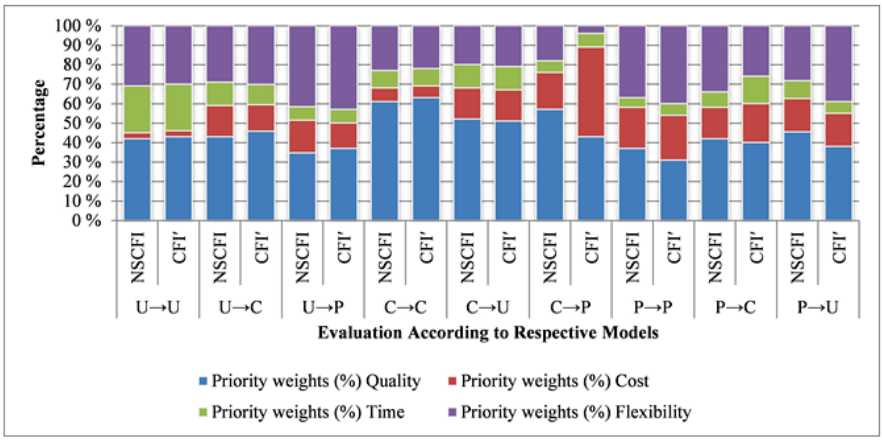
4.2 Comparison of Competitive Priority Weights for NSCFI and CFI'

The analysis of data obtained from the questionnaire responses is presented and discussed below along with the results. NSCFI and CFI′ were used for the evaluation of responses. The reason why these two methods were chosen was, as discussed earlier, because they are the most developed and up-to-date CFI models. As the starting point, all cooperation relations were considered to have a balanced resource allocation and balanced competitive priorities. This means quality, cost, time and flexibility competitive priorities are all weighted 25%.

A comparison between the average values for each attribute calculated by using the NSFCI and the CFI′ models are helpful in understanding the differences between these two models. Based on the values that each model produces, Figure 3 illustrates the percentage of average change for resource and their respective relation groups. It should be noted that, in order to avoid any confusion, the arithmetic mean of each attribute was calculated for the NSCFI results by taking the sum of past and future values and dividing them by 2. It can be seen from Figure 3 that there is no substantial difference between the results except for the company-public, public-company, and university-company relations. Unlike the company and public relation sectors discussed below, there are no divergent relations for the university group in terms of priority allocation. Except for slight differences, the traditional model NSCFI and the new model CFI′ results are similar and follow a similar pattern. That being said, according to Figure 3, the university-university relation differs from others in the way that resource weights are distributed. The number of time-related attributes for this relation is 10 which is the highest number of time attributes among all the other 8 relations. Therefore, the increase in the weight of time is a natural result.

NSCFI finds quality as the most prioritized group for company-public cooperation, while CFI′ results suggest cost is the most prioritized. However, the number of cost attributes in the company-public relation is 5 (in total 25 attributes in the whole questionnaire) and the percentages of some of the cost attributes are extremely high compared to the rest. This seems to be the main reason for the difference and for the shift to the cost from other resource groups.

Figure 3: Comparison of competitive priority weights for NSCFI and CFI'



Note: U = University, C = Companies, P = Public Sector

For the public sector, while public-public and public-university relations have slight changes in percentages, the public-company relation has in total 20 percent distributed differently when compared to its NSCFI results. In terms of major priority, the public-university relation is the only one that does not match the priority that the traditional model suggests. According to this, while quality is the most prioritized by 45 percent, the public-university flexibility has the major priority of 39 percent.

Lastly, according to the results calculated using the traditional method NSCFI, quality is the most dominant competitive priority as it is more prioritized for 7 out of 9 different relations, followed by flexibility which is more prioritized for 2 out of 9. For the CFImethod, quality was also found to be most prioritized for 5 relation groups, followed by flexibility (3) and cost (1). According to the results of both methods, time was not found to be a major competitive priority for any of the relation groups.

4.3 Trend Behavior (NSCFI) and CFI' Results by Number of Attributes

Based on the experience and expectation values indicated in the questionnaires, both methods have a single output rather than two separate results (past and future). This provides an image for observing the general situation. It should be noted that for both NSCFI and CFI methods, the lower - and upper-level limits used for identifying the critical and non-critical (balanced) attributes are the same.

Table 4: Trend behavior (NSCFI) and CFI′ results by number of attributes

Cooperation		Trend behaviour of NSCFI				CFI′ results		
		Total	Worse	Better	Neutral	Under-resourced	Non-critical	Over-resourced
University→university	Number of attributes	41	-	11	30	3	36	2
University→company		43	5	19	19	14	20	9
University→public		35	15	12	8	5	22	8
Company→company		48	-	7	41	6	37	5
Company→university		43	-	4	39	6	30	7
Company→public		25	10	7	8	15	5	5
Public→public		25	11	6	8	5	14	6
Public→company		*25*	9	6	10	6	15	4
Public→university		*35*	12	15	8	12	16	7

According to the trend analysis, university-university, company-company, and company-university relations move towards the better trend (range between lower- and upper-limits) since there are no attributes with a worse trend for these three groups. This shows that there is improvement expected for these attributes and the cooperation area they belong to. University-company, public-company, and public-university relations also show improvement as most of the attributes either move towards the better or remain unchanged. There are, however, a number of attributes which follow a worse trend and thus require adjustments in the relative areas of cooperation. Lastly, according to the trend analysis, university-public, company-public, and public-public cooperation have the least performance in terms of trend behaviour, as the number of attributes with worse trends is higher than the others for these three.

4.4 Bottlenecks

Focusing on the most critical attributes can increase the possibility of making significant improvements rather than attempting to revise each critical attributes. Attributes with the lowest CFI values do not necessarily determine that they are in the critical stage (Mäntynen & Takala 2010). They should be further verified through trend development behaviour analysis and validated with the stakeholders involved in the case study. Trend development behaviour analysis is an extension analysis based on S&R's result. It indicates the trend development based on an evaluation of each attribute from past to future; worse, same or better. It provides an overview of the result to enhance the ability to respond to the result more efficiently.

Based on the trend analysis, a total of 62 attributes are recognized to be worse in the future, while 171 attributes are expected to stay the same and 108 attributes are suggested to get better. These amounts arise from a total of all cooperation. The focus is on the 62 attributes with worse development trends which are further analysed to identify the most critical attributes among them. As a result, the attributes are further compressed into six main categories based on similarities found within them. These five attributes are suggested to be the most critical factors based on the high frequency of occurrence among all critical attributes with worse trend development.

Figure 4: Bottlenecks

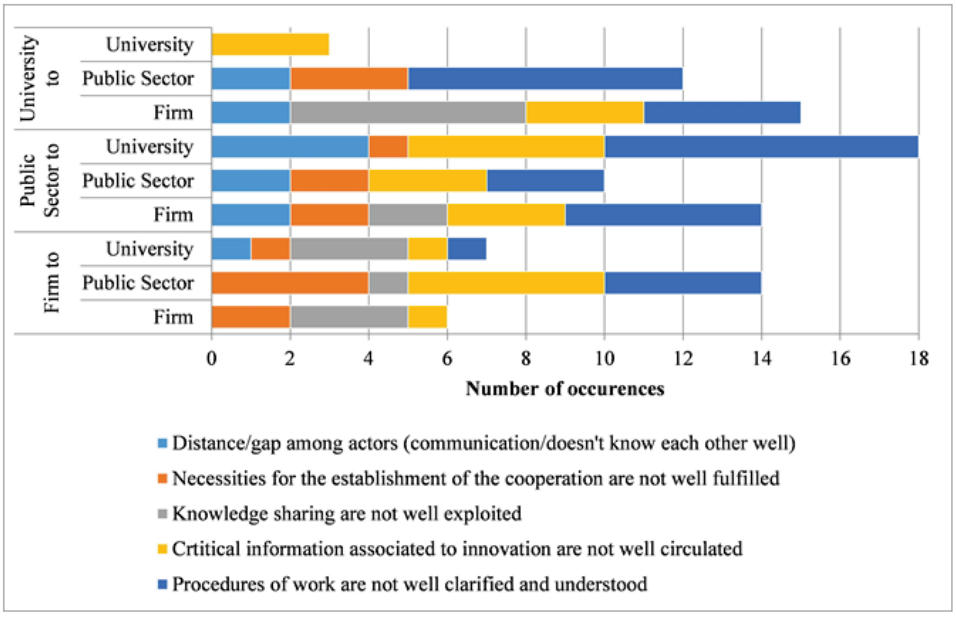


Table 5: The overall top ten areas of cooperation for further development

Specific area of cooperation for development	Number of critical attributes
Environmental regulation and planning	21
Labor market agencies	17
Educational system	8
Research region and patenting activities	7
Spatial planning	7
Infrastructure	7
Regional development	6
Process development	6
Research subject	5
Marketing development	5

5 Discussion

This research demonstrates the evaluation of innovation in cooperation activities among firms, universities and public sector by applying the triple helix framework to enhance the effectiveness of cooperation through the identification of constraints in the process by implementing the Sense and Respond approach. A working version of this research was presented at a workshop session with the title "Can Local Furniture Manufacturers Compete Globally?" at the Management International Conference 2016 in Pula, Croatia. A weak market test to validate the result of this study was performed during this session and the authors have received feedback from a practical point of view and suggestions on how to advance the research. The participants indicate that the results reflect the existing situation and some of the critical attributes are already at the development stage.

5.1 Competitive Priorities

Results generated by both models suggest that quality is the most dominant competitive priority in performing innovation activities within all cooperation in the Slovenian forest based industry. Based from Bojnec and Fertő (2014) and Mörec (2011), Slovenian wood based companies hardly compete in terms of cost, price and quality because Italy and Austria which are the major importers of Slovenian wood products they have a better cost and quality advantage. Additionally, with regards to product

categorization, rather than raw wood materials or semi-finished products, the domestic and international market preference is more towards finished wood products. Therefore, products with more value added are more competitive and sellable, thus demanding the industry to pursue and emphasize quality and flexibility at the operational level, which is consistent with the findings of this research.

5.2 Areas for Development

Cooperation in the area of "environmental regulation and planning" as well as "labour market agencies" seems to have the most number of critical attributes which call for further attention and development.

In their S3, Slovenia wishes to build on their natural assets, supports the vision of a green Slovenia and aims to transform into a circular economy. Having an industry with abundant source of natural resources, the Slovenian forest-based industry consists of great opportunities and potential sustainable development to be exploited within their products and services. Additionally, process development within the value chain particularly demands for the integration of environmental standards. To establish the success of this strategy, effective environmental sustainability management as well as human resources with required knowledge and skills towards this effort are fundamental. Currently, the public sector is the actor who actively incorporates environmental elements within their innovation activities. Triple helix interactions initiate the route for immediate effects and accelerates the effort into the value chain network by requesting universities and firms to consider environmental features within the cooperation.

According to SPS (2014), innovation competencies among local youth labor are still lacking. The findings from this study confirmed that this area needs further attention in terms of the necessity of required skills and knowledge directly related to research and innovation. The furniture industry especially needs creative skills as their source of innovation in order to add values to their end products. Following the labor market agencies is the educational system which also calls for improvement. The new system and structure of knowledge institutions call for socially relevant research to be applied within the industry.

5.3 Bottlenecks within the Cooperation

Five attributes are suggested to be the most critical factors based on the high frequency of occurrence among all critical attributes with worse trend development. First, the lack of understanding about work procedures in certain areas of cooperation appear to be the main problem that occurs in almost all interactions and this weak point covers more than fifty percent of the university to public sector interaction. Clarity of procedures is needed to act as a map for an outsider to assist them in identifying necessary processes before committing to cooperation. Innovative cooperation is a fairly new development after the disorganization of the structures from the previous system in the Slovenian forest-based industry. They are still tuning to strengthen and establish an effective cooperation. Moreover, the industry consists of a greater number of micro and small enterprises which have less capability to afford quality management. However, they are more flexible to changes and with the help of the analysis, they can make corrective adjustments accordingly.

Next, the circulation of critical information associated to innovation are not sufficiently well developed in all interactions and is particularly critical in the university to university interaction which holds hundred percent of the bottleneck. Exchanging information in an open network will help build shared understanding and values. The respondents seem to have difficulty to collect information concerning innovation such as technical information, production information and process information.

Competitive pressure among newly established companies in the industry creates insecurity in providing too much information. They need to sustain a certain level of trust in order to avoid inhibit contribution from the other spheres.

A similar number of occurrences was found in the third and fourth category, which are "knowledge sharing is not well exploited" and "necessities for the establishment of the cooperation are not well fulfilled". The necessity means that the needs required from each respective sphere to perform in the cooperation is not reasonably satisfied. For instance, based on cooperation in environmental regulation and planning, the public sector thinks that the process development does not fulfil the environmental standards as required by their organizations. On the other hand, based on the labour market agencies' cooperation, firms think that labour market actors do not fulfil the necessities of their firm sufficiently. Due to these mismatches, both sides of the sphere should seek an understanding of specified needs in order to achieve mutual benefit among them.

Furthermore, knowledge sharing which is a key to knowledge creation and innovation is underexploited among the spheres. Limited number of research in relative cooperation indicates the lack of transfer of knowledge which is critical in innovation-driven development. Consequently, prototype of products and services are insignificantly commercialized based on the lack of patents and patenting activities among the cooperation.

Explicitly, bottlenecks exist to a certain extent in all interactions, which eventually affect the functioning of the cooperation. Nevertheless, the number of non-critical attributes or well-resourced attributes surmounts to the critical ones and this signifies that the cooperation is essentially progressing to a certain level. Identification of suitable competitive priority is fundamental in order to successfully compete in the marketplace. Moreover, this research has recognized a number of constraints which limit the promotion of innovation cooperation among the triple helix stakeholders based on their current experience and expectations in organizational resource allocations. By making corrective adjustments accordingly, Slovenian forest-based resources could be more sustainably managed, thus increasing innovation performance which is directly linked to global competitiveness within the industry. In order to achieve sustainable competitive advantage, evaluation has to be performed regularly to verify that the organizational resources are used and transformed productively. The Slovenian forest-based industry's capability has to be continuously adjusted to the needs of the market, which would eventually lead to global competitive advantage, thus calling for extremely flexible organizations.

5.4 Research limitations and future direction

In this section, the researchers acknowledge some limitations of the study and propose ideas for further research. Firstly, this study focuses on the Slovenian forest-based industry, therefore, the findings exhibit results for the whole forest-wood-furniture industry when as a matter of fact, it consists of several different value chains. Future research can consider addressing needs of a specific value chain within the industry, for instance, the furniture value chain which is one of the potential areas for Slovenia's economic advantage (SPS, 2014). Next, the number of respondents involved in this study to represent each sphere is quite small. Although it does not affect the validation of this study, a greater number of responses would generate more comprehensive outcomes. Another limitation of the study is the time constraint. The SCA analysis and S&R method require continuous evaluation of the conditions by nature. After the sleet disaster in 2014, although the recovery process started immediately, the enabling environment has been rather turbulent in Slovenia. Considering the fact that the responses were obtained in early 2015, it is possible that the interpretation of actors in the forest industry were prejudiced by the temporary conditions. Future studies can investigate the

longitudinal and up-to-date situation of the industry as efforts to recover the disaster's waste have taken place and it is interesting to discover the impacts on overall industry performance.

6 Conclusion

The current turbulent business environment demands organizations that not only compete using their own capabilities but together with other members of the network to generate a value chain synergetic impact to create cooperation advantage in knowledge creation and innovation activities. This study is supporting these efforts by highlighting the areas for improvement in business processes and organizational routines of the triple helix institutional actors in the forest-based industry of Slovenia to enhance their innovation competitiveness. Some obstacles need further development, such as; (1) communication gap among actors; (2) necessities for the establishment of the cooperation are not acquired; (3) knowledge sharing are under-exploited; (4) critical information associated to innovation are not well circulated, and (5) procedures of work are not well clarified and understood. Bureaucratic hurdles should be minimized, particularly in public sector agencies to accelerate the process of innovation into the marketplace. Universities as main human resource producers are essential in configuring the actual knowledge and skills needed in order to supply accordingly. Firms who have practical exposure to the business environment should serve as a locus to coordinate the needs as well as opportunities of the industry's value chain to other spheres. It is necessary to engage all stakeholders to increase the resiliency of the industry. Ultimately, trust, strong commitment and effort towards goal achievement from all spheres are fundamental in the success of all cooperation.

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