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Measuring Firm Innovativeness: Development and Refinement of a New Scale

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ABSTRACT

Firm innovativeness is the propensity of firms to create and/or adopt new products, processes, and business systems. Previous research has consistently shown firm innovativeness to be a driver of firm growth and critical for maintaining competitiveness. While previous research has acknowledged the importance of innovativeness, a valid and reliable scale for measuring firm innovativeness does not exist. The purpose of this study was to develop a new scale for measuring innovativeness, specific to the forest products industry through a systematic and structured scale development process. A new innovativeness scale will provide researchers with a systematic method for evaluating the connection between innovativeness and firm performance. This paper discusses all of the stages of the scale development process including the theoretical development of the scale, initial item generation, and an overview of the two-stage study in the North American softwood sawmilling which was used to refine the scale. Finally, the reliability and validity of the new scale is assessed.

Keywords: firm innovativeness, scale development, measurement

Introduction

The concept of innovativeness has been the subject of considerable research in recent years in various fields including sociology, psychology, economics, marketing, and management. Within this theme, there have been various lines of research including looking at innovativeness from the perspectives of products, individuals, or firms. The results of these studies have led to the development of two distinct innovativeness constructs. The first construct, largely developed from the marketing, sociology, and psychology literature, focuses on consumer innovativeness (i.e., Midgely and Dowling 1978, Foxall and Haskins 1986, Clark and Goldsmith 2006). The second construct, largely developed from the management, economics, and marketing literature, focuses on firm innovativeness (i.e., Damanpour et al. 1989, Desphande et al. 1993, Wolfe 1994, Hult et al. 2004). The focus of this study is the firm innovativeness construct or the propensity of firms to innovate.

Innovation has been examined as an output by several researchers (e.g., Aiken and Hage 1971, Kimberly and Evanisko 1981, Meyer and Goes 1988) trying to determine the conditions under which an organization would innovate. Innovation has also been examined as a process to determine how innovativeness becomes a part of an organization (e.g., Van de Ven et al. 1989), which is how this paper addresses innovativeness. Gopalakrishman and Damanpour (1994) noted that since each of these perspectives examines a specific aspect of innovativeness and, therefore, innovativeness is measured differently, the results have not been easily reconciled. Even within a research perspective, the results are not always consistent (Wolfe 1994). Additionally, these multiple research streams have resulted in numerous definitions of innovativeness and measurement methodologies and an inconsistent viewpoint on the conceptualization and measurement of innovativeness (Wolfe 1994, Cho and Pucik 2005).

While previous research has acknowledged the importance of innovativeness, many problems exist with current methodologies for measuring the innovativeness of a firm. Deshpande and Farley (2004) acknowledged the weaknesses of scales currently available and call for a universally reliable scale for measuring innovativeness. Crespell et al. (2006) also recognized the weakness of current scales for measuring innovativeness and call for the creation of a robust, reliable, and valid scale to measure the construct of innovativeness.

This study follows a two-stage scale development process to develop and refine a new multi-item measure of innovativeness in industrial manufacturing firms. *Accordingly, the specific objective of the study is to develop a valid and reliable measure of firm innovativeness for firms in the forest products industry.*

Theoretical Background

Definition of Firm Innovativeness

Multiple definitions of firm innovativeness have been developed in previous research. An innovative firm has frequently been defined as one that adopts innovations (Utterback 1974, Daft 1982, Attewell 1992) and, therefore, the more innovations a firm adopts, the more innovative it is. Rogers (2003, pg. 22) presented a more comprehensive definition, including the time of adoption by defining innovativeness as "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than any other member of the system."

Hurley and Hult (1998) identified firm culture as a crucial aspect of innovativeness and defined it as "the notion of openness to new ideas as an aspect of a firm's culture." Foxall (1984) recognized two aspects of firm innovativeness, technical and behavioral progressiveness, and presented innovativeness as the "capacity and tendency to purchase new products and services." Gebert et al. (2003) combined technical and behavioral progressiveness with internal creativity and defined innovativeness as "the capacity of an organization to improve existing products and/or processes, and the capacity to utilize the creativity resources of the organization to the full[est]."

Recent work by Hovgaard and Hansen (2004) examined innovation in the forest products industries of Oregon and Alaska. Three aspects of innovativeness were identified – product, process, and business systems – showing that firms view not only new products and manufacturing processes as

innovations, but also new business systems. Product innovation was defined as a successful change in a firm's output that can be in the form of either goods or services. Process innovation was defined as the introduction of new elements in an organization's production process. Business systems innovation included all innovations related to the internal and external operations of the business (i.e., the introduction and integration of new management systems, marketing methods, developing new markets, administrative processes, staff development programs, etc.).

The definition of innovativeness used in this study is adapted from the above definitions and is, therefore, more comprehensive. Innovativeness here is the *propensity of firms to create and/or adopt new products, manufacturing processes, and business systems.*

Previous Approaches to Measuring Innovativeness

A literature review revealed five methods commonly used to measure innovativeness. The advantages and disadvantages of these measures are detailed in **Table 1**.

Table 1. Advantages and disadvantages of previous innovativeness measures.

Approach	Studies	Advantages	Disadvantages
Current technology	– Robertson and Wind (1980) – Damanpour and Evan (1992) – Subramanian and Nilakanta (1996) – Shook and Ganus (2004)	– Ease of use – Can assess innovativeness over time	– Does not account for product or business systems innovativeness – Often focuses on one or a few technologies – Assumes each technology is equally available to all firms – Respondent recall might not be accurate
Self-evaluation	– Capon et al. (1992) – Gebert et al. (2003) – Crespell et al. (2006)	– Easy to account for multiple aspects of innovativeness – Respondents are familiar with organization – Can integrate aspects of firm culture/climate	– Potential for respondent bias
Research and development funding	– Cohen et al. (1987)	– Can track innovativeness over time	– Funding has not been consistently shown to correlate positively with more innovations – Not easy to distinguish R&D funding in all firms – Does not account for all aspects of innovativeness
Number of new products	– Acs and Audretsch (1988) – Audretsch and Acs (1991) – Vazquez et al. (2001)	– Is a direct result of innovative process – Can track innovativeness over time	– Does not account for all aspects of innovativeness
Intellectual property	– Mansfield (1986) – Dutta and Weis (1997) – Artz et al. (2003)	– Can track innovativeness over time	– Many ideas are not patented or are not patentable – Patent does not mean the idea is being used

The concern over inadequate measures of innovativeness has been addressed by numerous authors, including Miller and Friesen (1983), Capon et al. (1992), Avlonitis et al. (1994), Subramanian and Nilkanta (1996), Hurley and Hult (1998), Lyon et al. (2000), Chandler et al. (2000), North and Smallbone (2000), Gebert et al. (2003), Wang and Ahmed (2004), and Crespell et al. (2006); however,

these articles fail to develop a measurement instrument according to commonly accepted scale development procedures such as that outlined by Churchill (1979). Although Wang and Ahmed (2004) began the process of developing a new measure of organizational innovativeness, they only completed one stage of the scale development process outlined by Churchill (1979). They note this limitation and discuss how their organizational innovativeness construct requires further development.

Dimensions of Innovativeness

Previous research has resulted in the development of numerous characterizations of innovation: radical or incremental, product or process, administrative or technical, just to name a few. Wang and Ahmed (2004) provide an overview of the numerous multi-dimensional characterizations presented in previous literature (**Table 2**). The five dimensions of innovativeness emerging from previous research were product, market, process, behavior, and strategic. **Table 2** shows how firm innovativeness was conceptualized in previous manuscripts using the five dimensions from Wang and Ahmed (2004) and the three dimensions from Hovgaard and Hansen (2004). There is significant overlap between Wang and Ahmed (2004) and Hovgaard and Hansen (2004), with product and process being considered dimensions of firm innovativeness by both. Hovgaard and Hansen (2004) consider the market, behavior, and strategic dimensions from Wang and Ahmed (2004) as part of business systems, resulting in a total of six dimensions of firm innovativeness displayed in **Table 2**. This multiplicity reveals the inconsistent views of this concept.

Table 2. Dimensions of firm innovativeness identified in previous research (adapted from Wang and Ahmed (2004) and Hovgaard and Hansen (2004)).

Author	Product	Market	Process	Behavior	Strategic	Business Systems
Schumpeter (1934)	X	X	X			
Miller and Friesen (1983)			X	X	X	
Capon et al. (1992)		X			X	
Avlonitis et al. (1994)	X		X	X	X	
Subramanian and Nilkanta (1996)			X			
Hurley and Hult (1998)				X		
Rainey (1999)				X	X	
Lyon et al. (2000)	X		X			
North and Smallbone (2000)	X	X	X	X		
Boer and During (2001)	X		X			X
Wang and Ahmed (2004)	X	X	X	X	X	
Crespell et al. (2006)	X		X			X
Knowles et al. (2007)	X		X			X

Boer and During (2001), Crespell et al. (2006), and Knowles et al. (2007) conceptualize innovativeness in a manner similar to Wang and Ahmed (2004), but use three dimensions instead of five, where the third dimension is business systems innovativeness, a combination of behavioral, strategic, and market innovativeness as defined by Wang and Ahmed (2004). One important aspect of innovativeness that these studies, with the exception of Knowles et al. (2007), fail to account for is the

distinction between the creation and adoption of innovations. Previous research has generally viewed these two aspects of innovativeness independently.

Principles of Scale Development

The main objective of this work is the development of a new self-evaluation scale to measure innovativeness. To meet this objective, a structured scale development process was adopted following the three processes outlined by Churchill (1979), DeVellis (2003), and Netermeyer et al. (2003). While the terminology used in these three processes differs slightly, the underlying ideas and the steps involved are similar. DeVellis (2003) advocates a process that includes the following eight steps:

Step 1. Determine clearly what it is you want to measure

Step 2. Generate an item pool

Step 3. Determine the format for measurement

Step 4. Have the initial item pool reviewed by experts

Step 5. Consider inclusion of validation items

Step 6. Administer items to a development sample

Step 7. Evaluate the items

Step 8. Optimize scale length

Netermeyer et al. (2003) advocate a four-step process that includes the following:

Step 1. Construct definition and content domain

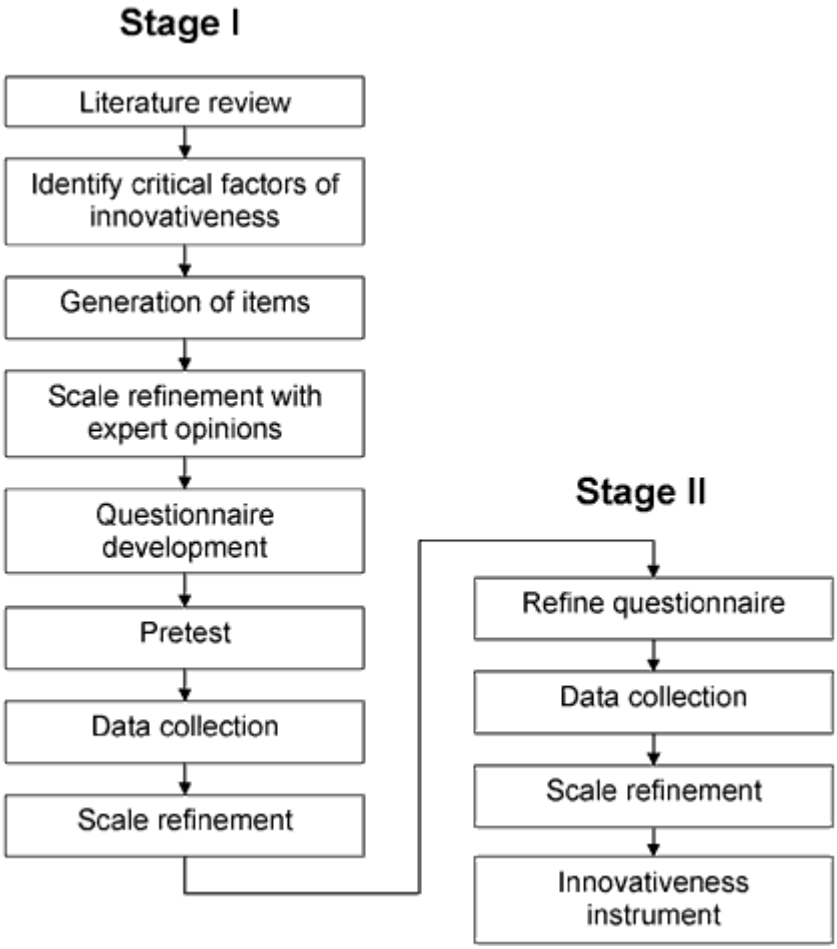
Step 2. Generate and judge measurement items

Step 3. Design and conduct studies to develop and refine the scale

Step 4. Finalize the scale

Based on these scale development principles, a two-stage scale development process was followed in this study (**Fig. 1**).

Figure 1. Scale development procedure followed for developing the innovativeness instrument.



Stage I

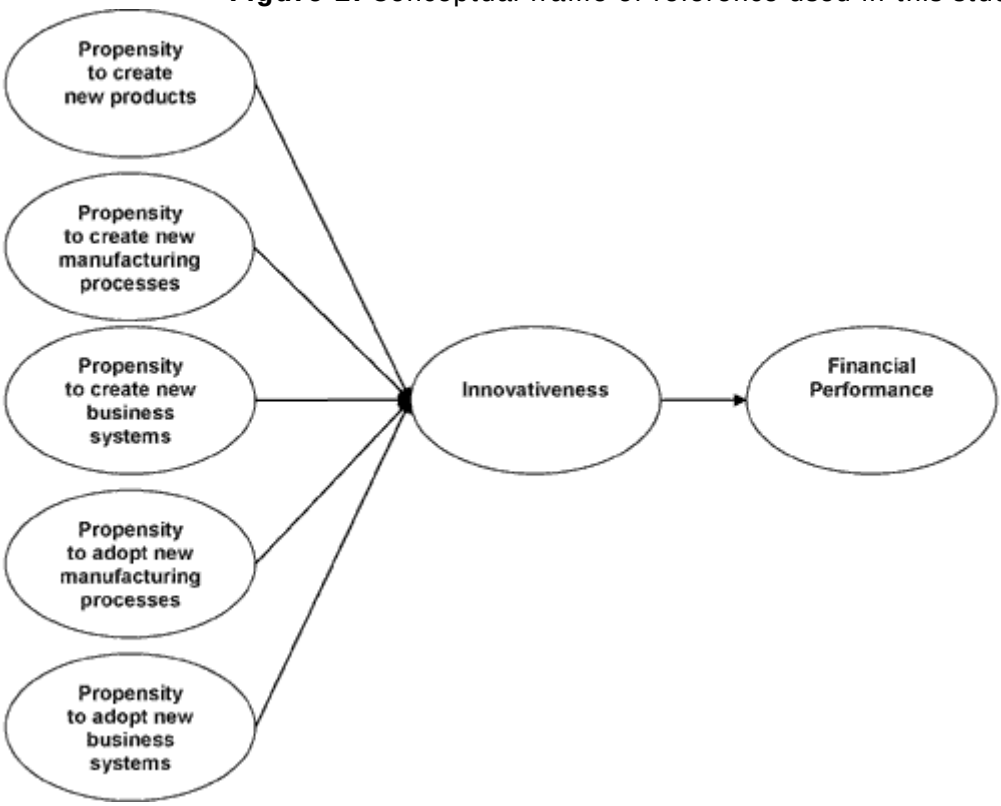
Identification of Critical Factors of Innovativeness

Based on the definition of innovativeness used in this research and the review of literature regarding the dimensions of innovativeness, six dimensions of innovativeness have been identified for this work:

1. the propensity to create new products,
2. the propensity to create new manufacturing processes,
3. the propensity to create new business systems,
4. the propensity to adopt new products,
5. the propensity to adopt new manufacturing processes, and
6. the propensity to adopt new business systems.

For Stage I of this research, the propensity to adopt new products was not included in the theoretical frame of reference (**Fig. 2**) because the authors argued that firms in the softwood sawmilling industry do not adopt new products directly, but instead adopt new products through the adoption of the manufacturing process required to produce those new products. For example, a sawmill producing only rough sawn stock would have to adopt new equipment to begin producing surfaced stock. The omission of the propensity to adopt new products resulted in firm innovativeness being composed of five dimensions. Based on this conceptual frame of reference (**Fig. 2**), a new measure of innovativeness, the *propensity to create and adopt scale*, was developed and refined as outlined below.

Figure 2. Conceptual frame of reference used in this study.



Generation of Items

Scale development begins with careful examination of the previous literature. Based on this review, a preliminary list of 42 items was generated (Miller and Friesen 1983, Desphande et al. 1993, Hurley and Hult 1998, Vazquez et al. 2001, Gebert et al. 2003, Wang and Ahmed 2004). Items assessing the same aspects of innovativeness were combined to create a single item. This process resulted in a 25 item propensity to create and adopt scale. The specific items used in the scale and the sources from which they were adapted are presented in **Table 3**.

Table 3. Item generation and source material for the propensity to create and adopt scale.

Item	Adapted from
Propensity to create new products:	

1. Our company actively develops new products.	Avlonitis et al. (1994) Vazquez et al. (2001)
2. Our company sees creating new products as critical to our success.	Avlonitis et al. (1994) Gebert et al. (2003)
3. When it comes to creating new products, our company is far better than the competition.	Gebert et al. (2003)
4. Over the past three years, our company has been better than before regarding developing new products.	Gebert et al. (2003) Wang and Ahmed (2004)
5. Within our company, we are able to implement new product ideas from other parts of our organization.	Hurley and Hult (1998) Gebert et al. (2003)
Propensity to create new manufacturing processes:	
6. Our company actively develops in-house solutions to improve our manufacturing processes.	Avlonitis et al. (1994) Vazquez et al. (2001)
7. Our company sees new manufacturing processes as critical to our success.	Deshpande et al. (1993) Avlonitis et al. (1994) Gebert et al. (2003)
8. When it comes to creating new processes, our company is far better than the competition.	Gebert et al. (2003) Wang and Ahmed (2004)
9. Over the past three years, our company has been better than before regarding developing new manufacturing processes.	Gebert et al. (2003) Wang and Ahmed (2004)
10. Within our company, we are able to implement new manufacturing process ideas from other parts of our organization.	Hurley and Hult (1998) Gebert et al. (2003)
Propensity to create new business systems:	
11. Our company actively develops in-house information technology solutions.	Vazquez et al. (2001)
12. Our company actively develops in-house managerial approaches.	Wang and Ahmed (2004)
13. Our company sees creating new business systems as critical to our success.	Gebert et al. (2003) Wang and Ahmed (2004)
14. When it comes to creating new business systems, our company is far better than the competition.	Gebert et al. (2003) Wang and Ahmed (2004)
15. Within our company, we are able to implement new business systems ideas from other parts of the organization.	Hurley and Hult (1998) Gebert et al. (2003)
Propensity to adopt new manufacturing processes:	
16. Our company tends to be an early adopter of new manufacturing processes.	Deshpande et al. (1993) Avlonitis et al. (1994) Wang and Ahmed (2004)
17. Our company actively seeks new manufacturing processes from outside this organization.	Hurley and Hult (1998) Jerez-Gomez et al. (2005)
18. Having the latest, most efficient manufacturing processes is critical for our success.	Avlonitis et al. (1994) Gebert et al. (2003) Wang and Ahmed (2004)
19. Within our company, we are able to implement new manufacturing processes used by other organizations.	Jerez-Gomez et al. (2005)
20. Our company considers manufacturing ideas provided by external sources critical to our success.	Jerez-Gomez et al. (2005)
Propensity to adopt new business systems:	
21. Our company tends to be an early adopter of new business systems.	Deshpande et al. (1993)

	Wang and Ahmed (2004)
22. Having the latest, most efficient business systems is critical for our success.	Wang and Ahmed (2004)
23. Within our company, we are able to implement new business systems used by other organizations.	Jerez-Gomez et al. (2005)
24. Our company considers business systems ideas provided by external sources as critical to our success.	Jerez-Gomez et al. (2005)
25. Our company actively seeks new business systems from outside this organization.	Hurley and Hult (1998) Jerez-Gomez et al. (2005)

Scale Refinement with Expert Opinions

The items used in the propensity to create and adopt scale were reviewed by experts using a two-step process.

The preliminary step in refining the propensity to create and adopt scale was to have it reviewed by four forest products marketing experts from academia familiar with the firm innovativeness construct. Each of the participating experts was given an envelope containing 25 slips of paper, with each slip of paper containing one of the 25 items used in this scale. They were asked to place each of the 25 items into groups, grouping items they felt to be similar. After each had grouped the items, they were asked to assign each group a name. Prior to this process, the participating experts had no knowledge of the proposed model (**Fig. 2**).

The results of this procedure were consistent with the model and provide support for the face validity of the propensity to create and adopt scale by confirming that the items appear to assess the dimensions of innovativeness they were intended to assess.

The second step in the review by experts was to have the propensity to create and adopt scale reviewed by three experts in academia and five industry consultants and managers. The expert reviewers provided feedback and, based on this feedback, minimal changes were made to the wordings of some items.

Questionnaire Development

The questionnaire used in Stage I of this research was part of a larger study on firm innovativeness (Knowles et al. 2007). The questionnaire included two sections for use in this study: (1) the propensity to create and adopt scale (**Table 3**) and (2) a four-item firm performance measure. The four items used to assess performance were sales level, sales growth rate, cash flow, and gross profit margin.

Data Collection

Five hundred sawmills in North America (United States and Canada) were randomly selected from *The Random Lengths Big Book*. The target respondent for the questionnaire was the top manager at each sawmill. In an attempt to identify the name of the mill manager, two attempts were made to contact each sawmill by telephone. For those mills that were not successfully contacted, the questionnaire package was addressed to the mill manager. The questionnaire package consisted of

three questionnaires; three self-addressed, stamped, return envelopes; and a cover letter that briefly described the purpose of the study and identified the target audience for the questionnaire. One questionnaire package was sent to each of the 500 randomly selected sawmills.

A modified Dillman approach was used for the mailing. The first wave was mailed in May 2005, followed by a reminder postcard that was mailed in June 2005. The second wave was mailed in July 2005 and was followed up with telephone calls to the non-responding mills. For mills choosing not to respond to the questionnaire after the second wave, some descriptive data was collected to be used in testing for nonresponse bias. The information collected from the mills that did not respond included the relative volume of species processed (% of total production) and size, as measured by number of employees and total production volume. In total, responses were received from 88 sawmills and 53 questionnaires were undeliverable resulting in an adjusted response rate of 19.0 percent. The data collected in Stage I was part of a larger study on firm innovativeness. While three questionnaires were sent to each mill, only the responses from the top manager were used for this paper.

Scale Refinement

The 25-item propensity to create and propensity to adopt scale was refined based on methodologies advocated by Churchill (1979), DeVellis (2003), and Netermeyer et al. (2003). In this process, exploratory factor analysis (EFA) was used initially to explore the factor structure of the data collected in this study. The 25 items in the propensity to create and adopt scale and the four items used to measure firm performance were analyzed using EFA in SPSS. Factor loadings greater than 0.40 were considered to be significant (Hair et al. 1999). Cross-loaded items were removed from further analysis, resulting in the removal of four items. Cross-loading was defined as loadings on two or more factors within 10 percent of each other (Hair et al. 1989). The remaining 25 items (4 performance and 21 from scale) were reexamined using EFA. The results showed four innovativeness factors and one performance factor, instead of the five innovativeness factors and one performance factor as hypothesized in **Figure 2**. The EFA results showed that the items assessing the propensity to create new processes and the propensity to adopt new products were grouped into one factor instead of the two proposed in **Figure 2**. Additionally, the items assessing the propensity to create new business systems and the propensity to adopt new business systems were grouped into one factor instead of the two proposed in **Figure 2**. Finally, three items formed factor five. These items all used similar wording and were intended to measure the firm's propensity to create new products, processes, and business systems, respectively. Upon further review of these items, it became apparent that the wording in these questions was misleading (the wording could be interpreted as propensity to adopt instead of propensity to create) so they were eliminated from further analysis.

The results of the EFA are summarized in **Table 4**. The EFA had a Kaiser–Meyer–Olkin coefficient = 0.899 and a statistically significant Bartlett test of Sphericity (Chi-square = 2512.1, df = 406, $p < 0.001$) indicating that the properties of the correlation matrix justified the use of factor analysis. From these results it can be seen that the items assessing product innovativeness (factor 1), process innovativeness (factor 3), business systems innovativeness (factor 4), and performance (factor 5) were generally grouped together. The exception to this is the three items that form factor 2: 5) Within our company, we are able to implement new product ideas from other parts of our organization; 10) Within our company, we are able to implement new manufacturing process ideas from other parts of our

organization; and 15) Within our company, we are able to implement new business systems ideas from other parts of our organization.

Table 4. Results of the initial exploratory factor analysis on the propensity to create and adopt scale.

Item[a]	Factor[b]				
	1	2	3	4	5
1. Our company actively develops new products.	**0.511**	0.385	0.020	−0.246	−0.011
2. Our company sees creating new products as critical to our success.	**0.490**	0.122	0.090	−0.319	0.219
3. When it comes to creating new products, our company is far better than the competition.	**0.594**	0.190	0.329	−0.070	0.103
4. Over the past three years, our company has been better than before regarding developing new products.	***0.441***	***0.413***	*0.071*	*−0.125*	*0.237*
11. Our company actively develops in-house information technology solutions.	**0.415**	0.330	0.252	−0.113	−0.050
12. Our company actively develops in-house managerial approaches.	***0.318***	***0.347***	*0.284*	*−0.103*	*−0.156*
5. Within our company, we are able to implement new product ideas from other parts of our organization.	0.113	**0.905**	−0.27	0.008	0.028
10. Within our company, we are able to implement new manufacturing process ideas from other parts of our organization.	-0.039	**0.819**	0.255	0.078	−0.099
15. Within our company, we are able to implement new business systems ideas from other parts of the organization.	0.042	**0.888**	−0.100	−0.169	−0.045
6. Our company actively develops in-house solutions to improve our manufacturing processes.	0.220	−0.143	**0.836**	−0.038	−0.181
7. Our company sees creating new manufacturing processes as critical to our success.	0.137	0.027	**0.584**	−0.258	0.179
8. When it comes to creating new processes, our company is far better than the competition.	0.249	0.238	**0.555**	−0.080	−0.096
9. Over the past three years, our company has been better than before regarding developing new manufacturing processes.	0.188	0.236	**0.522**	−0.025	0.176
16. Our company tends to be an early adopter of new manufacturing processes.	0.263	0.043	**0.552**	−0.309	0.009
17. Our company actively seeks new manufacturing processes from outside this organization.	−0.243	0.106	**0.755**	−0.219	0.098
18. Having the latest, most efficient manufacturing processes is critical for our success.	−0.184	0.281	**0.641**	−0.094	−0.021
19. Within our company, we are able to implement new manufacturing processes used by other organizations.	−0.026	0.325	**0.581**	−0.058	0.173
20. Our company considers manufacturing ideas provided by external sources critical to our success.	*−0.425*	***0.473***	***0.445***	*−0.224*	*0.121*
13. Our company sees creating new business systems as critical to our success.	0.229	0.374	0.100	**−0.435**	−0.008
14. When it comes to creating new business systems, our company is far better than the competition.	*0.290*	***0.395***	*0.080*	***0.377***	*−0.018*
21. Our company tends to be an early adopter of new business systems.	0.170	−0.080	−0.001	**−0.896**	−0.048
22. Having the latest, most efficient business systems is critical for our success.	0.002	0.006	−0.132	**−0.926**	0.006
23. Within our company, we are able to implement new business systems used by other organizations.	0.131	0.117	−0.011	**−0.792**	0.004
24. Our company considers business systems ideas provided by external sources as critical to our success.	−0.111	−0.088	0.258	**−0.855**	0.012
25. Our company actively seeks new business systems from outside this organization.	−0.253	0.084	0.179	**−0.847**	0.012
a) Sales level	−0.070	0.049	−0.034	0.012	**0.809**

b) Sales growth rate	0.049	0.003	−0.145	−0.092	**0.859**
c) Cash flow	0.060	−0.148	0.209	0.129	**0.879**
d) Gross profit margin	0.003	−0.020	−0.061	0.006	**0.894**

[a] Numbers refer to item numbers in **Table 3**.
[b] Values in **bold** indicate factor with heaviest loading. Values in *italics* indicate cross-loading.

The 23 items remaining after the initial EFA were used in a second EFA to examine how the removal of poorly worded items and cross-loading items affected the results. The results of this EFA are presented in **Table 5**. It can be seen that this EFA resulted in four factors.

Table 5. Results of EFA using 23 items remaining after initial EFA.

Item[a]	Factor[b]			
	1	2	3	4
1. Our company actively develops new products.	**0.835**	0.175	0.286	−0.012
2. Our company sees creating new products as critical to our success.	**0.719**	0.153	0.314	0.217
3. When it comes to creating new products, our company is far better than the competition.	**0.831**	0.272	0.154	0.097
4. Over the past three years, our company has been better than before regarding developing new products	**0.782**	0.232	0.202	0.218
11. Our company actively develops in-house information/technology solutions.	**0.740**	0.307	0.209	−0.55
12. Our company actively develops in-house managerial approaches.	**0.643**	0.324	0.241	−0.160
13. Our company sees creating new business systems as critical to our success.	**0.671**	0.358	0.458	0.000
14. When it comes to creating new business systems, our company is far better than the competition.	**0.696**	0.292	0.436	−0.007
6. Our company actively develops in-house solutions to improve our manufacturing processes.	0.431	**0.620**	0.102	−0.199
7. Our company sees creating new processes as critical to our success.	0.481	**0.589**	0.309	0.179
17. Our company actively seeks new manufacturing processes from outside this organization.	0.229	**0.852**	0.299	0.087
18. Having the latest, most efficient manufacturing processes is critical for our success.	0.290	**0.775**	0.210	−0.029
19. Within our company, we are able to implement new manufacturing processes used by other organizations.	0.458	**0.726**	0.175	0.152
20. Our company considers manufacturing ideas provided by external sources critical to our success.	0.174	**0.791**	0.353	0.112
21. Our company tends to be an early adopter of new business systems.	0.491	0.237	**0.730**	0.039
22. Having the latest, most efficient business systems is crucial for our having success.	0.317	0.173	**0.779**	0.042
23. Within our company, we are able to implement new business systems used by other organizations.	0.447	0.187	**0.763**	−0.009
24. Our company considers business systems ideas provided by external sources as critical to our success.	0.277	0.469	**0.755**	0.038
25. Our company actively seeks new business systems from outside this organization.	0.214	0.500	**0.784**	0.041
a) Sales level	−0.020	0.030	0.076	**0.812**
b) Sales growth	0.069	−0.076	0.135	**0.870**
c) Cash flow	0.066	0.148	−0.109	**0.861**
d) Gross profit margin	0.046	0.032	−0.017	**0.886**

[a] Numbers refer to item numbers in **Table 3**.
[b] Values in **bold** indicate factor with heaviest loading. Values in *italics* indicate cross-loading.

Exploratory factor analysis was also used to explore the factor structure of the 25-item propensity to create and adopt a scale without the four items used to assess performance. The results of this analysis are not presented in this paper, but were similar to the results presented.

Based on the results of the second EFA, the remaining items were used in confirmatory factor analysis (CFA) to examine the proposed model using the two-step approach advocated by Anderson and Gerbing (1988) and Byrne (1998) in which the hypothesized model was compared to a series of more restrictive models, allowing the researcher to test and compare various models and select the one that provides the best fit (Noar 2003).

The following models were compared:

1. One-factor model – all items load onto one latent variable
2. Propensity to create and adopt model – items load on latent variables according to the model proposed in **Figure 2**
    1. Model 1 with covariances of latent variables constrained at 1
    2. Model 2 with covariances of latent variables unconstrained
3. Product, Process, Business Systems model – items load on latent variables according the model proposed in **Figure 3** which was derived based on analysis of Models 1, 2a, and 2b.

The above series of sequential Chi-square models were tested, including the null (one factor model) and the alternative models. The statistical fit of each of the models was examined and the fits were compared by examining the differences in Chi-square values for each model. The resulting improvement in measurement of each model was determined by the changes in Chi-square values and degrees of freedom from each model (**Table 6**).

Figure 3. New innovativeness model proposed based on the results of the scale refinement process used in Stage I.

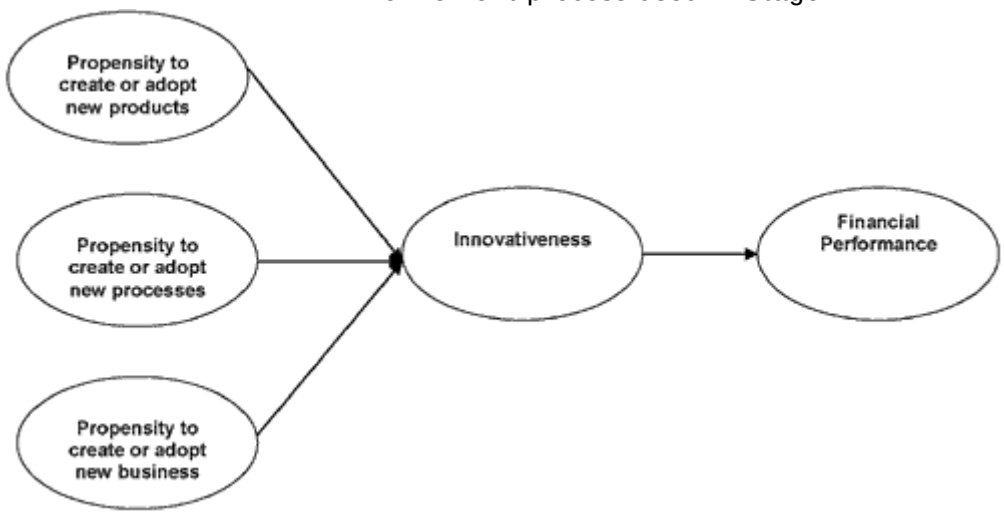


Table 6. Results of the three CFA models from Stage I of scale refinement process.

Model	Chi-square	Degrees of freedom	Change in Chi-square	*p*-value
1. One-factor model	1501.5	301		
2a. Propensity to create and adopt model constrained	1399.3	299	102.2	< 0.001
2b. Propensity to create and adopt model unconstrained	870.6	284	528.7	< 0.001
3. Product, process, and business systems model	526.0	203	344.6	< 0.001

The results of the scale refinement process show that the product, process, and business systems model is best supported. The fit indices for this model were X^2 = 526.0, df = 203, comparative fit index (CFI) = 0.93, Delta2 = 0.93, relative noncentrality index (RNI) = 0.88, root mean square error of approximation (RMSEA) = 0.137, non-normed fit index (NNFI) = 0.92. By comparison, the fit indices for the propensity to create and adopt model were X^2 = 870.6, df = 284, CFI = 0.91, Delta2 = 0.91, RNI = 0.89, RMSEA = 0.160, NNFI = 0.89. The refined model shows improvement on all fit indices with the exception of RNI.

The scale refinement process revealed that the theorized model (**Fig. 2**) was not supported by the data, suggesting a reduction in the number of dimensions of innovativeness. The new model reduced the number of dimensions from five (propensity to create new products, propensity to create new processes, propensity to create new business systems, propensity to adopt new processes, propensity to adopt new business systems, **Fig. 2**) to three (product, process, business systems, **Fig. 3**). Based on the results of the CFA, respondents differentiated between product, process, and business systems innovativeness, but did not differentiate between creation and adoption. The failure of respondents to differentiate between creation and adoption infers that they view innovativeness as adding something new to the firm, regardless of whether the new item was created inside or outside the firm. After reviewing the results of Stage I and receiving feedback from experts working on firm innovativeness, we realized that it was a mistake to omit the propensity to adopt new products in Stage I. To correct this mistake, we integrated the concept back into the model for Stage II.

The results of the scale refinement procedure resulted in a refined propensity to create and adopt scale composed of 19 of the original 25 items (**Table 5**). Since respondents did not differentiate between creation and adoption, the refined scale to be used in Stage II was composed of three dimensions (product, process, and business systems) containing a total of 18 items. This refined scale was based on Model 3 from Stage I of the scale refinement process (**Table 6**). The items were equally divided among the three dimensions. Within each dimension, three items assessed the firm's propensity to create and three items assessed the firm's propensity to adopt. The items used in the refined scale were items that were used in the propensity to create and adopt scale, with the exception of the three items assessing adopting new products. Based on feedback from other researchers, the propensity to adopt products was included in the refined scale. The items used to measure the propensity to adopt new products were constructed from the items used to measure the propensity to adopt new processes and the propensity to adopt new business systems.

Stage II

Questionnaire Development

The questionnaire used in Stage II of this research was part of a larger study on innovativeness in the forest products industry. The questionnaire included two sections relevant to this study: (1) the 18-item propensity to create and adopt new products, processes, and business systems measure of innovativeness developed in Stage I; and (2) a four-item measure of firm performance. The four items assessing firm performance were return on sales, sales growth rate, after tax return on assets, and overall competitiveness. The items used to assess innovativeness and firm performance are shown in **Table 7**.

Table 7. Items used to assess innovativeness and firm performance in Stage II.

Product Innovativeness
a) Our company actively develops new products in-house.
b) Our company sees creating new products as critical to our success.
c) When it comes to creating new products, our company is far better than the competition.
d) Our company tends to be an early adopter of new products.
e) Within our company, we are able to implement new products used by other organizations.
f) Our company actively seeks new products from outside this organization.
Process Innovativeness
g) Our company actively develops in-house solutions to improve our manufacturing processes.
h) Our company sees creating new manufacturing processes as critical to our success.
i) When it comes to creating new processes, our company is far better than the competition.
j) Our company tends to be an early adopter of new manufacturing processes.
k) Our company actively seeks new manufacturing processes from outside this organization.
l) Within our company, we are able to implement new manufacturing processes used by other organizations.
Business Systems Innovativeness
m) Our company actively develops in-house information technology solutions.
n) Our company sees creating new business systems as critical to our success.
o) When it comes to creating new business systems, our company is far better than the competition.
p) Our company tends to be an early adopter of new business systems.
q) Within our company, we are able to implement new business systems used by other organizations.
r) Our company actively seeks new business systems from outside this organization.
Firm Performance
1) Return on sales (ROS)
2) Sales growth rate
3) After tax return on assets (ROA)
4) Overall competitiveness

Data Collection

The sample for Stage II of the study was composed of softwood sawmills in the United States and Canada, excluding sawmills located in Quebec because of very low response rates in Stage I of the study. This low response rate was likely the result of the questionnaire being sent out in English and not translated into French. The sample frame consisted of all softwood sawmills in the United States

and Canada that were listed in the 2005 *Random Lengths Big Book*, that were not included in Stage I of the study. This resulted in a sample frame that included 463 softwood sawmills. Telephone calls were made to each mill listed in the sample frame that did not provide the name of the top manager, the address, or the fax number of the sawmill.

Each sawmill in the sample was mailed a study announcement letter, addressed to the top manager, providing a description of the study objectives, methodology, and expected outcomes.

Approximately two weeks after mailing the announcement letter, the top manager at each of the selected sawmills was faxed a cover letter with an attached copy of the questionnaire. The cover letter outlined the objectives of the study, the expected outcomes of the study, and described how to respond to the questionnaire. Respondents were encouraged to respond by fax. But, they were also given a mailing address where they could send their completed questionnaire. Additionally, a URL was provided where the questionnaire was available in an on-line format. Approximately one week after faxing the original questionnaire, a reminder postcard was mailed to all sawmills that had not responded. Approximately one week after the reminder postcard, a second questionnaire package was faxed to all sawmills that had not responded. As a result of a lower than expected response rate from the faxed questionnaires, a questionnaire package was mailed to all non-responding mills. Conversations with several mill mangers indicated that mills receive a large amount of unsolicited junk mail through the fax machine. Therefore, the unsolicited material is trashed without being read.

Twenty-nine undeliverable addresses and closed sawmills resulted in an adjusted sample frame of 434 sawmills. In total, 109 sawmills responded to the questionnaire for an adjusted response rate of 25.1 percent.

Scale Refinement

The product, process, and business systems model was refined using the procedure outlined in Stage I of this study. As with Stage I, the first step was to analyze the data with EFA (**Table 8**).

Table 8. Results of EFA on product, process and business systems scale.

Item	Factor[a]			
	1	2	3	4
a) Our company actively develops new products in-house.	**0.734**	0.139	0.122	0.369
b) Our company sees creating new products as critical to our success.	**0.824**	0.226	0.045	0.168
c) When it comes to creating new products, our company is far better than the competition.	**0.731**	0.296	0.280	0.324
e) Within our company, we are able to implement new products used by other organizations.	**0.631**	0.466	0.140	0.269
h) Our company sees creating new manufacturing processes as critical to our success.	**0.698**	0.209	0.152	0.374
i) When it comes to creating new processes, our company is far better than the competition.	**0.544**	0.270	0.436	0.430
m) Our company actively develops in-house business systems solutions.	***0.490***	***0.540***	*0.139*	*0.231*
n) Our company sees creating new business systems as critical to our success.	***0.565***	***0.571***	*0.157*	*0.006*
o) When it comes to creating new business systems, our company is far better than the competition.	**0.540**	0.395	0.474	0.207
p) Our company tends to be an early adopter of new business systems.	0.187	**0.775**	0.264	0.302
d) Our company tends to be an early adopter of new products.	*0.312*	***0.577***	0.257	***0.604***

f) Our company actively seeks new products from outside this organization.	0.500	**0.602**	0.112	0.133
q) Within our company, we are able to implement new business systems used by other organizations.	0.407	**0.710**	0.198	0.097
r) Our company actively seeks new business systems from outside this organization.	0.115	**0.851**	0.176	0.239
g) Our company actively develops in-house solutions to improve our manufacturing processes.	0.388	−0.117	0.238	**0.665**
j) Our company tends to be an early adopter of new manufacturing processes.	0.195	0.380	0.240	**0.767**
k) Our company actively seeks new manufacturing processes from outside this organization.	0.274	0.400	0.336	**0.570**
l) Within our company, we are able to implement new manufacturing processes used by other organizations.	0.292	0.235	0.146	**0.667**
1) Return on sales (ROS)	0.147	0.092	**0.871**	0.126
2) Sales growth rate	0.167	0.205	**0.663**	0.422
3) After tax return on assets (ROA)	0.121	0.168	**0.876**	0.167
4) Overall competitiveness	0.088	0.210	**0.862**	0.166
[a] Values in **bold** indicate factor with heaviest loading. Values in *italics* indicate cross-loading.				

The EFA had a Kaiser–Meyer–Olkin coefficient = 0.921 and a statistically significant Bartlett test of Sphericity (Chi-square = 1551.2, df 153, $p < 0.001$) indicating that the properties of the correlation matrix justified the use of factor analysis. The results of the EFA show that the product, process, and business systems scale is performing as proposed in **Figure 3** with factor 1 representing product innovativeness, factor 2 representing process innovativeness, factor 3 representing performance, and factor 4 representing business systems innovativeness.

The 18 items in the product, process, and business systems scale were analyzed with CFA (**Table 9**). The following models were compared:

1. One-factor model – all 18 items from the product, process, and business systems model load onto one latent variable
2. Product, process, business systems model – items load on latent variables according to the model proposed in **Figure 2**
    a. Model 1 with covariances of latent variables constrained at 1
    b. Model 2 with covariances of latent variables unconstrained
3. Refined product, process, business systems model
    c. Model 1 with covariances of latent variables constrained at 1
    d. Model 2 with covariances of latent variables unconstrained

The above series of sequential Chi-square models were tested, including the null (one factor model) and the alternative models. The statistical fit of each of the models was examined and the fits were compared by examining the differences in Chi-square values for each model. The resulting improvement in measurement of each model was determined by the changes in Chi-square values and degrees of freedom from each model (**Table 9**).

Table 9. Results of the four alternative CFA models from Stage II of scale refinement process.

Model	Chi-square	Degrees of freedom	Change in Chi-square	*p*-value
1. One-factor model	1267.5	209		
2a. Product, process, and business systems model constrained	1052.1	209	215.6	< 0.001
2b. Product, process, and business systems model unconstrained	810.2	203	241.9	< 0.001
3a. Refined product, process, and business systems model constrained	601.5	151	208.7	< 0.001
3b. Refined product, process, and business systems model unconstrained	494.1	142	107.4	< 0.001

The CFA results of this scale resulted in the deletion of two of the items assessing process innovativeness and one of the items assessing business systems innovativeness from the model because they had low loadings and did not fit the model well. This resulted in a refined product, process, and business systems scale composed of 15 items. The fit indices for this refined model were X^2 = 494.1, df = 142, CFI = 0.91, Delta2 = 0.91, RNI = 0.86, RMSEA = 0.152, NNFI = 0.89 as compared to the fit indices for the original product, process, and business systems model X^2 = 810.2, df = 203, CFI = 0.89, Delta2 = 0.89, RNI = 0.85, RMSEA = 0.166,and NNFI = 0.88. The refined model shows improvement on all fit indices. The fit indices of the refined model generally meet the minimum recommended values with the CFI and Delta2 values being above 0.90 (Bentler 1990). The Chi-square, RMSEA, RNI, and NNFI, however, fall slightly below the recommended values (Bentler 1990, Hu and Bentler 1999). These fit indices are sensitive to sample size, and the low sample size in this study may have contributed to the relatively weak fit for these models.

The results presented in **Table 9** show there was an improvement in Chi-square with each subsequent model. The unconstrained refined product, process, and business systems model had the lowest Chi-square value and provided the best fit of all of the models tested, indicating this model was the best supported.

Table 10 presents the regression weights, standardized loadings, and critical ratios from the refined product, process, and business systems model. The regression weights of all items loading onto their respective factors are above 0.70, with critical ratios above 1.96, making them significant at the 0.05 level.

Table 10. Results of CFA with the refined product, process, and business systems model.

Item[a]	R^2	Loadings					
		Product		Process		Business systems	
		Standardized	Critical ratios	Standardized	Critical ratios	Standardized	Critical ratios
Product		--		0.45		0.48	
a	0.67	0.82					

b	0.58	0.76	9.12				
c	0.78	0.88	13.36				
d	0.53	0.73	8.60				
e	0.52	0.72	8.45				
f	0.60	0.78	9.37				
Process				--		0.43	
h	0.36			0.60			
i	0.76			0.87	7.01		
j	0.57			0.76	6.38		
k	0.52			0.72	6.17		
Business systems						--	
l	0.64					0.80	
m	0.54					0.73	8.19
n	0.53					0.73	8.04
o	0.64					0.80	9.11
p	0.72					0.85	9.82

[a] Letters refer to item labels in **Table 7**.

Reliability and Validity

The structured scale development process advocated by Churchill (1979) and used in this research is designed to create a valid and reliable measure of a construct. Accordingly, the specific steps used in this research were:

- The use of multiple items to assess each dimension of innovativeness.
- The use of previously developed and empirically tested measurement items when possible.
- Reference to previous research and theory for the development of new items.
- Review from experts to assure face validity.
- The use of CFA to ensure that each item loads onto its intended component factor, without cross-loading on other factors.
- Test and comparison of multiple models.
- Selection of the model with the best fit.

Composite Reliability

Cronbach's alpha was assessed for the refined product, process and business systems scale (**Table 11**). The coefficient alpha for the 15-item scale was 0.946. This value is higher than the coefficient alpha of 0.909 reported by Wang and Ahmed (2004) for their 20-item organizational innovativeness measure. The alpha value of each of the three component factors was higher than the minimum level recommended by Price and Mueller (1986), indicating the component factors have acceptable levels of internal consistency.

Table 11. Results of coefficient alpha calculation for the refined product, process, and business systems scale and each of the three component factors.

Components	Items	Item-total correlation[a]	Alpha if item deleted[b]	Alpha of component factor	Item-total correlation[b]	Alpha if item deleted[b]
Product innovativeness	Crprd1	0.710	0.889	0.903	0.725	0.942
	Crprd2	0.751	0.882		0.708	0.942
	Crprd3	0.812	0.873		0.822	0.940
	Aprd	0.673	0.893		0.747	0.941
	Aprd2	0.674	0.893		0.713	0.942
	Aprd3	0.782	0.877		0.781	0.941
Process innovativeness	Crprc1	0.565	0.790	0.808	0.509	0.946
	Crprc2	0.689	0.728		0.750	0.941
	Crprc3	0.643	0.752		0.712	0.942
	Aprc2	0.625	0.760		0.678	0.943
Business systems innovativeness	Crbs2	0.724	0.856	0.883	0.710	0.942
	Crbs3	0.632	0.879		0.692	0.943
	Abs1	0.716	0.858		0.670	0.943
	Abs2	0.742	0.853		0.718	0.942
	Abs3	0.793	0.842		0.757	0.941

[a] Results of alpha calculation on component factors.
[b] Results of alpha calculation on full 15-item scale.

Discriminant and Convergent Validity

The discriminant and convergent validity of the innovativeness construct were assessed following the procedure outlined by Bagozzi et al. (1991). First, the standard measurement model was estimated allowing all factors to covary. Second, a new measurement model similar to the previous one (except that the correlation between any two factors was fixed at one) was estimated. Finally, the difference in Chi-square values between the models in steps one and two was calculated. The resulting changes in Chi-square were significantly different ($p < 0.001$), indicating discriminant validity.

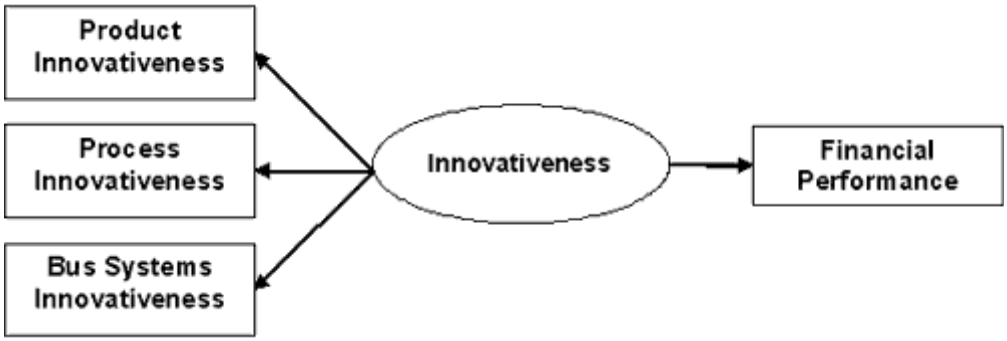
Second, the average variance extracted test was used to examine discriminant validity. For this test, the variance extracted estimates for the factors of interest were compared with the square of the correlation between those factors. Discriminant validity is demonstrated if the variance extracted estimates exceed the corresponding squared correlation (Fornell and Larcker 1981, Netermeyer et al. 1990). The variance extracted estimates exceeded the corresponding square correlations in all cases. These tests provide support for the discriminant and convergent validity of the constructs examined in this study.

Nomological Validity

As an initial step to assess nomological validity, the relationship between innovativeness and financial performance was examined using structural equations modeling with LISREL. The items used to assess product, process, and business systems innovativeness (Knowles et al. 2007) were each averaged to represent the latent variables product, process, and business systems innovativeness (**Fig.**

4). The individual items used to measure financial performance were combined into a composite variable for this analysis.

Figure 4. Proposed model used to test nomological validity.



Structural equations modeling was used to test the linkages proposed in the model in **Figure 4**. The results show this model was generally supported (**Table 10**). The Chi-square, CFI, Delta2, RNI, RMSEA, and the NNFI are reported to show overall model fit (Bollen 1989, Bentler 1990, Gerbing and Anderson 1992, Hu and Bentler 1999). In the model, CFI, Delta2, RNI, and NNFI were above the minimum recommended value of 0.90 (Bentler 1990). Additionally, RMSEA for the proposed model falls in the range of 0.08 to 0.10 indicating a mediocre fit (MacCallum et al. 1996).

Table 12 presents the parameter estimates and associated t-values for the proposed model (**Fig. 4**).

Table 12. Fit statistics for structural equations model evaluating the relationship between firm innovativeness and firm performance.

Model	Chi-square	CFI	Delta2	GFI	RMSEA
Proposed model	22.67 (df = 12, p = 0.02)	0.98	0.98	0.094	0.095

The effect of innovativeness on performance was positive and highly significant in the model with a t-value of 5.00 ($p < 0.001$). This result is consistent with the relationship between innovation and performance from previous literature (e.g., Damanpour et al. 1989, Narver and Slater 1990, Han et al. 1998, Hurley and Hult 1998, Crespell et al. 2006) providing initial support for nomological validity. Further examination of the validity of this scale using two independent samples can be found in Crespell et. al (2008).

Discussion and Conclusion

This paper presents the development and refinement of a new measure of firm innovativeness, which is significant for several reasons. The most significant reason is that this measure departs from the previous methods of attempting to measure innovativeness in part, through a comprehensive assessment of all of the dimensions of innovativeness. Wang and Ahmed (2004) developed a measure that accounted for all aspects of innovativeness, but only completed one stage of the scale refinement

process. While the measure developed in this study could benefit from further refinement, it has been subjected to a two-stage development process and, therefore, represents a significant improvement over previous measures of firm innovativeness. This use of this new scale should help resolve some of the inconsistent results found in previous firm innovativeness literature.

The scale development procedure showed that respondents did not differentiate between the concepts of creation and adoption, which indicates that something new to the firm is viewed as innovative regardless of its origin. The forest products industry does not have a strong history of focusing on development of innovations in products, processes, and business systems, but has been adept at adopting appropriate innovations, especially process innovations (West and Sinclair 1991, Lee et al. 1999). The fragmented nature of the sawmilling industry has meant that product development has not received strong attention (Juslin and Hansen 2003).

Additionally, the two-stage process resulted in a scale with three dimensions of innovativeness consistent with the three dimensions identified by Hovgaard and Hansen (2004). The scale development process confirmed that forest industry managers view product innovativeness, process innovativeness, and business systems innovativeness as the three dimensions of firm innovativeness.

The propensity to create and adopt scale developed in this manuscript is composed of three dimensions of firm innovativeness: the propensity to create/adopt new products, processes, and business systems. While initial assessments show the scale to have acceptable reliability and validity, more work must be done to assess reliability and validity of the scale in other industrial manufacturing sectors.

This measure was developed using the North American softwood sawmilling industry. Yet, the items comprising the measure are not specific to that sector or even to the forest products industry. Consequently, this measure holds promise for use in the broader context of industrial manufacturing industries. Future work is planned to investigate the scale's applicability for other manufacturing industries. This work will allow for further investigation into the relationship between firm innovativeness and financial performance, with the goal of clearing up some of the discrepancies found in previous literature.

Limitations

There are several limitations associated with this research, the most notable being that the sample sizes from both Stage I and Stage II do not meet the recommended minimum size (200 responses or 10 responses per item) for using confirmatory factor analysis. The small sample sizes obtained in this study (n = 88, Stage I and n = 109, Stage II) may have had an effect on the fit of the investigated models. The results of this study should be verified using sample sizes that meet the recommended minimum levels.

A second limitation of this research is the use of only one sector (softwood sawmilling) within an industry (the forest products industry) for sampling. Future work is planned to verify the results of this work in other sectors of the forest products industry and other manufacturing industry.

A third limitation of this work is the use of subjective measures of firm performance. While previous research has shown a strong relationship between subjective and objective measures of firm performance (i.e., Dess and Robinson 1984), future work should focus on validating the scale developed in this paper with objective performance measures. The use of this scale with objective performance measures will help with the assessment of the scale's nomological validity. Additionally, the nomological validity of this scale should be assessed with other related constructs such as organizational culture.

A fourth limitation of this work is the relatively few items used to assess business systems innovativeness. The business systems dimension of innovativeness has been characterized as multiple dimensions in previous work outside of the forest products industry (i.e., Wang and Ahmed 2004) and, therefore, may be more complex than the product and process dimensions. While the conceptualization of business systems innovativeness used in this paper is supported by previous literature (Hovgaard and Hansen 2004), future work should consider adding additional items in order to obtain a more comprehensive assessment of business systems innovativeness.

Churchill (1979) identified the creation of a measurement instrument as an iterative process, requiring multiple stages of data collection and scale refinement. While the current study utilizes a two-stage process, which is more thorough than has been done in previous innovativeness measure development work, further work is required to complete the refinement of this measure. The items used to assess product adoption were excluded from Stage I of this study. As a result, these items have only been through one-stage of the scale refinement process.

Finally, respondents in both Stage I and Stage II of this work represented sawmills of all sizes, ranging from mills with one employee up to mills with more than 400 employees and mills producing less than 1 million board feet per year to more than 400 million board feet per year. This results in the assumption that innovativeness is not affected by firm size. The results of previous research regarding the effect of firm size on innovativeness are mixed. In future work, eliminating small mills from the sample frame should be considered.

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