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The state of innovation in the British Columbia value-added wood products sector: The example of chain of custody certification

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ABSTRACT

This paper investigates the practices of the value-added wood products industry in British Columbia with respect to innovativeness using the results of an online survey. The survey employed an indirect self-evaluation scale to assess the propensity to create and (or) adopt new products, processes and business systems. Using chain of custody certification as an example of business systems innovation, this study also investigated the attitudes of the value-added wood products manufacturers, who were already certified or who may become certified, towards innovation in this form. Results show that the respondents rated themselves as more innovative with respect to business systems innovation compared to product and process innovations. Overall, innovation levels were low in the BC value-added wood products sector, a result which was confirmed in the case of chain of custody certification.

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1 Introduction

Historically, the forest industry in British Columbia (BC), Canada, has been a production-focused sector, largely mass producing and exporting primary forest product commodities, such as lumber, plywood and pulp and paper (Schultz et al. 2013). However, after decades of industry growth, the forest-based economy in BC has recently waned, and growth rates in the production of these commodities have levelled off or declined (Edenhoffer and Hayter 2013). Overall, many industry observers believe that the BC forest products industry faces significant challenges with respect to maintaining its competitiveness and levels of employment (Schultz et al. 2013; Innes 2009).

Given the current situation, enhancing innovation is increasingly seen as a path to competitive advantage and improved financial performance. Due to the rise of manufacturing in developing countries, notably China, there has been an escalation of interest among stakeholders in the potential for innovation to counteract the loss of global competitiveness and increase profitability (Hansen 2010). However, contrary to common belief, the notion that innovation is a key to competitiveness is not widely supported in the forest products industry literature (Knowles et al. 2008). The forest sector is perceived as being traditionally conservative and reluctant to adopt changes, even when these can be shown to be beneficial (Innes 2009). Hansen et al. (2014) describe forest sector companies as typically isolated, with limited knowledge transfer capacities, a tendency to inadequately utilize market opportunities and a weak focus on innovation.

Most innovation research focusing on the forest products industry suggests that there are three primary areas of innovation: product, process and business systems (Hovgaard and Hansen 2004; Hansen et al. 2007). Product innovation refers to developing products in new ways that satisfy customer needs, or create new, previously unrecognized needs. Process innovation refers to

improved processes, such as improved efficiency in raw material utilization, computer-aided manufacturing and customized machinery (Hovgaard and Hansen 2004). Business systems innovation represents the myriad activities that a firm can use to improve business and marketing management practices (Hovgaard and Hansen 2004). Consequently, innovativeness is defined as the propensity of firms to create and (or) adopt new products, manufacturing processes and business systems (Knowles et al. 2008). In other words, an innovative firm tends to be an early adopter of new concepts, products and technologies; tends to develop, create and apply new ideas, concepts and products; or some mix of the two (Hansen et al. 2014).

Most existing research points to a forest products industry that is focused on process innovation (Hansen 2010), particularly as it relates to cutting the cost of production of a limited range of commodity products (Innes 2009). For example, the twentieth century saw primary wood processing (lumber production) increasing its wood utilization rate (by volume) from 25-30 percent of the log to over 50 percent of the log (Wagner and Hansen 2005). However, the resultant product, dimension lumber, has remained largely unchanged over the past decades, justifying the industry's reputation as a laggard with respect to product or business systems innovation. That said, recent unique ways of addressing environmental issues, e.g. third-party forest certification, have been regarded as a distinct form of business systems innovation (Wagner and Hansen 2005).

A range of factors hindering innovation in the forest sector has been reported in previous research. For instance, institutional and other barriers to innovation may sometimes explain the relatively slow adoption of innovations in the forest sector (Rosenberg et al. 1990; Innes 2003). Little space in new policy development for innovation means that many government forestry departments are oftentimes risk-averse and unwilling to create policies that can promote

1 innovation (Vosick et al. 2007). A similar pattern was evident at an industrial scale: larger
2 companies in the U.S. forest products industry are more likely to adopt process innovation, but
3 smaller companies may neutralize this competitive advantage by more likely adopting product
4 and business systems innovations (Wagner and Hansen 2005), suggesting that resources and
5 higher levels of networking increase the ability to be innovative (Crespell et al. 2006). Lack of
6 priority, lack of slack resources (time and money), low levels of knowledge, lean centralized
7 organizations, a traditional culture, and a commodity mentality are all cited as significant barriers
8 to innovation within forest products companies (Hansen 2006; Stendahl and Roos 2008).

9 While innovation-related research in the forest products industry has focused largely on the
10 primary wood products sector, secondary or value-added manufacturers appear better able to turn
11 innovativeness into improved financial performance (Valimaki et al. 2004; Crespell and Hansen
12 2008). However, insight into the innovation portfolio of the secondary wood products sector is
13 still scant. There is no universally accepted definition of value-added wood products, but most
14 industry observers agree on a general definition based on product groups. Value-added wood
15 products use solid wood as inputs for remanufacturing into semi-finished and finished products.
16 Examples include various types of panels, engineered composites, millwork, hardwood
17 components, as well as consumer products like doors, windows, furniture and cabinets (Vlosky
18 et al. 1998). Several value-added products, such as engineered wood products, represent a
19 relatively new category of products, providing an example of product innovation. Companies
20 developing these products have been able to open new markets not previously available to the
21 traditional forest products industry (Innes 2009).

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1 In this paper, we use the example of forest certification as an example of an innovation that
2 value-added wood producers can pursue. Forest certification is a mechanism that has as its
3 primary objective the improvement of forest management through marketing incentives (Upton
4 and Bass 1996). Forest certification aims at greater efficiency in forest resource use through an
5 expected increase in consumer demand for sustainably produced forest products (Cashore et al.
6 2004). It has also been variously defined as a market-based conservation initiative aimed at
7 reducing the impacts of poor or illegal logging (Leslie 2004), a nonstate market-driven
8 mechanism providing incentives to conform to procedures and standards in sustainable forest
9 management (Cashore et al. 2004), or a process of labeling wood that has been harvested from a
10 well-managed forest (Natural Resources Defense Council 2016), amongst others. The emergence
11 and interest in non-state market-driven forest certification programs can be traced to the
12 economic and political trends in the early 1990s, when market-oriented policy instruments
13 became increasingly important strategic tools both domestically and internationally (Cashore et
14 al. 2003).

15 There are normally two types of forest certification, namely forest management certification and
16 chain of custody certification (Elliot 2000). Forest management certification involves the
17 inspection of forest management on the ground against specific standards which usually include
18 ecological, economic and social elements, as well as a review of relevant documents such as
19 management plans and inventories. Chain of custody (CoC) certification, on the other hand, is a
20 market-based tool that involves tracing round wood and processed timber products through the
21 CoC (or supply chain) from the forest through processing and distribution to the final purchaser.
22 The process of chain of custody certification provides assurance to customers in the marketplace
23 that certified wood products originate from sustainably managed forests. Situated in the middle

of the forestry supply chain, value-added wood producers are ideally suited to adopt CoC as a business innovation (Vidal et al. 2005).

The BC value-added wood products sector has the potential to be a champion of environmentally-friendly or 'green' products and to create thousands of new jobs, hundreds of millions of dollars in incremental manufacturing sales, new profits for entrepreneurs and higher government revenue streams to pay for public services (Schultz et al. 2013). However, it has yet to gain prominence as an industrial sector in BC, despite the 'wood culture' that is in place (Parfitt 2011). A possible explanation for this failure may be that value-added wood products companies are unable or unwilling to take the risks that are inevitably associated with innovation and may face a number of significant challenges related to innovation, including a fear of change, ineffective management and poor communications (Crespell and Hansen 2008).

2 Methodology

The Tailored Design Method (Dillman 2000) was used to design and administer an online survey. According to McIlhenney et al. (2013), there are 700 to 800 value-added wood producers in British Columbia. Lists of companies were obtained primarily from the directory of secondary manufacturing in BC, as well as from other sources, such as the Log World directory and membership lists of the BC Wood Specialties Group. Email addresses of companies were obtained either from companies' websites or by telephoning them. Telephone conversations with company representatives were conducted to ensure that the targeted audiences for this survey were management representatives of the companies. The final list included 373 value-added producers in British Columbia with valid email addresses. All of these 373 companies were contacted via email and invited to participate in an online survey. Since this research was

1 conducted through an online survey, only companies that had valid email addresses were invited
2 to participate in the survey. Companies that did not have email addresses or refused to provide
3 their email addresses were excluded from the study.

4 The initial email containing a survey link was sent to the 373 identified value-added wood
5 producers in British Columbia in October, 2013. The email explained the objectives of the
6 survey, the importance of participation by companies, and the overall value of the survey to the
7 sector. Non-respondents were sent follow-ups three times every two weeks after the initial
8 deadline. This was done as multiple contacts are more effective than using other techniques to
9 increase the response rate for surveys (Dillman 2000).

10 In this study, innovativeness was defined as the propensity of firms to create and (or) adopt new
11 products, manufacturing processes and business systems (Knowles et al. 2008), a categorization
12 that is supported by previous forestry industry research findings (Hovgaard and Hansen 2004;
13 Hansen et al. 2007). To measure innovativeness in the BC value-added wood products sector, an
14 indirect self-evaluation scale was designed to assess the propensity of value-added manufacturers
15 to innovate on these three dimensions. This scale was composed of nine items, each being
16 assessed using a five-point Likert scale (with 1 being “strongly disagree” and 5 being “strongly
17 agree”). Survey items that were considered to be indicators of product innovation included
18 readiness to develop new products, readiness to take on a leading role in R&D for new products
19 and having a diversified product line. Items for process innovation included readiness to install
20 new processing equipment, efficiency in raw material use and capitalizing on innovative
21 processes from other industries. Business systems innovation included factors such as readiness
22 in seeking new customers, willingness to bear marketing costs and the ability to train new
23 marketing managers.

Means were calculated for each variable, i.e., type of innovativeness, with the assumption – common in market studies – that the five points on the scale are equi-distant (interval scale). A one-sample *t*-test was used to determine if the means for these scales were significantly different from the midpoint of the scale (3), which indicates a neutral position regarding firm innovativeness. Testing to determine if the values are significantly different from the scale midpoint gives an indication that respondents have strong opinions (one way or the other) regarding the innovativeness of their firms.

K-means cluster analysis was used to categorize responding companies based on their degrees of innovativeness. Innovation-related questions on which cluster analysis was performed were asked of certified and interested companies only (40 companies in total). The three variables used to create clusters of companies included product innovation, process innovation and business systems innovation. *K*-means cluster analysis is a useful technique used for classification of objects without prior assumptions about the population (Punj and Stewart 1983). The procedure identifies relatively homogeneous groups of cases based on selected characteristics and is frequently used in marketing research when there is a need to group the firms or consumers in homogenous groups in order to find comparable segments to test the market (Ketchen and Shook 1998). The *K*-means clustering procedure was undertaken in this analysis using SPSS 22.0 and solutions for two and three clusters were explored. However, only the two cluster solution is reported here as it yielded meaningful results. Ten iterations were required to minimize variability within and maximize variability between the two clusters.

Three variables were chosen for the analysis of the companies' characteristics in the two-cluster solution. These variables included company size, proportion of sales in the international markets and interest in CoC certification. We used the number of full-time employees as an indicator for

company size. Previous research has shown that larger companies tend to be more innovative than smaller companies (Rametsteiner and Weiss 2004). Therefore, it was assumed that the size of the company could affect its propensity to adopt and (or) create innovation. Additionally, companies that are export-oriented have been found to be more innovative (Wagner and Hansen 2005). According to UNECE (2013), markets for value-added wood products are more advanced in the USA and Europe than in Canada. Therefore, a desire to increase the proportion of sales in international markets, particularly in the USA and Europe, could be an indication of more innovative companies. As the data representing the average sales volumes in the US and European markets were given in percentages (between 0% and 100%), they were normalized using the arcsine transformation, *i.e.* $x' = \arcsin \sqrt{x\%}$. Finally, having an interest in CoC certification is an example of a business systems innovation; many value-added wood products companies are changing their corporate strategies by addressing environmental issues through initiatives such as third-party environmental certification (Karna et al. 2002). Adoption and/or interest in CoC certification can, therefore, be considered a direct indication of business systems (market) innovation.

Independent samples *t*-tests ($\alpha = 0.05$) were performed to test if there were any significant differences in the two clusters between the number of full-time employees and the proportions of products destined to export markets (the United States and Europe) using Levene's *F*-Test (for homogeneity of variances) and Welch's *t*-test (with equal variances not assumed). A *Z*-test ($\alpha = 0.05$) was used to compare the proportions of certified companies between the two clusters.

Finally, using Rogers' (2003) Diffusion of Innovations (DOI) theory, perceived attributes of an innovation, including relative advantage, compatibility, complexity, trialability and

observability, were measured in order to determine factors that inhibit or facilitate CoC certification adoption (as an example of a business systems innovations). A five-point Likert-type scale, with 1 being “strongly disagree” and 5 being “strongly agree”, was applied to assess these perceived attributes (that were treated as interval in nature). For each item in the Likert scale, means were computed in order to position the relative importance of each item, and 95% percent confidence intervals were constructed. Mean values of each statement were tested against a neutral value of 3 (at $\alpha = 0.05$), which represents a neutral attitude for each variable, in order to ascertain whether or not the perceived attributes of innovation were significant.

The reliability or the internal consistency, of the scale items used in the survey were estimated by using a reliability coefficient, Cronbach’s alpha. An internal consistency analysis was performed separately for each of the constructs of quality management. Typically, a reliability coefficient of 0.7 is considered to be acceptable; however, lower thresholds are also sometimes used in the literature (Nunally 1978). Higher values of Cronbach’s alpha indicate a higher degree of reliability. The reliability values for most of the scales used in this study range from 0.6 to 0.8, indicating that scales used was generally reliable.

Content validity is the degree to which elements of an assessment instrument are relevant to and representative of the targeted construct for a particular assessment purpose (Haynes et al. 1995).

A measure has content validity if there is a general agreement among the subjects and researchers that the instrument has measurement items that cover all aspects of the variable being measured. In this study, the innovativeness questions were mainly based on previous studies (Hovgaard and Hansen 2004; Hansen et al. 2007) who had selected the measurement items based on an extensive literature review. Furthermore, the authors of this study reviewed the relevant

literature on Rogers' Theory of Diffusion of Innovations to develop constructs to measure perceived attributes of innovations and made adjustments to the instrument to ensure content validity.

3 Results

3.1 Non-response bias

Of the 373 companies sampled, 123 companies completed the survey, resulting in a 33% response rate. In order to test for non-response bias, the data were divided into two groups according to the completion dates of each response, as comparing early (initial) respondents to respondents of follow-up mailings (later respondents) can be used to test for non-response bias (Armstrong and Overton 1977). Responses from the first two email invitations were considered early respondents and the respondents from last two email invitations were considered late respondents. Data from the early respondents were combined and tested against the data from the later respondents on three key variables: proportion of certified and non-certified companies, average number of full-time employees and average percentage of sales volume within BC.

Two-tailed *t*-test and Z-tests were conducted to test the hypotheses that there were no significant differences between the population parameters between early and late respondents with respect to the average number of full-time employees, the average percentage of sales volume within BC and certification status (certified or not). Since the data representing the average percentage of sales volume within BC were given in percentages between 0% and 100%, an arcsin transformation was conducted to normalize the data.

Table 1 summarizes the means and the proportions for each variable selected, as well as the *p*-values ($\alpha = 0.05$) obtained by testing the differences between each set of means and

1 proportions. Notably, no between-group mean differences were found between early and late
2 respondents. From this, it was concluded that non-response bias was not a major factor in this
3 research. Although the non-response bias was not found to be statistically significant, there were
4 some unavoidable limitations given the nature of the sampling in which only companies with a
5 valid email address were targeted. Therefore, to generalize the results to the entire value-added
6 wood products sector, the study should have also involved companies that were excluded using
7 this approach.

8 To further test for non-response bias, an existing study based on a large survey conducted in
9 2006 (Stennes & Wilson 2008) was used as a benchmark. This study reflected the entire
10 population of the BC value-added wood producers. Three variables, including the firm size
11 (measured by the average number of full-time employees and annual sales revenue), proportion
12 of domestic sales and types of species utilized were used for comparative purposes (Table 2).
13 These three variables were seen as a valid characterization of the BC value-added wood products
14 sector, and have been used similarly in previous studies (DeLong et al. 2007; Kozak et al. 2003).

15 Although there were similarities between this study and the Stennes and Wilson (2008) study,
16 some differences were also observed, indicating that there may be some degree of bias in our
17 study. However, it could be argued that the observed differences merely reflect temporal
18 differences, as other research has shown that the secondary wood products manufacturing sector
19 in Canada is changing rapidly (DeLong et al. 2007). The sector began to decline in 2007 as a
20 result of the 2008 recession, combined with the collapse of the North American housing market
21 (Natural Resources Canada 2015). The recession heralded a period of slow global demand which
22 significantly affected British Columbia's lumber output (Statistics Canada 2013). This, in turn,
23 has changed the size, focus and nature of the value-added wood products sector and, from 1990

1 to 2012, BC's share of the Canadian export market for almost all sub-sectors of the value-added
2 wood sector has declined (Schultz et al. 2013).

3 **3.2 Innovativeness in the BC value-added wood products sector**

4 The propensity of the BC value-added wood products sector to create and (or) adopt innovation
5 is shown in Table 3. Among the items measuring product innovations, the propensity to develop
6 new products and having diversified product lines, both with means of 3.8, were found to be
7 significantly different from the midpoint (3). The respondents were less ready to take a leading
8 role in R&D for new products, having the lowest mean (3.1) among all items that measure
9 product innovations.

10 In terms of process innovations, the propensity for efficient raw material use (mean = 3.9) and
11 the propensity to install new processing equipment (mean = 3.3) were significantly different
12 from the midpoint. Value-added producers were not taking advantage of innovative processes
13 from other leading industries, having the lowest mean (mean = 3.2) among all items measuring
14 process innovations.

15 Business systems innovations were rated marginally higher (overall mean of 3.6) than product or
16 process innovations (both with overall means of 3.5). Of the business systems innovations, the
17 propensity to look for new customers had the highest mean value (mean = 4.1) and was
18 statistically different from the midpoint. The organization's readiness to bear the cost of
19 marketing for products promotion was also significantly different from the midpoint, with a
20 mean of 3.5.

3.4 Two-cluster solution

A K-means cluster analysis, based on the propensity to innovate statements shown in Table 3, was conducted to categorize groups of value-added companies according to their degree of innovativeness. As the cluster analysis was performed on companies that were currently certified or were interested in certification (n=40), the two-cluster solution resulted in equal sample sizes of 20 members in each cluster. The final cluster centres are shown in Table 4 with the mean of Cluster 1 being 3.8 and the mean of Cluster 2 being 3.2, indicating that Cluster 2 has more of a tendency towards neutrality where innovation is concerned.

In order to establish profiles of the clusters, the characteristics of each cluster were aggregated. Table 5 shows the variables that were used to study the distinct characteristics of each cluster, including average numbers of employees, average percentages of export volumes (USA and Europe) and proportions of certified and non-certified, but interested, companies.

The mean number of employees in Cluster 1 was 42.1 versus 91.8 in Cluster 2. However, there was no significant difference between the numbers of full time employee means in the two clusters. Similarly, the mean sales percentages to USA and European markets were not significantly different between the two clusters, nor were the proportions of certified companies.

Even though no significant differences between the two clusters were uncovered, some distinct trends were noted. Cluster 1 was comprised primarily of medium-sized companies, with almost one-quarter (24.4%) of their sales volume being exported to the United States. These companies showed a generally neutral view towards innovation with 80.0% of the companies being certified. Cluster 2 was comprised primarily of larger companies with higher proportions of export volumes destined for the United States (24.4% vs 37.3%). These companies also showed

1 a generally neutral view towards innovation, but the proportion of certified companies was lower
2 than in Cluster 1, at 70.0%.

3 **3.3 Attitudes of certified and interested companies**

4 Of the 121 total respondents, 41.0% were certified, while another 13.0% of respondents were not
5 certified, but were interested in becoming certified within five years. The remaining 46.0% were
6 not certified and had no interest in becoming certified. The certified (n = 49) and interested
7 companies (n = 15) were further investigated to determine their attitudes towards chain of
8 custody certification.

9 With aggregated ratings significantly higher than neutral, certified companies (CCs) believed
10 that certification helped to improve their corporate image (mean = 3.9), was compatible with
11 company values (mean = 3.8) and helped in meeting requirements of other policy instruments
12 such as LEED⁴, the Lacey Act⁵ and FLEGT⁶ (mean = 3.5) (Figure 1). A majority of certified
13 companies (CCs) also believed that certification helps access new markets (mean = 3.4) and that
14 the requirements of certification standards fit well with their existing processes and procedures
15 (mean = 3.3). However, attitudes regarding the likelihood of enhanced effectiveness of the
16 production processes (mean = 2.2) were significantly lower than neutral. Other variables under
17 study showed no significant differences from neutral.

18 As shown in Figure 1, most of the non-certified, but interested companies (NCICs) had generally
19 positive views about most of the statements (with scores higher than the neutral point). For 17

⁴ The Leadership in Energy and Environmental Design (LEED) program, administered by the Green Building Council is the leading third-party certifier of sustainable construction projects in North America. It was initiated in 1998 as a voluntary program for designing sustainable, high-performance buildings (Germain et al. 2010).

⁵ The Lacey Act aims to build markets for verifiably legal products by banning the import and sale of illegally-sourced timber and other plant products in the United States (U.S. Fish & Wildlife Service 2016).

⁶ Forest Law Enforcement, Governance and Trade (FLEGT) is the European Union response to illegal logging, which aims to reduce illegal logging by strengthening sustainable and legal forest management, improving governance and promoting trade in legally produced timber (EU FLEGT 2016).

out of the 18 statements, the mean for these companies indicated strong agreement or agreement (a rating above 3). NCIC respondents believed CoC certification can be adapted or modified to suit the production process within their organizations (mean = 4.4). NCICs also viewed CoC certification as a pathway to meeting requirements of LEED, the Lacey Act and FLEGT (mean = 4.4), indicating that they perceive CoC certification to be compatible with other market-driven instruments. Unlike certified companies, NCICs believed adopting CoC certification will lead to increased price premiums on certified products (mean = 4.3), indicating that many interested companies perceived the relative advantage of CoC certification positively. NCICs also agreed that CoC certification helps access new markets (mean = 3.9) and that it improves corporate image (mean = 4.0) and is compatible with company values (mean = 4.1). In terms of the impact of CoC certification on the effectiveness of the production process, NCIC respondents held similarly negative views as CCs (mean = 2.8).

4 Discussion

The results of this study indicate that despite significant differences compared to a neutral scale value, mean values for all types of innovativeness tended to cluster closer to the scale midpoint (3) than to the upper end of the scale (5), with the exception of the propensity to look for new customers. This indicates that, overall, the value-added wood manufacturers in this study, while embracing innovation to a certain extent, do not have particularly strong positive (or negative) views on the innovativeness of their firms. The cluster analysis shows a distinct homogeneity within the BC value-added wood products sector when it comes to innovativeness. This implies that the value-added wood products sector follows the trend of primary manufacturers in terms of innovativeness, a result that was borne out in a study conducted by Knowles et al. (2008), which

1 assessed the innovativeness of softwood sawmills in the USA and Canada and found that
2 respondents did not have strong positive views about the innovativeness of their mills.

3 That the respondents in this study had very positive views regarding only one item related to
4 business systems innovativeness, the propensity to look for new customers, is encouraging given
5 that the industry has traditionally focused on existing customers versus new customers, and
6 consequently, incremental versus radical innovations (Hansen 2006). A customer focus suggests
7 not merely reacting to existing customer demands, but proactively seeking to meet the needs of
8 new customers and the changing needs of existing customers (Leavengood and Anderson 2014).
9 According to Hansen (2006), firms rely heavily on customers for innovative ideas. Customers
10 can be significant drivers of innovation and successful new product development (NPD) by
11 maintaining close connections with manufacturers during product development. Experts suggest
12 that the wood products industry needs to shift to a market-oriented culture in order to improve
13 innovation performance and a major component of such a shift includes how firms interact with
14 their customers and competitors (Leavengood and Bull 2014). Many value-added wood product
15 manufacturers in BC lack in-house capacity and resources to design and develop new products
16 (Schultz et al. 2013). Unfortunately, there is insufficient recent empirical data in BC to suggest
17 which new products have the greatest growth potential, which markets should be pursued and
18 which products best match with its current resource base. These knowledge gaps need to be
19 filled.

20 This survey found that the major focus of innovations in the value-added industry was for
21 business systems. These results are consistent with Wagner and Hansen (2005), who found that
22 smaller companies are more likely to adopt business systems innovations, whereas larger
23 companies outperform smaller companies in process innovations since they have greater access

1 to capital for these purposes. In another study of 587 U.S. firms, Cohen and Klepper (1996)
2 found that large firms have a greater incentive to engage in R&D activities for which they have
3 ‘appropriability advantages’ compared to smaller firms. These advantages are strong when
4 knowledge is less tradeable, in ‘disembodied forms’, as in the case of process innovations given
5 effective intellectual property protection. Our survey results also indicate that the respondents
6 were least innovative with respect to taking a leading role in R&D for new products. R&D and
7 innovation are inextricably connected (Leavengood and Bull 2014). Capacity to innovate is a
8 central factor of success for value-added wood products sectors around the world, and
9 governments generally play a major role through direct investment in research and education
10 (Schultz et al. 2013). Despite the presence of world class universities and research institutions in
11 BC focusing on wood products, the capacity to undertake research related to the technology
12 interests and needs of the value-added wood sector wood products is significantly challenged
13 (Schultz et al. 2013). The sector is composed primarily of small and medium sized enterprises,
14 and management capacity is routinely focused on their normal business operations, with a lack of
15 organizational slack to focus on short- and long-term research interests. Hence, individual
16 engagement between producers and the research infrastructure is particularly challenging in BC
17 (Schultz et al. 2013).

18 In this study, the two-cluster solution showed that, on average, both clusters had generally
19 neutral views on all three measures of product, process and business systems innovations. This
20 indicates that, regardless of the company size, adoption and creation of innovations in the BC
21 value-added wood products sector is largely slow and homogenous. Given that the majority of
22 businesses in this sector are small- and medium-sized enterprises (SMEs) (DeLong et al. 2007),
23 enterprises oftentimes lack the capacity to invest in innovation-related activities. The

Organization for Economic Co-operation and Development (OECD 2010) estimates that, on average, firms tend to spend 1-2% of turnover on various innovation-related activities, but this share exceeds 5% for large firms in some countries. Paradoxically, Canada is a leading country, spending more than 5% of turnover on innovation, both in the categories of SMEs and large manufacturing firms (OECD 2010). A more thorough understanding of what proportion of the annual turnover is spent on innovation by the BC value-added wood products manufacturers and what barriers to innovation exist for these SMEs are research questions that should be addressed in future studies. These questions are especially germane as innovation is central to the success of the value-added wood products sector in light of increasingly fickle markets and intense competition from low-cost producers in developing regions.

The two-cluster solution also failed to uncover significant difference between the clusters with respect to the proportion of certified companies. While the adoption of chain of custody certification has grown in the past few years in the BC value-added sector (Gilani 2015), our survey indicated that a large number of companies were not interested in pursuing certification. The example of certification – as a business innovation – illustrates that, despite all the perceived benefits of certification, chain of custody certification is characterized by a slow rate of adoption, hence corroborating the overall view that innovation progresses slowly in the sector. This result is surprising given that many companies in the forest sector are shifting to the use of raw materials from well-managed forests, addressing environmental concerns and using certification processes to demonstrate their sustainability credentials due to changing market requirements and globalization (Leavengood and Bull 2014). In fact, over the past few decades, environmental certification and a corporate focus on exports are two of the more successful initiatives that have been noted with respect to business systems innovations in the forest sector (Wagner and Hansen

2006). This implies that, while certified forest companies are investing in chain of custody certification as a tool to access new markets, such as the United States and Europe where more stringent measures to control illegal wood are in place, the value-added wood products sector in BC is lagging in this regard. Given that certification is generally regarded as a pathway for addressing legality requirements (UNECE 2012), initiatives such as the Lacey Act amendments and FLEGT may help to catalyze interest in certification among BC value-added wood producers should emergent markets dictate proof of legality.

This survey indicated a difference in attitudes towards CoC certification between two groups of respondents, certified companies (CCs) and non-certified but interested companies (NCICs). This may be because NCICs had not yet adopted the CoC certification, so their responses reflect their expectations, whereas CCs responses were more indicative of their actual experiences (Figure 1). From the survey results, it can be generalized that NCICs were relatively optimistic about the economic benefits of CoC certification, whereas the actual experience of CCs demonstrates that while certification improves the corporate image, tangible benefits such as price premiums have not yet been achieved.

According to this study, CCs considered a company's corporate image and meeting the regulatory requirements of LEED certification as the two most important determining factors for adopting CoC certification, a result that is consistent with the findings of previous studies (Perera et al. 2008; Chen et al. 2011). In this context, CoC certification appears to imply that a company is managing its business well and is showing ethical and environmental responsibility. The fact that a company has been awarded the CoC certification by an independent third-party enhances its perceived reliability and credibility.

1 The NCICs in this study were generally optimistic about certified wood markets, believing that
2 certification had the potential to command price premiums and would help to meet the regulatory
3 requirements for LEED certification. Interestingly, current Canadian procurement requirements
4 involve a commitment from the Public Works and Government Service Canada to achieve LEED
5 Gold standard certification for all new public buildings (Government of Canada 2010). Such
6 policies can create momentum and catalyze further adoption of forest certification (beyond
7 merely CoC) because wood products certified by an FSC standard also contribute, in a very
8 minor way, to certification under the LEED standard (Tikina et al. 2012).

9 Seeking market benefits and compatibility with companies' values (such as access to new
10 markets) also appear to be motivating factors for CCs and NCICs to adopt CoC certification.
11 Both groups were also of the view that CoC certification does not enhance the efficiency of the
12 production process. The most likely explanation for this is that maintaining certification requires
13 an enormous amount of paperwork and tracking and (or) the allocation of physical space for
14 separating CoC-certified products from other products (Chen et al. 2011).

15 NCICs did not perceive CoC certification to be a complex process, which is not surprising given
16 that they had not actually adopted certification and were not, therefore, exposed to the
17 particularities of the CoC process and standards. Conversely, even though CCs had a general
18 belief that the CoC standards are relevant to the value-added wood products industry, they
19 perceived CoC certification to be a relatively complex process. CCs indicated difficulties in
20 factors such as understanding CoC standards, choosing the right certification scheme, and a lack
21 of clarity surrounding CoC standards. Furthermore, CoC certification requires significant
22 resources to train staff, which adds increased burden to these manufacturers.

Finally, for value-added wood producers (in British Columbia and elsewhere) interested in adopting CoC certification, it should be noted that the diversity of ecolabels, reflecting the multitude of certification schemes that proliferate the market, can be confusing to customers and weaken the credibility of all labels (Fisher et al. 2005). Coordination and competition in the field of certification has been cited as a major challenge to the legitimacy of certification schemes (Marx 2011). Different organizations that essentially have the same social and environmental goals are currently operating alongside one another. Competition between the certifiers can lead to a 'race to the bottom' in an effort to increase market shares, thereby compromising enforcement mechanisms (Marx 2014). However, initiatives have been developed to achieve greater cooperation among certification schemes (Fischer et al. 2005). For example, the Programme for the Endorsement of Forest Certification (PEFC), which is an umbrella organization, has developed a common standard and endorses national forest certification programs that meet its requirements.

5 Conclusions

This paper aimed to provide insights into the state of innovation in the British Columbia value-added wood products sector. Innovation has been very slow in this sector, and largely restricted to business systems innovation. While very few of the items measuring innovativeness were rated highly, our results confirm the importance of business systems innovation relative to product and process innovation. The measures of innovativeness that were rated more highly revolved around a propensity to look for new customers (business systems innovation), efficiencies in raw material use (process innovation) and diversified product lines (product innovation).

1 Chain of custody certification provides an interesting potential business innovation in the BC
2 value-added wood products sector, and some companies currently use it as a marketing tool.
3 However, the sector has been slow to adopt this innovation, again supporting the view that many
4 value-added wood producers have been slow to adopt innovative practices. Identification of the
5 main driving forces revealed some dissimilarities in the motivations and attitudes toward CoC
6 certification between the certified companies and non-certified but interested companies (CCs
7 and NCICs, respectively). Among the NCICs, initiation of the CoC process is motivated by
8 external factors, mainly linked to the price premiums and participation in LEED projects. CCs,
9 on the other hand, appear to be affected by both internal and external factors, in particular,
10 internal corporate policies that view certification as being compatible with their companies'
11 values and corporate images, as well as the need to meet external market demand conditions,
12 such LEED requirements. CCs do not consider price premiums to be an added benefit in the
13 adoption of CoC certification and find the process difficult to implement due to its complexity.
14 Nevertheless, both groups of respondents were of the view that CoC certification is compatible
15 with their company's values.

16 The findings of this research suggest that companies within the BC value-added wood products
17 could refocus their innovation efforts on product and process innovation as they may benefit
18 from a more balanced portfolio approach to innovation and a more structured approach to
19 business systems innovation. The increasing importance of environmental issues, the increasing
20 competition from low-cost manufacturers in developing countries, the evolution of entirely new
21 products and many other changes could result in a very different sector to what exists today. To
22 cope with these changes and to remain globally competitive, actors in BC's value-added wood

- 1 products sector should consider the adoption of genuine innovation strategies as a prerequisite
- 2 for their continued success.

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Table 1: Variables tested for non-response bias (early respondents vs. late respondents)

	Early respondents (n = 56)	Late respondents (n = 67)	p-value
Certification Status			
Certified	27.9%	37.5%	0.25
Non-certified	49.0%	50.0%	0.91
Average number of full-time employees	39.7	53.7	0.47
Average percentage of sales volume within BC	55.2%	36.0%	0.93

Table 2: Comparison of key variables in this study with Stennes & Wilson (2008)

Variable		Current research	Stennes & Wilson (2008)
Firm size	Mean employment	38.3	25.0
	Annual sales revenue	28.7 % *	33.0 %
Sales within BC		95%	97.0%
Species consumed	Douglas-fir	21.5 %	55.0 %
	Western red cedar	23.2%	53.0 %

* Percentage of companies with upto \$1 million sales category

Table 3: Results of propensity to create and (or) adopt measures of innovativeness in the BC value-added wood products sector

Variable	Measurement	N	Mean	Std. Error Mean	Sig. (2- tailed)
Product Innovations	Our company is always seeking ways to develop new products*	40	3.8	.12	.00
	Our company takes leading role in R&D for new products	40	3.1	.12	.44
	Our company has a diversified product line*	40	3.8	.13	.00
Process Innovations	Our company is always ready to install new processing equipment*	40	3.3	.13	.00
	Our company is very efficient in raw material use*	40	3.9	.10	.00
	Our company takes advantage of innovative processes from other leading industries	40	3.2	.12	.07
Business Systems Innovations	Our company is ready to look for new customers*	40	4.1	.10	.00
	Our company is ready to bear the cost of marketing for products promotion*	40	3.5	.11	.00
	Our company is ready to train new marketing managers	40	3.1	.118	.14

* Denotes significantly different from midpoint of scale (3) at alpha = 0.05
(1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree)

Table 4: Final cluster centers

	Cluster	
	1	2
Our company is always seeking ways to develop new products	4	3
Our company takes leading role in research & development for new products	3	3
Our company has a diversified product line	4	3
Our company is always ready to install new processing equipment	4	3
Our company is very efficient in raw material use	4	4
Our company takes advantage of innovative processes from other leading	4	3
Our company is ready to look for new customers	4	4
Our company is ready to bear the cost of marketing for products promotion	4	3
Our company is ready to train new marketing managers	4	3
Cluster Centre Means	3.8	3.2

(1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree)

Table 5: Characteristics of the two clusters

		Cluster 1 n= 20	Cluster 2 n = 20
Number of employees		42.1	91.8
Export sales destination	United States	24.5%	37.3%
	Europe	18.3%	12.5%
Certification status	Certified	80.0%	70.0%
	Non certified, but interested	20.0%	30.0%
Cluster Centre Means		3.8	3.2

(1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree)

Figure 1: Mean attitudes of certified companies (CCs) and non certified, but interested companies (NCICs) towards CoC certification (including 95% confidence intervals)
* = Significantly different from a neutral level of 3 (alpha =0.05)