

Article

# A Course of Innovations in Wood Processing Industry within the Forestry-Wood Chain in Slovakia: A Q Methodology Study to Identify Future Orientation in the Sector

Erika Loučanová, Hubert Paluš \* and Michal Dzian

Department of Marketing, Trade and World Forestry, Technical University in Zvolen, T. G. Masaryka 24, 96053 Zvolen, Slovakia; loucanova@tuzvo.sk (E.L.); michal.dzian@gmail.com (M.D.)

\* Correspondence: palus@tuzvo.sk; Tel.: +421-455-206-444

Academic Editors: Phillip G. Comeau, Maarten Nieuwenhuis and Timothy A. Martin

Received: 21 April 2017; Accepted: 13 June 2017; Published: 15 June 2017

**Abstract:** As innovations are the basic premise of commercial success in the market the main objective of this paper is to determine the main course of innovations in wood-processing industry within the forestry-wood chain in Slovakia from the viewpoint of representatives of wood processing companies. Using a Q-methodology approach the emphasis is also put on identification of differences between the opinions of small individual entrepreneurs and representatives of capital companies. Based on the results of structured interview with representatives of 33 wood processing companies the main findings suggest that future innovation activities in the sector will be related to the technology innovations mainly in processing of coniferous timber. However, the extent of such innovations is perceived differently depending on the company size and ownership category. While small individual entrepreneurs expect only slight innovation changes in the industry aimed at the meeting of required standards, managers of capital companies tend to foresee the future vision in restructuralisation of wood-processing industry.

**Keywords:** innovations; forestry-wood chain; Q-methodology

---

## 1. Introduction

Innovation activities are basic premise of commercial success in entrepreneurial unit for sustainable development of its business in the conditions of market economy. These activities present an important dynamizing factor of each enterprise and, at the same time, create a significant connecting bridge between the present and future of each company. Schumpeter defined innovation [1] as the setting up of a new production function, to denote the application of new ideas to the production process. Several authors [2–4] state that innovation is in the center of economic change. While radical innovations shape big changes in the world, incremental innovations fill in the process of change continuously. Innovations can be classified as introduction of a new product, process innovations, opening of a new market, development of new sources of inputs supply and changes in industrial organization.

If the enterprise is interested in increasing its investments, implementing new innovations and competitiveness, it has to search for all available sources and, especially, to make use of all supporting factors influencing its innovative processes.

However, the implementation of innovations is effected by specific investments and the conditions under which these investments would be realized. As mentioned by Paluš et al. [5], enterprises are willing to implement these investments only under specific conditions, which reduces the level of risk.

As presented by e.g., Klenk and Wyatt [6] some conditions related to risk mitigation can be eliminated by purposeful mobilization of knowledge and understanding leading to the innovations. Fazey et al. [7] indicates that the cooperation based on conceptual approach adopted by involved parties represents a route of knowledge spreading and innovation implementation. For the purpose of innovations development, Rametsteiner and Weiss [8] propose a more complex system view of innovation “as a complex non-linear process involving a range of players and different interactions”, with the focus on the social elements of the system.

Non-linear innovation model is considered to be an open innovation model. The basis for its application is in the utilization of external research capacities together with the company’s internal capacities, and in orientation in searching for selected elements of innovative process in external environment, respectively [9]. Such an open access to innovation process facilitates penetration of the innovation flow within organizations or within countries, which is presently also supported by innovative platforms of informative and communication technologies stimulating the innovations.

Innovative management is oriented on future direction of the enterprises and aims at providing the compatibility with the organizational environmental policy that represents driving forces of environmentally oriented strategy of the enterprises based on the principle of sustainable development [9].

Innovation process is strongly connected with forecasting in innovative process. The prognosis is systematically derived statement or prophecy about future state of investigated object, i.e., innovation in the innovative process, which shall be implemented under specific conditions in a specific period. The main objectives of forecasting in innovative process are most often the estimates of market changes, customer needs, development of competitors, development of market capacity as well as estimates of technology development, changes of disposable incomes and macroeconomic parameters [9].

The issue of innovation modeling and forecasting in wood-processing industry in the context of forestry-wood chain in Slovakia has not been broadly examined in the past, rather it has been specifically focused on the modeling and forecasting of wood and wood products market in Slovakia. The first models originating from the year 1985 were elaborated by Šupín [10] who dealt with the issue of modeling tropical logs import to former Czechoslovakia and forecasting its future development. In his later work [11] he presented forecasting models of forest products foreign trade from Slovakia to the European countries. Forest products supply and demand estimation was in detail investigated by Paluš and Šupín [12], Trenčiansky [13,14], Paluš [15], and Konôpka [16]. Parobek et al. [17] quantified wood material flows in the forestry-wood supply chain in Slovakia. Härtl and Knoke [18] examined the impact of oil price development on wood supplies in Germany. Single market models were improved during the years and even if it appears they have nothing to offer more, Hurmekoski et al. [19] argue that the movement in technology processing and continuous improving of the processes or production brings new challenges also for the issue forecasting and, moreover, as mentioned also by d’Annunzio [20], the forecasts of future development is becoming more and more demanded article. Furthermore, in the area of forest management practices a multidisciplinary research oriented on the assessment of forest management approaches in protected areas was carried out by Machar et al. [21], complex challenges of maintaining for innovative research, management and policy approaches by Hansen et al. [22] and Riguelle et al. [23] described a support system for the strategic management of crises by the forest community.

In the Slovak Republic the area of forests reaches slightly over 2 million ha. With its diverse tree species composition dominated by beech (33.2%), spruce (23.4%), and oaks (10.6%), the growing stock was 478.12 million m<sup>3</sup> and felling 9.14 million m<sup>3</sup> in 2015. Timber sales represent the most important source of income for forestry sector in Slovakia. Totally, in 2015, the domestic timber supplies were 8.61 million m<sup>3</sup> with the increasing trend in a share of hardwood timber. Taking into account imported timber volumes, the domestic processing industry consumed 6.9 million m<sup>3</sup>, while export accounted for over 2.6 million m<sup>3</sup> with a significant share of coniferous logs. On the other hand, wood processing

industry in Slovakia has sufficient production capacities to process the entire volume of harvested coniferous timber. Hardwood sawmills are able to consume up to 500,000 m<sup>3</sup> of logs annually [24].

As for the situation in forestry sector Šterbová et al. [25] state that current machinery of contractors is old and worn out and does not meet the needs for the development of modern technology and therefore has a negative impact on the environment. A lack of financial resources can be considered as the main cause of this situation [26]. However, as Dobšínská et al. [27] argue, in comparison to the past, the conditions for the implementation of innovations in forestry have significantly improved and enterprises are looking for ways to draw financial support for the implementation of innovative projects. Similar findings have also been reported from innovation research for forestry sector in the Czech Republic where EU subsidies and co-operation with suppliers, customers and services were identified as positive factors for implementation of innovations [28,29]. There are strong relations between suppliers, customers and producers in the sector in development of innovations [30,31]. Stone et al. [31] state that collaboration can be highly innovative and it can play an important role in the forest industry innovation efforts. In general the forestry represents a conservative and isolated field, with limited knowledge transfer, which is not able to invest enough in innovativeness and innovations [32]. Nevertheless, it appears that forest entrepreneurs face the same realities and react in the same way as their counterparts in other sectors [33].

According to the National program for the utilization of wood potential in the Slovak Republic [34], wood processing industry reports insufficient competitiveness on domestic and mainly on foreign markets. This is caused by a lack of own financial resources for innovations, essentially for small and medium wood processing companies, and consequently this economic unstable situation causes complications in preparation and implementation of innovations that would lead to the increased competitiveness. Most of domestic wood processing thus face difficulties in direct access to foreign markets and their production is often sold as semi-finished or low value products to subsequently processing companies. Parobek et al. [35] pointed out that the comparative advantages are changing with the level of wood products processing and, in particular, they decline with the increasing value added to the products. Trade specialisation is also influenced by the level of wood processing. While on the raw material level and the level of semi-finished mechanical wood products with low added value, such as sawnwood, Slovakia is inter-industry specialised, with the increasing added value of products its trade turns to be intra-industry specialised. The customers have not changed their consumption behavior towards wood as a material and therefore it is advisable to maintain the existing position and implement innovative strategic business models that emphasize wood as a material and its quality compared to substitute materials [36,37]. These models define the expectations and needs based on the environmental, as well as other considerations [38] and identify the specific product characteristics according to the customer requirements. This identification should be an important impulse for the companies to identify trends and to assume consecutive arrangements, improvements and innovations for selected products [39] in implementing the quality management systems with the aim of ensuring a higher efficiency in the whole sector [40]. Therefore, the forest sector must continually strive to improve or at least to maintain its market performance [41]. Results of the study by Kaputa et al. [42] also confirm that foreign competition is considered to be the most significant barrier for the Slovak exporters of wood products followed by the need to invest in promotional activities and limited access to capital. Moreover, there is an absence of the strategic development of the overall forest based sector that would provide more effective solutions for the problems arising from the transformation of the industry structure as well as the problems related to business relations within the supply chain influenced by a number of above mentioned factors and cyclical changes in timber prices. Klenk and Wyatt [6] argue that the strategy in the forestry sector should be focused on knowledge mobilisation that leads to innovations, which entails a level of engagement with partners that is creative and transformative rather than mainly informative and cooperation. In the long term, it should create new avenues for innovation in this sector and to all wood and forestry complex.

The main goal of this paper is to determine the main course of innovations in wood-processing industry within the forestry-wood chain in Slovakia from the viewpoint of representatives of wood processing companies using a Q-methodology approach. The emphasis is also put on identification of differences between the opinions of small individual entrepreneurs and managerial representatives of larger capital companies. Several studies [24,34,43,44] point out existing differences between these two categories. Managers rarely examine the underlying decisions necessary for achieving synergy while assuming that others will make the decisions necessary for achievement of expected synergies. This is because managers are often compensated based on the size of the company they manage rather than the wealth created for owners [45]. According to the theory [46], owners seek to maximize their wealth while managers tend to maximize their own best interests. Bucar et al. [47] argue that it is important to understand differences between managers and entrepreneurs/owners regarding exporting perceptions. For example, note that entrepreneurs/owners assume financial, psychic, and social risks and receive the resulting rewards of monetary and personal satisfaction and independence while managers have the power to allocate the resources but are not taking the same risks [42,48].

## 2. Materials and Methods

Methodology applied in this paper is based on Q-methodology, which is an important evaluation tool for the respondents attitudes towards given issues and successfully combines qualitative as well as quantitative approach to the research [49]. Q-methodology is effective for obtaining data from small samples, and it offers respondents a concise and valid way of expressing their viewpoints with minimal researcher interference and is an efficient tool in research involving the exploration and comparison of different points of view [50–53]. The procedure of Q sorting is the technical means whereby data are obtained for factoring [54]. As an independent research tool it was adopted in many scientific fields, for example in market research, politology, in the field of psychology or environmental protection [55]. Several studies using Q-methodology were published endoscopic gastrostomy feeding [56], psychosis [57], political science [54], utilization of public land [58] or in understanding participant's perspective in national forest management [59], for mapping stakeholder perceptions in participatory forest management [60] or incorporating values into community-scale sustainable forest management plans [61].

Q methodology is primarily an exploratory technique. It cannot prove hypotheses. It can, however, bring a sense of coherence to research questions that have many, potentially complex and socially contested answers [62]. The method employs a by-person factor analysis in order to identify groups of participants who make sense of (and who hence Q 'sort') a pool of items in comparable ways. It asks its participants to decide what is 'meaningful' and hence what does (and what does not) have value and significance from their perspective [63].

Procedures of the application of Q-methodology in this paper can be summarized in several steps:

- Problem definition and development of Q—sample. Based on the Report on Forestry in the Slovak Republic [30] there were the following nine statements (S1–S9) created by grouping the identified elements indicating future development in wood-processing industry as follows:
  - S1 Restructuring of the industry will be related to the closing of wood processing capacities.
  - S2 Restructuring of the industry will be related to the innovations of processing technologies.
  - S3 Technology innovations of the industry will relate to the processing of coniferous raw wood material.
  - S4 Technology innovations of the industry will relate to the processing of non-coniferous raw wood material, namely processing of higher quality classes of timber.
  - S5 From the viewpoint of assortments structure, do you see the future of the industry depending on the import of raw wood material from abroad.
  - S6 Development of the industry will be related to the diversification of production towards higher value products.

- S7 Development of the industry will be related to the diversification of production towards lower value products (biomass).
- S8 Direction of technology development in the industry will be focused on the purchase of new technologies.
- S9 Technologies used in the industry will be innovated only slightly in order to meet the minimum required by standards.

Q sample was determined on the basis of annually published information by the Ministry of Agriculture of SR in the Report on the State of Forestry [24,34,43] and these topics represent long-term discussed challenges in the forestry-wood chain in the Slovak Republic. Based on the review of available Reports the statements were selected in a way to list problems characteristic for both company managers and owners.

The statements were proposed on the current trends in reforestation in Slovakia, which lies in the expansion of beech, oak and other broadleaves stands at the expense of conifers. This development is related to the effort to increase the forest stands resistance to pests and windstorms. At the same time, the decreasing volume of coniferous felling causes the problem for the domestic wood processing industry that is not adapted to the changing patterns and structure of wood deliveries [64,65]. Currently, the pulp and paper industry as well as producers of wood based panels report sufficient production capacities to process low quality hardwood timber, however, there is a lack of operations specialized in processing higher quality classes. On the other hand the vast majority of domestic wood processors focuses on coniferous sawlogs processing. Therefore, the domestic sawmilling industry needs to undergo a substantial transformation to reflect to the changing timber supply conditions. Presently, up to 95% of domestic sawmills focus on softwood [34,66]. The following facts indicate that the situation in the Slovak woodworking industry is currently associated with a significant transformation.

- Based on this information there were individual quality or cost oriented statements [45,46] identified and proposed to be associated either with company owners or company managers. It is assumed that larger companies would have better possibilities to invest into existing technologies or to expand their production capacities (S2) with possible diversification towards non-coniferous timber processing (S4) as the present processing capacities are at low level. Similarly, due to the need to dispose sufficient financial resources, that is not the case for small entrepreneurs [43,44], larger companies are identified with statements S6 (Development of the industry will be related to the diversification of production towards higher value products) and S8 (Direction of technology development in the industry will be focused on the purchase of new technologies). On the other hand, orientation of innovations in the field of coniferous processing (S3) was assigned to small company owners as the most of the present mills are mainly represented by small entrepreneurs and therefore it is not assumed that they would radically change their established production patterns requiring availability of significant financial resources. This assumption is also a basis for the statement 9 that does not even suppose continuous innovation but only the orientation on meeting the required standard requirements (minimum innovations). Statement 5 (From the viewpoint of assortments structure, do you see the future of the industry depending on the import of raw wood material from abroad) is formulated with regard to the changing conditions in wood supplies (increasing share of domestic non-coniferous wood) and is intended for company owners to consider increase the imports of coniferous raw wood material from abroad in order to compensate insufficient domestic supply while staying with established processing technologies. Given that the structure of supplies may change the Statement 1 (Restructuring of the industry will be related to the closing of wood processing capacities) was formulated to find out whether such changes can result in shutting down the existing coniferous mills. Another statement assigned to company owners is the Statement 7 (Development of the industry will be related to the diversification of production towards lower value products—biomass) assuming that small entrepreneurs would be motivated to invest at least to production of biomass instead of investing



to higher value added products. Typology of statements is quality oriented for company managers and cost oriented for company owners [45,46].selection of P-sample of respondents sorting the specified statements. For this purposes we contacted professionals in a given field focusing individually on the owners and individually on the managers of wood processing companies. According to [62] large numbers of participants are not required for a Q methodological study as it aims to reveal some of the main viewpoints that are favoured by a particular group of participants. Following the recommendations of Kallay [49] not to include more than 50 participants, the final sample size was set to 33 respondent.

- Selection of Q-distribution. This includes the selection of the way for evaluating Q-sample, determination of the evaluation line ranking values from positive to negative attitude, and determination of the shape of the “forced” distribution [63] indicating the number of items that can be assigned to each ranking position as illustrated in Figure 1.
- Research implementation on determined Q-sample. For the purposes of this paper there was a structured interview used to address 33 respondents representing wood-processing companies, out of which 19 were representatives of capital companies such as limited companies and corporations (company managers) and 14 represented small individual entrepreneurs (company owners). The central task in the interviews was the Q sort, added upon by a number of open questions to gather qualitative data for interpretation of the factors [54,67]. Individual owners were represented by small entrepreneurs for whom a lack of own financial resources to support innovations is typical. This fact leads to the economic instability and difficulties in preparation and implementation of innovations that would increase competitiveness [43].
- Processing and evaluation of collected data was realized using the PQMethod software [68] and the interpretation of results was based on the basis of calculated indicators. The total number of statements that were sorted was 9 (S1–S9). The values of the Q-sort columns ranked from –2 to +2. The number of statements that could be assigned to individual scale values in our case followed the pattern 1 2 3 2 1. Calculated intercorrelations among Q-sorts were factor-analysed with the centroid method and resulting factors were rotated analytically. Finally, after selecting two relevant factors for which z-scores and factor scores were calculated Q-sort values for statements sorted by consensus vs. disagreement were obtained and used as a basis for interpretation.

-2	-1	0	+1	+2
Most disagree				Most agree

Figure 1. Shape of the used Q-grid.

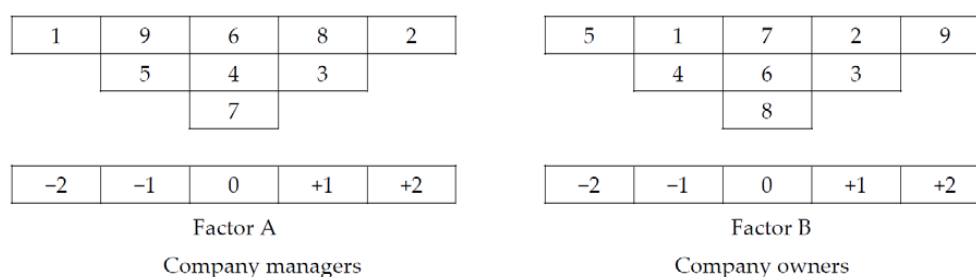
### 3. Results

Factor scores representing integer values based on z-scores were used to reconstruct the Q-sort of each factor. Resulting factor scores for individual statements are illustrated in Table 1. Based on the assumed association of statements to a respective group of respondents each statement is classified as a statement either for company owners (CO) or company manager (CM).

**Table 1.** Factor scores generated from Q-methodology testing of different company stakeholders in the forestry-wood sector in Slovak Republic.

	Statements	Type	Factors	
			A	B
S1	Restructuring of the industry will be related to the closing of wood processing capacities.	CO	−1	−2
S2	Restructuring of the industry will be related to the innovations of processing technologies.	CM	1	2
S3	Technology innovations of the industry will relate to the processing of coniferous raw wood material.	CO	1	1
S4	Technology innovations of the industry will relate to the processing of non-coniferous raw wood material, namely processing of higher quality classes of timber.	CM	−1	0
S5	From the viewpoint of assortments structure, do you see the future of the industry depending on the import of raw wood material from abroad.	CO	−2	−1
S6	Development of the industry will be related to the diversification of production towards higher value products.	CM	0	0
S7	Development of the industry will be related to the diversification of production towards lower value products (biomass).	CO	0	0
S8	Direction of technology development in the industry will be focused on the purchase of new technologies.	CM	0	1
S9	Technologies used in the industry will be innovated only slightly in order to meet the minimum required by standards.	CO	2	−1

Distribution of factor scores within each factor were compared with the types of statements in order to define mutual relations. At the poles of the distribution of factor A there are several statements related to the attitudes of company managers (item S2 ranked 2, item S8 ranked 1) and for factor B items related to the attitudes of company owners (item S9 ranked 2, item S3 ranked 1, item S5 ranked −2, item S1 ranked −1). Q-grids for both factors are illustrated in Figure 2.

**Figure 2.** Q-grids of differences in statements of company managers and owners.

#### Factor A: Company managers

There is a strong belief, that restructuring of the industry will be related to the innovations of processing technologies (item S2 ranked 2) oriented to the processing of coniferous raw wood material (item S3 ranked 1) with the intention to purchase new technologies. On the other hand, managers of larger companies do not link changes in industry to the closing of wood processing capacities (item S1 ranked −2) and do not suppose increasing share of supplies from imports (item S5 ranked −1) as well as they are not convinced that innovations will be limited only to the extend to meet the basic standard requirements (item S9 ranked −1). Respondents of this group were neutral regarding the increased processing of non-coniferous high quality raw wood assortments and related technology innovations (S4) and the both statements S6 and S7 assuming innovations related to the diversification of production towards either higher or lower added value.

#### Factor B: Company owners

Company owners tend to suppose that technologies used in the industry will be innovated only slightly in order to meet the minimum standards requirements (item S9 ranked 2), restructuring of the industry will be related to the innovations of processing technologies (item S2 ranked 1) and will be oriented to the processing of coniferous wood (item S3 ranked 1). In contrary, they do not expect changes in origin of wood supplies (item S5 ranked -2), innovations that would relate to the processing of non-coniferous raw wood material, (item S4 ranked -1) and they do not anticipate closure of production capacities (item S1 ranked -1). They have neutral attitude towards production diversification (S6 and S7) as well as to the purchase of new technologies (S8).

The greatest difference between the factor A and factor B can be seen in statement S9 (Technologies used in the industry will be innovated only slightly in order to meet the minimum required by standards). To the future, company managers do not consider that innovations will only take place in a small extent in order to meet the required standard (factor A; S9 ranked -1) while company owners represented by small entrepreneurs mostly agree with this option (factor B; S9 ranked 2).

#### 4. Discussion

Generally, Q-methodology is a method used in qualitative surveys and can be effectively employed as a powerful technique for single case studies of various kinds. It adopts a multiple-participant format in order to explore highly complex and socially contested concepts and subject matters from the point of view of the group of participants involved [63]. It can show the particular combinations or configurations of themes which are preferred by the participant group. Results of this study should be understood in the context of the research assumptions made. These relate to the subjectivity in determining the importance of selected Q-sort of statements and defining their theoretical linkages to companies, development of Q-grid form, selection of factors and sample of respondents. On the other hand, all examined statements address the key issues relating to the future innovation activities in wood processing industry in Slovakia that have been closely discussed during the recent years at different levels from policy makers to individual companies. Therefore, it can be assumed that the views of selected sample of respondents would correspond with the general view of industry representatives.

Based on the presented results it can be supposed that innovations in the wood processing industry, as a part of forestry-wood chain, will be focused on technology innovations and related to the processing of coniferous raw wood material. While small company owners will rather be expecting slight technology innovations ensuring compliance with the existing standards, managers of larger companies see the future development in restructuring the industry that will be related to the innovations of processing technologies. Company managers are more oriented to radical innovations due to the fact that the forestry-wood chain is not well organized in terms of cooperation between the suppliers and buyers in Slovakia and the wood processing industry is focused on low value added products. This situation creates opportunities for companies disposing financial resources to innovation development. Neutral position of managers to statement S4 indicates that in a long term there is a possibility for the development of investments supporting the processing of non-coniferous raw wood material as there is an increasing trend in supplies of non-coniferous timber due to the enhancing area of broadleaved tree species. Oppositely, company owners are essentially focused on incremental innovations that do not take into consideration these long term facts and are more cost oriented rather than quality oriented.

The differences between the visions of both groups may follow from the greater interest in support and implementation of innovations by large companies, especially those with foreign capital participation, compared to small ones which economic situation does not allow to generate sufficient financial resources to support innovation activities [44] as well as reflect to the theory that the owners tend to maximize their wealth while managers tend to maximize their own best interests [46].



Outdated and worn equipment that does not meet the requirements of modern technology and has a negative impact on the environment as well as the lack of funds is considered a major cause of this state [25,44]. Different views of both group of respondents are also supported by findings of Haluza [66] who states that the situation in the Slovak wood processing working industry is currently associated with a significant transformation. The need for overall improvement in the sector is also emphasized by the National program for the utilization of wood potential in the Slovak Republic [43] that states that there is a lack of own financial sources for innovation support, especially in small and medium wood processing companies, accompanied by economic instability in the part of enterprises and, at the same time, there is an absence of long-term strategy of the development of wood processing industry that would provide more efficient solutions of the present problems resulting in low competitiveness of the industry.

Situation in the forestry chain sector has improved during the recent years and companies seek for opportunities how to apply for financial support for implementation of innovations [27]. This is mainly valid for big companies that support mainly technological innovations aimed at purchase of new technologies. Small companies represented by entrepreneurs, however, perceive new technology innovations in a more negative way as they, as stated by Šterbová [25,34] are mainly subcontractors of foreign wood processing and trading companies with weak negotiation power. Due to this reason the enormous innovations are not typical in this industry segment and changes are usually applied as moderate changes of applied technologies in order to meet specific requirements of customers.

As presented by Šterborá et al. [25], the best way how to eliminate the identified differences in attitudes to innovation in forestry-wood chain is to use the existing opportunities, such as for example availability of financial loans, different supporting programs as well as cooperation with all stakeholders known as the strategy of partnership that could represent a long-term strategy for this sector. Therefore, such cooperation can be defined as the common denominator for the innovation development. In this context, it can be recommended to reinforce the existing cooperation through innovation pathways that are based on the existing innovation knowledge basis [69], as suggested by Hansen and Nybakk [70]. Similar recommendation aimed at the support of cooperation within vertical cooperation or model innovation system to stimulate innovation development are presented for example by Fazey et al. [7], Rametsteiner and Weiss [8], Rametsteiner et al. [71], and Klenk and Wyatt [6].

Our proposal to eliminate differences in orientation of innovations in wood processing industry within the forestry-wood chain in Slovakia, which is focused on the strategic cooperation, is similar to some other countries as reported by Klenk and Wyatt [6] who presented the strategy of innovation development in the sector of the forestry within the model of knowledge coproduction leading to innovations and solving the problems in this sector. This is in line with the national strategies concerning the forest-based sector in the EU regions that are based on increasing the appreciation of domestic wood raw material and on high finalization of processing the wood processed in the territory of the respective country, oriented to quality instead of cost minimizing. Contrary to this, the problem of high wood raw material export persists in the regions of Central Europe since it helps to create active trade balance [72].

## 5. Conclusions

The Slovak wood processing industry has traditionally been built on the domestic forest resources and its production capacities adapted to the volume and structure of wood supply. Recent changes in the composition of wood deliveries will affect the industry in terms of used technologies and will create the need for innovations.

It is possible to conclude that innovation activities in wood processing industry as a part of forestry-wood chain in Slovakia will move towards the innovations of processing technologies will be related to the processing of coniferous raw wood material. Bigger companies will focus on the purchase of new technologies, while small companies will be oriented on the innovations of the existing technology with the aim to meet the requirements of the existing standards. This difference in future orientation of innovations is mainly caused by a lack of financial resources to support

innovations in small enterprises. One of the possible ways how to eliminate these differences is to strengthen cooperation among stakeholders and, based on this cooperation, to develop a long-term innovation strategy for the sector. Such an innovation strategy has to be based on the improved relations between the forestry and wood processing sector, knowledge and respect of mutual needs with a view of enhanced utilization of domestic forest resources and increasing added value within the whole forestry-wood chain at national level.

**Acknowledgments:** The authors are grateful for the support of the Scientific Grant Agency of the Ministry of Education, Science, Research, and Sport of the Slovak Republic, Grant No 1/0473/16, “Dynamics and Determinants of Wood Based Products Market in the Slovak Republic”. The paper originated in terms of the Project “Centre of Excellence: Adaptive Forest Ecosystems”, based on the support of SOP Research and Development funded by the European Regional Development Fund under contract No. 262201200006 and No. 26220120049.

**Author Contributions:** E.L. and H.P. prepared the literature review and elaborated chapters Materials and Methods, Results, Discussion and Conclusions. M.D. helped with the literature review and data collection.

**Conflicts of Interest:** The authors declare no conflict of interest.

## References

1. Shumpeter, J.A. *Business Cycle: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*; McGraw-Hill: New York, NY, USA, 1939; p. 1095.
2. OECD. Oslo Manuals. The Measurement of Scientific and Technological Activities. Available online: <https://www.oecd.org/sti/inno/2367580.pdf> (accessed on 13 May 2017).
3. Kotsemir, M.; Abroskin, A. Innovation Concepts and Typology—An Evolutionary Discussion. Available online: <https://www.hse.ru/pubs/share/direct/document/76780100> (accessed on 13 May 2017).
4. OECD. Oslo Manuals. Guidelines for Collecting and Interpreting Innovation Data, 3rd ed. Available online: <http://www.oecd-ilibrary.org/docserver/download/9205111e.pdf?expires=1495107141&id=id&accname=guest&checksum=58906A7AD892177ACBE37578AA30C87E> (accessed on 11 May 2017).
5. Paluš, H.; Loučanová, E.; Kaputa, V. Kontrakty a manažment rizika inováčného procesu poskytovateľov lesníckych služieb na Slovensku. *Zpr. Lesn. Výzkumu* **2015**, *61*, 77–86. (In Slovak).
6. Klenk, N.L.; Wyatt, S. The design and management of multi-stakeholder research networks to maximize knowledge mobilization and innovation opportunities in the forest sector. *For. Policy Econ.* **2015**, *61*, 77–86. [CrossRef]
7. Fazey, I.; Bunse, L.; Msika, J.; Pinke, M.; Preedy, K.; Evely, A.C.; Lambert, E.; Hasting, E.; Morrie, S.; Reed, M.S. Evaluating knowledge exchange in interdisciplinary and multi-stakeholder research. *Glob. Environ. Chang.* **2014**, *25*, 204–220. [CrossRef]
8. Rametsteiner, E.; Weiss, G. Innovation and innovation policy in forestry: Linking innovation process with systems models. *For. Policy Econ.* **2006**, *8*, 691–703. [CrossRef]
9. Loučanová, E. *Inovačné Analýzy a Stratégie*; Technical University in Zvolen: Zvolen, Slovakia, 2016; p. 149. (In Slovak)
10. Dzian, M. *Prognózovanie Vývoja Dodávok Dрева pre Slovenský DSP*; Technical University in Zvolen: Zvolen, Slovakia, 2016; p. 78. (In Slovak)
11. Šupín, M. *Európsky trh s Drevom a Výrobkami z Dрева*; Technical University in Zvolen: Zvolen, Slovakia, 1997; p. 50. (In Slovak)
12. Šupín, M.; Paluš, H. Modeling sawnwood demand in the Slovak Republic. In *Acta Facultatis Xylologiae Zvolen*; Technical University in Zvolen: Zvolen, Slovakia, 1999; pp. 115–122.
13. Trenčiansky, M. Modelovanie ponuky dreva pre tuzeský trh na príklade vlákninových sortimntov. In *Financovanie 2000/1 Lesy—Drevo*; Technical University in Zvolen: Zvolen, Slovakia, 2001; p. 50. (In Slovak)
14. Trenčiansky, M. Dopyt po sortimentoch dreva na trhu v SR. In *Acta Facultatis Forestalis Zvolen*; Technical University in Zvolen: Zvolen, Slovakia, 2004; pp. 363–375. (In Slovak)
15. Paluš, H. *Modelovanie Dopytu po výrobkoch z dreva na trhu v SR*; Technical University in Zvolen: Zvolen, Slovakia, 2002; p. 49. (In Slovak)
16. Konôpka, J.; Konôpka, B. Vývoj náhodnej ťažby dreva na Slovensku a jej prognóza pre vietor, sneh a námrazu do roku 2025. *Lesnícky Časopis-For. J.* **2007**, *53*, 273–291.

17. Parobek, J.; Paluš, H.; Kaputa, V.; Šupín, M. Analysis of wood flows in Slovakia. *BioResources* **2014**, *9*, 6453–6462. [[CrossRef](#)]
18. Härtl, F.; Knoke, T. The influence of the oil price on timber supply. *For. Policy Econ.* **2014**, *39*, 32–42.
19. Hurmekoski, E.; Hetemäki, L.; Linden, M. Factors affecting sawnwood consumption in Europe. *For. Policy Econ.* **2015**, *50*, 236–248. [[CrossRef](#)]
20. D'Annunzio, R.; Sandker, M.; Finegold, Y.; Min, Z. Projecting global forest area towards 2030. *For. Ecol. Manag.* **2015**, *352*, 124–133. [[CrossRef](#)]
21. Machar, I.; Simon, J.; Rejsek, K.; Pechanec, V.; Brus, J.; Kilianova, H. Assessment of forest management in protected areas based on multidisciplinary research. *Forests* **2016**, *7*, 285. [[CrossRef](#)]
22. Hansen, A.; Ireland, K.; Legg, K.; Keane, R.; Barge, E.; Jenkins, M.; Pillet, M. Complex challenges of maintaining whitebark pine in Greater Yellowstone under climate change: A call for innovative research, management, and policy approaches. *Forests* **2016**, *7*, 54. [[CrossRef](#)]
23. Riguelle, S.; Hébert, J.; Jourez, B. WIND-STORM: A decision support system for the strategic management of windthrow crises by the forest community. *Forests* **2015**, *6*, 3412–3432. [[CrossRef](#)]
24. Ministerstvo pôdohospodárstva a rozvoja vidieka, SR. *Správa o Lesnom Hospodárstve v Slovenskej Republike za rok 2015—ZELENÁ SPRÁVA*; Ministry of Agriculture and Rural Development of the Slovak Republic: Bratislava, Slovakia, 2016; p. 37. (In Slovak)
25. Štěrbová, M.; Loučanová, E.; Paluš, H.; Ivan, L.; Šálka, J. Innovation strategy in Slovak forest contractor firms—A SWOT analysis. *Forests* **2016**, *6*, 12. [[CrossRef](#)]
26. Ambrušová, L.; Marttila, J. *Comparison of Outsourced Operations in Wood Procurement in Finland and Slovakia*; Finnish Forest Research Institute: Vantaa, Finland, 2012; p. 22.
27. Dobšínská, Z.; Sarvašová, Z.; Šálka, J. Changes of innovation behaviour in Slovakian forestry. In *The Annals of the "Stefan cel Mare"*; University of Suceava; Fascicle of The Faculty of Economics and Public Administration: Suceava, Romania, 2010.
28. Pudevítrová, L.; Jarský, V. Inovační aktivity v lesním hospodářství České Republiky. *Zpr. Lesn. Výzkumu* **2011**, *56*, 320–328. (In Czech)
29. Jarský, V. Analysis of the sectoral innovation system for forestry of the Czech Republic. Does it even exist? *For. Policy Econ.* **2015**, *59*, 56–65.
30. Anderson, F. A comparison of innovation in two Canadian forest services support industries. *For. Policy Econ.* **2006**, *8*, 674–682. [[CrossRef](#)]
31. Stone, I.J.; Benjamin, J.G.; Leahy, J. Applying innovation theory to Maine's logging industry. *J. For.* **2011**, *109*, 462–469.
32. Hansen, E.N.; Nybakk, E.; Panwar, R. Innovation insights from North American forest sector research: A literature review. *Forests* **2014**, *5*, 1341–1355. [[CrossRef](#)]
33. Drolet, S.; LeBel, L. Forest harvesting entrepreneurs, perception of their business status and its influence on performance evaluation. *For. Policy Econ.* **2010**, *12*, 287–298. [[CrossRef](#)]
34. Ministerstvo pôdohospodárstva a rozvoja vidieka, SR. *Správa o Lesnom Hospodárstve v Slovenskej Republike za rok 2014—ZELENÁ SPRÁVA*; Ministry of Agriculture and Rural Development of the Slovak Republic: Bratislava, Slovakia, 2015; p. 86. (In Slovak)
35. Parobek, J.; Paluš, H.; Loučanová, E.; Kalamárová, M.; Glavonič, B. Competitiveness of central European countries in the EU forest products market with the emphasis on Slovakia. *Acta Fac. Xylologiae* **2016**, *58*, 125–136.
36. Olšiaková, M.; Loučanová, E.; Paluš, H. Monitoring changes in consumer requirements for wood products in terms of consumer behavior. *Acta Fac. Xylologiae* **2016**, *58*, 137–149.
37. Loučanová, E.; Kalamárová, M.; Parobek, J. The competitiveness of wood products from the perspective of used material. *Acta Fac. Xylologiae* **2014**, *57*, 155–163.
38. Paluš, H.; Mat'ová, H.; Križanová, A.; Parobek, J. A survey of awareness of forest certification schemes labels on wood and paper products. *Acta Fac. Xylologiae* **2014**, *56*, 129–138.
39. Loučanová, E.; Parobek, J.; Paluš, H. Identification of Slovak customers' requirements for storage furniture based on the KANO model. *Acta Fac. Xylologiae* **2014**, *56*, 109–117.
40. Gejdoš, P. Analysis of performance improvement of wood processing companies in Slovakia and the Czech Republic through the implementation of quality management systems. *Acta Fac. Xylologiae* **2016**, *58*, 113–124.

41. Kaputa, V.; Paluš, H.; Vlosky, R.P. Barriers for wood processing companies to enter foreign markets: A case study in Slovakia. *Eur. J. Wood Wood Prod.* **2016**, *74*, 109–122. [CrossRef]
42. Ministry of Agriculture of the, SR. Proposal of the National Program for the Utilization of Wood Potential in the Slovak Republic, 2016. Available online: [www.mpsr.sk/download.php?fid=7417](http://www.mpsr.sk/download.php?fid=7417) (accessed on 20 November 2016).
43. Oravec, M.; Slamka, M. Produkcia a Využívanie Drevnej Biomasy na Slovensku, 2014. Available online: [https://www.siea.sk/materials/files/medzinarodne/projekty/biomasspolicies/Oravec\\_Slamka\\_Produkcia\\_a\\_vyuzivanie\\_drevnej\\_biomasy\\_jun\\_2014\\_SIEA\\_BiomassPolicies.pdf](https://www.siea.sk/materials/files/medzinarodne/projekty/biomasspolicies/Oravec_Slamka_Produkcia_a_vyuzivanie_drevnej_biomasy_jun_2014_SIEA_BiomassPolicies.pdf) (accessed on 12 November 2016).
44. Katz, J.P.; Niehoff, B.P. How owners influence strategy—A comparison of owner-controlled and manager-controlled firms. *Long Range Plan.* **1998**, *31*, 755–761. [CrossRef]
45. Amihud, Y.; Lev, B. Risk reduction as a managerial motive for conglomerate mergers. *Bell J. Econ.* **1981**, *12*, 605–617. [CrossRef]
46. Bucar, B.; Glas, M.; Hisrich, R.D. Ethics and entrepreneurs: An international comparative study. *J. Bus. Ventur.* **2003**, *18*, 261–281. [CrossRef]
47. Hisrich, R.D.; Peters, M.P.; Shepherd, D. *Entrepreneurship*; McGraw-Hill: Boston, MA, USA, 1998; p. 640.
48. Kállay, É. Q methodology: The investigation of meaning systems in different life-conditions through proverbs. *Cogn. Creier Comport.* **2007**, *11*, 353–369.
49. Eden, S.; Donaldson, A.; Walker, G. Structuring subjectivities? Using Q methodology in human geography. *Area* **2005**, *37*, 413–422. [CrossRef]
50. O’Riordan, M.; McDonagh, J.; Mahon, M. Local knowledge and environmentality in legitimacy discourses on Irish peatlands regulation. *Land Use Policy* **2016**, *59*, 423–433. [CrossRef]
51. Barry, J.; Proops, J. Seeking sustainability discourses with Q methodology. *Ecol. Econ.* **1999**, *28*, 337–345. [CrossRef]
52. Hermelingmeier, V.; Nicholas, K.A. Identifying five different perspectives on the ecosystem services concept using Q methodology. *Ecol. Econ.* **2017**, *136*, 255–265. [CrossRef]
53. Brown, S.R. *Political Subjectivity: Applications of Q Methodology in Political Science*; YALE University Press: London, UK, 1980; p. 355.
54. Müller, F.N.; Kals, E. Die Q-methode. Ein innovatives verfahren zur erhebung subjektiver einstellungen und meinungen. *Forum Qual. Sozialforschung* **2004**, *5*, 17. (In German)
55. Merrick, S.; Farrel, D. Head and neck cancer patients’ experiences of percutaneous endoscopic gastrostomy feeding: A Q-methodology study. *Eur. J. Cancer Care* **2012**, *21*, 493–504. [CrossRef] [PubMed]
56. Dudley, R.; Siitarinen, J.; James, I.; Dodgson, G. What do people with psychosis think caused their psychosis? A Q methodology study. *Behav. Cogn. Psychother.* **2009**, *37*, 11–24. [CrossRef] [PubMed]
57. Asah, S.T.; Bengston, D.N.; Wendt, K.; DeVaney, L. Prognostic framing of stakeholders’ subjectivities: A case of all-terrain vehicle management on state public lands. *Environ. Manag.* **2012**, *49*, 192–206. [CrossRef] [PubMed]
58. Steelman, T.A.; Maguire, L.A. Understanding participant perspectives: Q-methodology in national forest management. *J. Policy Anal. Manag.* **1999**, *18*, 361–388. [CrossRef]
59. Dasgupta, P.; Vira, B. “Q Methodology” for Mapping Stakeholder Perceptions in Participatory Forest Management; University of Cambridge: Cambridge, UK, 2005; p. 49.
60. Rodriguez-Piñeros, S.; Focht, W.; Lewis, D.K.; Montgomery, D. Incorporating values into community-scale sustainable forest management plans: An application of Q methodology. *Small-Scale For.* **2012**, *11*, 167–183.
61. Stainton, R.; Stenner, P.; Gleeson, K.; Stainton Rogers, W. *Social Psychology: A Critical Agenda*; Polity Press: Cambridge, UK, 1995; p. 320.
62. Watts, S.; Stenner, P. Doing Q methodology: Theory, method and interpretation. *Qual. Res. Psychol.* **2005**, *2*, 67–91. [CrossRef]
63. Paluš, H.; Parobek, J. Changing patterns of roundwood deliveries in Slovakia. In *Markets for Wood and Wooden Products*; WoodEMA: Zagreb, Croatia, 2013; pp. 77–94.
64. Paluš, H. Changes in energy wood supplies in the Slovak Republic. In *Wood Processing and Furniture Manufacturing Challenges on the World Market and Wood-Based Energy Goes Global*; WoodEMA: Zagreb, Croatia, 2015; pp. 261–266.
65. Haluza, I. Drevári, Ktorí Myslia na Odolnejšie Lesy. Available online: <https://www.etrend.sk/trend-archiv/rok-2017/cislo-6/drevari-ktori-myslia-na-odolnejsie-lesy.html> (accessed on 10 February 2017). (In Slovak)

66. Cuppen, E.; Breukers, S.; Hisschemöller, M.; Bergsma, E. Q methodology to select participants for a stakeholder dialogue on energy options from biomass in the Netherlands. *Ecol. Econ.* **2010**, *69*, 579–591. [[CrossRef](#)]
67. Schmolck, P. PQMethod Manual. Available online: <http://schmolck.userweb.mwn.de/qmethod/pqmanual.htm> (accessed on 14 May 2017).
68. Hansen, E.N.; Bull, L. An illustration of lessons for forest sector researchers and managers from current new product development research. *J. For. Prod. Bus. Res.* **2010**, *7*, 1–7.
69. Hansen, E.N.; Nybakk, E. When innovativeness determines market orientation: The forest sector and the Great Recession. *BioProd. Bus.* **2016**, *1*, 1–12.
70. Rametsteiner, E.; Hansen, E.N.; Niskanen, A. Introduction to the special issue on innovation and entrepreneurship in the forest sector. *For. Policy Econ.* **2006**, *8*, 669–673. [[CrossRef](#)]
71. Kupčák, V.; Pek, R. The level of the wood raw material base processing in the Czech Republic. *Procedia Econ. Financ.* **2015**, *34*, 557–564.
72. Oblak, L.; Glavonjčić, B. A model for the evaluation of radio advertisements for the sale of timber products. *Drvna Ind.* **2014**, *65*, 303–308. [[CrossRef](#)]



© 2017 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).